Dr. MAHALINGAM COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds
An Autonomous Institution Since 2011.
Approved by AICTE / Affiliated to Anna University.
Accredited by NAAC with 'A++' Grade.
Tier-1* - Accredited by NBA.
Part of NIA Educational Institution

Curriculum and Syllabi

B.E. Electrical and Electronics Engineering

Semesters I to VIII

Regulations 2019

(2021 Batch Onwards)

Dr. Mahalingam College of Engineering and Technology
Department of Electrical and Electronics Engineering

Vision

We develop globally competent Electrical and Electronics Engineer to solve real time problems of the industry and society and conduct research for the application of knowledge to the society

Mission

In order to foster growth and empowerment, we commit ourselves to

- Develop electrical and electronics engineers of high caliber to meet the expectations of industries through effective teaching-learning process
- Improve career opportunities in core areas of electrical and electronics engineering.
- Inculcate leadership qualities with ethical and social responsibilities

Programme: B.E. Electrical and Electronics Engineering

Programme Educational Objectives (PEOs) - Regulations 2019

B.E. Electrical and Electronics Engineering graduates will:

PEO1. Technical Expertise: Acquire a professional career and personal development in industries / higher studies / research assignments / entrepreneurs.

PEO2. Life-long learning: Sustain to develop their knowledge and skills throughout their career.

PEO3. Ethical Knowledge: Exhibit professionalism, ethical attitude, communication skills, team work and adapt to Current trends.

Programme Outcomes (POs) - Regulations 2019

On successful completion of B.E. Electrical and Electronics Engineering programme, graduating students/graduates will be able to:

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO2. Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi disciplinary settings

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs) - Regulations 2019

On successful completion of B.E. Electrical and Electronics Engineering programme, graduating students/graduates will be able to:

PSO 1. Design and analyze systems associated with industrial control, power and automotive industries.

PSO 2. Develop products to cater the societal and industrial needs **considering recent technological developments** in Electrical & Electronics Engineering.

Dr. Mahalingam College of Technology, Pollachi

2019 Regulations - Course Code Generation Procedure for UG Courses(v1)

1	2	3	4	5	6	7	8	9	10
1	9	A	U	B	G	1	1	0	1

Regulations (positions 1–2)

Mode of Assessment	
Character Type – Number	
1	Theory
2	Theory with Practical
3	Practical
4	Practical with Theory
5	Theory with SSU
6	Customized

Semester Number	
Character Type – Number	
1 to 8	Semester
0	Floating

Sequence Number
Character Type – Number
01, 02, 03, . . . , 99

Board/Department/Programme	
Character Type – Alphabet	
AU	Automobile
CE	Civil
CS	Computer Science
EC	Electronics and Communication
EE	Electrical and Electronics
EI	Electronics and Instrumentation
IT	Information Technology
MC	Mechatronics
ME	Mechanical
CH	Chemistry
EN	English
MA	Mathematics
PH	Physics
PS	Professional Skills
SH	Science and Humanities

Course Type	
Character Type – Alphabet	
B	Basic Science
S	Engineering Science
H	Humanities
C	Professional Core
E	Professional Elective
O	Open Elective
N	Online
I	Industry Offered
V	One Credit
P	Project/Skill Development/ Internship
M	Mandatory Non-Credit

Common to any Programme	
Character Type – Alphabet	
G	Generic
C	Common
N	Non-Common

Programme: B.E Electrical and Electronics Engineering
2019 Regulations
Curriculum for Semesters I to VIII

Course Code	Course Title	Duration	Credits	Marks
19SHMG6101	Induction Program	3 Weeks	-	100

Semester I

Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
19MABC1101	Matrices and Calculus	3	1	0	4	100	AU,CE,EC,EE, EI & ME
19ENHG2101	Communication Skills – I	2	0	2	3	100	All
19CHBC2001	Chemistry for Electrical Sciences	3	0	2	4	100	EC,EE &EI
19MESC2001	Introduction to Engineering	2	0	2	3	100	AU,EC,EE,EI & ME
19MESN4101	Engineering Graphics	1	0	3	2.5	100	-
19PSHG6001	Wellness for Students	0	0	2	1	100	All
Total		**11**	**1**	**11**	**16.5**	**500**	

Semester II

Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
19ENHG2201	Communication Skills - II	2	0	2	3	100	All
19MABC1201	Ordinary Differential Equations and Complex Variables	3	1	0	4	100	AU,CE,EC,EE EI &ME
19PHBC2001	Physics for Electrical Sciences	3	0	2	4	100	EC,EE &EI
19EESN2201	Electron Devices	3	0	2	4	100	-
19CSSC2001	C Programming	3	0	2	4	100	AU,CE,EC,EE EI & ME
19EECN4201	Electrical CAD	1	0	3	2.5	100	-
19CHMG6201	Environmental Sciences	1	0	0	-	100	All
19PSHG6003	தமிழர்மரபு /Heritage of Tamils**	1	0	0	1	100	All
Total		**17**	**1**	**13**	**23.5**	**800**	-

** Applicable only for 2022 Batch

Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1302	Numerical Methods and Linear Algebra	3	1	0	4	100	EC,EE,EI
19EECN1301	DC Machines and Transformers	3	0	0	3	100	-
19EECN1302	Electric Circuits	3	1	0	4	100	-
19EECC2301	Digital Electronics	3	0	2	4	100	EE,EI
19EECN2301	Instrumentation and Testing	3	0	2	4	100	-
19EECN3301	DC Machines and Transformers Laboratory	0	0	3	1.5	100	-
19EECN4301	Process Engineering in Electrical & Electronic Parts	1	0	3	2.5	100	-
XXXXXXXXX	One Credit Course	0	0	2	1	100	-
19PSHG6002	Universal Human Values 2 :Understanding Harmony	2	1	0	3	100	All
19PSHG6004	தமிழரும்தொழில்நுட்பமும் / Tamils and Technology**	1	0	0	1	100	All
Total		**19**	**3**	**12**	**28**	**900**	-

Semester IV

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABG1401	Probability and Statistics	3	1	0	4	100	All
19EECN1401	Synchronous and Induction Machines	3	0	0	3	100	-
19EECN2401	Electronic Circuits	3	0	2	4	100	-
19CSSC2401	Data Structures and Algorithms	2	0	2	3	100	EE,EI
19EECN3401	Synchronous and Induction Machines Laboratory	0	0	3	1.5	100	-
19EESN4401	Process Engineering in Mechanical Part Assembly	1	0	3	2.5	100	-
XXXXXXXXX	One Credit Course	0	0	2	1	100	-
19EEPN6401	Mini-Project	0	0	4	2	100	-
Total		**12**	**1**	**16**	**21**	**800**	**-**

Course Code	Course Title	Duration	Credits	Marks
XXXXXXXXXX	Internship or Skill Development*	2 Weeks	1	100

*Refer to clause: 4.8 in UG academic regulations 2019, ** Applicable only for 2022 Batch

Semester V

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EECN1501	Generation, Transmission and Distribution	3	0	0	3	100	-
19EECN2502	Microprocessors and Microcontrollers	3	0	2	4	100	-
19EECN1503	Linear Integrated Circuits	3	0	0	3	100	-
19EECN1504	Fundamentals of Power Electronics	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – I	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – II	3	0	0	3	100	-
XXXXXXXXXX	Open Elective-I	3	0	0	3	100	-
19EECN3501	Integrated Circuits Laboratory	0	0	3	1.5	100	-
19PSHG6501	Employability Skills 1: Teamness and Interpersonal Skills	0	0	2	1	100	-
Total		**21**	**1**	**7**	**24.5**	**900**	**-**

Semester VI

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EECN2602	Introduction to Python Programming	2	0	2	3	100	-
19EECN1602	Control Systems	3	1	0	4	100	-
19EECN1603	Fundamentals of Digital Signal Processing	3	1	0	4	100	-
19EEEXXXXX	Professional Elective – III	3	0	0	3	100	-
XXXXXXXXXX	Professional Elective – IV	3	0	0	3	100	-
XXXXXXXXXX	Open Elective-II	3	0	0	3	100	-
19EECN3601	Power Electronics Laboratory	0	0	3	1.5	100	-
19EEPN6601	Innovative and Creative Project	0	0	4	2	100	-
19PSHG6601	Employability Skills 2: Campus to Corporate	0	0	2	1	100	-
Total		**17**	**1**	**11**	**24.5**	**900**	**-**

Course Code	Course Title	Duration	Credits	Marks
XXXXXXXXXX	Internship or Skill Development*	2 or 4 Weeks	1	100

*Refer to clause: 4.8 in UG academic regulations 2019

Semester VII

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EECN1701	Power System Analysis and Stability	3	1	0	4	100	-
19EECN2701	Electric Drives and Control	3	0	2	4	100	-
XXXXXXXX	Professional Elective – V	3	0	0	3	100	-
XXXXXXXX	Professional Elective – VI	3	0	0	3	100	-
XXXXXXXX	Open Elective – III	3	0	0	3	100	-
19EECN3701	Power System Simulation Lab	0	0	4	2	100	-
Total		**15**	**1**	**6**	**19**	**600**	**-**

Semester VIII

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEPN6801	Project	0	0	16	8	200	-
Total		**0**	**0**	**16**	**8**	**200**	**-**

Course Code	Course Title	Duration	Credits	Marks
XXXXXXX	Internship or Skill Development*	8 or 16 weeks	4	100

*Refer to clause: 4.8 in UG academic regulations 2019

Total Credits (2021 Batch): 169

Total Credits (2022 Batch): 171

Vertical wise Electives

Power Engineering Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEN1003	High Voltage Engineering	3	0	0	3	100	-
19EEEN1004	HVDC Transmission	3	0	0	3	100	-
19EEEN1007	Smart Grid	3	0	0	3	100	-
19EEEN1016	Advanced Power System Protection	3	0	0	3	100	-
19EEEN1017	Power System Reliability	3	0	0	3	100	-
19EEEN1018	Distributed Generation and MicroGrid	3	0	0	3	100	-
19EEEN1019	Transient in Power System	3	0	0	3	100	-
19EEEN1059	Power System Operation and Control	3	0	0	3	100	-

Converters and Drives Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEN1005	Power Electronic Applications to Renewable Energy	3	0	0	3	100	-
19EEEN1008	Switched Mode Power Supplies	3	0	0	3	100	-
19EEEN1009	Special Electrical Machines	3	0	0	3	100	-
19EEEN1011	Power Electronic Applications in Power Systems	3	0	0	3	100	-
19EEEN1060	Multilevel Power Converters	3	0	0	3	100	-
19EEEN1061	Design and Analysis of Switching Power Converters	3	0	0	3	100	-
19EEEN1062	Design of Photovoltaic Systems	3	0	0	3	100	-
19EEEN1063	Wind Energy Conversion Systems	3	0	0	3	100	-

Embedded Systems & VLSI Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEC1021	Embedded Control of Power Electronics	3	0	0	3	100	EE, EI
19EEEC1022	Advanced Microprocessors	3	0	0	3	100	EE, EI
19EEEC1028	CMOS Analog IC Design	3	0	0	3	100	EE, EI
19EEEC1030	Testing of VLSI Circuits	3	0	0	3	100	EE, EI
19EEEC1031	ASIC Design	3	0	0	3	100	EE, EI
19EEEC1064	Embedded C Programming	3	0	0	3	100	EE, EI
19EEEC1065	Embedded Systems for Automotive Applications	3	0	0	3	100	EE, EI
19EEEC1066	IoT for Smart Systems	3	0	0	3	100	EE, EI

Electric Vehicle Technology Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEC1047	Smart Grid Interface for EV	3	0	0	3	100	EE, EI
19EEEC1049	Advanced sensors for Electric Vehicle	3	0	0	3	100	EE, EI
19EEEC1051	Automotive Electrical & Electronic Systems	3	0	0	3	100	EE, EI
19EEEC1067	Testing of Electric Vehicles	3	0	0	3	100	EE, EI
19EEEC1068	Design of Electric Vehicle Charging System	3	0	0	3	100	EE, EI
19EEEC1069	Electric Vehicle Architecture	3	0	0	3	100	EE, EI
19EEEC1070	Design of Motor and Power Converters for Electric Vehicles	3	0	0	3	100	EE, EI
19EEEC1071	Intelligent Control of Electric Vehicles.	3	0	0	3	100	EE, EI

Control and Automation Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEN1072	Advanced Control Systems	3	0	0	3	100	-
19EEEN1073	Digital Control Engineering	3	0	0	3	100	-
19EEEC1001	Industrial Automation	3	0	0	3	100	EC,EE
19EEEC1003	Virtual Instrumentation	3	0	0	3	100	EC,EE
19EIEC1001	Robotics and Automation	3	0	0	3	100	EE,EI
19EEEN1038	Industry 4.0	3	0	0	3	100	-
19EEEN1041	Fundamentals of Power Plant Instrumentation	3	0	0	3	100	-
19EEEN1043	Industrial IoT	3	0	0	3	100	-

Diversified Electives

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19EEEN1001	Renewable Energy Sources	3	0	0	3	100	-
19EEEN1006	Power Quality	3	0	0	3	100	-
19EEEN1010	Computer Aided Design of Electrical Apparatus	3	0	0	3	100	-
19EEEN1012	Electrical Energy Utilization and Conservation	3	0	0	3	100	-
19EEEN1013	Protection and Switchgear	3	0	0	3	100	-
19EEEN1014	Electrical Machine Design	3	0	0	3	100	-
19EEEN1015	Flexible AC Transmission Systems	3	0	0	3	100	-
19EEEN1020	Deregulated Power System	3	0	0	3	100	-
19EEEN1021	Energy Storage Systems	3	0	0	3	100	-
19EEEN1023	Embedded System Design	3	0	0	3	100	-
19EEEN1024	Digital Image Processing	3	0	0	3	100	-
19EEEN1025	Communication Engineering	3	0	0	3	100	-

19EEEN1026	Computer Architecture	3	0	0	3	100	-
19EEEN1027	Industrial Data Communication Network	3	0	0	3	100	-
19EEEN1029	VLSI Design	3	0	0	3	100	-
19EEEN1032	Low Power VLSI Design	3	0	0	3	100	-
19EEEN1033	Micro Electro Mechanical Systems	3	0	0	3	100	-
19EEEN1034	Hardware Description Language	3	0	0	3	100	-
19EEEN1035	Illumination Engineering	3	0	0	3	100	-
19EEEC1002	Automotive Electronics	3	0	0	3	100	EC,EE
19EEEN1040	Quality Engineering	3	0	0	3	100	-
19EEEC1005	Industrial Safety	3	0	0	3	100	EC,EE
19MEEC1014	Engineering Economics and Cost Analysis	3	0	0	3	100	AU,EC,EE,EI,ME
19MEEC1015	Principles of Management	3	0	0	3	100	EC,EE,EI, MC,ME
19EEEC1004	Disaster Management	3	0	0	3	100	EC,EE,EI
19MEEC1020	Systems Approach for Engineers	3	0	0	3	100	EE,ME
19EEEN1039	Discrete Mathematics	3	0	0	3	100	-
19EEEN1058	Operations Research	3	0	0	3	100	-
19CSEC1001	Programming using JAVA	3	0	0	3	100	EC,EE.EI
19CSEC1002	Data Mining and Analytics	3	0	0	3	100	EC,EE.EI
19CSEC1003	Software Testing	3	0	0	3	100	EC,EE.EI
19CSEC1004	Database Management System Concepts	3	0	0	3	100	EC,EE.EI
19EEEN1036	Artificial Intelligence of Things	3	0	0	3	100	-
19EEEN1037	Machine Learning Techniques	3	0	0	3	100	-
19EEEN1044	Powertrain Management system	3	0	0	3	100	-
19EEEN1045	Vehicle dynamics	3	0	0	3	100	-
19EEEN1046	Digital Control of Power Electronic Converter	3	0	0	3	100	-
19EEEN1048	Advanced electric drives for Electric vehicle	3	0	0	3	100	-

19EEEC1050	Testing & Certification of Electric Vehicle	3	0	0	3	100	-
19EEEN1052	Image Processing and Computer Vision	3	0	0	3	100	-
19EEEC1053	Industry 4.0 – Smart Factories	3	0	0	3	100	-
19EEEN1054	Introduction to Big Data	3	0	0	3	100	-
19EEEN1055	Data Acquisition Systems and Signal Processing	3	0	0	3	100	-
19EEEN1056	Database and Network security	3	0	0	3	100	-
19EEEN1057	Smart Sensor Technologies	3	0	0	3	100	-
19MEEC1025	Fundamentals of Entrepreneurship	3	0	0	3	100	All
19MEEC1026	Design Thinking and Innovation	3	0	0	3	100	All
19ITEN1029	Intellectual Property Rights	3	0	0	3	100	All
19SCEC2001	Cyber Security	3	0	0	3	100	All

Open Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19EEOC1001	Electric and Hybrid Vehicles	3	0	0	3	100
19EEOC1002	Energy Auditing And Conservation	3	0	0	3	100
19EEOC1003	Solar Energy System	3	0	0	3	100
19EEOC1004	Control Systems for Engineers.	3	0	0	3	100

Regulations 2019

Detailed Syllabi for

Semesters I to VIII

Course Code: 19SHMG6101	Course Title: Induction Program (common to all B.E/B.Tech programmes)
Course Category: Mandatory Non-Credit Course	**Course Level: Introductory**
Duration: 3 Weeks	**Max. Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain various sources available to meet the needs of self, such as personal items and learning resources
2. Explain various career opportunities, opportunity for growth of self and avenues available in the campus
3. Explain the opportunity available for professional development
4. Build universal human values and bonding amongst all the inmates of the campus and society

List of Activities:

1. History of Institution and Management: Overview on NIA Education Institutions-Growth of MCET – Examination Process-OBE Practices – Code of Conduct – Centre of Excellence
2. Lectures by Eminent People, Motivational Talk – Alumni, Employer
3. Familiarization to Dept./Branch: HoD Interaction – Senior Interaction – Department Association
4. Universal Human Value Modules: Module 1, Module 2,Module 3 and Module 4
5. Orientation on Professional Skill Courses
6. Proficiency Modules – Mathematics, English, Physics and Chemistry
7. Introduction to various Chapters, Cell, Clubs and its events
8. Creative Arts: Painting, Music and Dance
9. Physical Activity: Games and Sports, Yoga and Gardening
10. Group Visits: Visit to Local areas and Campus Tour

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain various sources available to meet the needs of self, such as personal items and learning resources through visit to local areas and campus	Understand
CO2: Explain various career opportunities and avenues available in the campus through orientation sessions	Understand
CO3: Explain the opportunity available for professional development through professional skills, curricular, co-curricular and extracurricular activities	Understand
CO4: Build universal human values and bonding amongst all the inmates of the campus and society for having a better life	Apply

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	1	2	-	-	1	1
CO2	1	-	-	-	-	-	-	2	1	2	-	-	1	1
CO3	1	-	-	-	-	-	-	2	1	2	-	-	1	1
CO4	2	-	-	-	-	-	-	2	1	2	-	-	2	2

High-3; Medium-2;Low-1

Course Code:19MABC1101	Course Title:Matrices and Calculus (Common to AU,CE ,EC,EE ,EI and ME)		
CourseCategory:Basic Science		**CourseLevel: Introductory**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Determine the canonical form of a Quadratic form using Orthogonal transformation
2. Use different testing methods to check the convergence of infinite series
3. Apply differential and integral calculus to determine the evolute of a curve and improper integrals
4. Apply partial derivatives to find extreme values of functions of two variables
5. Apply multiple integrals to find area of plane curves and volume of solids

Unit I Matrices 9+3 Hours

Rank of a matrix - System of linear equations – Symmetric - Skew symmetric and orthogonal matrices-(Definitions and examples only) – Eigenvalues and Eigenvectors - Diagonalization of symmetric matrices through orthogonal transformation – Cayley-Hamilton Theorem - Transformation of quadratic forms to canonical forms through orthogonal transformation.

Unit II Sequences and Series 9+3Hours

Sequences - Definition and Examples - Series- Tests for convergence- Power series - series for exponential, trigonometric and logarithm functions - Comparison Test – Integral Test - Cauchy's root test - D Alembert's ratio test - Alternating series- Leibnitz's test.

Unit III Differential and Integral Calculus 9+3Hours

Curvature – Radius of curvature - Evolutes and Involutes - Evaluation of definite and improper integrals - Beta and Gamma functions and their properties.

Unit IV Multivariable Differentiation 9+3Hours

Limit – continuity - Mean value theorems and partial derivatives-Taylor's series and Maclaurin's series – Jacobian – Maxima, Minima and saddle points - Method of Lagrange's multipliers.

Unit V Multivariable Integration 9+3 Hours

Multiple Integration: Double integrals - Change of order of integration in double integrals - Change of variables (Cartesian to polar, Cartesian to spherical and Cartesian to cylindrical) - Triple integrals - Applications: areas and volumes.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the canonical form of a quadratic form using orthogonal transformation	Apply
CO2: Use different testing methods to check the convergence of infinite series	Apply
CO3: Determine the evolute of a curve and evaluate improper integrals using beta gamma functions	Apply
CO4: Apply partial derivatives to find extreme values of functions of two variables	Apply
CO5: Apply multiple integrals to find area of plane curves and volume of solids	Apply

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 9th Edition, John Wiley& Sons, 2006.

T2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi, 2008.

T3. Ramana B.V., higher Engineering Mathematics, Tata McGraw-Hill, New Delhi, 11th Reprint, 2010.

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

R2. N.P.Bali and Manish Goyel, A text book of Engineering Mathematics, Laxmi Publication, Reprint, 2008.

R3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Web References:

1.https://onlinecourses.nptel.ac.in/noc16_ma05

2.https://nptel.ac.in/courses/122101003/2

3.https://nptel.ac.in/syllabus/111104092/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO2	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO3	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO4	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO5	3	2	1	1	-	1	-	1	1	1	1	2	2	2

High-3; Medium-2;Low-1

Course Code:19ENHG2101	Course Title:Communication Skills – I (Common to all B.E/B.Tech Programmes)		
CourseCategory: Humanities		CourseLevel: Introductory	
L:T:P(Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours:60	Max Marks:100

Pre-requisites

- The student should have undergone English as his/her first or second language in school.

Course Objectives

The course is intended to:

1. Listen and understand monologues and dialogues of a native speaker on par with B1 of CEFR level
2. Speak in simple sentences to convey their opinions and ideas on par with B1 of CEFR level
3. Read and infer a given text on par with B1 of CEFR level
4. Draft basic formal written communication on par with B1 of CEFR level

Unit I Listening 15 Hours

Importance of active listening –Physical condition needed for active listening-Identifying relevant points while taking notes.- Framing questions at different linguistic contexts - Listening for specific details of concrete monologues and dialogues –Listening to organize ideas - Developing ideas –Listening to compose paragraphs – Paraphrasing the aural input.

Unit II Speaking 15 Hours

Importance of note making to practice speaking - Traditional note making, developing Mind map - Collecting points from various sources - Identifying relevant ideas needed for the speech -Using mind-map to organize thought processing - Prioritizing the ideas - Types of sentences - Frequently used words (Institution, home and leisure) - Mother Tongue Influence - Expressing the thoughts in simple sentences - Tenses & Voices (Active & Passive) - Postures, gestures and eye contact - Intonation and Sentence stress - Express one's thoughts coherently.

Unit III Reading 15 Hours

Reading strategies - Skimming -Scanning - Interpretation of visual data - Factual texts on subjects of relevance - Inferring texts –Reading to write a review –Checking the accuracy of reading while presenting the interpreted data – Reading to comprehend.

Unit IV Writing 15 Hours

WritingSimple and short sentences **-** Writing E-mail, Memo, Note and Message - Letter Writing - Importance of punctuations -- Identifying the main points - Organising the main ideas - Writing a draft.

List of Tasks

1. BEC Preliminary Listening Test – I & Speaking Test – 1
2. BEC Preliminary Listening Test – 2 & Speaking Test – 2
3. BEC Preliminary Listening Test – 3 & Speaking Test – 3
4. BEC Preliminary Listening Test – 4 & Speaking Test – 4
5. BEC Preliminary Listening Test – 5 & Speaking Test – 5
6. BEC Preliminary Listening Test – 6 & Speaking Test – 6

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Listen actively and paraphrase simple messages and specific details of concrete monologues and dialogues	Apply
CO2: Express one's views coherently in a simple manner	Apply
CO3: Read and comprehend factual texts on subjects of relevance	Understand
CO4: Write texts bearing direct meanings for different contexts maintaining an appropriate style	Apply

Text Book(s)

T1. Whitby Norman, Business Benchmark Pre-intermediate to Intermediate Students' Book CUP Publications, 2nd Edition, 2014.

T2. Wood Ian, Williams Anne, Cowper Anna, Pass Cambridge BEC Preliminary, Cengage Learning, 2nd Edition, 2015.

T3. Learners Book prepared by the Faculty members of Department of English.

Reference Book(s)

R1. BEC-Preliminary - Cambridge Handbook for Language Teachers, 2nd Edition, CUP 2000.

R2. Hewings Martin - Advanced Grammar in use - Upper-intermediate Proficiency, CUP, 3rd Edition, 2013.

Web References

1. http://www.grammarinenglish.com -Jan 23,2018
2. https://www.northshore.edu/support_centre /pdf/listen-notes.pdf
3. http://www.examenglish.com/BEC/BEC_Vantage.html- Jan 23, 2018

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	3	3	-	2	2	2
CO2	-	-	-	-	-	-	-	2	3	3	-	2	2	2
CO3	-	-	-	-	-	-	-	1	-	3	-	2	1	1
CO4	-	-	-	-	-	-	-	1	-	3	-	2	2	2

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19CHBC2001</td><td colspan="2">Course Title: Chemistry for Electrical Sciences (Common to EC,EE and EI)</td></tr>
<tr><td colspan="2">CourseCategory: Basic Science</td><td colspan="2">CourseLevel: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 2</td><td>Credits:4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Higher Secondary Chemistry I and II

Course Objectives

The course is intended to:

1. Explain the principles of electrochemistry and batteries
2. Explain the mechanism of corrosion and corrosion control
3. Explainthe concepts of spectroscopic techniques
4. Describe the basics of biofuels and fuel cells
5. Describe synthesis, properties and applications of nano-materials

Unit I Electrochemistry and Batteries 9 Hours

Cells – Types of cells– galvanic and electrolytic cells – emf and its measurement – Nernst equation –Batteries – types and Characteristics, Construction, working and applications - Alkaline battery, Lead –Acid battery, Nickel-Cadmium battery, Lithium ion battery

Unit II Corrosion and its Control 9 Hours

Corrosion – dry and wet corrosion – mechanism of electrochemical corrosion – galvanic corrosion and concentration cell corrosion, Factors influencing corrosion. Corrosion Control methods – Cathodic protection methods, Metallic coating – Galvanizing, Tinning – Chrome plating and Electroless plating of Nickel

Unit III Spectroscopic Techniques 9 Hours

Spectroscopy- Electromagnetic spectrum, Absorption and Emission spectroscopy – Relationship between absorbance and concentration – Derivation of Beer-Lambert's law (problems). UV – Visible Spectroscopy, Atomic Absorption Spectroscopy, Flame photometry – Principle, Instrumentation and applications.

Unit IV Biofuels and Fuel Cells 9 Hours

Biomass – Biogas – Constituents, manufacture and uses. General outline of fermentation process – manufacture of ethyl alcohol by fermentation process. Combustion – Calorific values – Gross and bet calorific value – problems based on calorific value. Fuel cells – Construction working and applications of Hydrogen Oxygen fuel cells, methanol oxygen fuel cells, solid oxide fuel cells

Unit V Synthesis and Applications of Nano Materials 9 Hours

Introduction – Difference between bulk and Nano materials – size dependent properties. Nano scale materials –particles, clusters, rods and tubes. Synthesis of Nanomaterials: Sol-gel process, Electro deposition, Hydrothermal methods. Applications of Nano materials in Electronics, Energy science and medicines. Risk and future perspectives of nano materials.

List of Experiments 30 Hours

1. Estimation of iron in water by spectrophotometry
2. Estimation of Fe^{2+} by potentiometric titration
3. Determination of corrosion rate by weight loss method
4. Measurement of emf of electrochemical cell – Poggendorff's method
5. Determination strength of acid by pHmetry
6. Conductometric titration of strong acid against strong base

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Explainbatteries based on their characteristics, construction, working principle and applications	Understand
CO2:	Explain the mechanism of corrosion and its control techniques	Understand
CO3:	Use Beer- Lambert's law and other spectroscopic methods for chemical analysis	Apply
CO4:	Calculate energy potential of fuel cells and calorific value of biofuels	Apply
CO5:	Describe synthesis, properties and applications of nano-materials	Understand

Text Book(s)

T1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition., Dhanpat Rai Pub, Co., New Delhi (2018).

T2. Wiley Engineering Chemistry, 2nd Edition, Wiley India Pvt. Ltd. New Delhi (2011).

Reference Book(s)

R1. S. S. Dara, S. S. Umare "A text book of Engineering Chemistry" 12thEdition S. Chand & Co. Ltd., New Delhi (2014).

R2. Charles P. Poole, Jr., Frank J. Owens "Introduction to Nanotechnology" Wiley India Pvt. Ltd. New Delhi (2003)

Web References

1. http://nptel.ac.in/courses/122101001/downloads/lec.23.pdf
2. https://nptel.ac.in/courses/104106075/Week1/MODULE%201.pdf
3. https://nptel.ac.in/courses/103102015/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	3	3	2	3	2	-	-	1	1
CO2	2	1	-	-	-	3	3	2	3	2	-	-	1	1
CO3	3	2	1	1	-	3	3	1	-	1	-	-	2	2
CO4	3	2	1	1	-	3	3	1	-	1	-	-	2	2
CO5	2	1	-	-	-	3	3	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19MESC2001</td><td colspan="3">Course Title: Introduction to Engineering
(Common to AU,EC,EE,EI and ME)</td></tr>
<tr><td colspan="3">Course Category: Engineering Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
2: 0: 2</td><td colspan="2">Credits:3</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the career opportunities in engineering
2. Explain how to acquire engineering competencies
3. Explain how to remain, relevant and versatile as an engineer
4. Observe engineering products and processes
5. Take ownership for learning and development
6. Identify and rectify unsafe conditions and acts

Unit I Career Opportunities in Engineering 5 Hours

Technicians, engineers and scientists, history of engineering. 17 sustainable development goals set by UNO, concept of small e to big E. career choices for an engineer, types of industries, academia and research as career choices, entrepreneurship as a career choice, various departments in engineering industries, roles available in engineering industries. innate skills, learnt skills (competencies), graduate attributes, roles of engineers and the corresponding competencies, career opportunities in engineering in terms of roles & competencies

Unit II Developing Specific Skills and Competencies 5 Hours

OBE Model, PEOs and POs, technical POs, professional POs, mapping with Graduate attributes, Classification of courses, resources available in the campus and e-resources,

resources and facilities available to acquire specific competencies, on-campus and off-campus activities, the methods by which students can systematically involve in activities, significance of professional skill courses, plan for utilizing the resources and facilities to develop specific competencies.

Unit III Staying Relevant through Continuous Improvement / Environmental Versatility 7 Hours

Rate of change, technology life cycle (TLC), features of a dynamic and complex environment in which students operate or will operate, impact of globalization & technical advancements, importance of remaining, relevant and versatile in a dynamic and complex environment with the help of technology life cycle, activities/process to remain relevant and versatile, environmental scanning, Life- long learning.

Unit IV Observe every Product And Processes with an Engineering Perspective and Inquisitiveness 4 Hours

Product -Need, purpose - primary and secondary function, various stages of manufacturing and its processes. Product - assembly of several simple engineering devices/systems. Product- Parts, principles and laws (mechanical, electrical and electronics), functional relationship between the parts, role of programming in engineering products. Significance of materials and their advancements in improvements in product.

Unit V Learning and Development Leveraging the Resources and Infrastructure 6 Hours

Process Of Learning, Situated Learning with Examples, Own Learning (Not Copying), Differences between Real Life and Simulated Environment, the Sprit Of Experimentation, Various Learning Enablers, Measure the performance against the plan.

Unit VI **Unsafe Conditions and Acts and following Environment Friendly Practices** **3 Hours**

Safety-definition, importance of personal safety. Statistics of road accidents. Unsafe condition and unsafe act- definition, cause and effects, identification of the unsafe conditions and acts in home/hostel, labs, class rooms, public places. Importance of environment friendly practices.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the career opportunities in engineering in terms of roles & competencies	Understand
CO2: Explain how a student can acquire the competencies	Understand
CO3: Explain how to remain, relevant and versatile in a dynamic and complex environment	Understand
CO4: Observe every product and processes with an engineering perspective and inquisitiveness	Apply
CO5: Choose to take ownership for his/her learning and development leveraging the resources and infrastructure	Understand
CO6: Identify and rectify unsafe conditions and acts and follow environment friendly practices	Understand

Text Book(s):

T1. Worksheets and Handouts prepared by MCET team.

Reference Book(s):

R1. L. A Bloomfield, "How things work: The physics of everyday life", Wiley, 5thEdition, 2013.

R2. C. Mason, "How things work," Usborne Publishing Ltd 2009.

R3. D.K. Publishing, "How things work encyclopedia", 2010.

R4. J. E. Gordon, "The New Science of Strong Materials or Why You Don't Fall through the Floor" Princeton University Press; With a New introduction by Philip Ball,2018.

R5. R.P. Feynman," Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher", Basic Books; 4thEdition 2011.

Web References:

1. https://en.wikibooks.org/General_Engineering_Introduction/Engineering_Science
2. https://science.howstuffworks.com/engineering-channel.html

Laboratory Component **30 Hours**

List of RiaLab Exercises

1. Career opportunities with roles and responsibilities

2. Observe every product and processes with an engineering perspective and inquisitiveness

a) Primary and Secondary functions of products and their equivalents

b) Primary and Secondary functions of parts of the products, their manufacturing processes and materials

c) Structural and functional relations of the product

3. Safe and unsafe acts and conditions in day-to-day life and professional practices.

4. Skills for Hobby project (At least TWO)

a) Soldering and de-soldering practices

b) Circuit and component testing using multi-meter & CRO

c) Battery operated circuit connections and testing

d) Simple switching circuits using relays and transistors

e) Adhesives used in part assembly

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	3	1	-	1	2	2
CO2	2	1	-	-	-	2	2	1	3	1	-	1	2	2
CO3	2	1	-	-	-	2	2	1	3	1	-	1	2	2
CO4	3	2	1	1	-	2	2	1	3	1	-	1	3	3
CO5	2	1	-	-	-	2	2	1	3	1	-	1	2	2
CO6	2	1	-	-	-	2	2	1	3	1	-	1	2	2

High-3; Medium-2; Low-1

Course Code:19MESN4101	Course Title: Engineering Graphics		
Course Category: Engineering Science		**Course Level: Introductory**	
L:T:P(Hours/Week) **1: 0: 3**	**Credits:2.5**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- NIL

Course Objective

The course is intended to:

1. Communicate combination of basic shapes using engineering drawing

Unit I Introduction to Engineering Drawing 10 Hours

Importance of engineering drawing – Types of pencils – Drawing sheets – Freehand sketching –Dimensions to construct – 2D geometries – 3D solids – Types of geometries and solids – Transformation of 2D geometries into 3D solids

Unit II Freehand Sketching 10 Hours

Pictorial view – Multiple views – Basic solids – Combination of basic solids

Unit III AutoCAD 15 Hours

Getting started – Graphical User Interface – Work space settings – Drawing commands – Modifying commands – Annotations - Plot.

Unit IV Orthographic Projection 15 Hours

Principles of projection – First angle projection – Third angle projection – Combination of basic solids – Sectional views – Auxiliary views

Unit V Development of Surfaces 10 Hours

Development of lateral surfaces of simple solids – Prisms, pyramids, cylinders and cones.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Communicate combination of basic shapes using engineering drawing in AutoCAD meeting all the required standards	Apply

Text Book(s)

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, “ Engineering Drawing and Design”, Tata McGraw Hill India, New Delhi, 7^{th} Edition (2017).
T2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”,Charotar Publishing House, Gujarat, 53^{rd} Edition (2015).
T3. K. V. Natrajan, “A Text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 48^{th} Edition (2018).

Reference Book(s)

R1. BasantAgarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, (2008).

R2. Cencil Jensen, Jay D. Helsel and Dennis R. “Short Engineering Drawing and Design”. Tata McGraw Hill Publishing Company Limited (2012).

Publications Of Bureau Of Indian Standards

1. IS 10711 – 2001: Technical products Documentation – Size and lay out ofdrawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods. The mode of delivery is like practical

Web References

1. http://nptel.ac.in/courses/112103019/
2. https://en.wikipedia.org/wiki/Engineering_drawing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	2	3	2	-	2	2	2

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19PSHG6001</td><td colspan="3">Course Title: Wellness for Students
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
0: 0: 2</td><td colspan="2">Credits:1</td><td>Total Contact Hours:30</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Set SMART goals for academic, career and life
2. Apply time management techniques
3. Articulate the importance of wellness for success in life.
4. Understand the dimensions of wellbeing and relevant practices

Unit I Goal Setting

Understanding Vision and mission statements - Writing personal mission statements – ‘Focus’ as a way of life of most successful people. Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume. Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment.

Unit II Time Management - Tools and Techniques

Importance of planning and working to time. Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying ‘NO’ – Managing procrastination

Unit III Practices for Physical Wellness

Concept of wellness – impact of absence of wellness - Wellness as important component to achieve success. Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods

Simplified Physical Exercises. Fitness as a subset of Wellness – health related physical fitness - skill related physical fitness. Joint movements, Warm up exercises, simple asanas, WCSC simplified exercises.

Unit IV Practices for Mental Wellness

Meditation: Mind and its functions - mind wave frequency – Simple basic meditation – WCSC meditation and introspection tables. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.

Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) – hazards of junk food - food and the gunas

Unit V Putting into Practice

Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews.

Course Outcomes	**Cognitive/ Affective**
At the end of this course, students will be able to:	
CO1. Set well-articulated goals for academics, career, and personal aspirations	Apply
CO2. Apply time management techniques to complete planned tasks on time	Apply
CO3. Explain the concept of wellness and its importance to be successful in career and life	Apply
CO4. Explain the dimensions of wellness and practices that can promote wellness	Apply
CO5. Demonstrate the practices that can promote wellness	Valuing

Text book(s)

T1. Reading material, workbook and journal prepared by PS team of the college.

Reference Book(s)

R1. Stephen R Covey, “First things first”, Simon & Schuster Uk, Aug 1997.
R2. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster Uk, 2004.
R3. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, “Value education for harmonious life (Manavalakalai Yoga)”, Vethathiri Publications, Erode, I Edition. (2010).
R4. Dr. R. Nagarathna, Dr.H.R. Nagendra, “Integrated approach of yoga therapy for positive health”, Swami Vivekananda Yoga Prakashana, Bangalore, Edition(2008).
R5. Tony Buzan, Harper Collins, The Power of Physical Intelligence (English).

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	1	1	-	-	-
CO2	-	-	-	-	-	-	1	1	1	-	-	
CO3	-	-	-	-	-	1	1	1	1	-	-	1
CO4	-	-	-	-	-	1	1	-	1	-	-	-
CO5	-	-	-	-	-	1	1	-	1	-	-	1

High-3; Medium-2; Low-1

Semester II

<table>
<tr><td colspan="2">Course Code:19ENHG2201</td><td colspan="3">Course Title: Communication Skills – II (common to all B.E/B.Tech programmes)</td></tr>
<tr><td colspan="3">CourseCategory: Humanities</td><td colspan="2">CourseLevel: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
2: 0: 2</td><td colspan="2">Credits:3</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Communication Skills I

Course Objectives

The course is intended to:

1. Listen and understand monologues and dialogues of a native speaker on par with B2 of CEFR level
2. Speak in simple sentences to convey their opinion and ideas on par with B2 of CEFR level
3. Read and infer a given text on par with B2 of CEFR level
4. Draft basic formal written communication on par with B2 of CEFR level

Unit I Listening 15 Hours

Importance and purpose of extensive listening and intensive listening -Body Language – Listening tasks on complex and abstract themes- Correlating Ideas related to listening input – importance of empathetic- listening for main ideas – Paraphrasing- Listening to native speakers English –Compound and Complex sentences - Developing ideas – Listening to compose paragraphs.

15 Hours

Unit II Speaking

Jotting down ideas collected from listening to speak – organising the ideas – Expressing one's view coherently – Understanding grammatical elements (Noun – Pronoun Antecedent) – Expressing ideas assertively – Answering questions during presentations – Understanding the use of discourse markers – word stress and sentence stress – voice modulation and pauses – Highlighting significant points – interpretation of visual data – Using verbal cues - Preparing simple hand - outs.

15 Hours

Unit III Reading

Reading strategies – Skimming &Scanning – Inferring meaning- Barriers to reading – sub vocalisation, Eye fixation, Regression – Speed Reading Techniques - Reading different types of texts and their contexts with speed – Note making – Reading a review – Paraphrasing – Reading to comprehend

15 Hours

Unit IV Writing

Reported speech& Concord (Subject - verb Agreement) - Report writing - Different kinds of Report - Structure of the report - Writing Proposal - Plagiarism – References – Appendices – Techniques for Report writing – Registers.

List of Tasks

1. BEC Vantage Listening Test – I &Speaking Test–1
2. BEC Vantage Listening Test – 2 & Speaking Test – 2
3. BEC Vantage Listening Test – 3 & Speaking Test – 3
4. BEC Vantage Listening Test – 4 & Speaking Test – 4
5. BEC Vantage Listening Test – 5 & Speaking Test – 5
6. BEC Vantage Listening Test – 6 & Speaking Test – 6

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Listen actively and empathetically, and paraphrase discussions and presentations on complex and abstract themes and topics	Apply
CO2: Express one's views coherently, fluently and confidently highlighting the significant points with supporting details	Apply
CO3: Read and comprehend different types of texts and their contexts reasonably at moderate speed	Understand
CO4:Write detailed reports on variety of subjects synthesizing information gathered during listening & reading citing appropriate references	Apply

Text Book(s)

T1. Whitby Norman, Business Benchmark Upper Intermediate Students' Book CUP Publications, 2^{nd} Edition, 2014

T2. Learners Book prepared by the Faculty members of Department of English

Reference Book(s)

R1. Cambridge BEC Vantage - Practice Tests, Self-study Edition, Cambridge University Press, 2002

R2. Hewings Martin - Advanced Grammar in use - Upper-intermediate Proficiency, CUP, 3^{rd}Edition, 2013.

Web References

1. http://www.grammarinenglish.com -Jan 23, 2018
2. https://www.northshore.edu/support_centre /pdf/listen-notes.pdf
3. http://www.examenglish.com/BEC/BEC_Vantage.html- Jan 23, 2018

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	3	3	-	2	2	2
CO2	-	-	-	-	-	-	-	2	3	3	-	2	2	2
CO3	-	-	-	-	-	-	-	1	-	3	-	2	1	1
CO4	-	-	-	-	-	-	-	1	-	3	-	2	2	2

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19MABC1201</td><td colspan="2">Course Title: Ordinary Differential Equations and Complex Variables
(Common to AU,CE,EC,EE,EI and ME)</td></tr>
<tr><td colspan="2">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 1: 0</td><td>Credits:4</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Matrices and Calculus

Course Objectives

The course is intended to:

1. Explain the concepts of vector differentiation and integration
2. Determine the solution of second and higher order ordinary differential equations
3. Construct analytic functions
4. Use the concept of complex integration to evaluate definite integrals
5. Apply Laplace transform techniques to solve ordinary differential equations

Unit I Vector Calculus 9+3 Hours

Gradient – Divergence – Curl – Line integrals – Surface integrals – Volume integrals – Theorems of Green, Gauss and Stokes (without proof)and their applications.

Unit II Complex Variables (Differentiation) 9+3Hours

Cauchy-Riemann equations – Analytic functions – Properties – Harmonic functions – Finding harmonic conjugate – Conformal mapping (w=z+a, w= az, w=1/z) – Mobius transformation and their properties.

Unit III Complex Variables (Integration) 9+3 Hours

Contour integrals – Cauchy Integral formula (without proof) – Cauchy Integral theorem – Taylor’s series – Singularities of analytic functions – Laurent’s series–Residues – Cauchy Residue theorem (without proof) – Evaluation of real definite integrals around unit circle and semi-circle (Excluding poles on the real axis).

Unit IV Ordinary Differential Equations of Higher Orders 9+3 Hours

Second and higher order linear differential equations with constant coefficients – Second order linear differential equations with variable coefficients (Cauchy - Euler equation–Legendre's equation) – Method of variation of parameters – Solution of first order simultaneous linear ordinary differential equations

Unit V Laplace Transform 12 Hours

Laplace Transform – Properties of Laplace Transform – Laplace transform of integrals – Laplace transform of periodic functions -Inverse Laplace transforms - Convolution theorem – Solution of ordinary differential equations by Laplace Transform method– Applications on engineering problems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of vector differentiation and integration.	Apply
CO2: Use the concept of complex variables to construct analytic functions	Apply
CO3: Use the concept of complex integration to evaluate definite integrals	Apply
CO4: Determine the solution of second and higher order ordinary differential equations	Apply
CO5: Apply Laplace transform techniques to solve ordinary differential equations	Apply

Text Book(s)

T1. Erwinkreyzig, Advanced Engineering Mathematics, 9th Edition,, John Wiley& Sons, 2006.

T2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, NewDelhi, 2008.

T3. Ramana B.V., higher Engineering Mathematics, Tata McGraw-Hill, New Delhi, 11th Reprint, 2010.

Reference Book(s)

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th Edition, Pearson, Reprint, 2002.

R2. N.P.Bali and Manish Goyel, A text book of Engineering Mathematics, Laxmi Publication, Reprint, 2008.

R3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Web References

1. https://onlinecourses.nptel.ac.in/noc16_ma05
2. https://nptel.ac.in/courses/122101003/2
3. https://nptel.ac.in/courses/111105035/22

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO2	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO3	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO4	3	2	1	1	-	1	-	1	1	1	1	2	2	2
CO5	3	2	1	1	-	1	-	1	1	1	1	2	2	2

High-3; Medium-2;Low-1

Course Code:19PHBC2001	Course Title:Physics for Electrical Sciences (Common to EC,EE,EI)		
Course Category: Basic Science	Course Level: Introductory		
L:T:P(Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the concepts of static electric field
2. Explain the concepts of static magnetic field
3. Explain the behavior of materials in electric and magnetic fields
4. Explain electric and magnetic fields using Maxwell's equation
5. Explain the phenomenon of Electromagnetic wave propagation

Unit I Electrostatics 9 Hours

Definition of electric charge-Coulomb's Law – Electric field intensity – Field intensity due to point and line charges – Electric flux density -Gauss's law- Application of Gauss's law: Due to a line charge and a plane sheet of charge – Electric potential-Equipotential surfaces-Potential gradient.

Unit II Magnetostatics 9 Hours

Definition of magnetic flux- magnetic field intensity-Lorentz Law of force- Biot –savart Law, Ampere's Law- Application of Ampere's Law: Magnetic induction due to a long linear conductor and solenoid - Magnetic field due to straight conductors- circular loop – Magnetic flux density (B) - Magnetic potential.

Unit III Electric and Magnetic Fields in materials 9 Hours

Dielectrics: An atomic view - Dielectric Polarization- Dielectrics and Gauss's law- Dielectric Strength- Energy stored in a dielectric medium - Capacity of a condenser - Capacitance - coaxial, Spherical capacitor- Poisson and Laplace Equation.

Magnetic susceptibility and permeability- properties of dia, para and ferro magnetic materials- hysteresis loop.

Unit IV Electromagnetic Induction 9 Hours

Faraday's law – Lenz's law – Time varying magnetic field - self Inductance - self Inductance of a solenoid- Mutual inductance- Mutual inductance of two solenoids. Charge conservation law - continuity equation- displacement current- Maxwell's equations.

Unit V Electromagnetic Waves 9 Hours

Electromagnetic waves in free space - Poynting vector - Propagation of electromagnetic waves in dielectrics – Phase velocity- Propagation of electromagnetic waves through conducting media- penetration or skin depth.

List of Experiments 30 Hours

1. Verification of Ohms' law.
2. Test the Faraday's hypothesis of magnetic field induction.
3. Determination of specific resistance of the given material using Carey foster's bridge.
4. Determination of Dielectric constant of a given material.
5. Determination of inductance using Maxwell's bridge.
6. Determination of wavelength of the given light source using spectrometer.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the laws and concepts of static electric field	Understand
CO2: Explain the laws and concepts of static magnetic field	Understand
CO3: Explain the behavior of materials in electric and magnetic fields	Understand
CO4: Explain time varying electric and magnetic fields using Maxwell's equation	Understand
CO5: Explain the phenomenon of Electromagnetic wave propagation in different media	Understand

Text Book(s)

T1. R.K.Gaur and S.L.Gupta, “Engineering Physics”, DhanpatRai publications, New Delhi, 8thEdition, 2011.
T2. M.N.Avadhanulu and P.G.Kshirsagar, “Text Book of Engineering Physics”, S. Chand & Company Ltd., New Delhi, 2014.
T3. W. H. Hayt and John A. Buck, “Engineering Electromagnetics”, Tata McGraw Hill, New Delhi. 6thEdition, 2014.

Reference Book(s)

R1. David Griffiths, “Introduction to Electrodynamics”, 4thEdition, Pearson Education, 2013
R2. D. Halliday., R. Resnick and J. Walker, “Fundamentals of Physics”, Wiley Publications, 2008.
R3. K. A. Gangadhar and P. M. Ramanathan, “ Electromagnetic Field Theory”, Khanna Publishers, New Delhi, 5thEdition, 2013.
R4. Mathew. N. O. Sadiku, “ Elements of Electromagnetics”, 4thEdition, Oxford University Press, 2009
R5. John D. Kraus and Daniel A. Fleisch, “ Electromagnetic with Applications”, Tata McGraw Hill, New Delhi. 5thEdition, 2010.

Web References

1. http://openems.de/start/index.php
2. http://nptel.iitm.ac.in

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	1	2	3	2	-	1	1	1
CO2	2	1	1	-	-	-	1	2	3	2	-	1	1	1
CO3	2	1	1	-	-	-	1	2	3	2	-	1	1	1
CO4	2	1	1	-	-	-	1	2	3	2	-	1	1	1
CO5	2	1	1	-	-	-	1	1	-	1	-	1	1	1

High-3; Medium-2; Low-1

Course Code:19EESN2201		**Course Title: Electron Devices**	
Course Category: Engineering Science		**CourseLevel: Introductory**	
L:T:P(Hours/Week) **3: 0: 2**	**Credits:4**	**Total Contact Hours:75**	**Max Marks:100**

Pre-requisites

- Physics for Electrical Sciences

Course Objectives

The course is intended to:

1. Explain the various terminologies of electrical quantities in AC and DC Circuits
2. Differentiate special diodes from PN junction diodes
3. Explain the construction and characteristics of Bipolar Junction Transistors
4. Explain the construction and operation of Junction Field Effect Transistors
5. Describe the operation of MOSFETs and basic power devices

Unit I Electrical Quantities 9Hours

Need of S.I.Units, Definitions of electrical quantities: Charge, Resistivity, Conductivity, Voltage, Current, Power, Energy. **DC Circuits:** Ohms Law, Kirchhoff's Current Law and Voltage Law. Behavior of R, L, C in DC circuits, Series resistive circuit-Voltage division rule, Parallel resistive circuit-Current division rule and series-parallel resistive circuit.**AC Circuits:** Faradays laws of electromagnetic induction. Alternating Quantities: Time period, Cycle, frequency, Angular frequency, Expression of average value, RMS value, Form factor, peak factor of sinusoidal waveform. Behavior of R, L, C circuit. Power factor concepts in series RL, RC and RLC circuit. Power triangle – Active power, Reactive power and Apparent power.

Unit II Diodes 9 Hours

Semiconductor Diode: PN junction - forward and reverse bias conditions. Ideal diode - Practical diode - V-I Characteristics of a diode – Temperature dependence of the V-I Characteristics – Diode specifications – Diode Resistance – Static and dynamic – Diode junction Capacitance – Transition and Diffusion capacitances - Diode Equivalent circuits.

Special Diodes:Zener diode - Schottky Diode, Light emitting diodes – Photo diodes – Diode numbers and lead identification – Diode testing.

Unit III Bipolar Junction Transistors 9 Hours

Bipolar Junction Transistor and its types – NPN and PNP Transistor – Transistor operation - Configurations of BJT – Input and output characteristics of CE, CB and CC configurations.

Eber -Moll Model of transistors – Transistor as a switch – Transistor specifications – lead identification –Package types –Transistor testing.

Unit IV Field Effect Transistors 9 Hours

BJT versus FET - JFET and its types, construction and operation of n- channel and p-channel JFETs – characteristics curves – Effect of temperature on JFET parameters – FET characteristic parameters and specifications – FET data sheet specifications. FET applications – Testing FETs.

Unit V MOSFETS and Power Devices 9 Hours

MOSFETs: Depletion MOSFETs and Enhancement MOSFETs – Differences between JFETs and MOSFETs –Precaution in handling MOSFETs, MOSFET as a switch.Construction and operation of Power transistor, UJT, SCR, Diac,Triac and IGBT.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the various terminologies of electrical quantities in AC and DC Circuits	Understand
CO2: Differentiate special diodes from PN junction diodes	Understand
CO3: Explain the construction and characteristics of Bipolar Junction Transistors	Understand
CO4: Explain the construction and operation of Junction Field Effect Transistors	Understand
CO5: Describe the operation of MOSFETs and basic power devices	Understand

Text Book(s)

T1. V.Jegatheesan, K.Vinoth Kumar & R.Saravanakumar, Basic Electrical and Electronics Engineering, Wiley India, 1st Edition,2011.

T2. Millman.J, Halkias.C and SatyebrantaJit, “Electronic Devices & Circuits”, TMH, New Delhi, 2nd Edition,2008.

Reference Book(s)

R1. Anil K.Maini, VarshaAgarwal, “Electronic Devices and Circuits”, Wiley India Private Ltd, New Delhi, 1st Edition, 2015.

R2. Salivahanan.S, Suresh Kumar.N and Vallavaraj.A, “Electronic Devices and Circuits”, TMH, New Delhi, 2nd Edition,2008.

R3. Robert Boylestad and Louis Nashelsky, “Electron Devices and Circuit Theory” Pearson Prentice Hall, 10th Edition, July 2008.

R4. Streetman Ben G. and Banerjee Sanjay, “Solid State Electronic devices”, PHI, 6th Edition, 2006.

R5. David A. Bell, “Electronic Devices and Circuits”, Oxford, 5th Edition, April 2008.

Web References:

1. http://nptel.ac.in/video.php?subjectId=117103063
2. http://nptel.ac.in/video.php?subjectId=117106091
3. www.youtube.com/watch?v=Wf19Il0ts84

Laboratory Component **30 Hours**

List of Experiments:

1. Verification of Kirchhoff’s Current and Voltage Law.
2. a)Verification of Voltage division rule
   b) Verification of Current division rule
3. Measurement of peak value, average value, RMS value of sinusoidal waveform using CRO
4. Testing of Diodes
5. V-I Characteristics of Diode
6. Testing of Transistors and FETs

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	-3	1	1
CO2	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	3	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code:19CSSC2001	**Course Title: C Programming** **(Common to AU,CE,EC,EE,EI and ME)**		
Course Category: Engineering Science		**Course Level: Introductory**	
L:T:P(Hours/Week) **3: 0: 2**	**Credits:4**	**Total Contact Hours:75**	**Max Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain about computer organization and problem solving techniques
2. Write programs using appropriate programming constructs
3. Develop programs using arrays, functions & strings
4. Implement programs using pointers, structures& unions
5. Write programs using files & preprocessor directives

Unit I Introduction 7 Hours

Generation and Classification of Computers –Basic Organization of a Computer – Software development life cycle – Problem Solving Techniques : Algorithm,Pseudocode and Flow Chart.

Unit II C Programming Basics 10 Hours

Introduction to C programming – Structure of a C program – Keywords – Identifiers-Constants–Variables –Data Types– Operators and Expressions –Formatted & Unformatted I/O functions–Decision statements –Loop control statements.

Unit III Arrays, Functions and Strings 10 Hours

Arrays: Characteristics –One-dimensional and Two-dimensional arrays – Functions: Declaration & Definition of function –Built in function – User defined function –Types of functions –Call by value &reference– Strings: Formatting strings–String handling functions.

Unit IV Pointers, Structures and Union 9Hours

Pointers: Features and Types of pointers – Arithmetic operations with pointers–Pointers and Arrays –Structures: Features– Operations on Structures–Array of structures – Unions.

Unit V Files and Pre-Processor Directives 9 Hours

Introduction to Files –Stream and File Types–File operations (Open, close, read, write) – Command line arguments–Pre-processor Directives: Macro Expansion, File Inclusion, Conditional Compilation.

Laboratory Component 30 Hours

List of Experiments:

1. Programs to process data types, operators and expression evaluation(any 1)
   a. To find area of rectangle/circle/square
   b. To find the simple interest and compound interest
2. Programs using decision and looping statements(any 2)
   a. To find the maximum number among 3 given numbers
   b. To check whether given year is leap year or not
   c. To display the Fibonacci series
   d. To find the factorial of a number
3. Programs using Arrays
   a. To search for particular number among N numbers(1D array)
   b. To compute matrix addition (2 D array)
4. Programs using Functions and Strings(any 2)
   a. To swap two numbers using call by reference
   b. To find the cube of a number
   c. To manipulate strings using string functions
   d. To check whether the string is palindrome or not
5. Programs using Pointer, Structure & Union
   a. To perform arithmetic operations using pointers
   b. To display the information of N students using Structure
   c. To display the employee details using Union
6. Programs using Files (any 1)
   a. To read the contents of a text file
   b. To copy the contents from one file into another

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain about computer organization and problem solving techniques	Understand
CO2: Write programs for the given scenario using appropriate programming constructs	Apply
CO3: Develop programs using arrays, functions & strings for the given scenario	Apply
CO4: Implement programs for given application using pointers, structures& unions	Apply
CO5: Write programs using files & preprocessor directives for simple problems	Apply

Text Book(s)

T1. Ashok N.Kamthane, Amit.N.Kamthane, "Programming in C", 3rd Edition, Pearson Education, 2015.

Reference Book(s)

R1. Ajay Mittal, "Programming in C-A Practical Approach",3rd Edition, Pearson Education, 2010.

R2. Yashavant P.Kanetkar, "Let Us C", 16th Edition, BPB Publications,2018

R3. PradipDey, Manas Ghosh, "Computer Fundamentals and Programming in C", 2nd Edition, Oxford University Press,2013

Web References

1. http://www.cprogramming.com/
2. http://www.c4learn.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	3	1	1
CO2	3	2	1	1	1	-	-	1	3	1	-	-	2	2
CO3	3	2	1	1	1	-	-	1	3	1	-	-	2	2
CO4	3	2	1	1	1	-	-	1	3	1	-	-	2	2
CO5	3	2	1	1	1	-	-	1	3	1	-	-	2	2

High-3; Medium-2;Low-1

Course Code:19EECN4201	Course Title: Electrical CAD		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours:60	Max Marks:100

Prerequisites:

- Nil

Course Objectives

The course is intended to:

1. Draw electrical and electronics engineering drawings as per standards
2. Prepare PCB engineering documents for electronic circuits
3. Prepare electrical wiring and wiring harness documents for electronic circuits

Unit I Introduction to ECAD 9+6 Hours

Drawings – documents – symbols – terminologies – structure - drawing tools –Standards: need, list - IPC, ISO.

Experiment-1. Identification of electrical and electronics components based on their symbols

Unit II – PCB Design 3+24 Hours

PCB design flow - capture project setup: design inputs, schematic, net list

PCB engineering: board, part, noise, trace width, space, signal layer and power/ground layers

Setup PCB: physical requirements, footprint, DRC, route, silk screen and annotation

Experiment-2.PCB design for LED circuit

Experiment- 3.PCB design for diode bridge rectifier

Experiment - 4.PCB design for voltage regulator

Experiment - 5.PCB design for a power supply circuit

Experiment - 6.PCB design to interface a switch

Experiment - 7.PCB design for multivibrator circuit

Experiment - 8.PCB design for water level controller **(Product - PBL 1)**

Unit III Wiring and Harness Diagram 3+15Hours

Wiring and harness diagram – necessity - Schematic: connectors, wires & cables, size, length - Wiring Harness: cable markers, part no, labels and publish project

Experiment - 9. Wiring schematic diagram of fog lamp for a car

Experiment - 10. Wiring harness diagram of fog lamp for a car

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to:	
CO1. Explain electrical & electronics engineering drawings, documents and standards	Understand
CO2. Prepare PCB engineering documents for the given electronic circuit as per industry standards	Apply
CO3. Prepare electrical wiring diagram and wiring harness drawing as per industry standards	Apply

Text Books:

1.Lab Manual prepared by MCET EEE team of the college.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	3	2	-	2	1	1
CO2	3	2	2	2	2	-	-	2	3	2	-	2	2	2
CO3	3	2	2	2	2	-	-	2	3	2	-	2	2	2

High-3; Medium-2; Low-1

Course Code:19CHMG6201	Course Title: Environmental Sciences (Common to all B.E/B.Tech Programmes)	
Course Category: **Mandatory Non-Credit Course**	**Course Level: Introductory**	
L:T:P(Hours/Week)1: 0: 0	**Total Contact Hours:15**	**Max. Marks: 100**

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Create awareness for conservation and equitable use of natural resources.
2. Explain the measures of prevention of pollution and disaster management.
3. State the importance of environmental legislation in India.
4. Expose the general environmental issues relevant to human health.
5. Explain the innovative measures for day to day environmental issues.

Unit I Natural Resources 2 Hours

Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

Unit II Environmental Pollution and Disaster Management 2 Hours

Role of an individual in prevention of pollution; Disaster management : floods, earthquake, cyclone and landslides.

Unit III Environmental Ethics and Legislations 2 Hours

Environmental ethics : Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation.

Unit IV Environmental Issues and Public Awarness 2 Hours

Public awareness - Environment and human health

Unit V Environmental Activities 7 Hours

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
ii) Slogan making event
iii) Poster making event

(b) Actual Activities:

i) Plantation

ii) Cleanliness drive
iii) Drive for segregation of waste
iv)To know about the different varieties of plants
v) Shutting down the fans and ACs of the campus for an hour or so

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Describe the measures for conservation and equitable use of natural resources	Understand
CO2: Describe the measures for pollution prevention and disaster management	Understand
CO3: Brief the importance of environmental legislation in India .	Understand
CO4: Explain the general environmental issues in relevant to human health	Understand
CO5: Demonstrate innovative measures for day to day environmental issues	Understand

Text Book(s):

T1.Benny Joseph, "Environmental Studies", Tata McGraw Hill, New Delhi, 2006.

T2.Mackenzie Davis and Susan Masten, "Principles of environmental engineering and science", Mc-Graw Hill, 3rd Edition, 2014.

Reference Book(s):

R1.Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol.I and II, Enviro Media.

R2.Cunningham, W.P.Cooper,T.H. Gorhani, "Environmental Encyclopedia", Jaico Publishing House, Mumbai, 2001.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1					3	3	2	1	2				
CO2	1					3	3	2	1	2				
CO3	1					3	3	2	1	2				
CO4	1					3	3	2	1	2				
CO5	1					3	3	2	1	2				

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19PSHG6003</td><td colspan="3">Course Title:HERITAGE OF TAMILS
(Common to all B.E/B.TechProgrammes)</td></tr>
<tr><td colspan="2">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0 :0</td><td>Credit: 1</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.
2. Understand the Contribution of Tamils to Indian National Movement and IndianCulture.

HERITAGE OF TAMILS

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils &Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIANCULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO.1 Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.	Understand
CO.2 Understand the Contribution of Tamils to Indian National Movement and IndianCulture.	Understand

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை
(வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Course Code: 19PSHG6003	**Course Title:HERITAGE OF TAMILS (Common to all B.E/B.TechProgrammes)**		
Course Category: Humanities		**Course Level: Introductory**	
L:T:P (Hours/Week) 1: 0 :0	**Credit: 1**	**Total Contact Hours: 15**	**Max Marks:100**

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்ள இயலும்.

CO.2இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்ள இயலும்.

தமிழர் மரபு

அலகு 1 – மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி –தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு 2 – மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு 3 – நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு 4 – தமிழர்களின் திணைக் கோட்பாடுகள் 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக் கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு 5 – இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு 3

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறபகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுய மரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத் துப் படிகள்– தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

Course Outcomes		**Cognitive Level**
மாணவர்கள் இப்பாடத்தை கற்றபின்		
CO.1	மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
   Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Semester III

<table>
<tr><td colspan="2">Course Code:19MABC1302</td><td colspan="2">Course Title: Numerical Methods and Linear Algebra (Common to EC, EE & EI)</td></tr>
<tr><td colspan="2">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 1: 0</td><td>Credits:4</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Matrices and Calculus
- Ordinary Differential Equation and Complex variables

Course Objectives

The course is intended to:

1. Solve the system of linear equations, nonlinear equations and calculate the dominant Eigen value
2. Determine the unknown values from the given set of data & Compute derivatives and integrals
3. Solve first ordinary differential equation
4. Apply the concept of vector spaces to electrical network problems
5. Apply the concept of Inner product spaces in Fourier approximation

Unit I Solution of Equations and Eigen value Problems 9+3 Hours

Solution of system of linear equations – Direct methods: Gaussian elimination method – Indirect methods: Gauss Jacobi method, Gauss-Seidel method – sufficient conditions for convergence – Solution of nonlinear equations: Newton Raphson method – Power method to find the dominant Eigen value and the corresponding Eigen vector.Application of Eigen value and the corresponding Eigen vector.

Unit II Interpolation, Numerical Differentiation and Integration 9+3 Hours

Newton's forward, backward interpolation — Lagrange’s interpolation. Numerical Differentiation and Integration — Trapezoidal rule — Simpson’s 1/3 rule — Double integration using Trapezoidal rule.

Unit III **Numerical Solution of Ordinary Differential Equation** **9+3 Hours**

Numerical solution of first order ordinary differential equation-Single step method: Taylor's series- Euler's method - Runge-Kutta method of fourth order — Multi step method: Milne's and Adams – Bash forth predictor corrector methods for solving first order equations.

9+3 Hours

Unit IV **Vector Spaces**

System of linear equations -Vector spaces- Subspace of a vector space- basis and dimension of vector space - linear combination and spanning sets of vectors -linear independence and linear dependence of vectors-Row space, Column space and Null space- Rank and nullity of subspaces. Applications to linear equations: Simple electrical network problems to find loop current using Kirchhoff's voltage law.

Unit V **Orthogonality and Inner Product Spaces** **9+3 Hours**

Inner product of vectors: length of a vector, distance between two vectors, and orthogonality of vectors-Orthogonal projection of a vector-Gram-Schmidt process to produce orthogonal and orthonormal basis -Inner product spaces- Fourier approximation of continuous functions using inner product spaces.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Solve the system of linear equations, nonlinear equations and calculate the dominant Eigen value	Apply
CO2: Determine the unknown values from the given set of data and compute derivatives and integrals	Apply
CO3: Solve first ordinary differential equation	Apply
CO4: Apply the concept of vector spaces to electrical network problems	Apply
CO5: Apply the concept of Inner product spaces in Fourier approximation	Apply

Text Book(s)

T1. Grewal, B.S. and Grewal, J. S., “Numerical Methods in Engineering and Science”, 11th Edition, Khanna Publishers, New Delhi, 2013.

T2. David C Lay, “Linear Algebra and its Applications’, 5th Edition, Pearson Education, 2015.

Reference Book(s)

R1. Gerald, C. F. and Wheatley, P. O., “Applied Numerical Analysis”, 7th Edition, Pearson Education Asia, New Delhi, 2006.

R2. Jain M. K., Iyengar, S. R. and Jain, R. K, “Numerical Methods for Scientific and Engineering Computation’, New Age Publishers, 2012.

R3. Sastry.S.S “Introductory Methods of Numerical Analysis”, 3rd Edition, PHI, 2003.

R4. Gilbert Strang, “Linear algebra and its Applications’, 4th Edition, Cengage Learning India Private Limited, 2012.

Web References

1. http://nptel.ac.in/courses/122104018/node2.html

2. http://nptel.ac.in/courses/111105038/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	3	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	3	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	3	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	3	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code:19EECN1301	Course Title: DC Machines and Transformers		
Course Category: Professional Core		**Course Level: Introductory**	
L: T: P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Introduction to Engineering
- Physics for Electrical Sciences

Course Objectives

The course is intended to:

1. Learn about the construction, operation and characteristics of DC generators
2. Study about the construction, operation and characteristics of DC motors
3. Impart knowledge on speed control of DC motors and testing of DC machines
4. Study about the single phase transformers and auto transformers
5. Impart knowledge on three phase transformers and testing of transformers

Unit I DC Generators 9 Hours

Principle of electromechanical energy conversion - Constructional features of a DC machine – Principle of operation – EMF equation – Methods of excitation: Self and separately excited generators – Characteristics: series, shunt and compound generators - applications – armature reaction - commutation – Parallel operation of shunt and compound generators.

Unit II DC Motors 9 Hours

Principle of operation – Back EMF and torque equation – Characteristics: series, shunt and compound motors – applications – losses and efficiency – Necessity of starter - 3point and 4 point starter.

Unit III Speed Control and Testing Of DC Machines 9 Hours

Speed control: DC series and shunt motors – Electrical Braking: Plugging, Dynamic and Regenerative braking - Testing of DC Machines: Brake Test, Swinburne's test, Hopkinson's test and Retardation test.

Unit IV Transformers 10 Hours

Constructional details of core and shell type transformers – Principle of operation – EMF equation – Transformation ratio –Transformer on no load – Transformer on load - Equivalent circuit – Regulation – Losses and efficiency – Condition for maximum efficiency – All day efficiency - Parallel operation of single phase transformers – Auto transformer – Comparison with two winding transformers.

Unit V Three phase Transformers and testing of Transformers **8 Hours**

Three phase transformer constructional features – Three phase transformer connections.
Testing of transformers: Polarity and voltage ratio tests, Load test, Open circuit and short circuit test, Sumpner's test and Separation of No load losses.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the constructional details of DC machine, operation and performance of DC generators	Understand
CO2: Describe the operation, characteristics and applications of DC motors	Understand
CO3: Explain the speed control & braking of DC motor and various tests to determine the performance of DC machines	Understand
CO4: Explicate the construction, operation and performance of single phase transformers	Understand
CO5: Explain the different tests to determine the performance of transformers and three phase transformer construction & its connections	Understand

Text Book(s)

T1. Nagrath I.J Kothari D.P, "Electric Machines", Tata McGraw Hill Publishing Company Ltd, 5th Edition, 2017.

T2. MurugeshKumar.K, "Electrical Machines Volume - I", Vikas Publishing House Pvt. Ltd, 1st Edition, 2010.

Reference Book(s)

R1. Bimbhra. P.S, "Electric Machines", Khanna Publishers, 2ndEdition, 2017.

R2. Gupta. J.B, "Theory and Performance of Electrical Machines", S.K.Kataria and

Sons, 4th Edition, 2013.

R3. S.K. Bhattacharya, “Electric Machines”, Tata McGraw Hill Publishing Company Ltd, 4th Edition, 2017.

R4. A.E.Fitzgerald, Charles Kingsley, Stephen.D.Umans, “Electric Machinery”, TataMcgraw Hill Publishing Company Ltd, 6th Edition, 2017.

R5. V.K Mehta, Rohit Mehta, “Principle of Electrical Machines”, S.Chand Publishing, 2014.

Web References

1. http://nptel.ac.in/courses/108105017/
2. http://www.nptelvideos.in/2012/11/electrical-machines-i.html
3. http://www.nptelvideos.com/electrical_engineering/

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	2	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19EECN1302	Course Title: Electric Circuits		
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 1: 0	Credits:4	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Electron Devices

Course Objectives

The course is intended to:

1. Compute the various electric circuit parameters using circuit reduction, mesh and node analysis
2. Apply the concept of network reduction technique to DC and AC circuits
3. Explain the concept of Resonance and simple coupled circuits
4. Apply Laplace transformation technique to obtain the transient responses of RL, RC, RLC circuits
5. Explain the various three phase circuits behavior with balanced and unbalanced three phase loads

Unit I Basic Circuit Analysis 9+3 Hours

Review of Kirchhoff's laws - series and parallel circuits, equivalent resistance, Source transformation, star/delta conversion.Concepts of AC circuits – RMS value, average value, form and peak factors – real and reactive power – power factor-Mesh current and Node voltage methods of analysis for D.C and A.C circuits.

Unit II Circuit Theorems for DC and AC Circuits 9+3 Hours

Thevenin's and Norton's Theorem- Superposition Theorem –– Maximum power transfer theorem – Reciprocity Theorem

Unit III Resonance and Coupled Circuits 9+3Hours

Resonance: Series and Parallel - Quality factor, Resonant frequency, bandwidth and their relations. Effect of variation of Q on resonance.

Coupled circuits: Mutual inductance – Coefficient of coupling – dot convention – analysis of simple coupled circuits. Series and parallel connections of coupled coils

Unit IV Transient Response 9+3Hours

Source free response of RL and RC circuits – Source free response of RLC circuit Forced (step) response of RL and RC circuits –– Forced (step) response of RLC circuit – Forced response of RL RC and RLC circuit to sinusoidal excitation.

Unit V Three Phase Circuits 9+3 Hours

Three phase balanced / unbalanced voltage sources – Analysis of three phase 3 wire and 4 wire circuits with star and delta connected loads, balanced and unbalanced – phasor diagram of voltage & currents – Power and power factor measurements in three phase circuits.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Compute the various electric circuit parameters using circuit reduction, mesh and node analysis	Understand
CO2: Apply the concept of network reduction technique to DC and AC circuits	Apply
CO3: Explain the concept of Resonance and simple coupled circuits	Understand
CO4: Apply Laplace Transformation technique to obtain the transient responses of RL, RC, RLC circuits	Apply
CO5: Explain the various three phase circuits behavior with balanced and unbalanced three phase loads	Apply

Text Book(s)

T1. William H. Hayt, Jack Kemmerly, Steven M. Durbin. “Engineering Circuit Analysis” Tata McGraw-Hill, New Delhi, 8th Edition, 2013.

T2. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Tata McGraw-Hill, New Delhi, 6th Edition, 2019.

Reference Book(s)

R1. Chakrabati A, “Circuits Theory (Analysis and synthesis), DhanpatRai& Sons, New Delhi, 7th Edition, 2018.

R2. M Nahvi, Joseph Edminister, K UMA RAO "Electric circuits", Schaum'sSeries,Tata McGraw-Hill, New Delhi, 5th Edition, 2010..

R3. Robert L. Boylestad, "Introductory Circuit Analysis" Pearson, USA, 16th Edition, 2016.

R4. A. Sudhakar,Shyammohan S Palli, "Circuits and Networks Analysis and Synthesis"Tata McGraw-Hill, New Delhi, 5thEdition,2015.

R5. Dr. M. Arumugam,N.Premkumar, "Electric circuit theory"Khanna Publishers, New Delhi,5thEdition,2002.

Web References

1. https://nptel.ac.in/courses/108102042/
2. https://nptel.ac.in/courses/117106108/
3. https://nptel.ac.in/courses/108102097/

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code: 19EECC2301	Course Title: Digital Electronics (Common to EE and EI)		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week): 3: 0: 2	Credits:4	Total Contact Hours:75	Max Marks:100

Pre-requisites

- Electron Devices

Course Objectives

The course is intended to:

1. Illustrate the number systems, Boolean laws and simplification techniques
2. Design Combinational circuits
3. Design synchronous sequential circuits
4. Design asynchronous sequential circuits
5. Explain the various memory devices, shift registers and logic families

Unit I Number System and Boolean Algebra 9 Hours

Review of Number Systems-Complements: 1's and 2's- Arithmetic operation of Signed binary numbers-Boolean Algebra: Basic theorems, Simplification of Boolean functions, Representation of Boolean function in canonical and standard forms-Simplification of Boolean expressions using K maps and QuineMccluskey method.

Unit II Combinational Circuits 9 Hours

Basic Gates, Universal gate implementation, Design of Adder, Subtractor, Comparators, Code converters, Encoders, Decoders, Multiplexers, De-multiplexers- Function realization using multiplexer.

Unit III Synchronous Sequential Circuits 9 Hours

Flip Flops: SR, JK, T, D- Level and Edge Triggering- Analysis of Synchronous sequential circuits-Design of Synchronous sequential circuits with state diagram, state table, state reduction and state assignment- Design of counter.

Unit IV Asynchronous Sequential Circuits 9 Hours

Analysis of Asynchronous Sequential Circuits-Design of Asynchronous sequential circuits with primitive flow table, State Reduction and State Assignment- Races, Cycles and Hazards: Static, Dynamic, Essential, HazardsElimination.

Unit V Memory Devices, Shift registers and Logic Families 9 Hours

Memories: ROM, PROM, EPROM – FPGA -Shift registers – Ripple counters –
Logic families: TTL, ECL, CMOS.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Illustrate the number systems, Boolean laws and simplification techniques used in digital design	Understand
CO2: Develop the combinational circuits using logic gates	Apply
CO3: Develop the synchronous sequential circuits using basic flip flops	Apply
CO4 :Develop the asynchronous sequential circuits eliminating hazards and races	Apply
CO5: Explain the various memory devices, shift registers and logic families	Understand

Text Book(s)

T1. A.Anandkumar, Fundamentals of digital circuits, 4th Edition, PHI Learning Pvt Ltd, 2016

T2. John F.Wakerly, Digital Design Principles and Practice, Pearson Education, 5thedition, 2018.

Reference Book(s)

R1. Malvino and Leach, Digital Principles and Applications, Tata McGraw Hill, New Delhi, 8thEdition, 2014.

R2. S.Salivahanan and S. Arivazhagan, Digital Circuits and Design, Oxford University Press, 5thEdition, 2018.

R3. Morris Mano. M. Michael D Ciletti, “Digital Design”, Pearson Education, 4thEdition, 2008.

R4. John M.Yarbrough, Digital Logic, Application & Design, Thomson, 2010.

R5. Donald D. Givone, “Digital Principles and Design”, TMH,2003.

Web References

1. https://nptel.ac.in/courses/117105080/
2. https://nptel.ac.in/courses/117106086/

Laboratory Component 30 Hours

1. Simplification of Boolean Expression using K map and its implementation
2. Design of full adder/ full subtractor using logic gates
3. Design of encoder/ decoder using logic gates
4. Design of multiplexer using logic gates
5. Design of basic flip flops
6. Design of shift registers

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO5	2	1	-	-	-	-	-	1	3	1	-	3	1	1

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code:19EECN2301</td><td colspan="3">Course Title: Instrumentation and Testing</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 2</td><td>Credits:4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the fundamental concepts of measurements
2. Understand the measurement of electrical quantities
3. Understand the measurement of physical quantities and functioning of display devices.
4. Describe the data acquisition and storage devices
5. Explain the test concept of virtual instrumentation and test procedures

Unit I Basics of Measurements 9 Hours

SI Units, Standards, Functional elements of an instrument, Static and Dynamic characteristics – Errors. PMMC and MI Instruments: Construction - Working - Errors – D Arsonval Galvanometer: Construction - Working - Errors.

Unit II Electrical Quantity Measurements 9 Hours

Bridges: Wheatstone's bridge, Maxwell bridge, Schering bridge and Wein bridge.

Potentiometers: Crompton potentiometer and drysdale polar potentiometers - Watt meter - Single phase energy meter, Power factor meter, LCR Meter - Instrument transformers.

Unit III Physical Quantity Measurements and Display Devices 9 Hours

Classification of transducer – Selection and specification of transducers – Resistive, Capacitive and Inductive transducers – Piezoelectric and Optical transducer. Display Devices: CRT Display, digital CRO, DSO, LED, LCD & Dot matrix display.

Unit IV Data Acquisition System and Storage Devices 9 Hours

Data acquisition system: components - signal conditioning – Sample and hold circuit - ADC – DAC. Storage devices: X-Y recorder, magnetic tape recorder, hard disk, CD ROM, USB drive.

Unit V Virtual Instrumentation and Test Procedures 9 Hours

PC based instrumentation – Bed of nails fixtures. Introduction to LabVIEW environment - LabVIEW foundation – Signal acquisition using LabVIEW – Test procedure automation.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Explain the fundamental concepts of measurements and measuring instruments.	Understand
CO2: Describe the measurement of various electrical parameters.	Understand
CO3: Illustrate the measurement of physical parameters and the concept of display devices.	Understand
CO4: Describe data acquisition system and storage devices.	Understand
CO5: Explain the fundamentals of virtual instrumentation and the test procedures.	Understand

Text Book(s)

T1. A K. Sawhney “A course in Electrical and Electronic Measurements and Instrumentation”, Dhanbat Raj & Co., 2015.

T2. Handouts prepared by MCET team.

Reference Book(s)

R1. Alan V. Oppenheim, Alan S.Willsky, S.HamidNawab, “Signals & Systems”, 2ndEdition, Prentice Hall, 2015.

R2. K. Lal Kishore and Kishore, “Electronic Measurements and Instrumentation”, Pearson, 1st Edition, 2009.

R3. Jovithajerome, “Virtual Instrumentation Using LABVIEW”, 2010, PHI learning Pvt ltd

R4. Jose Moreira, Hubert Werkmann, "An Engineer's Guide to Automated Testing of High-Speed Interfaces", 2nd Edition, ARTECH house, 2010.

R5. Wilson, "Test and measurements: know it all", Newnes (imprint of Elsevier), 2009, Oxford,UK.

Web References:

1. https://www.sciencedirect.com/science/article/pii/B9780123819604000073
2. https://www.sciencedirect.com/science/article/pii/B9780123819604000061
3. https://www.mclpcb.com/pcb-testing-methods-guide

Laboratory Component **30 Hours**

List of Lab Exercises

1. Measurement of R,L and C using bridges and RLC meter
2. (i) Measurement of electrical parameters Voltage and Current
   (ii) Measurement of Power and Energy
3. Measurement of physical parameters (Temperature, Pressure, Displacement)
4. Introduction to LabVIEW foundation
5. Development of signal conditioners and converters using LabVIEW
6. Development of data acquisition system using LabVIEW

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	1	1	3	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	3	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code:19EECN3301		Course Title: DC Machines and Transformers Laboratory	
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Prerequisites:

- Nil

Course Objectives

The course is intended to:

1. Compare the performance of DC generators
2. Compare the performance of DC motors
3. Predict the performance of DC machine
4. Determine the performance of single phase transformers
5. Predict the performance of single phase transformers

List of experiments

1. Open circuit and load characteristics of self and separately excited DC shunt generators
2. Load characteristics of DC compound generator with differential and cumulative connection
3. Load characteristics of DC shunt and series motor by brake test
4. Speed control of DC shunt motor using armature and field control method
5. Predetermination of efficiencies as Generator and Motor from Swinburne's test
6. Hopkinson's test on DC motor-generator set
7. Load test on single phase transformer
8. Open circuit and short circuit tests on single phase transformer
9. Sumpner's test on transformers
10. Separation of no-load losses in single phase transformers

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to:	
CO1.Compare the performance of different types of DC generators	Apply
CO2.Compare the performance of different types of DC motors	Apply
CO3.Predict the performance of DC machine by indirect test	Apply
CO4.Determine the performance of single phase transformer by direct test	Apply
CO5.Predict the performance of single phase transformer by indirect test	Apply

Reference Book(s)

1. D.P.Kothari, B.S.Umre “Laboratory Manual for Electrical Machines”, I.K. International Publishing House Pvt.Ltd,2017.

2. ”DC Machines & Transformer Laboratory Manual” Prepared by Department of Electrical and Electronics Engineering.

Web References

1. www.ee.iitkgp.ac.in/faci_em.php
2. www.eee.griet.ac.in/.../2014/12/DC-Machines-Lab-Manual.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	2	3	2	-	-	2	2
CO2	3	2	1	1	-	-	-	2	3	2	-	-	2	2
CO3	3	2	1	1	-	-	-	2	3	2	-	-	2	2
CO4	3	2	1	1	-	-	-	2	3	2	-	-	2	2
CO5	3	2	1	1	-	-	-	2	3	2	-	-	2	2

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code:19EECN4301</td><td colspan="3">Course Title: Process Engineering in Electrical and Electronic Parts</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
1: 0: 3</td><td>Credits:2.5</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Prerequisites:

- Nil

Course Objectives

The course is intended to:
1. Prepare the process flow chart
2. Fabricate and assemble the identified Electrical part
3. Fabricate and assemble the PCB for the identified product
4. Fabricate and assemble the given wiring harness

Unit I Process Flow Chart for Electrical/Electronic Component / Product 9+6 Hours

Introduction to Process Engineering: Overview of manufacturing process- different process involved in manufacturing Electrical/Electronic components/products: transformer, PCB, wiring harness

Exercise:

1. Preparation of process flow chart for manufacturing of Electrical product.
2. Preparation of process flow chart for manufacturing of Electronic product.
3. Preparation of process flow chart for manufacturing of wiring harness.

Unit II Fabrication And Assembly of Electrical Part/Component 3+12 Hours

Fundamental and working principle of transformer: EMF Equation, Construction of transformer: primary and secondary winding, Types of Winding – Semi automatic winding, Manual winding, Automatic winding; Types of Insulation - Mylar tape, Impregnated paper – Types of cores – Standards.

Exercise:

[Construct 230 /12V, 500mA transformer as per the prepared process flow chart and test it]

4. Practice coil winding 230 /12V, 500mA transformer as per the prepared process flow chart.

5. Practice core assembly of 230 /12V, 500mA transformer as per the prepared process flow chart.

6. Perform basic test on the assembled transformer.

Unit III Fabrication And Assembly of Electronic Part/Component 3+12 Hours

BOM – Assembly process: Manual assembly process, automated assembly process-types of soldering: Manual soldering, wave soldering, reflow soldering - Types of PCB-Manufacturing steps: component placement and orientation, IPC Standards for assembly- Interpret the data sheets and standards.

Exercise:

[Fabricate and assemble the target PCB as per the derived flow chart using the data sheet and standards]

7. Practice soldering /de-soldering of components in the given PCB.

8. PCB fabrication for the given product.

9. Perform subsystem integration and testing of the given product

Unit IV Design and manufacture the Wiring Harness 3+12 Hours

Design parameters: wiring harness and its associated terms, loads, operating conditions, safety and regulatory requirements - harnessing types- Computer aided design (CAD) skill and scope for wiring harness- Wiring harness layout requirements, Test requirements- Wiring harness manufacturing & testing process: Manufacturing design & BOM, pre harnessing process & final laying board, Post harnessing process & tests.

Exercise:

10. Fitting the wires in form board

11. Practice wire crimping

12. Practice connector selection, dismantling and assembling connector accessories

Course Outcomes	Cognitive Level
At the end of the course students will be able to:	
CO1. Prepare the process flow chart for the given Electrical/Electronic component / Product	Understand
CO2. Fabricate and assemble the identified Electrical part/component – Transformer	Apply
CO3. Fabricate and assemble the PCB for identified product	Apply
CO4.Design and manufacture the wiring harness	Apply

References:

R1. Manual prepared by Caresoft Global manual.

R2. Manual prepared by Department of Electrical and Electronics Engineering.

R3. R. S. Khandpur, “Printed circuit Board Design, Fabrication, Assembly and Testing”, 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	3	1	1
CO2	3	2	1	1	2	-	-	2	3	2	-	-	2	2
CO3	3	2	1	1	2	-	-	2	3	2	-	-	2	2
CO4	3	2	1	1	2	-	-	2	3	2	-	-	2	2

High-3; Medium-2; Low-1

Course Code: 19PSHG6002	Course Title: Universal Human Values 2 :Understanding Harmony (Common to all B.E/B.TechProgrammes)		
Course Category: Humanities		**Course Level: Practice**	
L:T:P (Hours/Week) 2:1: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Induction Program (UHV 1)

Course Objectives

The course is intended to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Strengthening of self-reflection
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Development of commitment and courage to act

Unit I Introduction to Value Education 6+3 Hour

Need for the Value Education; Self -exploration as the process for value education ; Continuous Happiness and Prosperity: A look at basic Human Aspirations; Right understanding: Relationship and Physical Facilities ; Happiness and Prosperity: current scenario ; Method to fulfill the Basic human aspirations

Unit II Harmony in Human Being 6+3 Hour

Human being as a co-existence of self ('I') and the material 'Body'; needs of Self ('I') and 'Body'; The Body as an instrument of 'I'; Harmony in the self ('I'); Harmony of the self ('I') with body; Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

Unit III Harmony in the Family and Society 6+3 Hour

Harmony in the Family the basic unit of human interaction; Values in human to human relationship; Trust as the foundational values of relationship; Respect as the right evaluation ;Understanding harmony in the society (society being an extension of family); Vision for the universal human order

Unit IV Harmony in the Nature 6+3 Hour

Understanding the harmony in the Nature Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature; Existence as Co-existence at all levels; Holistic perception of harmony in existence.

Unit V Harmony on Professional Ethics 6+3 Hour

Natural acceptance of human values ;Definitiveness of Ethical Human Conduct; Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics ;Case study: holistic technologies, management models and production systems ;Strategy for transition towards value based life and profession

Course Outcomes At the end of this course, students will be able to:	**Affective Level**
CO1. Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO2. Appraise physical, mental and social wellbeing of self and practice techniques to promote wellbeing.	Responding
CO3. Value human relationships in family and society and maintain harmonious relationships.	Valuing
CO4. Respect nature and its existence for survival and sustainable of all life forms and hence practice conservation of nature	Valuing
CO5. Appreciate ethical behaviour as a result of value system in personal and professional situations	Receiving

Text Book(s):

T1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Book(s):

R1.Jeevan Vidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.

R2.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

R3. The story of stuff, Annie Leonard, Free Press, New York 2010.

Web References:

1. https://aktu.ac.in/hvpe/ResourceVideo.aspx
2. http://hvpenotes.blogspot.com/
3. https://nptel.ac.in/courses/109/104/109104068/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	1	2	2	-	-	2
CO2	-	-	-	-	-	1	2	2	2	1	-	2
CO3	-	-	-	-	-	2	2	2	2	1	-	2
CO4	-	-	-	-	-	2	2	2	2	-	-	2
CO5	-	-	-	-	-	1	2	2	2	-	-	2

High-3; Medium-2; Low-1

Course Code: 19PSHG6004	Course Title:TAMILS AND TECHNOLOGY (Common to all B.E/B.TechProgrammes)		
Course Category: Humanities		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.

2. Understand the Scientific Tamil & Tamil Computing.

TAMILS AND TECHNOLOGY

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions inSilappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO.1 Understand Weaving and Ceramic Technology, Designand Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.	Understand
CO.2 Understand the Scientific Tamil & Tamil Computing.	Understand

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

<table>
<tr><td>Course Code: 19PSHG6004</td><td colspan="3">Course Title:TAMILS AND TECHNOLOGY
(Common to all B.E/B.TechProgrammes)</td></tr>
<tr><td colspan="2">Course Category: Humanities</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0 :0</td><td>Credit: 1</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்ள இயலும்.

CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்ள இயலும்.

தமிழரும் தொழில்நுட்பமும்

அலகு 1 – நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு 2 – வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் ஷ சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம் மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள், பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ – சாரோசெனிக் கட்டிடக் கலை.

அலகு 3 – உற்பத்தித் தொழில்நுட்பம் 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு 4 வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன் வளம் – முத்து மற்றும் முத்துக் குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு 5 – அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி – கணினித் தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென் பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

Course Outcomes மாணவர்கள் இப்பாடத்தை கற்றபின்	Cognitive Level
CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

Semester IV

<table>
<tr><td colspan="2">Course Code:19MABG1401</td><td colspan="3">Course Title: Probability and Statistics
(Common to all B.E/B.TechProgrammes)</td></tr>
<tr><td colspan="3">Course Category: Basic Science</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 1: 0</td><td colspan="2">Credits:4</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Calculate expectations and variances of random variables
2. Apply the concepts of standard distributions to solve practical problems
3. Calculate the correlation and regression for two variables
4. Test the samples based on hypothesis
5. Analyze the samples based on variance

Unit I Probability and Random Variables 9+3 Hours

Axioms of Probability- Conditional Probability- Total Probability -Baye's Theorem- Random Variables- Probability Mass Function- Probability Density Functions- Properties - Moments-Moment generating functions and their properties.

Unit II Standard Distributions 9+3Hours

Binomial- Poisson- Uniform –Exponential- Normal Distributions and their properties-Functions of a random variable.

Unit III Two Dimensional Random Variables 9+3Hours

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and regression – Transformation of random variables.

Unit IV Testing of Hypotheses 9+3 Hours

Sampling Distributions- Testing of hypotheses for mean, variance, proportions and differences using Normal, t, Chi-Square and F distributions – Tests for independence of attributes and Goodness of fit.

Unit V **Design of Experiments** **9+3 Hours**

Analysis of Variance (ANOVA)- One way Classification – Completely Randomized Design(CRD) – Two way Classification – Randomized Block Design (RBD) – Latin square.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Calculate expectations and variances of random variables	Apply
CO2: Apply the concepts of standard distributions to solve practical problems	Apply
CO3: Calculate the correlation and regression for two variables	Apply
CO4: Test the samples based on hypothesis	Apply
CO5: Analyze the samples based on variance	Apply

Text Book(s)

1. Veerarajan T, “Probability, Statistics and Random process”, 4th Edition, Tata McGraw-Hill, New Delhi, 2013.
2. Dr.J.Ravichandran, “Probability and Statistics for Engineers”, 1st Edition, Wiley India Pvt.Ltd.,2010.

Reference Book(s)

1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, “Probability and Statistics for Engineers and Scientists”, 9th Edition Pearson Education, Asia, 2016.
2. M.R. Spiegel,J. Schiller and R.A. Srinivasan, “Schaum's Outlines Probability and Statistics”, 3rdEdition,Tata McGraw Hill Edition, 2009.
3. Morris DeGroot, Mark Schervish, “Probability and Statistics”, Pearson Educational Ltd, 4th Edition, 2014.
4. Johnson and C.B. Gupta,“Probability and Statistics for Engineers”, 9thEdition,Pearson Education, Asia, 2016.

Web References

1. https://onlinecourses.nptel.ac.in/111105041/
2. https://nptel.ac.in/downloads/111105041/
3. https://nptel.ac.in/courses/111105090/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td>Course Code:
19EECN1401</td><td colspan="3">Course Title: Synchronous and Induction Machines</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

The student should have undergone the course(s):

- DC Machines and Transformers

Course Objectives

The course is intended to:

1. Explain the terminology, principles and theory of operation of Synchronous generators
2. Explain the working, performance and applications of Synchronous motors
3. Interpret the construction types, losses, efficiency and parameters of Induction motors
4. Select the different starting and speed control methods of Induction motor
5. Discuss the construction, principle of operation and applications of single phase motors

Unit I Alternator 11 Hours

Introduction – Construction – Types - stationary armature - EMF equation – armature reaction – voltage regulation – pre-determination of regulation by EMF, MMF, and ZPF methods. Load characteristics – parallel operation – synchronizing torque, reactance and reluctance power – load sharing – alternator on infinite bus bar – two reaction theory – predetermination of voltage regulation for salient pole machines.

Unit II Synchronous Motor 8 Hours

Theory of operation – phasor diagrams - variations of current and power factor with excitation – selection of starting methods – hunting and methods of suppression – power angle relations – V and inverted V curves – application - synchronous condenser.

Unit III Three Phase Induction Motor 10 Hours

Constructional details – types of rotors – principle of operation – production of RMF – torque equation – torque slip characteristics – maximum torque – slip for maximum power – effect of rotor resistance – losses and efficiency - induction generators: PMSG, PMSM - performance calculation: equivalent circuit, testing – load test – no load and blocked rotor tests, circle diagram – separation of no load losses - Application.

Unit IV Starting And Control of Three Phase Induction motor 8 Hours

Selection of starting methods: DOL, stator resistance, auto transformer, rotor resistance and star–delta starters. Selection of speed control methods: Speed control by change of frequency, V/F ratio, number of poles and change of slip – Cogging – crawling - Electrical Braking: - plugging - regenerative and dynamic braking.

Unit V Single Phase Motor 8 Hours

Constructional details of single phase induction motor – double field revolving theory – equivalent circuit. Selection of self-starting methods: Types of Single phase induction motor - Split phase, capacitor start, capacitor start capacitor run, permanent split capacitor, shaded pole starting methods – starting and running characteristics – applications - Hysteresis motor, Universal Motor - characteristics – applications.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the terminology, principles and theory of operation of synchronous Generator	Understand
CO2: Explain the working, performance and applications of synchronous motors	Understand
CO3: Interpret the construction types, losses, efficiency, parameters and applications of three phase induction motor	Understand
CO4: Select the different starting and speed control methods for three phase induction motors	Understand
CO5: Select the suitable type of single phase motor based on the application	Understand

Text Book(s)

1. Nagrath I.J Kothari D.P, “Electric Machines”, Tata McGraw Hill publishing company Ltd, New Delhi, 3rd Edition,2010.
2. Murugesh Kumar, K, “Induction & Synchronous Machines”, Vikas publishing house Pvt.Ltd.,Noida, 1st Edition, 2009.

Reference Book(s)

1. Bimbhra. P.S., “Electrical Machinery”, Khanna Publishers, New Delhi, 7th Edition, 2011.
2. Gupta. J.B., “Theory and Performance of Electrical Machines”, S.K. Kataria& Sons, New Delhi, 4thEdition, 2010.
3. Theraja. B.L., Theraja. A.K. “A Textbook of Electrical Technology, Volume II(AC & DC Machines)”, S.Chand & Company Ltd, New Delhi, 5th Edition, 2006.
4. A.E.Fitzgerald, Charles Kingsley, Stephen .D. Umans, “Electric Machinery”, TataMcgraw Hill, New Delhi, 5th Edition, 2013.
5. V K Mehta & Rohit Mehta, “Principle of Electrical Machines”, S. Chand Publishing, 2nd Edition, 2009

Web References

1. http://www.nptelvideos.in/2012/11/basic-electrical-technology.html
2. http://www.nptelvideos.in/2012/11/electrical-machines-i.html
3. http://www.nptel.ac.in/courses/108106072/

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code:19EECN2401</td><td colspan="3">Course Title: Electronic Circuits</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 2</td><td>Credits: 4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Electron Devices
- Electric Circuit Analysis

Course Objectives

The course is intended to:

1. Explain the operation of rectifier circuits and voltage regulators
2. Explain the need and types of biasing circuits
3. Model the small signal transistor amplifier using hybrid parameters
4. Classify the power amplifiers based on the location of operating point
5. Explain the operation of Oscillators and Multivibrators

Unit I Rectifier Circuits and Regulators 10 Hours

Half wave, Full wave and Bridge rectifier – Average value, RMS value, Transformer Utilization factor, efficiency – Capacitive Filter; Voltage Regulators: Series regulator – Shunt regulator – Line regulation, Load regulation – Design of Zener diode regulator.

Unit II Biasing Circuits 8 Hours

Need for Biasing - Factors affecting Stability of Q- point - Stability factors – Types of BJT Biasing circuits: Fixed Biasing, Feedback Bias, Voltage Divider Bias – Biasing of JFET and MOSFET- Voltage divider biasing.

Unit III Small Signal Transistor Amplifier 10 Hours

Hybrid model of BJT, Graphical determination of hybrid parameters, Analysis of BJT amplifier: Common Emitter, Common Base – Design of single stage RC coupled amplifier using BJT – Frequency response of amplifier, Small signal model of FET amplifier.

Unit IV Large Signal Amplifiers 7 Hours

Comparison of Small signal and Large signal amplifier, Classification of Large Signal amplifier: Class A – Direct and Transformer coupled Class B – Push Pull, Complementary Symmetry amplifiers, Amplifier Distortion – Thermal Stability and heat sink.

Unit V Oscillators and Wave shaping Circuits 10 Hours

Classification of Oscillators, Barkhausen Criterion, RC Oscillators: RC phase shift and Wien Bridge oscillators, LC Oscillators: Hartley and Colpitts Oscillators, Crystal Oscillators - Clippers and Clampers, Multivibrators: Astable, Monostable and Bistable Multivibrators.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the operation and parts of a regulated power supply	Understand
CO2: Explain the types of biasing circuits and the factors affecting the stability	Understand
CO3: Explain the analysis of small signal transistor amplifier using hybrid parameters	Understand
CO4: Classify the power amplifiers and explain their operation	Apply
CO5: Model the operation of oscillators and multivibrators	Apply

Text Book(s)

T1. Robert L Boylestad, Louis Nashelsky, “Electronic Devices and Circuit Theory”, Pearson Education, 11thEdition, 2015.

T2. S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, “Electronic Devices and Circuits”by, Tata McGraw Hill, New Delhi, 2ndEdition 2008.

Reference Book(s)

R1. Anil K.Maini, VarshaAgarwal, “Electronic Devices and Circuits”, Wiley India Private Ltd, New Delhi, 1stEdition, 2015.

R2. David A. Bell, “Electronic Devices and Circuits”, Oxford, 5thEdition, April 2008.

R3. Thomas L Floyd, “Electronic Devices” Pearson prentice hall, 10th Edition, 2017.

R4. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.

R5. Streetman Ben G. and Banerjee Sanjay, “Solid State Electronic devices”, PHI, 6th Edition, 2006.

Web References

1. http://nptel.ac.in/video.php?subjectId=117103063

2. http://nptel.ac.in/video.php?subjectId=117106091

Laboratory Component **30 Hours**
List of Experiments

1. Half wave, Full wave rectifier and Bridge rectifier with and without capacitive filter
2. Frequency response of RC coupled amplifier
3. Clipping circuits and Clamping circuits
4. Series and Shunt voltage regulator
5. Simulation of Astable multivibrator using BJT
6. Simulation of Class B Complementary Symmetry power amplifier
7. Simulation of RC phase shift Oscillator using BJT

Reference Book:

1. Electronics Laboratory Lab manual prepared by Department of Electrical and Electronics Engineering.

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	3	1	-	3	1	1
CO3	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	3	1	-	-	2	2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19CSSC2401</td><td colspan="2">Course Title: Data Structures and Algorithms (Common to EE,EI)</td></tr>
<tr><td colspan="2">Course Category: Engineering Science</td><td colspan="2">CourseLevel: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:60</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites

- C Programming

Course Objectives

The course is intended to:

1. Design linear data structure
2. Implement Tree data structure
3. Implement Graph data structure
4. Demonstrate a familiarity with sorting in data structure
5. Apply suitable algorithm for searching and hashing techniques

Unit I Linear Data structure 6 Hours

Data Structures types - Abstract Data Types - List ADT: Array and Linked List Implementation - Stack ADT: Stack Model - Array Implementation of Stack –Queue ADT: Queue Model - Array Implementation of Queue

Unit II Non Linear Data Structure: Tree 6 Hours

Tree - Preliminaries - Binary tree - Tree traversal - Applications - Expression tree - Binary search tree – 2-3 Tree

Unit III Non Linear Data Structure: Graph 6 Hours

Representation of graph - Graph Traversals: Depth first and Breadth first traversal- Topological sort - Shortest path algorithms: Dijkstra's algorithms - Minimum Spanning Tree: Prim's and Kruskal's algorithms.

Unit IV Sorting 6 Hours

Simple Sorting Algorithms – Insertion sort -Shell Sort - Merge Sort – Quick Sort

External Sorting.

Unit V Searching and Hashing **6 Hours**

Linear Search – Binary Search – Hashing: Hash Functions – Separate Chaining – Open Addressing – Linear Probing – Quadratic Probing – Double Hashing.

List of Exercises **30 Hours**

1. Create a C program to implement Singly Linked list using Linked list implementation
2. Create a C program to implement Stack using array implementation
3. Create a C program to implement Queue using array implementation
4. Develop a C program to implement Binary search tree.
5. Develop a C program to implement Dijkstra’s algorithm.
6. Create a C program to implement Merge Sort / Quick Sort / Bubble Sort

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1:Design Linear data structure such as Linked List, Stack and Queue using C	Apply
CO2: Implement Tree data structure for the given Scenario	Apply
CO3: Implement Tree data structure for the given application	Apply
CO4: Demonstrate a familiarity with sorting in data structures for a real time Scenario	Apply
CO5: Apply suitable algorithm for searching and hashing techniques for given application	Apply

Text Book(s)

T1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd Edition, Pearson Education Asia, New Delhi, 2011

Reference Book(s)

R1. Sahni, “Data Structures Using C, The McGraw-Hill, New Delhi, 2006.

R2. Michael.T.Goodrich, “Data Structures and Algorithm Analysis in C”, Wiley student Edition, New Delhi, 2007

R3. Thomas H.Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein, “Introduction to Algorithms”, MIT Press, England, 2009.

Web References

1. https://www.coursera.org/specializations/data-structures-algorithms
2. http://www.csse.monash.edu.au/~lloyd/tildeAlgDS
3. http://freevideolectures.com/Course/2279/Data-Structures-And-Algorithms

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	1	3	1	-	-	2	1
CO2	3	2	1	1	2	-	-	1	3	1	-	-	2	1
CO3	3	2	1	1	2	-	-	1	3	1	-	-	2	1
CO4	3	2	1	1	2	-	-	1	3	1	-	-	2	1
CO5	3	2	1	1	2	-	-	1	3	1	-	-	2	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19EECN3401</td><td colspan="2">Course Title: Synchronous and Induction Machines Laboratory</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L : T : P (Hours / Week)
0 : 0 : 3</td><td>Credits :1.5</td><td>Total Contact Hours : 45</td><td>Max Marks :
100</td></tr>
</table>

Prerequisites:

- DC Machines and Transformer Laboratory

Course Objectives

The course is intended to:

1. Acquire knowledge of three phase alternators
2. Demonstrate the parallel operation of alternator
3. Demonstrate the working of starters and speed control induction motor
4. Acquire knowledge of Synchronous motors
5. Acquire knowledge of induction motors

List of experiments:

1. Load test on three phase Alternator
2. Regulation of three phase alternator by EMF method
3. Regulation of three phase alternator by MMF method
4. Regulation of three phase salient pole alternator by slip test
5. Determination of V and Inverted V curves of Synchronous Motor
6. Demonstrate the working of different types of starters and speed control of three phase Induction Motor
7. Load test on single phase induction motor
8. Load test on three phase Squirrel cage and Slip-ring induction motor
9. No load and blocked rotor test on a three phase induction motor – Equivalent Circuit and Circle Diagram
10. Parallel operation of three phase alternators

Course Outcomes		Cognitive Level
At the end of the course students will be able to:		
CO1.	Determine the performance of an alternator by direct and indirect method.	Apply
CO2.	Demonstrate the parallel operation of alternator and control of induction motor.	Apply
CO3.	Determine the synchronous motor's performance curves.	Apply
CO4.	Determine the performance of Synchronous motor.	Apply
CO5.	Determine the performance of Induction motor.	Apply

Reference Books

1. Gupta. J.B., "Theory and Performance of Electrical Machines", S. K. Kataria and Sons, 2010.

2. "Synchronous And Induction Machines Laboratory Manual" prepared by Department of Electrical and Electronics Engineering.

3. Bimbra P. S., Electrical Machinery, 7thEdition, Khanna Publishers, 2011.

4. Nagrath J. and D. P. Kothari, Theory of AC Machines, Tata McGraw Hill, 2006.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1		-	-	2	3	2	-	-	2	1
CO2	3	2	1	1		-	-	2	3	2	-	-	2	1
CO3	3	2	1	1		-	-	2	3	2	-	-	2	1
CO4	3	2	1	1		-	-	2	3	2	-	-	2	1
CO5	3	2	1	1		-	-	2	3	2	-	-	2	1

High-3; Medium-2; Low-1

Course Code:19EESN4401	Course Title: Process Engineering in Mechanical Part Assembly		
Course Category: Engineering Science		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the processes and procedures to perform casting and injection moulding
2. Describe the processes and procedures to perform machining
3. Illustrate the processes and procedures to perform sheet metal and metal joining
4. Manufacture the given parts by applying suitable standards and procedures as per the control plan for the required specification
5. Inspect the manufactured parts to perform corrective and preventive actionon the part using suitable testing methods

Unit I Casting and Injection Moulding 3+9 Hours

Packaging processes for electrical / electronic products. Passivation in metals (anodizing, galvanizing, chrome plating, Nickel Plating, Powder coating). Plastic moulding process – types, injection moulding process, compression moulding process Packaging processes for electrical / electronic products. Passivation in Plastics (PVD coating , hot dip coating , spraying)

Experiment-1. Preparation of mould using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).

Experiment - 2. Preparation of Mould Cavity for Gear Pattern.

Unit II Machining Operations 3+9 Hours

Process for making inserts (Heat staking, Ultrasonic assisted, insert Moulding, Cold Pressed)

Types of Snap Fits (Cantilever, U- Shaped,Torsion,Annular).

Experiment-3. Facing and Turning using lathe for water level controller.

Experiment-4. Drilling using drilling machine for water level controller.

Experiment-5. Making screw using Capstan / Turret lathe.

Unit III Sheet Metal and Metal Joining Processes 3 +9Hours

Sheet metal characteristics, shearing processes (piercing, perforation, blanking, trimming, notching, nibbling and shaving processes). CNC bending (CPU panel, MCB panel). Drawing, re-drawing, embossing, coining and stamping. Packaging processes for electrical / electronic product. Resistance welding and its types (spot, seam, projection, flash butt).welding symbol. Additive manufacturing – 3D printing.

Experiment-6. Drilling, tapping and bending operations in sheet metal.

Experiment-7. Transformer Casing for water level controller.

Experiment-8. Welding of Lap joint.

Experiment-9. Welding of T-joint.

Unit IV Standards, Dimensions and Control plan in Part Manufacturing 3+9 Hours

Production drawing, geometric dimensions and standards- straightness, flatness, circularity, perpendicularity, surface finish. Control plan –sequence of operation (work flow instruction), tools required, machining parameters, special requirements (finishing)

Experiment- 10 Inspection of dimensions using metrology tools

Unit V Corrective and Preventive Action using Suitable Testing Methods 3+9 Hours

Root cause analysis – material, dimensions, Geometry, Physical distortions – methods (fish-bone diagram). Reworking methods(Machining incase of stock availability , drilling , adhesive bonding

, repainting / recoating / replating)

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Identify the processes and procedures to perform casting and injection moulding	Apply
CO2: Build the processes and procedures to perform machining	Apply
CO3: Build the processes and procedures to perform sheet metal and metal joining	Apply
CO4: Build the given parts by applying suitable standards and procedures as per the control plan for the required specification	Apply
CO5: Interpret the manufactured parts to perform corrective and preventive action on the part using suitable testing methods	Understand

Text Book(s)

T1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Process for Engineering Materials", 5th Edition, Pearson Education, 2014.

T2. Worksheets and Handouts prepared by MCET team.

Reference Book(s)

R1. P. N. Rao, "Manufacturing Technology: Foundry, Forming and Welding", 4th (Vol.1) Kindle Edition, 2013

R2. Sharma, P.C., A Text book of Production Technology, S. Chand and Co. Ltd.2014.

R3. Roy. A. Lindberg, Processes and Materials of Manufacture, PHI / Pearson Education, 2006.

Web References

1. https://www.BOConline.co.uk

2. http://www.nimionlinelearning.gov.com

3.http://www.engineeringarticles.org/manufacturing-process-meaning-and-types/

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	-	2	3	2	-	-	2	2
CO2	3	2	2	1	-	-	-	2	3	2	-	-	2	2
CO3	3	2	2	1	-	-	-	2	3	2	-	-	2	2
CO4	3	2	2	1	-	-	-	2	3	2	-	-	2	2
CO5	2	1			-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEPN6401	**Course Title: Mini-Project**		
Course Category: Project		**Course Level: Practice**	
L:T:P (Hours/Week) 0: 0: 4	**Credits: 2**	**Total Contact Hours:60**	**Max. Marks:100**

Pre-requisites:

- Nil

Course Objectives:

The course is intended to:

1. Take up any practical problems and propose solution by formulating suitable methodology.
2. Work collaboratively in a team to successfully complete the project
3. Effectively communicate the results of projects in a written and oral format

The objective of Mini-Project is to provide students hands on experience on, troubleshooting, maintenance, fabrication, innovation, record keeping, documentation etc. thereby enhancing the skill and competency part of technical education. It is executed on an individual basis or two/three students in a group, under the guidance of a supervisor. The assignments in the Mini-Project involves

1. Surveying the recent literatures
2. Identifying the problems/areas for improvement
3. Formulating the objective of the project and suggest the suitable design methodology
4. Conducting analysis by Modeling /Simulation/Experiments
5. Preparing documentation
6. Periodically presenting the progress of project/results to the technical committee through reviews

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2: Work collaboratively in a team to successfully complete the project	Apply
CO3: Effectively communicate the results of projects in a written and oral format	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	-	-	-	3	3	2	1
CO2	-	-	3	-	-	-	-	3	3	-	3	3	2	1
CO3	-	-	-	-	-	-	-	3	-	3	-	3	2	1

High-3; Medium-2; Low-1

Semester V

Course Code: 19EECN1501		Course Title: Generation, Transmission and Distribution	
Course Category: Professional Core		Course Level: Introductory	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Electric Circuits

Course Objectives

The course is intended to:

1. Explain the concept of power generation.
2. Compute the transmission line parameters.
3. Determine the performance and mechanical design of transmission line.
4. Compute the voltage distribution in insulator and dielectric stress in cables.
5. Determine the voltage of AC and DC distributors

Unit I Power Generation 9 Hours

General structure of power system - types of generation: conventional- thermal power plant, hydro power plant, nuclear power plant-concept of distributed generations: solar and wind - load capacity factor - connected load - load curve and load duration curve - economics of power generation- types of tariff.

Unit II Transmission Line Parameters 9 Hours

Parameters of single and three phase transmission lines with single and double circuits: resistance, inductance and capacitance of solid. Stranded and bundled conductors- symmetrical and unsymmetrical spacing transposition- application of self and mutual GMD- skin and proximity effects.

Unit III Analysis of Transmission Lines 9 Hours

Transmission lines: types –short line, medium line and long line- equivalent circuits, surge impedance - transmission efficiency and voltage regulation - surge-impedance loading - introduction to shunt and series compensation-Ferranti effect and corona loss -calculation of sag and tensions.

Unit IV Insulators and Cables 9 Hours

Insulators: types, voltage distribution in insulator string, improvement of string efficiency- underground cables: constructional features of LT and HT cables, capacitance, dielectric stress and grading.

Unit V Distribution System 9 Hours

Feeders, distributors and service mains - radial and ring main systems - calculation of voltage in distributors with concentrated and distributed loads, A.C. single phase and three phase distribution systems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the structure of power system, sources of electrical energy, various factors of load curves, tariffs.	Understand
CO2. Compute the transmission line parameters.	Apply
CO3. Determine the performance and mechanical design of various types of transmission lines.	Apply
CO4. Compute the voltage distribution in insulator and dielectric stress in cables.	Apply
CO5. Determine the voltage at various load points of AC and DC distributors.	Apply

Text Book(s)

T1. Wadhwa,C.L.,"Electrical Power Systems",6th Edition,NewageInternational, 2014.

T2. M.L.Soni,Gupta,Bhatnagar, Chakrabarthy, 'A Text book on Power Systems Engineering', Danpat Rai& Sons, 1st Edition, 2010.

T3. V.K.Mehta, Rohit Mehta," Principles of Power System", S Chand & Co Ltd, 4th Edition, 2011.

Reference Book(s)

R1. S.N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd, 2nd Edition, 2010.

R2. B.R. Gupta, "Generation of Electrical Energy", S. Chand & Company Ltd, 4th edition, 2014

R3. Leonard L. Grigsby, “Electric Power Generation, Transmission and Distribution”, CRC Press, 3rd Edition, 2012.
R4. Haadi Saadat, “Power System Analysis”, TATA Mcgraw Hill, 3rd Edition, 2010.

Web References

1. nptel.ac.in/courses/108102047
2. www.tangedco.gov.in

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code 19EECN2502		Course Title: Microprocessors and Microcontrollers	
Course Category: Professional Core		**Course Level: Practice**	
L:T:P(Hours/Week) **3: 0: 2**	**Credits:4**	**Total Contact Hours:75**	**Max Marks:100**

Pre-requisites

- Digital Electronics

Course Objectives

The course is intended to:

1. Explain the basic architecture of microprocessor.
2. Choose appropriate technique to interface the peripheral devices with microprocessor.
3. Write PIC18/PIC16 microcontroller programs.
4. Develop on-chip peripheral's programs.
5. Design a microcontroller system.

Unit I Microprocessor Architecture 9 Hours

Evolution of Microprocessor, Introduction to 8 bit Microprocessor: ALU – Registers - System buses – Memory –Data Format - Opcode format - Addressing modes - Instruction sets and Computer languages - Internal operation of 8085 microprocessor- interrupts - 8086 architecture

Unit II 8085 Peripherals Interfacing 9 Hours

External Memory interfacing, Parallel Peripheral Interface, Keyboard/Display controller, USART, Interrupt controller, DMA controller.

Unit III PIC Microcontroller and Programming 9 Hours

PIC18FX Pin connection, Architecture: WREG register – File register – Status register, I/O Ports, Data type and Time delay in C , Logical operation, Data sterilization, Program ROM Allocation, Data RAM allocation, Introduction to MPLAB IDE.

Unit IV Interrupts and Timer 9 Hours

Programming Timer and Counter, Basics of Serial communication: Serial port programming, Interrupt: Timer Interrupt - External Hardware Interrupts - Serial Communication Interrupts, ADC characteristics: ADC Programming, PWM Programming

Unit V System Design and Application 9 Hours

LCD interfacing, Keyboard interfacing, SPI bus protocol, DS1306 RTC interfacing and programming, Relay and opto-isolator, stepper motor interfacing, DC motor interfacing, PWM motor control with CCP.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1.Explain the basic architecture of microprocessor	Understand
CO2. Choose appropriate technique to interface the peripheral devices with microprocessor	Understand
CO3.Write PIC18/PIC16 microcontroller programs using Embedded C.	Apply
CO4. Develop programs for on-chip peripherals	Apply
CO5. Design a system using microcontroller	Apply

Text Book(s)

T1. R.S.Gaonkar,"Microprocessor Architecture, Programming and Applications with the 8085", 5th Edition, Prentice Hall, 2002.

T2. Muhammad Ali Mazidi, RolinD.Mckinlay, Danny Causery,"PIC Microcontroller and Embedded systems using assembly and C PIC18", Pearson international edition, 2008.

Reference Book(s)

R1. A.K Ray ,K.M.Bhurchandi ,"Advanced Microprocessors and Peripherals" 3rd Edition McGraw Hill Education 2012.

R2. Douglas V.Hall, "Microprocessor and Interfacing, Programming and Hardware", Revised 2nd Edition, Tata McGraw Hill, Indian Edition 2007.

R3. Krishna Kant, "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051 and 8096", PHI, 2011.

R4. John B Peatman, "Designing with PIC Micro Controller", 1stEdition, Pearson, 2003.

R5. MykePredko, "Programming and Customizing the PIC Microcontroller", 3rd edition Tata McGraw hill 2008.

Web References:

1. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/TOC.htm
2. https://www.tutorialspoint.com/microprocessor/microprocessor_8086_overview.htm
3. http://www.microchip.com/design-centers/microcontrollers
4. https://electrosome.com/category/tutorials/pic-microcontroller/hi-tech-c/

Laboratory Component **30 Hours**

PIC16FXX/18FXX Microcontroller

1. Control the LED using switch.
2. Buzzer interfacing using Timer/Counter.
3. Relay interfacing using transistor driver circuit.
4. Transmission and Reception of a byte using on chip serial port.
5. Read the temperature sensor value using ADC and display it in LCD.
6. Speed and direction control of DC motor.

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO3	3	2	1	1	3	-	-	1	3	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	3	1	-	3	2	2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code:19EECN1503</td><td colspan="2">Course Title: Linear Integrated Circuits</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites The student should have undergone the course(s):

- Electron Devices
- Electronic Circuits

Course Objectives

The course is intended to:

1. Explain the fabrication process of Linear ICs
2. Describe the construction and characteristics of operational amplifier
3. Discuss the applications of operational amplifier
4. Discuss the working principle of comparators and data converters
5. Explain the working of special function ICs.

Unit I IC Fabrication 9 Hours

IC classification - Fundamentals of monolithic ICs –Basic Planar Processes - Construction of a typical Integrated circuit– Active and Passive Components of ICs: Monolithic transistors, Monolithic diodes, Integrated Resistors, Integrated Capacitors and Inductors. Thin and Thick film Technology

Unit II Circuit Configuration and Characteristics of OPAMP 9 Hours

Block Diagram of Op-amp - Current mirror and Current source - Widlar current source -Wilson current source - Ideal Op-amp characteristics and its equivalent circuit – DC characteristics - AC characteristics – Concept of frequency compensation-methods of improving slew rate

Unit III Applications of OPAMP 9 Hours

Ideal Inverting and Non-inverting amplifier - Voltage Follower - Adder– Subtractor - Instrumentation Amplifier - Integrator – Differentiator – Precision rectifiers: Half wave and Full wave rectifier - Fundamentals of Log and Antilog Amplifiers - Low Pass & High Pass Butterworth Filters - Sine wave generators.

Unit IV Comparators And Converters 9 Hours

Basic Comparators – Zero crossing detectors – Schmitt trigger– Window detector – DAC: specifications - weighted resistor type, R-2R Ladder type. ADC: Specifications - Flash type - Successive Approximation type - Dual Slope type.

Unit V - Special Function ICs and its Applications **9 Hours**

Timer IC 555 – Astable and Monostable multivibrators - Voltage Controlled Oscillator (VCO)- PLL IC 565: Principle of operation -Application of PLL for AM, FM and FSK demodulation - Voltage regulators-IC 78XX, IC79XX, IC LM317, general purpose regulator IC 723.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the fabrication process of Linear ICs.	Understand
CO2: Describe the construction and characteristics of operational amplifier	Understand
CO3: Discuss the applications of operational amplifier.	Understand
CO4: Discuss the working principle of comparators and data converters.	Understand
CO5: Explain the working of Timers, PLL circuits, Voltage regulator ICs.	Understand

Text Book(s)

T1. D. Roy Choudhery, Sheil B. Jain, Linear Integrated Circuits, 2nd Edition, New Age Publishers, 2010.

T2. Ramakant A. Gayakwad, Op-amps and Linear Integrated Circuits, 4th Edition, Pearson Education, 2009, PHI.

Reference Book(s)

R1. Robert F.Coughlin, Fredrick F. Driscoll, ‘Op-amp and Linear ICs’, PHI Learning, 6th Edition, 2012

R2. Jacob Millman, Christos C.Halkias, “Integrated Electronics - Analog and Digital circuits system”, Tata McGraw Hill, 2003

R3. James M. Fiore, Op Amps and Linear Integrated Circuits Concepts and Applications, 2nd Edition, Cengage Learning 2012.

R4. S. Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 3rd Edition, TMH, 2003

R5. David A. Bell, “Op-amp & Linear ICs”, Second Edition, Prentice Hall of India, 2005.

Web References

1. http://www.nptel.ac.in/courses/Webcourse-contents/IIT ROORKEE /Analog %20 circuits/html

2. http://www.555-timer-circuits.com

3. http://www.technologystudent.com/elec1/elecex.htm

4. http://freevideolectures.com/Course/2915/Linear-Integrated-Circuits#

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO3	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO4	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO5	2	1	-	-	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2;Low-1

Course Code: 19EECN1504	Course Title: Fundamentals of Power Electronics		
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Electric Circuits
- Electron Devices
- Electronic Circuits

Course Objectives

The course is intended to:

1. Explain various power switching devices
2. Compute the performance parameters
3. Identify a DC-DC converter
4. Explain the operation of inverters and harmonic reduction
5. Describe the operation of AC voltage controller and cyclo converter

Unit I Power Switches 9 Hours

Power Diode: reverse recovery characteristics, types

SCR: Two transistor model, turn-on methods, commutation techniques, dynamic behavior, types, series and parallel connection, UJT trigger circuit, protection circuits: over voltage and over current and snubber circuits, losses and cooling

MOSFET& IGBT: Construction, dynamic behavior and driver circuit

Unit II Controlled Rectifiers 9 Hours

1 pulse, 2 pulse, 3 pulse and 6 pulse converters with R and RL loads, dual converter, performance parameters, estimation of average load voltage.

Unit III DC Converters 9 Hours

Choppers: Principle of step-up and step-down operation, Time ratio control and current limit control.

Switching regulators: Operation of Buck, Boost and Buck-boost regulators.

Unit IV Inverters 9 Hours

single-phase half and full bridge, three-phase six step VSI and CSI, Control: voltage control of single phase inverter, output AC voltage control

Unit V AC-AC Converters 9 Hours

AC voltage controller: types of control - on-off, phase angle control and sequence control, Single phase: With R and RL loads, Three phase: Star and Delta connected loads.

Cycloconverter: single phase and three phase cyclo converters

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO6:Compare characteristics of switching devices.	Understand
CO7: Evaluate the performance of rectifiers.	Apply
CO8: Design DC-DC converter with given specifications	Apply
CO9:Analyze and evaluate the operation of Inverters	Apply
CO10: Analyze and evaluate the operation of AC-AC Converters	Apply

Text Book(s)

T3. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, 3rd Edition (reprint), 2011.

T2. S. Bimbhra, "Power Electronics", Khanna Publishers, 3rd Edition, 2004.

T3. M.D.Singh and K.B.Khanchandani, 'Power Electronics', Tata McGraw Hills Publishing Company Limited, 2nd Edition, 2006.

Reference Book(s)

R1. Ned Mohan, T.M.Undeland, W.P.Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 3rd Edition (reprint), 2009.

R2. Joseph Vithayathil, "Power Electronics: Principles and Applications", Tata McGraw-Hill,New Delhi,2010.

R3. Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, 1st Edition, 2012.

Web References

1. http://nptel.ac.in/courses/108101038/1
2. http://cusp.umn.edu/power_electronics.php
3. http://ecee.colorado.edu/copec/book/slides/slidedir.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code:19EECN3501	Course Title: Integrated Circuits Laboratory		
Course Category: Professional Core		**Course Level: Practice**	
L:T:P(Hours/Week) 0: 0: 3	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Prerequisites:

- Electron Devices
- Electronic Circuits

Course Objectives

The course is intended to:

1. Design basic electronic circuits.
2. Examine frequency response characteristics of filters.
3. Design op-amp circuits for open and closed loop applications.
4. Analyze the application of PLL.
5. Verify the output of multi-vibrators and power supplies.

List of experiments

1. Design of Inverting, Non inverting and differential amplifiers.
2. Design of Integrator and Differentiator
3. Design of Instrumentation amplifier.
4. Design of Active low-pass and High-pass filters.
5. Design of RC Phase shift and Wien bridge oscillators using op-amp.
6. Design of comparator applications.
7. Design of weighted resistor and R-2R ladder type DACs.
8. Study of various types of ADCs.
9. Design of Frequency Multiplier using PLL IC565.
10. Design of Astable and Monostablemultivibrators using NE555 Timer.
11. Design of DC power supply using LM723.

Course Outcomes	Cognitive Level
At the end of the course students will be able to:	
CO1. Design basic electronic circuits using op-amps and verify their outputs	Apply
CO2. Examine frequency response characteristics of filters.	Apply
CO3. Design op-amp circuits for open and closed loop applications and verify their outputs.	Apply
CO4. Analyze the application of PLL.	Apply
CO5. Verify the output of multi-vibrators and power supplies.	Apply

Reference Book(s)

1. "Linear Integrated Circuits Laboratory" Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Web References

1. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
2. Sergio Franco, Design with operational amplifiers and analog integrated circuits, McGraw-Hill,2002.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	2	3	2	-	-	2	2
CO2	3	2	1	1	1	-	-	2	3	2	-	-	2	2
CO3	3	2	1	1	1	-	-	2	3	2	-	-	2	2
CO4	3	2	1	1	1	-	-	2	3	2	-	-	2	2
CO5	3	2	1	1	1	-	-	2	3	2	-	3	2	2

High-3; Medium-2; Low-1

Course Code: 19PSHG6501	Course Title: Employability Skills 1: Teamness and Interpersonal Skills (Common to all B.E/B.Tech Programmes)		
Course Category: Humanities	**Course Level: Introductory**		
L: T:P (Hours/Week): 0:0:2	**Credit :1**	**Total Contact Hours: 30**	**Total Marks: 100**

Pre-requisites:

- NIL

Course objectives:

The course is intended to

1. Enrich effective communicative attributes and facilitate presentation and public speaking skills
2. Handle negativities and explore the true self
3. Inculcate interpersonal skills and to groom as a professional
4. Educate the importance of Nonverbal skill set to attain perfection
5. Provide teamness and its ethics to facilitate corporate working

Unit I Effective Communication and Presentation Skills 6 Hours

Barriers of Communication-Fear Of English- Handling Social Factors-Handling Psychological Factors-Handling-Practical Problems-Do's &Don't's-**Effective Presentation** - Presentation- Importance of Presentation- Slide orientation– Introduction in a presentation - Styles of a slide - Slide Templates- Font ,color, Background-Graph Diagrammatic representation- Delivery of presentation- Body Language &Gestures - Verbal Attributes- Communication-Handling stammers and breaks- Handling fear of stage- Maintaining Confidence- Content delivery methods-Do's and Don'ts in a presentation- Tips to handle it-Effective Conclusion

Unit II Positive Attitude and Handling Rejections 6Hours

A,B,C's Of Attitude-Influencing Factors -Individual Factors-Character Comparison -Strategies to Handle ourselves-Benefits of Positive Attitude- Do's&Don't's- **Handling Rejections**- Identifying Negativities -Nuances of handling it -Necessary changes-To do List-Creating One's self- Self Qualifiers

Unit III Interpersonal Skills 6Hours

Life skills-Core IP Skills -Importance of IPSkills-Tips to improve IP Skills-Necessity of IP Skills

Unit IV Body Language, Dressing and Grooming 6 Hours

Unconscious Physical moments- Metrics of Body Language- Good Posture -Head Motion-Facial Expression- Eye contact–Gestures-Dressing - Grooming & Outlook - Necessity of good Body Language

Unit V Team Ethics 6 Hours

Team Ethics-Necessity of Team Work- Teams Everywhere- Benefits of team culture -Reason for team failure-Conflicts- Handling Conflicts-Being a team player-Work difference from college

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to:	
CO1: Demonstrate effective communicative attributes as part of their skills and facilitate presentation & public speaking skills	Apply
CO2: Identify and explore the true self and handle negatives	Apply
CO3: Develop interpersonal skills and to groom as a professional	Apply
CO4: Explain the importance of Nonverbal skill set to attain perfection	Understand
CO5: Build teamness and its ethics to facilitate corporate working	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	-	1	1	-	-
CO4	-	-	-	-	-	-	-	-	-	1	-	1	-	-
CO5	-	-	-	-	-	-	-	2	1	-	-	1	-	-

High -3, Medium – 2, Low-1

Text Books

T1: John C Maxwell, " The 17 Indisputable Laws of Teamwork: Embrace Them and Empower Your Team", Harper Collins Leadership Publishers, 2013

Reference Books

R1: Patrick Lencioni, " The Five Dysfunctions of a Team: A Leadership Fable" Jossey Bass Publishers, 2006

R2: Malcolm Gladwell, "Talking to Strangers: What We Should Know about the People We Don't Know" Penguin Publishers, 2019

R3: Harvey Segler, " Body Language: Discovering & Understanding the Psychological secrets behind reading & Benefiting from Body Language" Kindle Edition, 2016

Mode of Delivery

1. Continuous learning and reviews guided by faculty
2. Guided Learning Workshop

Semester VI

Course Code: 19EECN2602	**Course Title: Introduction to Python Programming**		
Course Category: Engineering Science		**Course Level: Mastery**	
L:T:P(Hours/Week) 2: 0: 2	**Credits:3**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- C Programming
- Data Structures and Algorithms

Course Objectives

The course is intended to:

1. Identify various syntax and operators in python programming.
2. Illustrate control flow, library functions and file operations.
3. Implement object oriented features in python.
4. Apply database connectivity technique.
5. Design user interfaces.

Unit I Programming Constructs 6 Hours

Basics: Data Types – Declaring variables - Usage of Operators- Special functions - Python standards in Coding. Sequential Statements - Control statements - Performing Iterations – Strings - Tuples-Sets - Dictionary.

Unit II Functions 6 Hours

Functions: Defining & Calling function- Passing arguments to functions: Mutable & Immutable Data Types - Different types of arguments-Recursion-Scope of variables. Standard Library: Math, String, List, Date & Time Modules. Files: Open- Close- Write- Read.

Unit III OOP in python 6 Hours

Classes - Objects – Modifiers - Method Invocation – Inheritance – Polymorphism - Packages - Scopes and Namespaces - Interface - Exception Handling.

Unit IV Database Programming 6 Hours

DBM files - Pickled objects - Shelve files - Object Oriented Database - SQL Database interfaces

Unit V GUI Programming 6 Hours

GUI basics-Working with TKinter library- Adding widgets-Binding Events- Message and Entry-Check and Radio button- Menus and list-Canvas

Lab Experiments 30 Hours

1. Implement data types, operators and expressions
2. Implementation of Branching and Looping Constructs
3. Implementation of Functions
4. Implementation of Files handling techniques
5. Implementation of Class and Objects
6. Implementation of Database Connectivity with SQL Server
7. Implementation of T Kinter library

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Identify various syntax and operators in python programming for writing simple programs.	Apply
CO2: Illustrate control flow, library functions and file operations using user-defined and pre-defined functions.	Apply
CO3: Implement object oriented features in python for writing reusable codes.	Apply
CO4: Apply database connectivity technique for real time applications.	Apply
CO5: Design user interfaces using python based GUI components	Apply

Text Book(s)

T1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey, and Chris Meyers, “How to Think Like a Computer Scientist: Learning with Python”, 3rd Edition, O’Reilly, 2014.

T2. MarkLutz,”Powerful Object Oriented Programming Python”, 4th Edition, O’Reilly 2012.

Reference Book(s)

R1. Mark Lutz, “Learning Python, Powerful OOPs”, O’Reilly, 2011.

R2. Zelle, John M, “Python Programming: An Introduction to Computer Science”, Franklin Beedle & Associates, 2003.

R3. Budd, Timothy, “Exploring Python”, McGraw-Hill Science, 2009.

R4. Matplotlib for Python Developers: Effective techniques for data visualization with Python, 2nd Edition, Kindle Edition.

Web References

1.Python tutorial URL:https://docs.python.org/3/tutorial/

2. Advanced Python URL:https://www.learnpython.org/
3. Python basic tutorial URL:www.pyschools.com/
4.Data Visualization https://www.datacamp.com/courses/introduction-to-data-visualization-with-python/

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	1	1	-	-	1	2	3	-	-	2	2
CO2	3	2	1	1	1	-	-	1	2	3	-	-	2	2
CO3	3	2	1	1	1	-	-	1	2	3	-	-	2	2
CO4	3	2	1	1	1	-	-	1	2	3	-	-	2	2
CO5	3	2	1	1	1	-	-	1	2	3	-	-	2	2

High-3; Medium-2;Low-1

Course Code:19EECN1602	Course Title: Control Systems		
Course Category: Professional Core		Course Level: Practice	
L:T:P(Hours/Week) 3: 1: 0	Credits:4	Total Contact Hours:60	Max Marks:100

Pre-requisites

- Electric Circuits

Course Objectives

The course is intended to:

1. Model electrical and mechanical systems.
2. Determine the time response and time domain specifications.
3. Analyze the given first order and second order systems
4. Analyze the system stability.
5. Design compensator.

Unit I Control System Modeling 9+3 Hours

Basic Elements of Control System – Open loop and Closed loop systems - Transfer function, Modelling of Electrical systems, mechanical systems: Translational and rotational systems- Transfer function of armature and field controlled DC motor- Block diagram reduction Techniques – Signal flow graph

Unit II Time Response Analysis 9+3 Hours

Standard test signals - Time response of first order systems - Impulse and Step Response analysis of second order systems – Time Domain specifications - Steady state errors and error constants – Effects of P, PI, PD and PID Controllers on the system's response

Unit III Frequency Response Analysis 9+3 Hours

Frequency Response – Bode Plot: Gain margin, Phase margin, gain & phase crossover frequency-Polar Plot: Gain margin, Phase margin, - Frequency Domain specifications from the plots – correlation between time domain and frequency domain specifications

Unit IV Stability Analysis 9+3 Hours

Stability, Routh-Hurwitz Criterion, Concept of Root Locus Technique, Construction of Root Locus, Effects of adding poles and zeros – Nyquist Stability Criterion

Unit V Compensator Design 9+3 Hours

Performance criteria – Lag, lead and lag-lead networks – Compensator design using bode plots. Compensator Design using MATLAB.

Course Outcomes At the end of this course, students will be able to:		**Cognitive Level**
CO1.	Model electrical and mechanical systems using transfer function	Apply
CO2.	Determine the time response and time domain specifications of first order and second order systems	Apply
CO3.	Analyze the given first order and second order system with their frequency domain specifications.	Apply
CO4.	Analyze the stability of the given system.	Apply
CO5.	Design compensator using bode plot technique	Apply

Text Book(s)

T1. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 6th Edition 2017.

T2. Benjamin C. Kuo, 'Automatic Control systems',10th Edition Pearson Education, New Delhi, 2017.

Reference Book(s)

R1. Norman S. Nise, 'Control Systems Engineering', Fifth Edition, John Wiley, New Delhi, 2018.

R2. Samarajit Ghosh, 'Control systems Theory and Applications ',2nd Edition Pearson Education, New Delhi, 2012.

R3. M. Gopal, 'Control Systems, Principles and Design', 4th Edition Tata McGraw Hill, New Delhi, 2012.

R4. K. Ogata, 'Modern Control Engineering', Pearson Education India, 5th Edition New Delhi, 2015.

R5. Richard C.Dort and Robert H.Bishop, "Modern Control Systems ", Pearson Prentice Hall, 13th Edition 2016.

Web References

1. http://nptel.ac.in/courses/108101037/
2. https://www.tutorialspoint.com/control_systems/control_systems
3. http://lpsa.swarthmore.edu/Root_Locus/RLocusExamples.html
4. https://in.mathworks.com/help/control/examples/compensator-design-for-systems-represented-by-frequency-response-data.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	3	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	3	-	-	1	-	1	-	-	2	2

High-3; Medium-2;Low-1

Course Code: 19EECN1603	Course Title: Fundamentals of Digital Signal Processing		
Course Category: Professional Core		**Course Level: Practice**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- Digital Electronics

Course Objectives

The course is intended to:

1. Classify the type of signals & systems and Perform operation
2. Analyze the discrete time systems.
3. Compute Discrete Fourier Transform.
4. Design Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters.
5. Analyze the effects of finite word length.

Unit I Classification of Signals And Systems 9+3 Hours

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance - classification of signals: continuous and discrete, energy and power - mathematical representation of signals - Typical signal processing operations: Linear convolution, Circular Convolution, Correlation - Sampling of CT signals, Sampling Theorem, Effect of under Sampling- Aliasing- Reconstruction of CT signal from Samples

Unit II Analysis Of Signals 9+3 Hours

Fourier Series representation of DT periodic signals (DTFS)- properties, Representation of DT aperiodic signals by Fourier Transform (DTFT), properties - Z-transform and its properties, inverse z-transforms; difference equation – Solution by z transform - application to discrete systems - Stability analysis, frequency response –Convolution using Z-transform- Introduction to DFT – Properties of DFT.

Unit III Fast Fourier Transform 9+3 Hours

FFT algorithms – Radix-2 FFT algorithms – Decimation in Time (DIT-FFT) and Decimation in Frequency (DIF-FFT) algorithms – DFT analysis of sinusoidal signals. Fast convolution-overlaps save method – overlap add method.

Unit IV Design of Digital Filters 9+3 Hours

IIR design: Approximation of analog filter design - Butterworth and Chebyshev; digital design using impulse invariant and bilinear transformation - Warping, prewarping - Frequency transformation.

FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. FIR & IIR filter realization – Parallel & cascade forms.

Unit V Finite Word Length Effects 9+3 Hours

Number representations – Quantization – Truncation and Rounding– Quantization noise – Oversampling A/D and D/A Conversion – Quantization of filter coefficients – Effects of finite word length on digital filters – Finite word length effects in FFT algorithms.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Classify the type of signals & systems and Perform operation on signals	Understand
CO2:Analyze the discrete time systems using Z and Fourier transforms	Apply
CO3:Compute Discrete Fourier Transform of a given discrete time sequence using FFT.	Apply
CO4:Design Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) digital filters for a given specification	Apply
CO5:Analyze the effects of finite word length on filter implementation	Apply

Text Book(s)

T1. John G. Proakis&Dimitris G. Manolakis, “Digital Signal Processing – Principles, Algorithms&Applciations”, 4th Edition, Pearson Education/ Prentice Hall, 2007.

T2. S.Salivahanan, A. Vallavaraj, C. Gnanapriya, ‘Digital Signal Processing’, Tata McGraw Hill, New Delhi,2nd Edition, 2010.

Reference Book(s)

R1. Emmanuel C. Ifeachor& Barrie. W. Jervis, “Digital Signal Processing”, 2nd Edition, Pearson Education,Prentice Hall, 2002.

R2. Sophocles J. Orfanidis, “Introduction to Signal Processing, Prentice Hall, 1996.

R3. Li Tan, “Digital Signal Processing: Fundamentals and Applications”, Academic Press, 2008.

R4. Johnny R. Johnson, “Introduction to Digital Signal Processing”, Prentice-Hall International, 1989.

R5. Lonnie C. Ludeman, “Fundamentals of digital signal processing”, Harper and Row, 1986.

R6. Allan V. Oppenheim & Ronald W. Schafer, “Discrete Time Signal Processing”, Prentice Hall, 3rd Edition, 2009.

Web References

1. http://www.dspguide.com/pdfbook.html (free on-line text in pdf format).
2. www.dspguru.com
3. www.ti.com

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	1	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	1	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	1	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	1	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	1	2	2

High-3; Medium-2;Low-1

Course Code:19EECN3601	**Course Title: Power Electronics Laboratory**		
Course Category: Professional Core		**Course Level: Practice**	
L:T:P(Hours/Week) **0: 0: 3**	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Prerequisites:

- Nil

Course Objectives

The course is intended to:

1. Analyze the transient characteristics
2. Simulate and analyze the output of ac-dc converters
3. Simulate and analyze the output of dc-dc converters
4. Simulate and analyze the output of dc-ac converters
5. Simulate and analyze the output of ac-ac converters

List of experiments:

1. Determine the turn on and turn off time of MOSFET,SCR and also draw it’s characteristics.
2. Model the Single phase half and full converter using simulation and validate the result using hardware.
3. Model the Three phase half and full converter using simulation and validate the result using hardware.
4. Model the Single phase inverter using simulation and validate the result using hardware.
5. Model the Three phase inverter using simulation and validate the result using hardware.
6. Model the Step up chopper using simulation and validate the result using hardware.
7. Model the Step down chopper using simulation and validate the result using by hardware.
8. Model the Four quadrant chopper using simulation and validate the result using hardware.
9. Model the single phase AC voltage controller using simulation and validate the result using hardware.
10. Model the single phase Cycloconverter using simulation and validate the result using hardware.

Course Outcomes	Cognitive Level
At the end of the course students will be able to:	
CO1. Analyze the transient characteristics of MOSFET and SCR	Apply
CO2. Simulate and analyze the output of ac-dc converters	Apply
CO3. Simulate and analyze the output of dc-dc converter	Apply
CO4. Simulate and analyze the output of dc-ac converters	Apply
CO5. : Simulate and analyze the output of ac-ac converters	Apply

Reference Book(s):

1. ”Power Electronics Lab Manual” prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.
2. Muhammad H. Rashid”Power electronics Hand book”, Elsevier Inc.2018.

Web References:

1. https://nptel.ac.in/courses/108/102/108102145/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	2	3	2	-	3	2	2
CO2	3	2	1	1	2	-	-	2	3	2	-	-	2	2
CO3	3	2	1	1	2	-	-	2	3	2	-	-	2	2
CO4	3	2	1	1	2	-	-	2	3	2	-	-	2	2
CO5	3	2	1	1	2	-	-	2	3	2	-	-	2	2

High-3; Medium-2; Low-1

Course Code: 19EEPN6601	Course Title: Innovative and Creative Project		
Course Category: Project		**Course Level: Practice**	
L:T:P (Hours/Week) 0: 0: 4	**Credits: 2**	**Total Contact Hours:60**	**Max. Marks:100**

Pre-requisites:

- Mini-Project

Course Objectives:

The course is intended to:

1. Take up any practical problems and propose innovative/creative solution by formulating suitable design methodology.
2. Work collaboratively in a team to successfully complete the project
3. Effectively communicate the results of projects in a written and oral format

The objective of innovative and creative project is to enable the student to take up in-depth study in the broad field of Electrical/ Electronic Engineering, involving theoretical/simulation/practical work and to inculcate innovative thinking and thereby preparing students for main project. It is executed on an individual basis or two/three students in a group, under the guidance of a supervisor. The assignments in innovative and creative project involves

1. Surveying the recent literatures
2. Identifying the problems and suggest innovative/creative ideas in areas for improvement
3. Formulating the suitable objective and suggest the appropriate design methodology
4. Conducting analysis by Modeling /Simulation/Experiments
5. Preparing documentation
6. Periodically presenting the progress of project/results to the technical committee through reviews

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Take up any practical problems and propose innovative/creative solution by formulating suitable design methodology	Apply
CO2: Work collaboratively in a team to successfully complete the project	Apply
CO3: Effectively communicate the results of projects in a written and oral format	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	-	-	-	3	3	3	3
CO2	-	-	3	-	-	-	-	3	3	-	3	3	3	3
CO3	-	-	-	-	-	-	-	3	-	3	-	3	3	3

High-3; Medium-2; Low-1

Course Code: 19PSHG6601	**Course Title: Employability Skills 2: Campus to Corporate (Common to all B.E/B.Tech Programmes)**		
Course Category: Humanities	**Course Level: Introductory**		
L: T:P (Hours/Week): 0:0:2	**Credit :1**	**Total Contact Hours: 30**	**Total Marks: 100**

Pre-requisites:

- Nil

Course objectives:

The course is intended to:

1. Understand emotions and necessity to handle it to evolve as an effective social animal
2. Build effective resumes to project the positivesto be employable
3. Facilitate working in a collaborative work environment and to engage in healthy agreements for building person's professional facet
4. Enlighten the growth attribute to outperform, initiate and grow in professional arena
5. Practice effective handling of time and discarding the unprofessional habits.

Unit I Emotional Intelligence 6 Hours

Nature of Emotions- Importance of EI-EQ vs IQ-Behavioral difference between EQ & IQ-Acquiring Emotional Intelligence-Benefits of high EI -Steps to develop EI-Role of EI in Interviews

Unit II Resume Preparation 6Hours

Importance of Resume- Good Resume -Planning Resume-Organizing Resume-Spell check - Benefits of good resume- Resume Writing

Unit III Group Discussion 6Hours

Purpose of GD-Prerequisites of GD-Benefits of GD-Features of GD-Do's & Don'ts in GD-Accept Criticism &Feedback-Accepting Suggestions-GD Phrases-Effective Introduction& Conclusion- Preferred Etiquette of GD.

Unit IV Interview Etiquette (Netiquette) 6Hours

Definition of Interview-Types of Interview-Prior interview-Know the Company-Employer's perspective in interview-Non Verbal etiquette-Dressing-Verbal Communication in Interview-Facing Rejection in Interview-Do's & Don'ts in an

Interview-Common Interview Questions- Handling Stress Questions- Handling Telephonic Interviews.

Unit V Leadership Skills and Time Management 6 Hours

Leadership -Leadership Traits-Leadership styles-Types of Leaders-Qualities of a leader- Developing Perspectives

Time Management-Necessity of Time Management- Types of time-Estimation of time-Process of Time management-Efficient utilization of Time-Time wasting culprits Tips to manage time- Goal setting in Time Management

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to:	
CO1: Understand the emotions and necessity to handle them	Understand
CO2: Build effective resumes to project the positives to be employable	Apply
CO3: Facilitate collaborative work environment and to engage in healthy agreements for building person's professional facet	Understand
CO4: Formulate the growth attribute to outperform, initiate and grow in professional arena	Apply
CO5: Explain time management and impart leadership skills	Understand

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	-	1	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	1	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1		-	1	-	-
CO5	-	-	-	-	-	-	-	1	-	-	1	1	-	-

High -3, Medium – 2, Low-1

Text Books

T1: Thea Kelley, "Get That Job! The Quick and Complete Guide to a Winning Interview " Plover crest Press, 2017

Reference Books

R1: Daniel Goleman, " Emotional Intelligence Reader's Guide", BANTAM PUBLISHERS, 1997

R2: Daniel Goleman, Richard Boyatzis& Annie McKee, " Primal Leadership: Unleashing the Power of Emotional Intelligence" Harvard Business Review Press; Anniversary edition, 2013

R3: Stephen R Covey, " The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change" Simon & Schuster; Anniversary edition, 2013.

Mode of Delivery:

1. Continuous learning and reviews guided by faculty
2. Guided Learning Workshop

Semester VII

Course Code:19EECN1701		Course Title:Power System Analysis and Stability	
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 1: 0	**Credits:4**	**Total Contact Hours:60**	**Max Marks:100**

Pre-requisites

- Generation, Transmission and Distribution
- Numerical Methods and Linear Algebra

Course Objectives

The course is intended to:

1. Construct bus admittance matrix for power system network.
2. Apply numerical methods for power flow analysis.
3. Analyze the system's fault under balanced conditions.
4. Analyze the system's fault under unbalanced conditions
5. Analyze the stability of power system when it is subjected to a fault.

Unit I Introduction 9+3Hours

Single line diagram - Need for system planning and operational studies–Different types of power system analysis-per phase and per unit analysis- Generator, transformer, transmission line and load representation for Different power system studies -Primitive network-construction of Y-bus: Inspection and singular transformation methods.

Unit II Power Flow Analysis 9+3Hours

Statement of power flow problem-classification of buses-development of power flow modelling of complex variables form-iterative solution using Gauss-Seidel method-power flow model in polar form –iterative solution using Newton-Raphson method.

Unit III Fault Analysis– Balanced Faults 9+3Hours

Short circuit analysis: Importance, assumptions -analysis using Thevenin's theorem and Z-bus building algorithm-computations of short circuit capacity, post fault voltage and currents

Unit IV Fault Analysis–Unbalanced Faults 9+3Hours

Introduction to symmetrical components–sequence impedances–sequence circuits of synchronous machine ,transformer and transmission lines-sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem.

Unit V Stability Analysis 9+3Hours

Need for stability analysis in power system planning and operation- classification of power system stability-angle and voltage stability–Single Machine Infinite Bus (SMIB) system: Development of swing equation -equal area criterion -determination of critical clearing angle and time–solution of swing equation by modified Euler method and Runge - Kutta fourth order method.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Construct bus admittance matrix for power system network.	Apply
CO2: Apply numerical methods for power flow analysis.	Apply
CO3:Model the fault in the power system under balanced conditions	Apply
CO4:Model the fault in the power system under unbalanced conditions	Apply
CO5: Identify the stability of power system when it is subjected to a fault.	Apply

Text Book(s)

T1.John J.Grainger and W.D.StevensonJr.,'Power System Analysis' ,Tata McGraw-Hill, ,2017.

T2.HadiSaadat, 'Power System Analysis', Third Edition,Tata McGraw Hill Education Pvt.Ltd., New Delhi,2012.

Reference Book(s)

R1.NagrathI.J.and Kothari D.P., 'Modern Power System Analysis', Fourth Edition,Tata McGrawHill, 2011.

R2.Wadhwa, C.L., "Electrical Power Systems", Sixth Edition, New age International, 2018

R3.Kundur P., 'Power System Stability and Control, 10 th reprint, Tata McGraw Hill Education Pvt. Ltd.2010.

R4. Pai MA, ‘Computer Techniques in Power System Analysis’, Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
R5. T.K Nagsarkar,’Power System Analysis’, 2nd edition, Oxford Press, 2014.
R6. A.Venkatesan,‘Electrical Power Systems:Analysis, Security and Deregulation’,PHI Learning Pvt. Ltd,2012.

Web References

1. http://nptel.ac.in/courses/108105067/
2. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/power-system/ui/TOC
3. www.elcomhu.com/Electrical/Power%20System%20Stability/stability%20slides.
4. www.textofvideo.nptel.iitm.ac.in/108102047/lec26
5. www.elect.mrt.ac.lk/EE423_%20Fault_Analysis_Notes

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-		2	2
CO2	3	2	1	1	3	-	-	1	-	1	-		2	2
CO3	3	2	1	1	-	-	-	1	-	1	-		2	2
CO4	3	2	1	1	-	-	-	1	-	1	-		2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code: 19EECN2701	Course Title: Electric Drives and Controls		
Course Category: Professional Core		Course Level: Practice	
L:T:P (Hours/Week) 3:0:2	Credits:4	Total Contact Hours:75	Max Marks:100

Pre-requisites

- DC Machines and Transformers
- Synchronous and Induction Machines
- Power Electronics

Course Objectives

The course is intended to:

1. Understand the functions and load torque characteristics of different types of drives
2. Apply the working of rectifier and chopper fed dc motor drives
3. Apply the different types of speed controls of induction motor drives
4. Summarize the working of synchronous and BLDC motor drives
5. Outline the working of advanced electric drives and applications

Unit I Electric Drives 9 Hours

Parts of Electrical drives – Classification of electric drives - Typical load torque characteristics – Selection of motor power rating - Thermal model of motor for heating and cooling - Classes of duty cycle – Multi quadrant operation

Unit II DC Drives 9 Hours

Single and three phase controlled rectifier fed separately excited DC motor drives – Chopper fed DC drives: Class A, B, C, D and E – Applications: DC traction using chopper

Unit III Induction Motor Drives 9 Hours

Stator side Control: Stator voltage - frequency and v/f control - CSI fed induction motor drives - VSI fed induction motor drives - Rotor side Control – vector controlled induction motor drives.

Unit IV Synchronous and BLDC Motor Drives 9 Hours

Scalar control of synchronous motor drive: True synchronous mode and self-control mode of operations– Marginal angle control and power factor control - BLDC motor drives – Applications

Unit V Advanced Drives and Case Study 9 Hours

Switched reluctance motor drives – permanent magnet synchronous machine drives – Case study: Textile industry, Paper industry, Electric vehicles and Steel rolling mills

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the functions and characteristics of electric drives.	Understand
CO2: Demonstrate the various modes of operation of power converter fed DC Motor drives.	Apply
CO3: Demonstrate the functions of converters for induction motor drives.	Apply
CO4: Explain the functions of converters for synchronous and BLDC motor drives.	Understand
CO5: Explain the working of advanced drives and applications of electric drives	Understand

Text Book(s):

T1. Dubey.G.K, "Fundamental of Electrical Drives", Narosa publishing House, New Delhi, 2nd Edition, 2020.

T2. BimalK.Bose. "Modern Power Electronics and AC Drives", Pearson Education, 1st Edition, 2015.

Reference Book(s):

R1. VedamSubrahmanyam "Thyristor control of Electrical Drives", Tata McGraw Hill Publishers, 2017.

R2. R.Krishnan,"Electric motor drives: Modeling, analysis and control", Pearson Education, New Delhi, 2015.

R3. Karl Johan Astrom, Bjorn Wittenmark, "Computer Controlled Systems: Theory and Applications", 3rd Edition, Dover Publications Inc, 2012

R4. Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink", Wiley,2014

Web References:

- https://nptel.ac.in/courses/108/104/108104140/
- https://epd.wisc.edu/courses/introduction-to-electric-machines-and-drives/
- http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html

Laboratory Component **30 Hours**

List of Experiments

1. Simulation of closed loop control of converter fed DC motor.
2. Simulation of closed loop control of chopper fed DC motor.
3. Simulation of VSI fed three phase induction motor drive.
4. Simulations of three phase synchronous motor drive.
5. Speed control of DC motor using three phase controlled rectifier.
6. Speed control of 3 Phase induction motor using PWM inverter.
7. Induction motor speed control using DSP.
8. Induction motor speed control using FPGA.

Reference Book:

1. Electric Drives and Controls Laboratory Manual Prepared by Department of Electrical and Electronics Engineering, MCET

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	3	1	-	-	2	2
CO4	2	1	-	-	-	-	-	1	3	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	3	1	-	3	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code :19EECN3701</td><td colspan="2">Course Title :Power System Simulation Laboratory</td></tr>
<tr><td colspan="2">Course Category: Professional Core</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P (Hours/Week)
0:0:4</td><td>Credits:2</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Prerequisites

- Generation, Transmission and Distribution
- Power System Analysis and Stability
- Power System Operation and Control

Course Objectives

The course is intended to:

1. Study the modeling and parameter estimation of transmissions lines
2. Study the various methods used for solving load flow analysis.
3. Calculate fault current during various fault conditions.
4. Study the economics, dynamics and transient analysis of power systems.
5. Simulate the protection of generator, transformer and vacuum circuit breaker using hardware setup.

List of Experiments **60 Hours**

1. Computation of performance and modeling of transmission lines.

2. Formation of bus admittance matrix

3. Formation of bus impedance matrix

3. Load flow analysis by Gauss Seidel method.

4. Load flow analysis by Newton Raphson method.

5. Symmetrical and unsymmetrical fault analysis.

6. Simulation of electromagnetic transients in power systems

7. Transient and small signal stability analysis of single machine infinite bus system

8. Transient stability analysis of multi machine power system.

9. Scheduling economic dispatch in power system.

10. Load frequency dynamics of single area and two area system.

11. Analysis of AC generator protection using AC generator protection simulator setup.
12. Analysis of transformer protection using transformer protection simulator setup.
13. Testing of Vacuum circuit breaker using VCB test set.
14. Fault analysis of three phase alternator using 3 phase fault analyzer setup.
15. Simulation of solar power plant using PV syst.

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to:	
CO1: Develop a program to compute the characteristic parameters of transmission line and to build power system network matrices.	Apply
CO2: Develop a program to analyze the load flow for a given power system network.	Apply
CO3: Develop a program to calculate the fault current at various fault conditions.	Apply
CO4: Simulate and find solutions related with transient stability problem, economic dispatch problem and load frequency dynamics of a power system.	Apply
CO5: Demonstrate the protection of generator, transformer and vacuum circuit breaker using hardware setup.	Apply

Reference Book(s)

1. "Power System Simulation Lab" Manual prepared by Department of Electrical and Electronics Engineering, MCET, Pollachi.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	-	-	2	3	2	-	-	2	2
CO2	3	2	1	2	2	-	-	2	3	2	-	-	2	2
CO3	3	2	1	2	2	-	-	2	3	2	-	-	2	2
CO4	3	2	1	2	2	-	-	2	3	2	-	-	2	2
CO5	3	2	1	2	2	-	-	2	3	2	-	-	2	2

High-3; Medium-2; Low-1

Semester VIII

<table>
<tr><td colspan="2">Course Code: 19EEPN6801</td><td colspan="3">Course Title: Project</td></tr>
<tr><td colspan="3">Course Category: Project</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td colspan="2">L:T:P (Hours/Week) 0: 0: 16</td><td>Credits:8</td><td>Total Contact Hours:240</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites:

- Mini-Project
- Innovative and Creative Project

Course Objectives:

The course is intended to:

1. Take up any real-world problems and propose solution by formulating suitable design methodology.
2. Work collaboratively in a team to successfully complete the project
3. Effectively communicate the results of projects in a written and oral format

The objective of project is to enable the student to take up real world problems in the broad field of Electrical/ Electronic Engineering involving theoretical/simulation/practical work. It is executed on an individual basis or two/three students in a group, under the guidance of a supervisor. The assignments in project involves

1. Surveying the recent literatures
2. Identifying the real world problems and areas for improvement
3. Formulating the suitable objective and suggest the appropriate design methodology
4. Conducting analysis by Modeling /Simulation/Experiments
5. Preparing documentation
6. Periodically presenting the progress of project/results to the technical committee through reviews

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Take up any real-world problems and propose solution by formulating suitable design methodology.	Apply
CO2: Work collaboratively in a team to successfully complete the project	Apply
CO3: Effectively communicate the results of projects in a written and oral format	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	-	-	-	3	3	3	3
CO2	-	-	3	-	-	-	-	3	3	-	3	3	3	3
CO3	-	-	-	-	-	-	-	3	-	3	-	3	3	3

High-3; Medium-2; Low-1

Course Code: 19EEEN1003		Course Title: High Voltage Engineering	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Generation, Transmission and Distribution

Course Objectives

The course is intended to:

1. Deduce necessary equations to relate waves with respect to voltage causes for external effects.
2. Understand the performances of different mediums like gaseous, liquid and solid dielectrics and breakdown
3. Explore the methods to generate high voltage and high current.
4. Predict a method to measure high voltage and high current in the given application.
5. Classify the various high voltage testing methods.

Unit I Over Voltages in Electrical Power Systems 9 Hours

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, reflection and refraction of travelling waves- Protection against over voltages

Unit II Dielectric Conduction and Breakdown in Gaseous,Liquid and Solid Dielectrics 9 Hours

Properties of Dielectric materials - Gases as insulating media-Ionization process and current growth - Corona discharges. Liquids as insulators-Breakdown mechanisms in liquid dielectrics-electronic breakdown, suspended solid particle mechanism-Fundamentals of insulating oils-Various processes of breakdown in solid dielectrics

Unit III Generation of High Voltage and Currents 9 Hours

Generation of high DC voltages - Multiplier circuits -Van de Graff generator-Electrostatic generators -High alternating voltage generation using cascade transformers-Production of high frequency AC high voltages-Standard impulse wave shapes

Unit IV Measurement of High Voltages and Currents 9 Hours

HVDC measurement techniques - Measurement of power frequency A.C voltages-Rod gap

Measurement technique-sphere gap measurement technique-Potential divider for impulse voltage measurement of high D.C, A.C and impulse currents-Digital recorders.

Unit V High Voltage Testing and Insulation Coordination 9 Hours

Indian standards for HV testing, Tests on insulators-Testing of isolators and circuit breakers-Cable testing-Testing of transformers-Surge diverter testing-Insulation coordination-Correlation between insulation and protection levels.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO 1.	Explain the transient over voltage effects and wave equations.	Understand
CO 2.	Discuss the various types of breakdown in gases, liquids and solids.	Understand
CO 3.	Analyze the characteristics of high voltage, high current and impulse voltage generators.	Apply
CO 4.	Describe the methods to measure high voltage, high current and impulse voltage.	Understand
CO 5.	Identify the procedure for different high voltage tests conducted on electrical apparatus.	Apply

Text Book(s)

T1. M.S.Naidu, and Kamaraju, High Voltage Engineering, Tata McGraw Hill, 4th Edition, 2014.

T2. E.Kuffel and M. Abdullah, High Voltage Engineering, Pergamon Press, 2013.

T3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, 3rd Edition,2010.

Reference Book(s)

R1. Dieter Kind, An Introduction to High Voltage Experimental Technique Wiley Eastern Limited, 2012.

R2. T Alston, High Voltage Technology BS Publications, 2011.

R3. C.L. Wadhwa, High Voltage Engineering Wiley Eastern Limited, 2014.

R4. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, 2nd Edition Marcel Dekker, Inc., 2010.

R5. Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning Private Limited, New Delhi, 2nd Edition, 2013.

Web References

1. https://outledge.com/High-Voltage-Engineering-Theory-and-Practice-Second-Edition-Revised-and/Abdel-Salam/p/book/9780367398194
2. https://nptel.ac.in/courses/108/104/108104048/
3. https://www.engineeringbookspdf.com/high-voltage-engineering-theory-and-practice-by-m-khalifa/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1		-	-	1	-	1	-	-	2	2
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	2	2	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1004</td><td colspan="2">Course Title: HVDC Transmission</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Generation, Transmission and Distribution
- Power Electronics

Course Objectives

The course is intended to:

1. Understand the concept, planning of DC power transmission
2. Analyze HVDC converters and system control
3. Study about the HVDC protection system
4. Analyze harmonics and design of filters
5. Learn the testing procedures and the application of HVDC system

Unit I Introduction 9 Hours

DC Power transmission technology -Comparison of AC and DC transmission HVDC: Description, DC links, Planning, Reliability, current trends, Advantages, Limitations & Applications — Global scenario.

Unit II HVDC System Control 9 Hours

Principles of DC link control — converter control & bridge characteristics of 12 Pulse converters— system control: firing angle control, individual phase control and equidistant phase control — comparison — current and extinction angle control — starting and stopping of DC link — power control

Unit III MTDC and Protection 9 Hours

Multi terminal HVDC Systems: Introduction-Types of faults — commutation failure —arc through and misfire — Basics of protection — DC reactors — voltage and current oscillations — circuit breakers — over voltage protection — switching surges — lightning surges — lightning arresters for DC systems

Unit IV Harmonics and Filters 9 Hours

Sources of harmonics in HVDC systems —harmonic distortion factor — types and design of filter: AC & DC filter - Smoothing reactors -IEEE standard 1124-2003: DC Side Harmonic Performance of HVDC Transmission Systems.

Unit V High Voltage Testing of Electrical Power Apparatus 9 Hours

Introduction of DC cables —DC insulation — Practical dielectrics — Dielectric stress consideration — Economics of DC cables compared with AC cables-applications

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the general aspects of HVDC transmission.	Understand
CO2: Identify the converter configurations and control methods used in HVDC.	Apply
CO3: Compare the converter faults and its protection schemes	Understand
CO4: Design a suitable filter for harmonic elimination	Apply
CO5: Organize the types, application of cables in HVDC system	Apply

Text Book(s)

T1. Padiyar, K. R., "HVDC power transmission system", Third edition, Wiley Eastern Limited,New Delhi 2014

T2. Edward Wilson Kimbark, "Direct Current Transmission", Vol. I, Reprint Wiley inter science,New York,London, Sydney, 2001

T3. S.Kamakshaiah,V.Kamaraju,"HVDC Transmission", Second Edition, McGraw Hill,2020

Reference Book(s)

R1. Chan-Ki Kim, Vijay K. Sood, GiI-Soo Jang, Seong-Joo Lim, Seok-Jin Lee HVDC Transmission: Power Conversion Applications in Power Systems, 1^{st} edition Wiley 2009.

R2. Arrillaga, J., "High Voltage Direct Current Transmission", Revised 2^{nd} Edition ,Peter Pregrinus, London, 1998.

R3. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering",4^{th} Edition New Age Interantional (P) Ltd., New Delhi 2011.

R4. Dragan Jovcic, Khaled Ahmed, "HVDC: High Voltage Direct Current Transmission line",1^{st} Edition, Wiley 2015

Web References

1. https://nptel.harmonics.in/courses/108104048/
2. https://nptel.power apparatus.in/courses/108104013/
3. https://nptel.highvoltage.in/courses/108/106/108106160/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	1	1	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	-	2	2

High-3; Medium-2;Low-1

Course Code: 19EEEN1007	Course Title: Smart Grid		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Generation Transmission and Distribution

Course Objectives

The course is intended to:

1. Study about smart grid technologies and their benefits.
2. Familiarize the concepts of various monitoring system.
3. Study about different smart meters and advanced metering infrastructure.
4. Understand the various communication technologies and protocols used for smart-grid.
5. Identify the application areas and energy storage devices for smart grid.

Unit I Introduction to Smart Grid 9 Hours

Evolution of Electric Grid - Difference between conventional & Smart Grid - Need for Smart Grid - Smart grid drivers: functions, opportunities, challenges and benefits - Concept of Resilient &Self-Healing Grid - Present development & International policies in Smart Grid

Unit II Wide Area Monitoring System 9 Hours

Fundamentals of synchro phasor technology - concept and benefits of wide area monitoring system - Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC) - Operational experience and Blackout analysis using PMU

Unit III Smart Meters and Advanced Metering Infrastructure 9 Hours

Introduction to Smart Meters - Advanced Metering infrastructure (AMI) drivers and benefits-AMI protocols - Standards and initiatives - AMI needs in the smart grid - Intelligent Electronic Devices (IED) for monitoring & protection.

Unit IV Information and Communication Technology 9 Hours

Overview of smart grid communication system· - Radio communication - Mobile communication - Power line communication - Optical fiber communication - Communication protocol for smart grid

Unit V - Smart Grid Applications **9 Hours**

Overview and concept of renewable integration - Micro grids - Typical structure and configuration of a micro grid, AC and DC micro grids - Advanced Energy Storage Technology: Flow battery, Fuel cell, SMES, Super capacitors - Plug- in Hybrid electric Vehicles

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic concepts of smart grid.	Understand
CO2: Discuss the concepts of wide area monitoring system.	Understand
CO3: Demonstrate the functions of various smart meters.	Apply
CO4: Explain the various communication technologies used in smart grid.	Understand
CO5: Identify the various applications of smart grid.	Apply

Text Book(s):

T1. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sonsInc, IEEE press, 1st edition, 2012.

T2. Janaka Ekanayake, Nick Jenkins, Kithsiriliyanage, Jianzhong Wu, Akihiko Yokoyama,"Smart Grid: Technology and Applications", John Wiley & sons Inc, 1st edition, 2012.

T3. Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 1st edition, 2012.

Reference Book(s):

R1. Fereidoon Perry Sioshansi "Smart Grid: Integrating Renewable, Distributed & Efficient Energy" Elsevier·,1st edition, 2012.

R2. Ali Keyhani, Mohammad N. Marwali, Min Dai, "Integration of Green and Renewable Energyin Electric Power Systems", Wiley, 1st edition, 2009.

R3. Pengwei Du, Ning Lu, "Energy storage for smart grids: planning and operation for renewable and variable energy resources" Elsevfer, 1st edition, 2015.

R4. Quang-Dung Ho, YueGao, Gowdemy Rajalingham, Tho Le-Ngoc, "Wireless Communications Networks for the Smart Grid", Springer International – Publishing,1st edition, 2014.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2;Low-1

Course Code: 19EEEN1016	Course Title: Advanced Power System Protection		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Protection and Switchgear

Course Objectives

The course is intended to:

1. Have basic concepts of static relay and its design principles of phase and amplitude comparators.
2. Illustrate the application of static relays in over current protection scheme.
3. Illustrate the application of static relays in differential protection scheme and distance relaying schemes.
4. Illustrate the application of static relays in various equipment protection.
5. Program Microprocessor based protection system for the power system network.

Unit I Static Relays and Comparators 9 Hours

Advantages of static relays - Basic construction of static relays-Level detectors - Replica impedance - Mixing circuits - General equation for two input phase and amplitude comparators-Amplitude comparator: Circulating current type and opposed voltage type- rectifier bridge comparators- Phase comparator: Coincidence circuit type- block spike phase comparator

Unit II Static over Current Relays 9 Hours

Instantaneous over-current relay-Time over-current relays-basic principles - definite time and Inverse definite time over-current relays.

Unit III Static Differential & Distance Relays 9 Hours

Analysis of Static Differential Relays - Static Relay schemes - Duo bias transformer differential protection –Harmonic restraint relay. Static impedance-reactance - MHO and angle impedance relay -sampling comparator - realization of reactance and MHO relay using sampling comparator.

Unit IV Equipment Protection 9 Hours

Generators Percentage differential protection, Protection against stator internal faults, stator overheating protection; Rotor Protection – Field ground fault protection, loss of excitation protection; protection against motoring and protection against voltage regulator failure. **Transformer:** Percentage differential protection, protection against magnetizing inrush current, Buchholz relay, over fluxing protection.

Unit V Microprocessor Based Protective Relays 9 Hours

(Block diagram and flowchart approach only): Over current relays–impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance – MHO and offset MHO relays-Realization of MHO characteristics -Realization of offset MHO characteristics -Basic principle of Digital computer relaying.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic components of static relaying system and phaseand amplitude comparator.	Understand
CO2: Explain the phase comparator and implementation of static relayfor over current.	Understand
CO3: Explain the implementation of static relay schemes for differentialand distance relaying schemes	Understand
CO4: Identify the application of static relay schemes in various equipment protections.	Apply
CO5: Model the operation and control of microprocessor based relays.	Apply

Text Book(s)

T1. Badri Ram and D. N. Vishwakarma, "Power system protection and Switch gear",2nd edition TMH publication New Delhi 2013.

T2. T.S. Madhava Rao, Power system protection Static relays, 2nd edition, TMH publication 1993.

T3. Arun G. Phadke & JamesS. Thorp, Computer Relaying for Power System,3rdedition, John Wiley & Sons, 1998.

Reference Book(s)

R1.Mason, The Art and Science of protective relaying, Wiley Eastern Ltd, 1947.

R2.C.L. Wadhwa, Electrical power systems, New age International (P) Limited,2017.

R3.Sunil S. Rao, Switchgear and protection, Khanna Publications, 10th edition,1992

Web References

1. https://nptel.microprocessor.ac.in/courses/108/101/108101039/
2. https://nptel.contoller.ac.in/courses/108/107/108107167/
3. https://nptel.microcontroller.ac.in/courses/108/107/108107113/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2;Low-1

Course Code: 19EEEN1017		Course Title: Power System Reliability	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Generation, Transmission and Distribution

Course Objectives

The course is intended to:

1. Introduce the concepts of probability and reliability.
2. Explain the fundamentals of load forecasting system and reliability analysis.
3. Explain the fundamentals of generation system and reliability analysis.
4. Explain the fundamentals of transmission system and reliability analysis.
5. Illustrate the basic concepts of Expansion planning

Unit I Basic Probability Theory and Reliability Concepts 9 Hours

Probability - The binomial distribution - The Poisson distribution - The normal distribution – The general reliability function – The exponential distribution – Mean time to failure - Modeling of series and parallel systems – Markov processes – Continuous Markov Process – Application of Markov Process - Recursive techniques.

Unit II Load Forecasting 9 Hours

Classification and characteristics of Loads – Approaches to load forecasting – Forecasting methodology – Extrapolation – Correlation - Energy forecasting – Residential, Industrial and Commercial sales forecasts – Peak demand forecasting – Weather load model – Non-weather sensitive forecast – Weather sensitive forecast – Total forecast – Seasonal and annual forecasts – Annual and monthly peak demand forecasts - Use of AI in load forecasting

Unit III Generation System Reliability Analysis 9 Hours

Probabilistic generating unit models – Probabilistic load models – Reliability analysis for an isolated system – Interconnected systems – Load and Generator models – Interconnected effective load probability distribution – Reliability analysis of Interconnected areas - Determination of LOLP and expected value of demand not served – Determination of reliability of ISO and interconnected generation systems.

Unit IV Transmission System Reliability Analysis 9 Hours

Deterministic contingency analysis – DC Power Flow and Z Matrix method for contingency analysis - Probabilistic transmission system reliability analysis - Determination of reliability indices like LOLP and expected value of demand not served.

Unit V Expansion Planning 9 Hours

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic concepts of probability and reliability	Understand
CO2: Explain the objectives of Load forecasting in power system	Understand
CO3: Organize the fundamentals of reliability analysis in generating system	Apply
CO4: Identify the fundamentals of reliability analysis in transmissionsystem	Apply
CO5: Outline the basic concepts of expansion planning in power system	Understand

Text Book(s)

T1. A. J. Wood and B. F. Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 2016.

T2. Billinton R. and Ronald N.A. "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Program, 2008.

T3. Prabha S. Kundur, Om P.Malik,"Power System Stability and Control", McGraw Hill, 2nd edition2022.

Reference Book(s)

R1.Marko Čepin, "Assessment of Power System Reliability", Springer Publications, 2011.

R2.Ali Chowdhury; Don Koval, 'Power Distribution System Reliability: Practical Methods and Applications", Wiley-IEEE Press,2009.

R3.Birolini, "Reliability Engineering: Theory and Practice by Alessandro",Springer Publications,2004.

Web References

1. https://www.udemy.com/course/power-system-reliability-concepts/

2. https://nptel.ac.in/courses/108/105/108105104/
3. https://pdhonline.com/courses/e485/e485_new.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1018	Course Title: Distributed Generation and MicroGrid		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Generation, Transmission and Distribution
- Power Electronics

Course Objectives

The course is intended to:

1. Introduce various types of renewable energy sources
2. Illustrate the concept of distributed generation
3. Analyze the impact of grid integration
4. Study concept of AC and DC micro-grid
5. Control the operation of micro-grid

Unit I Introduction 9 Hours

Conventional power generation: advantages and disadvantages, Energy crises, Non - conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

Unit II Distributed Generations 9 Hours

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

Unit III Impact of Grid Integration 9 Hours

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Unit IV **Basics of a Micro grid** **9 Hours**

Concept and definition of micro-grid, micro-grid drivers and benefits, review of sources of micro-grids, typical structure and configuration of a micro-grid, AC and DC micro-grids, Power Electronics interfaces in DC and AC micro-grids

Unit V **Control and Operation of Micro grid** **9 Hours**

Modes of operation and control of micro-grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro-grid communication infrastructure, Power quality issues in micro-grids, regulatory standards, Micro-grid economics, Introduction to smart micro-grids.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Model the conventional power generation the	Apply
CO2: Apply the concept of distributed generation and installation	Apply
CO3: Design the grid integration system with conventional and non-conventional energy sources	Apply
CO4: Design the dc and ac micro grid	Apply
CO5: Identify the power quality issues and control operation of micro grid	Apply

Text Book(s)

T1.Nick Jenkins, JanakaEkanayake , GoranStrbac , "Distributed Generation", Institution of Engineering and Technology, London, UK,2010.

T2.S. Chowdhury, S.P. Chowdhury and P. Crossley, "Microgrids and Active Distribution Networks", The Institution of Engineering and Technology, London, United Kingdom, 2009.

T3.Math H. Bollen , Fainan Hassan, "Integration of Distributed Generation in the Power System", John Wiley &Sons, New Jersey, 2011.

Reference Book(s)

R1.Magdi S. Mahmoud, Fouad M. AL-Sunni, "Control and Optimization of Distributed Generation Systems", Springer International Publishing, Switzerland, 2015.

R2. NadarajahMithulananthan, Duong Quoc Hung, Kwang Y. Lee, "Intelligent Network Integration of Distributed Renewable Generation", Springer International Publishing, Switzerland, 2017.

R3. Ali K., M.N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley and sons, New Jersey, 2010.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1019		Course Title: Transient in Power System	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Power System Analysis and Stability

Course Objectives

The course is intended to:

1. Clarify the concepts, types, causes & effects of transients in power systems
2. Understand the switching transients generation with its control using equivalent circuits
3. Analyze switching transient in three phase power circuit
4. Understand the lighting strokes mechanism and the production of lighting surges.
5. Computation of transients in propagation, reflection and refraction of travelling waves on transmission line

Unit I Introduction and Survey 9 Hours

Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.

Unit II Switching Transients 9 Hours

Simple Switching Transients: Circuit closing and recovery transients, Arcing grounds, Damping, resistance switching and equivalent circuit for interrupting the resistor current.

Abnormal Switching Transients: Current chopping, Capacitance switching, Ferro-resonance, Transformer magnetizing inrush currents, Re-striking phenomenon and its effects on recovery voltage.

Unit III Transients in Three Phase Circuits 9 Hours

Switching of three phase transformers, Effect of types of neutral connection, Three phase capacitance switching, Symmetrical component method of analysis of three phase switching transients, Effect of open conductors.

Unit IV Lightning Transients 9 Hours

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

Unit V Traveling Waves on Transmission Line Computation of Transients 9 Hours

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Explain the concepts, types, causes & effects of transients in power systems.	Understand
CO2: Explain the switching transients generation with its control using equivalent circuits	Understand
CO3: Model the switching transient in three phase power circuit	Apply
CO4: Describe the lighting strokes mechanism and the production of lighting surges	Understand
CO5: Compute the transient in propagation, reflection and refraction of travelling waves on transmission lines	Apply

Text Books

T1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, NewYork, 2nd Edition, 2010.

T2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and SonsInc., 2nd Edition, 2009.

T3. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statisticalapproach', PHI Learning Private Limited, 2nd Edition, 2010.

T4. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba, Teruo Ohno, Koichi Yamabuki," PowerSystem Transients",CRC Press,2nd Edition,2020

Reference Book(s)

R1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', McGraw Hill, 5th Edition,2013.

R2. R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.

R3. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.

Web References

1.https://nptel.transients.ac.in/courses/108/105/108105133/

2.https://nptel.lightning transients.ac.in/courses/108/105/108105104/

3.https://nptel.travelling concepts.ac.in/courses/108/104/108104051/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1059	Course Title: Power System Operation and Control		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Prerequisites:

The student should have undergone the course(s):

- Generation, Transmission and Distribution
- Power System Analysis and Stability

Course Objectives

The course is intended to:

1. An overview of power system operation and control.
2. Study the economic operation of power system.
3. Model power frequency dynamics and to design power frequency controller.
4. Model reactive power -voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
5. Learn about SCADA and its application for real time operation and control of power systems.

Unit I Introduction 8 Hours

Structure of power system – load and load duration curves – load forecasting– components of system load: base load, load factor, diversity factor and important terms for deciding the type and rating of the generating plant with related problems – reserve: requirements, installed reserves, spinning reserves, cold reserves, and hot reserves.

Unit II Economic Dispatch & Unit Commitment 8 Hours

Economic dispatch: incremental cost curve, co-ordination equations, solution by direct method and λ-iteration method (No derivation of loss coefficients) – base point– participation factors.

Unit commitment: constraints-methods: priority ordering, dynamic programming.

Unit III Active Power & Frequency Control 11 Hours

Speed governing system: transfer function model – load frequency control of single area system: static & dynamic response – AGC in isolated and interconnected power systems – modelling of tie line – representation of two area system: static and dynamic response, frequency bias tie line control – selection of bias factor.

Unit IV Reactive Power & Voltage Control 11 Hours

Generation and absorption of reactive power – methods of voltage control: excitation control, shunt and series reactor, series and shunt capacitor, synchronous condenser, static VAR systems, tap changing transformers – comparisons of different types of compensating equipment for transmission systems. Excitation system: characteristics, modelling of excitation system – types: DC, AC.

Unit V Power System Security & SCADA 7 Hours

Power system security: Factors and operating states – recent trends in real time control of power systems – introduction to state estimation.

SCADA: Energy control centers, EMS functions.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the load pattern of the generating station	Understand
CO2:Estimate the economic load dispatch and unit commitment for a given generator and load specifications	Understand
CO3: Design a power-frequency controller for the given specification	Apply
CO4:Explain reactive power-voltage interaction for maintaining the voltage profile of a system	Understand
CO5: Explain computer applications for secured power system operations.	Apply

Text Books:

T1.Prabha S. Kundur, Om P.Malik,“Power System Stability and Control”, McGraw Hill, 2nd edition2022.

T2.Allen. J. Wood and Bruce F. Wollenberg, ‘Power Generation, Operation and Control’, John Wiley & Sons, Third edition, 2013.

T3.Nagrath I.J., KothariD.P.,”Power System Engineering”, Tata MCGraw Hill Publication,3rd Edition, 2019.

Reference Books:

R1.Sivanagaraju, G.Sreenivasan- “Power System Operation & Control”, Pearson Education India, First Edition, 2010.

R2.N.V.Ramana, “Power System Operation and Control,” Pearson Education India, First Edition, 2011.

R3.Olle.I.Elgerd, 'Electric Energy Systems theory – An introduction', Tata McGraw Hill Education Pvt. Ltd., NewDelhi, 2nd Edition, 2012.

R4.P.Venkatesh, B.V.Manikandan, S.Charles Raja, 'Electrical Power Systems: Analysis, Security and Deregulation', PHI Learning Pvt., Ltd., 2012 Edition.

Web References:

1. http://nptel.ac.in/courses/108104052.
2. http://nptel.ac.in/courses/108106022/LECTURE%207.pdf
3. http://www.pse.pl/uploads/kontener/UCTE_Operation_Handbook_Appendix1.pdf.
4. http://electrical-engineering-portal.com/how-reactive-power-is-helpful-to-maintain-a-system- healthy.
5. http://home.iitk.ac.in/~saikatc/EE632_files/Ps_security.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1005	Power Electronic Applications to Renewable Energy		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Fundamentals of Power Electronics

Course Objectives

The course is intended to:

1. Provide knowledge about the stand alone and grid connected systems
2. Design different power converters for solar based system
3. Classify the types of WECS
4. Analyze and comprehend the various operating modes of wind electrical generators
5. Explain the need for hybrid system

Unit I Introduction 9 Hours

Environmental aspects of electric energy conversion, Recent trends in energy consumption - Energy sources and their availability, Global scenario: solar PV, Wind – Solar PV -Basics, Types: Standalone and Grid connected SPPs - Wind: Aerodynamic factors & types of Wind power system.

Unit II PV System Conversion 9 Hours

Introduction to PV-Cells, I-V Characteristics, Block diagram of PV System, components, MPPT tracking components &Controlling algorithms, Factors affecting PV output, Power converters for Solar: DC Power conditioning converters – AC power conditioners line commutated converters (inversion mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing - synchronized operation with grid supply Solar- Economic aspect – Efficiency and performance.

Unit III Wind Energy 9 Hours

Fixed speed systems: Generating Systems- Constant speed constant frequency systems - Choice of Generators, Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model

Variable speed systems: Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes

Unit IV Power Converters in WECS 9 Hours

AC voltage controllers, Interleaved boost converters, Two level Voltage source converters, Three level Neutral point clamped converters, multi-input converters, PWM current source Converters, Control of grid connected inverter: Generator-Side Control Grid side Control, Future trends in wind conversion system converters.

Unit V Hybrid System 9 Hours

Wind / Solar PV integrated systems – Need for Hybrid Systems- Types &range of Hybrid system- selection of power conversion ratio – Optimization of system components in hybrid power system. Power quality issues hybrid renewable power system

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Model the types of PV and Wind energy system	Apply
CO2. Explain the components &converters required for PV.	Understand
CO3. Describe the operation of various generators available for WECS	Understand
CO4. Explain the Converters needed for WECS	Understand
CO5.Compare the types of hybrid system and its components	Apply

Text Book(s)

T1. Mukund R. Patel ―Wind and Solar Power Systems: Design, Analysis, and Operation‖,2nd Edition, Taylor and Francis, 2005.

T2. Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro ―Power Conversion and Control ofWind Energy Systems", 1st Edition ,Wiley,2011.

Reference Book(s)

R1. Rashid .M. H ―Alternate Energy in power electronics‖, 1 st Edition ,Academic press,2015

R2. S.N.Bhadra, D. Kastha, & S. Banerjee ,―Wind Electrical Systems‖, 1st Edition , Oxford University Press, 2009.

R3. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, ―Grid Converters for

Photovoltaic and Wind Power Systems – 2nd Edition ,Wiley,2011.

Web References

1. https://onlinecourses.nptel.power converters.ac.in/noc19_ee37/preview
2. https://nptel.hybrid.ac.in/noc20_ee28/preview
3. https://nptel.ac.in/courses/108/107/108107143/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1008	**Course Title: Switched Mode Power Supplies**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Fundamentals of Power Electronics
- Control Systems

Course Objectives

The course is intended to:

1. Study the different types of non-isolated and isolated DC-DC converters
2. Understand the voltage mode and current mode control of DC-DC converters
3. Understand the necessity of resonant converters and its types.
4. Derive the converter transfer functions and controller for DC-DC converters.
5. Understand the design of power converters.

Unit I DC/DC Converters 9 Hours

Basic topologies of buck, boost converters, buck-boost converters, and cuk converter, isolated DC/DC converter topologies–forward, and fly-back converters, half and full bridge topologies, modeling of switching converters.

Unit II Current mode and Current Fed Topologies 9 Hours

Voltage mode and current mode control of converters, peak and average current mode control, its advantages and limitations, voltage and current fed converters.

Unit III Resonant Converters 9 Hours

Need for resonant converters, types of resonant converters, methods of control, phase modulation technique with ZVS in full-bridge topology, series resonant converter and resonant transition converter.

Unit IV Converter Transfer Functions and Controller Design 9 Hours

Application of state-space averaging to switching converters, derivation of converter transfer functions for buck, boost, and fly-back topologies.

Controller Design-

Introduction, mechanisms of loop stabilization, shaping E/A gain vs. frequency characteristic, Conditional stability in feedback loops, stabilizing a continuous mode forward converter and discontinuous mode fly-back converter, feed-back loop stabilization with current mode control, the right-half plane zero.

Unit V Power Converter Design 9 Hours

Design of filter inductor & capacitor, and power transformer, Ratings for switching devices, current transformer for current sensing, design of drive circuits for switching devices, considerations for PCB layout.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain isolated and non-isolated DC-DC converters and their operation in continuous conduction mode and discontinuous conduction mode	Understand
CO2: Apply current control and voltage control methods to regulate the output power	Apply
CO3: Explain the necessity of Resonant Converters and apply it to the full bridge topology	Understand
CO4: Evaluate the controller stability for the given DC-DC converter	Apply
CO5: Design power circuit for given specifications	Apply

Text Book(s)

T1. Ned Mohan Tore M. Undel and, Power Electronics: Converters, Applications, and Design,3rd Edition, John Wiley & Sons, 2007.

T2. Abraham I. Pressman, Switching Power Supply Design, McGraw Hill International, 3rd Edition, 2009.

T3. Philip T Krein, Elements of Power Electronics‖, 2nd Edition, Oxford Press, 2014

Reference Book(s)

R1. P.C. Sen, Modern Power Electronics‖, Second Edition, S. Chand-2005

R2. Andrzej M. Trzynadlowski, Introduction to Modern Power Electronics, 2 nd Edition,illustrated Publisher John Wiley & Sons, 2015

R3. Christophe Basso, Switch-Mode Power Supplies SPICE Simulations and Practical Designs 2nd Edition, McGraw Hill, 2014

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1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/
2. http://ecee.colorado.edu/~ecen5807/notes.html
3. http://nptel.ac.in/courses/108108036/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-		1	1
CO2	3	2	1	1	-	-	-	1	-	1	-		1	1
CO3	2	1	-	-	-	-	-	1	-	1	-		1	1
CO4	3	2	1	1	-	-	-	1	-	1	-		1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1009		**Course Title: Special Electrical Machines**	
Course Category: Professional Elective		**Course Level: Practice**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Synchronous and Induction Machines
- DC Machines and Transformers
- Fundamentals of Power Electronics

Course Objectives

The course is intended to:

1. Prepare the students to have a basic knowledge of construction, classifications and principles of stepper motor with driver circuits.
2. Understand about the switched reluctance motor and its controllers.
3. Empower students to understand the construction, operation and characteristics of permanent magnet brushless dc motors.
4. Expose the students to the concepts of working, characteristics, and controls of permanent magnet synchronous motors.
5. Study the operation, performance, control of servo and commutator motors.

Unit I Stepper Motors 9 Hours

Construction – Principle of operation – Classifications: Variable reluctance, Hybrid – Single and multi-stack motors– Theory of torque predictions – Linear and non linear analysis – Characteristics – Drive circuits and closed loop controls - Applications.

Unit II Switched Reluctance Motors 9 Hours

Construction – Principle of working – Torque Equation – Power controllers: Two switching devices per phase, C-Dump and Split link – Microprocessor based control – Sensor less control.

Unit III Permanent Magnet Brushless DC Motor 9 Hours

Permanent Magnet materials – Magnetic Characteristics - Principle of operation – Types– Torque equations – Power controllers – Motor characteristics - DSP based control - Applications.

Unit IV Permanent Magnet Synchronous Motors 9 Hours

Principle of operation – EMF and torque equations –Phasor diagram – Converter Volt-ampere requirements – Torque speed characteristics –control methods - Applications.

Unit V Servo and Commutator Motors 9 Hours

Servo motors: Construction, Operation, Classifications, Characteristics, Control and applications Commutator motors: Construction, Principle of operation, Characteristics, Applications of Universal, repulsion motor.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Summarize the Construction, Classifications and Principles of Stepper Motor with driver circuits	Understand
CO2: Explain the basic principle of switched reluctance motor and its controllers	Understand
CO3: Outline the Construction, operation and characteristics of permanent magnet brushless DC motors	Apply
CO4: Describe the working, characteristics, controls of permanent magnet synchronous motors	Understand
CO5: Make use of the operation, performance, control of servo and commutator motors	Apply

Text Book(s)

T1. E. G. Janardanan, ‗Special Electrical Machines‘ PHI Learning Pvt. Ltd, 2014

T2. K. Venkataratnam, ‗Special Electrical Machines‘, Universities Press (India) PrivateLimited, 2008.

T3. Bimbhra. P. S ‗Generalized Theory of Electrical Machines‘, Khanna Publishers, 2013.

Reference Book(s)

R1. T. Kenjo, ‗Stepping Motors and Their Microprocessor Controls‘, Clarendon Press London,1995.

R2. Sen. P. C ‗Principles of Electrical Machines and Power Electronics‘, John Willey& Sons,2008

R3. T. J. E. Miller, ‗Brushless Permanent Magnet and Reluctance Motor Drives‘, ClarendonPress, 1989.

Web References

1. http://nptel.ac.in/courses/112103174/16
2. http://www.ti.com/lit/an/spra420a/spra420a.pdf
3. https://nit-edu.org/wp-content/uploads/2019/06/ch-39-Special-motors.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	3	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1011</td><td colspan="2">Course Title: Power Electronic Applications in Power Systems</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Fundamentals of Power Electronics

Course Objectives

The course is intended to:

1. Impart knowledge on the fundamental concepts of power systems
2. Discuss about the various compensation methods of transmission lines
3. Discuss the operation of conventional reactive power compensators
4. Understand the operation of emerging reactive power compensators
5. Discuss the concepts of HVDC & control

Unit I Introduction 9 Hours

High Power drives for Power systems controllers -Characteristics -Configuration for Large power control

Unit II Single Phase and Three Phase Converters 9 Hours

Properties – Current and voltage harmonics Effect of source and load impendence -Choice of best circuit for power systems - Converter Control - Gate Control -Basic means of Control – Control characteristics - Stability of control - Reactive power control - Applications of converters in HVDC system - Static VAR control - Source of reactive power - Harmonics and filters

Unit III HVDC 9 Hours

HVDC configurations, components of HVDC system: Converter, transformer, smoothing reactor, harmonic filter. Reactive power support -Operation of 6-pulse controlled rectifier in inverting mode of operation-Control of HVDC system -Rectifier and inverter characteristics - Limitations HVDC system using line commutated converters, modern HVDC system - HVDC light

Unit IV Reactive Power Compensation 9 Hours

Introduction, methods of Var generation, analysis of uncompensated AC line, Passive reactive power compensation - Compensation by a series capacitor connected at the midpoint of the line, Effect on Power Transfer capacity - Compensation by STATCOM and SSSC, Fixed capacitor-Thyristor controlled reactor (FC TCR) -Thyristor-switched capacitor- Thyristor controlled reactor (TSC-TCR), static VAR compensators

Unit V Static Applications 9 Hours

Static excitation of synchronous generators -Solid state tap changers for transformer - UPS Systems - Induction furnace control

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: To impart knowledge on different types of converter configurations	Understand
CO2: To study the different Applications of converters in HVDC systems	Understand
CO3: To design and analyze the different types of protection schemes for converters.	Apply
CO4: To design and chose the best circuit for power system	Apply
CO5: To impart knowledge on compensation by a series capacitor	Apply

Text Book(s)

T1. E. Acha, T.J.E.Miller, Power Electronic Control in Electrical Systems‖, Newnes,1st Edition, 2002.

T2. K.R. Padiyar, HVDC Power Transmission System – Technology and System Interaction, New Delhi, New Age International, 2002

T3. Ned Mohan, Electric power system, New York, John Wiley and Sons, 2012.

Reference Book(s)

R1. S. Kamakshaiah, V. Kamaraj , HVDC Transmission, New Delhi, Tata Mc Graw-Hill Education Pvt Ltd, 2011.

R2. B. Ned Mohan, Power electronic converters Applications and Design, New York, John Wiley and Sons, 2013.

R3. Mohd. Hasan Ali, Bin Wu, Roger A. Dougal, An Overview of SMES Applications in Power and Energy Systems, IEEE Transactions on Sustainable Energy, vol. 1, no. 1, April 2010.

Web References

1. http://nptel.singlephase.ac.in/courses/108104013/
2. http://nptel.reactivepower.ac.in/courses/108104052/26
3. http://nptel.compensation.ac.in/courses/108101040/20

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	3	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1060			Course Title: Multilevel Power Converters
Course Category: Professional Elective		Course Level: Mastery	
L : T : P (Hours/Week) 3 : 0 : 0	Credits : 3	Total Contact Hours : 45	Max Marks :100

Pre-requisites

- Fundamentals of Power Electronics

Course Objectives

The course is intended to:

- Describe multilevel I(MLI) topology (Symmetry & Asymmetry) with common DC bus link.
- Discuss the working of cascaded H Bridge multilevel inverter
- Discuss the modes of operation of Diode Clamped multilevel inverter
- Discuss the operation of Flying Capacitor MLI.
- Discuss the working of MLI with reduced switch count

Unit I Multilevel Topologies **9 Hours**

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology

Unit II Cascaded H-Bridge Multilevel Inverters **9 Hours**

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation(PWM). Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages - PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes -Staircase Modulation

Unit III Diode Clamped Multilevel Converter **9 Hours**

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.

Unit IV Flying Capacitor Multilevel Converter **9 Hours**

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.- Comparison between diode clamped and flying capacitor based MLI

Unit V Multilevel Converter With Reduced Switch Count 9 Hours

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor	Understand
CO2: Demonstrate the working principles of Cascaded H-Bridge MLI using Bipolar PWM and Unipolar PWM	Apply
CO3: Demonstrate the working principles of diode clamped MLI	Apply
CO4: Analyze the voltage balancing performance of flying capacitor based MLI	Apply
CO5: Demonstrate the working principles of reduced switch MLI	Apply

Text Book(s)

T1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition

T2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla," Multilevel Converters for Industrial Applications", CRC Press, 1st Edition, 2017.

Reference Book(s)

R1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, 1st Edition, Oct-2003.

R2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press,, 1st Edition,2017. .

R3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1st Edition .

R4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc, 1st Edition, 2021.

Web References

1. https://nptel.ac.in/courses/108102157
2. https://encyclopedia.pub/entry/5863

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1061	**Course Title: Design and Analysis of Switching Power Converters**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Fundamentals of Power Electronics

Course Objectives

The course is intended to

- Inculcate knowledge on harmonics standards.
- Impart knowledge on PWM rectifiers.
- Familiarize the design resonant converters.
- Provide knowledge on dynamic analysis of DC to DC Converters**.**
- Introduce the control techniques for control of resonant converters.

Unit I Power System Harmonics & Line Commutated Rectifiers 9 Hours

Average power-RMS value of an AC waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode- Discontinuous Conduction Mode-Single phase Rectifier's behavior for large value of Capacitance - Minimizing THD for small value of Capacitance- Three phase rectifiers-Continuous Conduction Mode-Discontinuous Conduction Mode- Introduction to Harmonic trap filters.

Unit II Pulse Width Modulated Rectifiers 9 Hours

Properties of Ideal rectifiers-Realization of non-ideal rectifier-Single phase converter system incorporating ideal rectifiers-Modeling losses and efficiency in CCM - high quality rectifiers-Boost rectifier-expression for controller duty cycle-expression for DC load current.

Unit III Resonant Converters 9 Hours

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching - Zero Voltage Switching -Classification of Quasi resonant switches-Zero Current and Zero Voltage Switching of Quasi Resonant Buck converter- Zero Current and Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

Unit IV Dynamic Analysis of Switching Converters 9 Hours

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-StateSpace Averaged model for Buck Converter, Boost Converter, Buck Boost Converter.

Unit V Control of PWM Rectifiers 9 Hours

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Average current control-Current programmed Control- Hysteresis control -PI Controller design.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand the standards for supply current harmonics and its significance.	Understand
CO2: Understand the functions of PWM rectifiers.	Apply
CO3: Analyze and design the resonant converters.	Analyze
CO4: Derive the state space model of basic and derived DC-DC converters.	Apply
CO5: Design an appropriate controller for PWM rectifiers.	Understand

Text Book(s)

T1. John G. Kassakian, Martin F. Schlecht, George C. Verghese, “Principles of Power Electronics”,Pearson, India, New Delhi, 2010

T2. Philip T Krein, “ Elements of Power Electronics”, Oxford University Press,1998.

Reference Book(s)

R1. Ned Mohan, “Power Electronics: A first course”, John Wiley,2011

R2. IssaBatarseh, Ahmad Harb, “Power Electronics- Circuit Analysis and Design, Secondedition,2018

Web References

1. http://www.euedia.tuiasi.ro/lab_ep/ep_files/Lab_no_8_c1.pdf
2. https://pe2bz.philpem.me.uk/Power/-%20-%20Power-Design%20-%20-/PowerElectDesign/Ch17slide.pdf

3. https://electronicscoach.com/resonant-converters.html
4. https://www.biomechatronics.ca/teaching/ape/notes/Lecture_7.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1062		Course Title: Design of Photovoltaic Systems	
Course Category: Professional Elective		Course Level: Mastery	
L : T : P (Hours/Week) 3 : 0 : 0	Credits : 3	Total Contact Hours : 45	Max Marks :100

Pre-requisites

- Electric Circuits

Course Objectives

The course is intended to:

- Understand PV technologies, cell characteristics and interconnection of PV modules.
- Study the PV system and its design methodology
- Learn PV sizing and battery
- Study the grid connected PV system and its interface requirements
- Study converters employed in solar power system

Unit I Introduction 9 Hours

Present Scenario - PV cell: technologies, IV and PV characteristics, Single diode equivalent circuit, Voc, Isc , fill factor and conversion efficiency - Losses in Solar cells - Modules and Array – Series and Parallel interconnection – Energy from Sun: Insolation and Irradiance, sunrise and sunset hour angles – solar related measuring devices.

Unit II PV System 9 Hours

Types of PV System – standalone PV system configurations – design methodology: PV powered DC fan without battery, PV powered DC pump and standalone system with battery and AC or DC load – wiring sizing – precise sizing – Hybrid PV system.

Unit III PV Sizing 9 Hours

PV sizing for applications without batteries -Batteries: Introduction, capacity, C-rate, efficiency, energy and power densities, factors affecting performance, comparison and selection- PV System Design: Load profile, days of autonomy, battery sizing, PV array sizing.

Unit IV Converters for PV system 9 Hours

Charge controller – battery charger: current control DC-DC Converters: buck, boost, buck-boost and control of DC-DC converter, DC-AC Converters: single phase, three phase and inverter with PWM – MPPT and algorithms.

Unit V Grid Connected PV System **9 Hours**

Principle – PV to grid topologies - Interface requirements – synchronizing with grid – operating limit – single phase and three phase d-q controlled grid connection – simple payback period – lifecycle costing - Solar PV system Installation, Monitoring and Trouble Shooting.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Examine the IV and PV characteristics of PV cell and interconnection of PV modules.	Understand
CO2: Design the standalone PV system.	Apply
CO3: Design the PV system with batteries.	Apply
CO4: Understand the converters used in solar power system	Understand
CO5: Understand the grid connected PV system and its monitoring and maintenance.	Understand

Text Book(s)

T1. Chetan, Singh Solanki: Solar Photovoltaics: Fundamentals, Technologies and Applications. PHI Learning Pvt Ltd, 2014.

T2. Gilbert M. Masters: Renewable and Efficient Electric Power Systems. John Wiley & Sons, 2004

Reference Book(s)

R1. Mukund R. Patel, Omid Beik: Wind and Solar Power Systems: Design, Analysis, and Operation, CRC Press, 2021.

R2. Roger A. Messenger & Jerry Ventre: Photovoltaic Systems Engineering. CRC Press, 2^{nd} ed,2004.

Web References

1. https://archive.nptel.ac.in/courses/117/108/117108141/
2. https://www.alternative-energy-tutorials.com/category/solar-power

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1063	**Course Title: Wind Energy Conversion Systems**		
Course Category: Professional Elective		**Course Level: Mastery**	
L : T : P (Hours/Week) 3 : 0 : 0	**Credits : 3**	**Total Contact Hours : 45**	**Max Marks :100**

Pre-requisites

- DC Machines and Transformers
- Synchronous and Induction Machines
- Fundamentals of Power Electronics

Course Objectives

The course is intended to:

- Learn about the characteristics of GCIGs
- Learn the design steady state analysis of SEIGs.
- Provide knowledge on single phase of GCIGs and SEIGs.
- Learn the design steady state analysis of SEIGs.
- Learn the design steady state analysis of PMSGs.

Unit I Characteristics of GCIGs 9 Hours

Principle of operation – steady-state analysis-characteristics of GCIGs- operation of GCIGs with different power electronic configurations.

Unit II Steady State Analysis of SEIGs 9 Hours

Process of self-excitation – steady-state equivalent circuit of SEIG and its analysis - performance equations - widening the operating speed-range of SEIGs by changing the stator winding connection with suitable solid state switching schemes - power electronic controllers used in standalone systems.

Unit III Single Phase Operation of GCIGs and SEIGs 9 Hours

Need for single-phase operation –typical configurations for the single-phase operation of three-phase GCIGs and SEIGs –stead state equivalent circuit and analysis using symmetrical components.

Unit IV Steady State Analysis of DFIGs 9 Hours

Different operating modes- steady-state equivalent circuit- performance analysis- DFIG for standalone applications- operation of DFIGs with different power electronic configurations for standalone and grid-connected operation

Unit V Steady State Analysis of PMSGs 9 Hours

Operation of PMSGs- steady-state analysis- performance characteristics- operation of PMSGs with different power electronic configurations for standalone and grid-connected operation.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the operation of GCIGs used in wind energy systems	Understand
CO2: Carry out the steady-state analysis of SEIGs	Apply
CO3: Design and implement of single phase operation of GCIGs and SEIGs	Understand
CO4: Carry out the steady-state analysis of DFIGs	Apply
CO5: Carry out the steady-state analysis of PMSGs	Apply

Text Book(s)

T1. Freris. L. L., "Wind Energy Conversion Systems", Prentice Hall 1990.

T2. S.N.Bhadra, D.Kastha,S.Banerjee, "Wind Electrical Sytems",Oxford University Press,2010.

Reference Book(s)

R1. Marcelo Godoy Simões and Felix A. Farret, 'Renewable Energy Systems: Design and Analysis with Induction Generators', CRC Press, ISBN 0849320313, 2004.

R2. Ion Boldea, 'Variable speed Generators', CRC Press, ISBN 0849357152, 2006. .

R3. Siegfried Heier, Rachel Waddington, 'Grid Integration of Wind Energy Conversion Systems, 2nd Edition', Wiley, June 2006, ISBN: 978-0-470-86899-7.

Web References

1. https://archive.nptel.ac.in/content/storage2/courses/108108078/pdf/chap6/teach_slides06.pdf
2. https://core.ac.uk/download/pdf/288369894.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1021</td><td colspan="3">Embedded Control of Power Electronics
(Common to EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td colspan="2">L:T:P (Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives

The course is intended to:

1. Understand the architecture and addressing modes of PIC 16C7X microcontroller.
2. Study the peripherals of PIC 16C7X
3. Understand the architecture and addressing modes of TMS320F2812 processor
4. Study the peripherals of TMS320F2182 processor
5. Apply control logics to converter and drives applications using PIC 16C7X and TMS320F2182

Unit I PIC 16C7X Microcontroller 9 Hours

Architecture memory organization – Addressing modes – Instruction set – Programming Techniques – simple programs

Unit II Peripherals of PIC 16C7X 9 Hours

Timers – interrupts – I/O ports – I2C bus for peripheral chip access – A/D converter – UART.

Unit III TMS320F2812 DSP 9 Hours

Introduction- System configuration registers - Memory Addressing modes – Instruction set Programming techniques – simple programs

Unit IV Peripherals of TMS320F2812 DSP 9 Hours

General purpose Input/output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB) - PWM signal generation

Unit V Applications of PIC and Signal Processors 9 Hours

Digital Controller Design for Buck Converter ,Voltage regulation of DC-DC converters- Stepper motor and DC motor control- Clarke‘s and Parks transformation-Space vector PWM- Control of Induction Motors and PMSM. Programming in assembly language -Typical applications in the control of power electronic converters for power supplies and electric motor drives.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Describe the architecture, addressing modes and Instruction set of PIC 16C7X microcontroller	Understand
CO2. Explain the peripherals of PIC 16C7X and their importance to power Converter applications.	Understand
CO3. Develop the programs using TMS320F2812 digital signal Processor	Apply
CO4. Explain the peripherals of TMS320F2812 and their importance to power converter applications	Understand
CO5. Implement simple switching logics for power converters using PIC 16C7X and TMS320F2812	Apply

Text Book(s):

1. John B.Peatman, ‘Design with PIC Microcontrollers’, 8 th Edition, Pearson Education, Asia 2009.
2. Hamid A.Toliyat, Steven Campbell, ’DSP based electromechanical motion control‘,CRC Press, 2003.

Reference Book(s):

1. Bar Ba C Programming and Application of a DSP to Control and Regulate Power Electronic Converters: Programming in C++" Anchor Academic Publishing, 2014.
2. Luca Corradini, Dragan Maksimović, Paolo Mattavelli, Regan Zane, "Digital Control of High-Frequency Switched-Mode Power Converters" IEEE press, Wiley , 2015.
3. Simone Buso, Paolo Mattavelli, "Digital Control in Power Electronics", Morgan and Claypool Publisher, 2006.

Web Reference(s):

1. Web References: 1. https://onlinecourses.nptel.ac.in/noc20_ee28/preview 2.
2. https://nptel.ac.in/courses/108/107/108107128/# 3.
3. https://onlinecourses.nptel.microcontroller.ac.in/noc21_ee18/preview

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1022	**Course Title: Advanced Microprocessors (Common to EE & EI)**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Course Objectives

The course is intended to:

1. Explain the basic concepts of advanced microprocessors.
2. Describe the architecture of Pentium processors.
3. Discuss the concepts and architecture of RISC processor.
4. Describe the concepts of the superscalar processors
5. Explain the architecture programming and interfacing of PC hardware

Unit I Microprocessor Architecture 9 Hours

Instruction Set – data formats -addressing modes-memory hierarchy-register file-cache—virtual memory and paging-segmentation- pipelining- instruction pipeline— pipeline hazard-instruction level parallelism-reduced instruction set- RISC VS CISC

Unit II Pentium Microprocessors 9 Hours

Introduction to Pentium Microprocessor- real and production mode operation- software model of Pentium – function description –registers-data organization- summary of the 80286,80386, and 80486- CPU architecture –bus operation-pipelining-branch

Unit III RISC Processors I 9 Hours

PowerPC620 – Instruction fetching – Branch Prediction – Fetching – Speculation, Instruction Dispatching –dispatch stalls – Instruction Execution – Issue stalls- Execution Parallelism– Instruction completion – Basics of P6 micro architecture – Pipelining – Memory subsystem.

Unit IV RISC Processors II 9 Hours

Intel i960 – Intel IA32- MIPS R8000 – MIPS R10000 – Motorola 88110 – Ultra SPARC Processor- SPARC version 8 – SPARC version 9.

Unit V PC Hardware Overview 9 Hours

Functional Units & Interconnection, New Generation Mother Boards 286 to Pentium 4 Bus Interface- ISA- EISA- VESA- PCI- PCIX. Peripheral Interfaces and Controller, Memory and I/O Port Addresses

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Explain the basic concepts of advanced microprocessors	Understand
CO2: Describe the architecture of Pentium processors.	Understand
CO3: Discuss the concepts and architecture of RISC processor.	Understand
CO4: Identify the concepts in the Superscalar Processors	Apply
CO5:Explain the overview of PC hardware	Understand

Text Book(s):

1. B.B.Brey The Intel Microprocessor 8086/8088 /80186/80188, 80286, 80386, 80486PENTIUM, PENTIUM Pro, PII, PIII & IV Architecture, Programming & Interfacing, Pearson Education ,2004.
2. John Paul Shen, MikkoH. Lipasti, ―Modern Processor Design‖, Tata Mcgraw Hill,2006

Reference Book(s):

1. Daniel Tabak , ―Advanced Microprocessors‖, McGrawHill.Inc., 2ndEdition 1995.
2. James L. Antonakos, ― The Pentium Microprocessor‖, Pearson Education, 1997.
3. Gene .H.Miller, ―Micro Computer Engineering‖, Pearson Education, 2003
4. Douglas V.Hall, ―Microprocessors and Interfacing‖, Tata McGraw Hill, 2nd Edition 2006
5. Mohamed Rafiquzzaman, ―Microprocessors and Microcomputer Based System Design‖, 2nd Edition, CRC Press, 2007.

Web Reference(s):

1. http://nptel.ac.in/courses/Webcourse-
2. https://ee641dm.wordpress.com/study-materials/
3. https://www.tutorialspoint.com/microprocessor/index.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1		3	1	1

High-3; Medium-2;Low-1

Course Code:19EEEC1028	**Course Title: CMOS Analog IC Design (Common to EE & EI)**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Course Objectives

The course is intended to:

1. Analyze the concept of CMOS Technology and Analog MOSFET models
2. Analyze the basic Analog MOS circuits.
3. Construct an amplifier and switching circuits using CMOS
4. Design an Op-amp and various nonlinear circuits using Op-amp.
5. Compare the performance of different forms of data conversion techniques.

Unit I Introduction to CMOS Technologies and Analog MOSFET Model 9 Hours

MOSFET- Structure, MOSFET Capacitances, Threshold Voltage , IV Characteristics , SPICE modeling, DC equations, Short Channel MOSFET . MOS Passive Elements – Capacitors and Resistors, Temperature and Voltage dependence of Capacitors and Resistors. Analog MOSFET models - Low frequency model , High frequency model , Temperature effects , Noise in MOSFET

Unit II Analog MOS Modeling 9 Hours

Current Mirror, Current sources, Self-biasing techniques, Band gap voltage references, Beta Multiplier based references. Common Drain and Common Gate amplifiers, Voltage dividers

Unit III Differential Amplifiers and Dynamic Analog Circuits 9 Hours

Differential Amplifier – Source coupled pair, Source cross coupled pair, Cascade load, Wide swing differential amplifiers. Dynamic Analog Circuits –MOSFET switch, Switched capacitor circuit.

Unit IV Operational Amplifiers 9 Hours

Operational Amplifiers – Basic CMOS Op-amp, Operational Trans conductance amplifier, Differential output Op-amp. Non Linear Analog Circuits – CMOS comparator, Analog multiplier, Level shifting circuit, Multiplier using squaring circuit

Unit V Mixed Signal Circuits 9 Hours

Data Conversion Fundamentals – Analog Vs. Discrete time signal, Converting analog to digital signal - Sample and hold circuit, mixed signal layout issues. Data Conversion Architecture – DAC, ADC.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Utilize the concept of CMOS Technology using MOSFET structure	Apply
CO2: Model the basic analog circuits using CMOS technology	Apply
CO3: Construct an amplifier and switching circuits using CMOS	Apply
CO4:Design an Op-amp and various nonlinear circuits using Op-amp	Apply
CO5: Identify the performance of different forms of data conversion techniques using mixed signal MOSFET circuits	Apply

Text Book(s):

1. Jacob Baker.R., Li.H.W., and Boyce.D.E., CMOS Circuit Design ,Layout and Simulation, Prentice-Hall of India,1988.
2. Mohammed Ismail and Terri Faiz, Analog VLSI Signal and Information Process, McGraw-Hill Book company,1994.

Reference Book(s):

1. Paul R. Gray and Meyer.R.G., Analysis and design of Analog Integrated circuits, John Wiley and Sons inc., USA, 3rd Edition, 1993.Reprint, 2002.
2. David. A. Johns and Martin. K., Analog Integrated Circuit Design, Wiley, 1997.
3. Malcom.R.Haskard, LanC.May, Analog VLSI Design - NMOS and CMOS ",Prentice Hall, 1998.
4. Jose E.France, YannisTsividis, Design of Analog-Digital VLSI Circuits for Telecommunication and signal Processing ", Prentice Hall, 1994
5. Randall L Geiger, Phillip E. Allen, Noel K.Strader, VLSI Design Techniques for Analog and Digital Circuits ", McGraw Hill International Company, 1990.

Web Reference(s):

1. http://nptel.ac.in/courses/117101105/
2. http://www.nptel.ac.in/syllabus/117101006/
3. http://www.people.rit.edu /iffeee/basic-analog-circuits.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code:19EEEC1030	Course Title: Testing of VLSI Circuits (Common to EE & EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course Objectives

The course is intended to:

1. Identify the faults in the digital circuits
2. Create Test Patterns for combinational logic circuit.
3. Create Test Patterns for sequential logic circuit.
4. Explain the different testability techniques for Testing
5. Explain various BIST Architecture and test algorithms.

Unit I Testing and Logic Simulation 9 Hours

Introduction to testing – Faults in Digital Circuits – Modeling of faults – Logical Fault Models – Fault detection and redundancy – Fault equivalence and fault Location – Fault dominance – Logic simulation – Types of simulation – Delay models – Gate Level Event – driven simulation.

Unit II Test Generation for Combinational Circuits 9 Hours

Test generation for combinational logic circuits – Testable combinational logic circuit design.

Unit III Test Generation for Sequential Circuits 9 Hours

Test generation for sequential circuits – design of testable sequential Logic circuits.

Unit IV Design for Testability 9 Hours

Design for Testability – Ad-hoc design – generic scan based design – classical scan based design – system level DFT approaches.

Unit V Self-Test and Test Algorithms 9 Hours

Built-In-Self-Test – test pattern generation for BIST – Circular BIST – BIST Architectures – Testable Memory Design – Test Algorithms – Test generation for Embedded RAMs.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Identify the faults in the digital circuits.	Apply
CO2: Create test Patterns for Combinational Logic Circuits.	Apply
CO3: Create test Patterns for sequential logic Circuits.	Apply
CO4: Model the different testability techniques for testing.	Apply
CO5: Identify various BIST Architecture and test algorithms	Apply

Text Book(s):

1. M.Abramovici, M.A.Breuer and A.D. Friedman, Digital systems and Testable Design‖,Jaico Publishing House, 2002.
2. P.K. Lala, Digital Circuit Testing and Testability‖, Academic Press, Academic Press, 2012.

Reference Book(s):

1. M.L.Bushnell and V.D.Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits‖, Kluwer Academic Publishers, 2002.
2. A.L.Crouch, Design Test for Digital IC's and Embedded Core Systems‖, Prentice Hall.International, 2002.
3. Robert J., Jr. Feugate, stevan M. McIntyre, Introduction to VLSI Testing‖, Prentice HalInternational, 1988.
4. Angela Krstic and Kwang-Ting Cheng Delay fault testing for VLSI Circuits‖, Kluwer Academic Publishers, 1998 .
5. Mike Tien and Chien Lee, High-Level Test Synthesis of Digital VLSI Circuits‖, Artech House, Inc., 1997.

Web Reference(s):

1. http://onlinelibrary.wiley.com/doi/10.1002/0471457787.fmatter/pdf
2. http://nptel.ac.in/courses/106103016/30
3. www.cs.colostate.edu/~malaiya/530/08/resources.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1031</td><td colspan="3">Course Title: ASIC Design
(Common to EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P (Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives

The course is intended to:

1. Explain the different types of ASICs and logic cells used in ASIC design
2. Explain the architecture of various programmable logic cells
3. Explain the interconnects in programmable logic cells and design software.
4. Develop a digital circuit using HDL.
5. Explain the physical design in ASIC Design flow

Unit I Introduction to ASIC 9 Hours

Types of ASICs - Design flow – CMOS transistors- CMOS Design rules –Combinational logic Cell - Sequential logic cell - Transistor as Resistor - Transistor parasitic capacitance – Library cell design.

Unit II Programmable ASICS, Logic Cells and I/O Cells 9 Hours

Anti-fuse - Static RAM - EPROM and EEPROM technology - Actel ACT - Xilinx LCA, Xilinx I/O blocks –- Altera MAX 5000 - Altera FLEX

Unit III ASIC Interconnect and Design Software 9 Hours

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 - Altera FLEX –Design systems – Logic Synthesis - Half gate ASIC -Low level design language - PLA tools

Unit IV Logic Synthesis 9 Hours

A logic synthesis example:- Adder and MUX units, FSM synthesis in VHDL, Memory synthesis in VHDL

Unit V Floor Planning, Placement and Routing 9 Hours

Floor planning, Placement, Routing- Global routing, detailed routing, special routing, Parasitic extraction, LVS and DRC.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Explain the different types of ASICs and logic cells used in ASIC design	Understand
CO2: Explain the architecture of various programmable logic cells.	Understand
CO3:Explain the interconnects in programmable logic cells and design software.	Understand
CO4:Model the digital circuit using HDL	Apply
CO5:Explain the physical design in ASIC Design flow	Understand

Text Book(s):

1. Michael John Sebastian Smith‖ Application Specific Integrated Circuits‖ Pearson Education 2006
2. Norman G. Einspruch, "Application Specific Integrated Circuit (ASIC) Technology", Academic Press, 2012.

Reference Book(s):

1. Morris Mano.M, —Digital Design‖, Pearson Education Pvt.Ltd, 3rd Edition,2013.
2. DouglasL. Perry, —VHDL: Programming by Example‖, McGraw-Hill, 4th Edition,2002

Web Reference(s):

1. www.vlsi.wpi.edu/cds/explanations/lvs.html
2. http://www.eng.auburn.edu/
3. http://www.geoffknagge.com/fyp/index.shtml asic

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	3	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1064	Course Title: Embedded C Programming (Common to EE & EI)		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Course Objectives

The course is intended to:

1. Expose the students to the fundamentals of embedded Programming
2. Introduce the GNU C Programming Tool Chain.
3. Study the basic concepts of embedded C.
4. Teach the basics of 8051 Programming.
5. Involve Discussions/ Practice/Exercise in revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

Unit I Basic C Programming 9 Hours

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

Unit II Embedded C 9 Hours

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout Mechanism - Creating loop timeouts - Creating hardware timeouts.

Unit III 8051 Programming in C 9 Hours

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051

Unit IV 8051 Serial Port And Interrupt Programming In C 9 Hours

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051

Interrupts and programming, Programming for timer configuration.

Unit V 8051 Interfacing 9 Hours

8051: ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor Interfacing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Deliver insight into embedded C programming and its salient features for embedded systems.	Understand
CO2: Illustrate the software and hardware architecture for distributed computing in embedded systems	Understand
CO3: Develop a solution for problems by using the concept learn in programming using the embedded controllers	Apply
CO4: Develop simple applications with 8051 by using its various features and interfacing with various external hardware.	Apply
CO5: Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.	Apply

Text Book(s):

1. Paul Deitel and Harvey Deitel, “C How to Program”, 9th Edition, Pearson Education Limited, 1st edition, 2022.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.

Reference Book(s):

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 1st edition, 2015.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 3rd edition, 1997.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2nd Edition 2007.
4. Myke Predko, “Programming and customizing the 8051 microcontrollers”,McGraww Hill 1st edition, 2000.

Web Reference(s):

1. https://www.hackerrank.com/
2. https://www.cprogramming.com/
3. https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programminglanguage-for-embedded-applications/
4. https://onlinecourses.nptel.ac.in/noc19_cs42/preview
5. https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
6. https://www.circuitstoday.com/getting-started-with-keil-uvision

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	2	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	2	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1065	Course Title: Embedded System for Automotive Applications(Common to EE & EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P (Hours/Week):3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course Objectives

The course is intended to:

1. Understand the fundamentals and building of Electronic Engine Control systems.
2. Teach on sensor functional components for vehicles.
3. Discuss on programmable controllers for vehicles management systems.
4. Teach logics of automation & communication techniques for vehicle communication.
5. Introduce the infotainment system development.

Unit I Introduction to Automotive Systems 9 Hours

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle Performance; Electronic control Unit– open-source ECU.

Unit II Sensors and Actuators for Automotives 9 Hours

Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

Unit III Vehicle Management Systems 9 Hours

Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.

Unit IV Onboard Diagnostics and Communication 9 Hours

OBD, Vehicle communication protocols - Bluetooth, CAN, LIN, FLEXRAY and MOST, Power line communication.

Unit V Recent Trends 9 Hours

Navigation- Autonomous car- Role of IoT in Automotive systems. Infotainment-Recent trends , Lightning Control, Pressure monitoring, Fuel injection System.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Insight into the significance of the role of embedded system for automotive applications.	Understand
CO2: Illustrate the need, selection of sensors and actuators and interfacing with ECU	Apply
CO3: Develop the Embedded concepts for vehicle management and control systems.	Apply
CO4: Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs	Apply
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.	Apply

Text Book(s):

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,8th Edition, 2017.

2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2nd Edition, 1999.

3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicle Technologies", SAE International, 2001, 1st Edition, 2017.

Reference Book(s):

1. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 1st Edition, 2004.
2. Jack Erjavec,JeffArias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage , 2nd Edition,2012.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford 2nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
5. Automotive Hand Book, Robert Bosch, Bently Publishers, 10th Edition, 2018

Web Reference(s):

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2. https://microcontrollerslab.com/can-communication-protocol/
3. https://ackodrive.com/car-guide/different-types-of-car-sensors/
4. https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
5. https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6. https://www.synopsys.com/automotive/what-is-autonomous-car.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	2	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1066	Course Title: IoT for Smart Systems (Common to EE & EI)		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Course Objectives

The course is intended to:

1. Introduce the Internet of Things technologies and its role in real time applications.
2. Select the Infrastructure required for IoT
3. Provide insight about the embedded processor and sensors required for IoT
4. Familiarize the accessories and communication techniques for IoT.
5. Familiarize the different platforms and Attributes for IoT

Unit I Introduction to Internet of Things 9 Hours

Overview, Hardware and software requirements for IoT, Sensor and actuators ,Technology drivers , Business drivers, Typical IoT applications , Trends and implications.

Unit II IoT Architecture 9 Hours

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture , IoT standards, Cloud computing for IoT

Unit III IoT Protocols 9 Hours

MQTT, CoAP, Bluetooth and BLE, LoRA and LORAWAN, RFID, Zig bee, GSM, GPRS, WiFi LWM2M -Recent trends.

Unit IV Embedded processors for IoT 9 Hours

Introduction to Python programming - Building IoT with Rasperry pi / Arduino - Implementation of IoT- Collect data from the edge devices to gateway using local network, Send the data to a server, Control the device from a server – Security.

Unit V Case Studies 9 Hours

Industrial IoT - Home Automation - Smart cities - Smart Grid - Connected vehicles - Patient Monitoring in Health Care – Agriculture - Productivity Applications - IoT Defense.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of IoT and its present developments.	Understand
CO2: Analyze different IoT technologies	Apply
CO3: Describe the different platforms and infrastructures available for IoT	Apply
CO4: Comprehend the embedded processors for IoT and its implementation	Apply
CO5: Implement IoT solutions for smart applications	Apply

Text Book(s):

1. Arshdeep Bahga and Vijai Madisetti:A Hands-on Approach “Internet of Things”, Universities Press 2015.

2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015
4. Adrian McEwen and Hakim Cassimally “Designing the Internet of Things “Wiley, 2014.

Reference Book(s):

1. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
2. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
3. Lingyang Song/Dusit Niyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
4. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.

Web Reference(s):

1. https://www.arduino.cc/reference/en/
2. https://www.raspberrypi.org/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	2	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	2	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	2	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEC1047	**Course Title: Smart Grid Interface for EV (Common to : EE & EI)**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Explain the smart grids components and architecture
2. Describe the functions of energy management systems
3. Explain the modern power distribution system functions
4. Understand the smart meter applications and standards.
5. Disseminate the role of smart grid in Electric Vehicles.

Unit I Introduction to Smart Grid 9 Hours

Introduction - Definitions and Need for Smart Grid -Today's Gird Versus Smart Grid, Rationale for Smart Grid- Evolution of Electric Grid, Smart Grid Concept– Functions – Opportunities – Benefits and challenges Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, Shareholders Roles and Function, Architecture, Technology Drivers.

Unit II Energy Management Systems 9 Hours

Energy Management System - Smart substations - Substation Automation - Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources – Energy Storage.

Unit III Distribution Management System 9 Hours

Distribution Management System – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles

Unit IV Smart Meters 9 Hours

Introduction to Smart Meters – Advanced Metering infrastructure, AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

Unit V Electric Vehicles 9 Hours

Plugin Electric Vehicles and hybrid, Vehicle classes, Vehicle Architecture, Gird to Vehicle Charging, Grid Impacts, Vehicle to Grid .

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the smart grids components and architecture	Understand
CO2.	Explain the functions of energy management systems	Understand
CO3.	Summarize the modern power distribution system functions	Understand
CO4.	Make use of the smart meter in applications and standards	Apply
CO5.	Identify the role of smart grid in Electric Vehicles	Apply

Text Book(s):

T1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.

T2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.

Reference Book(s):

R1 James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press 2012.

R2 Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & Sons Inc, 2012.

R3 Lars.T.Berger, K.Iniewski, “Smart Grid: Applications, Communications & Security” Wiley India Pvt. Ltd, Reprint 2015.
R4 Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.

Web References:

1. https://onlinecourses.nptel.ac.in/noc18_ee42/preview
2. https://www.energy.gov/oe/services/technology-development/smart-grid-future-electric-grid

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1049</td><td colspan="3">Course Title: Advanced Sensors for Electric Vehicle (Common to : EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Electron Devices
- Physics for Electrical Sciences

Course Objectives

The course is intended to:

1. Inculcate knowledge of digital transducers
2. Understand the seven generations of IoT sensors to appear.
3. Introduce the sensor technology for advanced driver assistance systems.
4. Disseminate the knowledge of sensor networks.
5. Provide the basic concepts of intelligent sensor systems.

Unit I Digital Transducers **9 Hours**

Digital voltmeter -Ramp type, Integrating type, ADC, Digital frequency meter - Working principle and applications. Frequency meter, Electronic counters - Transducers for the measurement of DC and AC voltages and currents - CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors.

Unit II Seven Generations of IoT Sensors **9 Hours**

Industrial sensors –Description and Characteristics–First Generation –Description and Characteristics–Advanced Generation –Description and Characteristics–Integrated IoT Sensors –Description and Characteristics–Polytronics Systems –Description and Characteristics–Sensors' Swarm –Description and Characteristics–Printed Electronics –Description and Characteristics–IoT Generation Roadmap

Unit III Sensor Technology for Advanced Driver Assistance Systems **9 Hours**

Basics of Radar Technology and Systems - Ultrasonic Sonar Systems - Lidar Sensor Technology and Systems - Camera Technology - Night Vision Technology - Use of Sensor Data Fusion - Integration of Sensor Data to On-Board Control Systems

Unit IV Sensor Networks 9 Hours

Introduction to sensor network, Unique constraints and challenges, Localization and Tracking, Networking Sensors, Infrastructure establishment, Sensor Tasking and Control, Sensor network databases, Sensor Network Platforms and tools, Industrial Applications and Research directions.

Unit V Intelligent Sensor Systems 9 Hours

Intelligent Sensor Systems- Intelligent pressure, Flow, Level, Temperature Sensors - Intelligent sensor, Complex sensors, biometric sensors - Application of intelligent sensor in electric vehicles.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the concept digital transducers	Understand
CO2.	Describe the seven generations of IoT sensors to appear.	Understand
CO3.	Make use of the sensor technology for advanced driver assistance systems.	Apply
CO4.	Outline the sensor networks.	Understand
CO5.	Make use of the different intelligent sensor systems.	Apply

Text Book(s):

T1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.

T2. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

Reference Book(s):

R1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, 5th Edition, Springer Vieweg, Wiesbaden 1998.

R2. Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz M. Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Taylor & Francis Group, LLC, 2018.

R3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

Web References:

1. http://nptel.ac.in/courses/117106093/
2. https://www.electronicsweekly.com/power/sensors-for-battery-management-systems-

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1051</td><td colspan="3">Course Title: Automotive Electrical & Electronic Systems (Common to : EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Understand the types of batteries, performance and lighting techniques of automotive systems
2. Analyze the various types of ignition system used in automobiles
3. Illustrate the components of charging and starting systems of vehicles
4. Summarize the various types of sensors and actuators used in automobiles
5. Analyze the Electronic Engine Control techniques

Unit I **Batteries and Lighting System** **9 Hours**

Lead acid and alkaline batteries, construction and working, battery rating, battery charging methods, testing and maintenance. Lighting system: insulated and earth return system, head light and side light, LED lighting system, head light dazzling and preventive methods.

Unit II **Ignition System** **9 Hours**

Ignition system- Construction and working of magneto coil and battery coil ignition systems, Centrifugal and Vacuum Advance Mechanism, spark plug types, spark advance mechanisms, electronic ignition systems - Transistorized ignition system, solid state ignition systems, capacitor discharge ignition system and distributor less ignition system.

Unit III **Starting and Charging System** **9 Hours**

Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids, Charging system components, Generators and Alternators, types, construction and Characteristics. Voltage and Current Regulation, Cut-out relays and regulators. Charging circuits for D.C. Generator.

Unit IV Sensors and Actuators 9 Hours

Sensors - Oxygen Sensors, Throttle Position Sensor, Engine Speed Sensor, Ignition Timing Sensor, Crankshaft Position Sensor, Manifold Absolute Pressure Sensor -Engine Coolant Temperature Sensor, Knock Sensor, Airflow rate sensor. Actuators - Fuel Metering Actuator, Fuel Injector, and Ignition Actuator.

Unit V Electronic Engine Control Systems 9 Hours

Comparison indirect and direct injection- mechanical and hydraulic actuated EDC - In-line fuel-injection pumps, helix and port controlled axial piston distributor, solenoid valve control, unit injectors, common rail systems, data processing, lambda closed loop control, torque-controlled EDC systems, control and triggering of actuators, gasoline direct injection systems, air assisted systems, principles and features of Bosch electronic systems, idle speed, knock and spark timing control. Case study of solar powered vehicle.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Differentiate various types of batteries and their testing methods and lightening systems employed in automobiles.	Understand
CO2.	Summarize various types of ignition techniques adopted in automobiles.	Understand
CO3.	Examine the operating principle of starter motor for starting and generator for charging system.	Apply
CO4.	Explain various types of sensors and actuators, their construction, operating principle and uses.	Understand
CO5.	Apply the various electronic control techniques for diesel and gasoline systems.	Apply

Text Book(s):

T1. Tom Denton, Automobile Electrical and Electronic Systems, Automotive Technology, Routledge Taylor and Francis Group,2017

T2. Tony Tranter “Automobile Electrical and Electronic Systems Essential theory & Practice”, Haynes Publishers, 2009.

Reference Book(s):

R1. A W Judge, Modern Electrical Equipment for Automobiles, Chapman & Hall, 2009.

R2. P. L. Kohli, Automotive Electrical Equipment, First Edition, McGraw-Hill, 2017.

R3. Robert Bosch Automotive Hand Book, 9th Edition, Robert Bosch, 2014.

R4. W. H. Crouse, Automotive Electrical Equipment, McGraw-Hill, 2009.

Web References:

1. https://nptel.ac.in/courses/107/106/107106088/
2. https://www.ti.com/solution/electrical-and-electronics-automotive-applications

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1067</td><td colspan="3">Course Title: Testing of Electric Vehicles
(Common to : EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L: T:P (Hours/Week):
3:0:0</td><td colspan="2">Credit :3</td><td>Total Contact Hours: 45</td><td>Total Marks: 100</td></tr>
</table>

Pre-requisites

- Nil

Course objectives:

The course is intended to

1. know various standardization procedures
2. learn the testing procedures for EV & HEV components
3. know the functional safety and EMC
4. realize the effect of EMC in EVs
5. study the effect of EMI in motor drives and in DC-DC converter system

Unit I EV Standardization 9 Hours

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

Unit II Testing of Electric Motors and Controllers for Electric and Hybrid Electric Vehicles 9 Hours

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

Unit III Fundamentals of Functional Safety and EMC 9 Hours

Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management – Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.

Unit IV EMC in Electric Vehicles 9 Hours

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements.

Unit V EMI in Motor Drive and DC-DC Converter System 9 Hours

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	describe the status and other details of standardization of EVs	Understand
CO2	illustrate the testing protocols for EVs and HEV components	Understand
CO3	analyze the safety cycle and need for functions safety for EVs	Apply
CO4	analyze the safety cycle and need for functions safety for EVs	Apply
CO5	evaluate the EMI in motor drive and DC-DC converter system	Apply

Text Books

T1. Vehicle Inspection Handbook”, JJ Keller and Associates ,Inc,2020

T2. Michael Plint& Anthony Martyr, “Engine Testing & Practice”, Butterworth Heinmenn, 3rd Edition, 2007.

Reference Books

R1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010

R2. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007

R3. Arvey Segler, " Body Language: Discovering & Understanding the Psychological secrets behind reading & Benefiting from Body Language” Kindle Edition, 2016

R4. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.

Web References:

1. https://www.nrel.gov/transportation/electric-vehicle-testing.html
2. https://www.tuv.com/world/en/e-mobility/electric-vehicle-testing-and-certification.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1068</td><td colspan="3">Course Title: Design of Electric Vehicle Charging System (Common to : EE & EI)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L : T : P (Hours/Week)
3: 0: 0</td><td colspan="2">Credits : 3</td><td>Total Contact Hours : 45</td><td>Max Marks :100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

- Discuss the charging station and standards
- Discuss the concepts of power converters in charging
- Elaborate the charging scheme in renewable based EV charging
- Demonstrate the wireless power transfer technique
- Design and simulate power factor correction circuits

Unit I Charging Stations and Standards 9 Hours

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

Unit II Power Electronics for EV Charging 9 Hours

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

Unit III EV Charging using Renewable and Storage Systems 9 Hours

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVCHSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV Wireless Power Transfer 9 Hours

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

UNIT V Power Factor Correction in Charging System 9 Hours

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Illustrate various charging techniques and to know charging standards and regulations	Understand
CO2: Demonstrate the working of DC-DC converters used for charging systems and principles	Understand
CO3: Illustrate the advantages of renewable system based charging systems	Understand
CO4:Demonstrate the principles of wireless power transfer & To analyze the standards for wireless charging	Understand
CO5: Design and simulate boost converter based power factor correction.	Apply

Text Book(s)

T1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 1st Edition, 2016.

T2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.

Reference Book(s)

R1.Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.

R2.Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 1st Edition, 2021.

R3.Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 1st Edition, 2022.

R4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

Web References

1. https://iaeimagazine.org/features/electric-vehicle-charging-station-design/

2. https://www.energy.gov/eere/electricvehicles/downloads/design-guidelines-electric vehicle-charging-stations

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1069		**Course Title: Electric Vehicle Architecture (Common to : EE & EI)**	
Course Category: Professional Elective			**Course Level: Mastery**
L : T : P (3:0:3)	**Credits : 3**	**Total Contact Hours : 45**	**Max Marks : 100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Understand the structure of Electric Vehicle, Hybrid Electric Vehicle
2. Explain the vehicle mechanics
3. Describe about the EV conversion components
4. Understand about the details and specifications for Electric Vehicles
5. Understand the concepts of Plug-in Hybrid Electric Vehicle

Unit I Electric Vehicle Architectures 9 Hours

Electric vehicle history, Evolution of electric vehicles, Social and environmental importance of hybrid and electric vehicles, Layout of an electric vehicle- Electric drive-train topologies, Transmission types for EV – Power flow control in electric drive train. Mountain Bike - Motorcycle - Electric Cars and Heavy duty EVs.-Details and Specification.

Unit II Hybrid Vehicle Architectures 9 Hours

Concepts of hybrid electric drive train, Hybrid vehicle architectures- Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Power flow control in all hybrid vehicle configurations.

Unit III Vehicle Mechanics, Power Components and Brakes 9 Hours

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire Road mechanics, Propulsion system design. Power train component sizing- Gears, Clutches, Differential, Transmission and vehicle brakes.

Unit IV Hybrid Vehicle Control Strategy 9 Hours

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

Unit V Plug-In Hybrid Electric Vehicle 9 Hours

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

Course Outcomes	**CognitiveLevel**
At the end of this course, students will be able to:	
CO1: Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs	Understand
CO2: Classify the various architectures of hybrid electric vehicles.	Understand
CO3: Describe the basics of vehicle mechanics, power components and brakes.	Understand
CO4: Describe the hybrid vehicle control strategy	Apply
CO5: Describe the concepts related in the Plug-In Hybrid Electric Vehicles	Understand

Text Book(s)

T1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

T2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.

T3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

Reference Book(s)

R1. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado - Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150.

R2.Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020.

R3. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles,and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.

Web references

1. https://www.nrel.gov/transportation/electric-vehicle-components.html

2. https://www.evaap.org/electric-vehicle-architecture/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1070</td><td colspan="2">Course Title: Design of Motor and Power Converters for Electric Vehicles
(Common to : EE & EI)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Discuss the drive cycles and requirements of EVs
2. Describe the working of motors used in Electric Vehicle
3. Analyze and model the buck/boost converter operation and to design the same
4. Elaborate the simulation basics of control systems
5. Derive transfer functions for DC-DC converters.

Unit I Electric Vehicle Dynamics 9 Hours

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power,energy requirements of EVs.

Unit II Motors for Electric Vehicles 9 Hours

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

Unit III Basics of Simulation In Control Systems 9 Hours

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHPZero Functions), state space modelling-transfer function from state space Model.

Unit IV Modeling of DC-DC Converters 9 Hours

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics -Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage -Frequency Response of Converter.

Unit V Power Stage Transfer Functions of DC – DC Converters 9 Hours

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	use appropriate electric machine for electric vehicle application	Understand
CO2.	compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)	Apply
CO3.	compute transfer function from state models	Apply
CO4.	design buck, boost and buck-boost converter.	Apply
CO5.	compute a power stage transfer functions for DC-DC converters	Apply

Text Book(s):

T1. K. T. Chau, " electric vehicle machines and drives design, analysis and application ", First Edition, Wiley Publishers, 2015.

T2. James Larminie, “Electric Vehicle Technology Explained”, First Edition, Wiley Publishers , 2003.

Reference Book(s):

R1. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, “Analysis of Electric Machinery”, McGraw-Hill Book Company,1995.

R2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall,2015.

R3. P. S. Bhimbra, “Generalized Theory of Electric Machines”, Khanna Publication,2018.

R4. B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education. s, Processes, Methods and Tools, SAE, 2016.

Web References:

1. https://nptel.ac.in/courses/108/104/108104011/.

2. / https://www.nrel.gov/docs/fy19osti/72198.pdf.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEC1071	**Course Title: Intelligent Control of Electric Vehicles (Common to : EE & EI)**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Design and drive the mathematical model of a BLDC motor and its characteristics
2. Learn the different control schemes for BLDC motor
3. Study the basics of fuzzy logic
4. Study the FPGA & VHDL basics
5. Implement fuzzy logic control of BLDC motor in real time

Unit I **Mathematical Model and Characteristics Analysis of The BLDC Motor** **9 Hours**

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients

Unit II **Speed Control for Electric Drives** **9 hours**

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

Unit III **Fuzzy Logic** **9 hours**

Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic -extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making.

Unit IV FPGA And VHDL Basics 9 Hours

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

Unit V Real Time Implementation 9 Hours

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Design the mathematical model of a BLDC motor and to discuss about its characteristics	Understand
CO2: Demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control.	Understand
CO3:Illustrate the basics of fuzzy logic system	Understand
CO4.Describe the basics of VHDL & FPGA applied to control of EVs.	Understand
CO5.Design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.	Apply

Text Book(s):

T1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018

T2. qbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 1st Edition,2021.

Reference Book(s):

R1. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1 st Edition 2015.

R2. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012.

R3. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002

R4. Robert Shorten, Sonja Stüdli, Fabian Wirth “Electric and Plug-in Hybrid Vehicle Networks Optimization and Control”, Emanuele Crisostomi, CRC Press, 1st Edition. 2018.

Web References:

1 https://nptel.ac.in/courses/

2 https://www.sciencedirect.com/science/article/pii/S1474667017403436

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1072	Course Title: Advanced Control Systems		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Control Systems

Course Objectives

The course is intended to:

1. Understand the state space phase analysis of closed loop system.
2. Derive describing functions of time invariant autonomous system.
3. Infer the stability properties of nonlinear systems.
4. Acquire knowledge of state feedback and state observer based nonlinear control system design.
5. Describe sliding mode controller

Unit I State Space Analysis Of Systems 9 Hours

Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms

Unit II Time Invariant Autonomous Systems 9 Hours

Solution of time invariant autonomous systems, forced system-state transition matrix-relationship between state equations and transfer function.

Unit III Stability Analysis 9 Hours

Introduction – Liapunov's stability concept – Liapunov's direct method – Lure's transformation – Popov's criterion – Circle criterion.

Unit IV State Feedback and State Observers 9 Hours

State Feedback - Gain Matrix - Pole Placement design using State feedback system – State observer Full order Observer-Reduced order observer – Design of state observer system.

Unit V Sliding Mode Control 9Hours

Variable structure systems - Basic concepts - Sliding modes in variable structure system conditions for existence of sliding regions – Case Study - Sliding mode approach to speed control of dc motors.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1.Explain the state space phase analysis of closed loop system.	Understand
CO2.Design and derive describing functions for time invariant autonomous systems.	Apply
CO3.Apply the stability properties of non-linear system using Liapunov's direct and indirect methods.	Apply
CO4.Design the non-linear controller using state feedback and state observer	Apply
CO5.Design sliding motor controller for given system	Apply

Text Book(s):

T1. M.Gopal, 'Modern control system theory', New Age International Publishers, Second Edition,2005

T2. Ogata, 'Modern control Design with Matlab and Simulink', John Wiley, New Delhi,

Reference Book(s):

R1. Gene F. Franklin, J. David Powell and Abbasemami-Naeini, "Feedback Control of Dynamic Systems", Fourth edition, Pearson Education, Low price edition.2008

R2. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2010.

R3. VadimUtkin, JurgenGuldner, Jingxin Shi, "Sliding Mode Control in Electromechanical System", Taylor and Francis, 1999.

R4. George J. Thaler, 'Automatic Control Systems', Jaico Publishers, 1993.

Web References:

1. http://www.nptel.ac.in/courses

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1	-	-	1	2	1	-	-	2	-
CO2	1	1	1	1	1	-	-	1	2	1	-	-	2	-
CO3	1	1	1	1	1	-	-	1	2	1	-	-	2	-
CO4	1	1	1	1	1	-	-	1	2	1	-	-	2	-
CO5	1	1	1	1	1	-	-	1	2	1	-	-	2	-

High-3; Medium-2; Low-1

Course Code: 19EEEN1073	**Course Title: Digital Control Engineering**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Control Systems

Course Objectives

The course is intended to:

1. Study the importance of sample data control system.
2. Give adequate knowledge about signal processing in digital control.
3. Study the importance of modeling of discrete systems and stability analysis of discrete data system.
4. Study the importance of state space representation for discrete data system.
5. Introduce the design concept for digital controllers.

Unit I Introduction 9 Hours

Introduction to digital control – Sampling Process – Sample and Hold Circuit – Zero and First Order hold – Z-Transform – Inverse Z- Transform – Region of convergence – Initial and Final Value Theorem.

Unit II Pulse Transfer Function and Time Response 9 Hours

Block diagram reduction methods – Reduction Rules- Multi-loop – MIMO Systems – Signal Flow Graph- steady state error – error transfer functions- Error Constants-Time-Domain Analysis of Second Order Systems-Time Response

Unit III Stability Analysis 9 Hours

Introduction-Jury Stability Test- Schur-Cohn stability Test- Bilinear transformation-Stability by Pole Location – Root locus method- Bode Plot- Nyquist Plot

Unit IV State Feedback and State Observers 9 Hours

Controllability and Observability - Response between sampling instants using state variable approach-Pole placement using state feedback. Dynamic output feedback-Effects of finite word length on controllability and closed loop pole placement.

Unit V State Feedback Controller Design 9Hours

Controllability and Observability - Response between sampling instants using state variable approach-Pole placement using state feedback. Dynamic output feedback-Effects of finite word length on controllability and closed loop pole placement.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Analyze signals in both time domain and Z domain.	Apply
CO2.	Solve the problems on discrete systems.	Apply
CO3.	Analyze the real time problems using discrete data system.	Apply
CO4.	Distinguish the conventional and state variable approaches.	Apply
CO5.	Design the discrete-date control systems.	Apply

Text Book(s):

T1. Gopal M, “Digital Control and State Variable Methods”, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, Second Edition, 2012.

T2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Private Ltd.,

Reference Book(s):

R1. Nagrath I J and Gopal M, "Control Systems Engineering", New Age International Publisher, New Delhi, 2010.

R2. Nise S Norman, “Control Systems Engineering”, John Wiley & Sons, Inc, Delhi, Third edition, 2010.

R3. Benjamin C Kuo, “Automatic Control Systems”,John Wiley & Sons, Inc., Delhi, 2009.

R4. Thomas Kailath, “Linear Systems”, Prentice Hall, 1980.

Web References:

1. www.goodreads.com/59581
2. nptel.ac.in/courses/108103008/25
3. web.mit.edu/2.14/StateSpace.pdf
4. www.nptelvideos.in/control-engineering.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1				1		1			2	
CO2	3	2	1	1				1		1			2	
CO3	3	2	1	1				1		1			2	
CO4	3	2	1	1				1		1			2	
CO5	3	2	1	1				1		1			2	

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEC1001</td><td colspan="3">Course Title: Industrial Automation
Common to : EC & EE</td></tr>
<tr><td colspan="3">Course Category: Professional Core</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Digital Electronics
- Control Systems

Course Objectives

The course is intended to:

1. Justify the need for automation in industry
2. Describe the architecture and types of PLC used in industry automation
3. Develop the PLC based control logic program according to their application
4. Explain industry networking Protocols and SCADA programming
5. Explain the applications of DCS in various power plants

Unit I Introduction to Factory Automation 9 Hours

History and developments in industrial automation- Vertical integration of industrial automation- Building blocks in Automation: Processing systems, Multi microprocessor systems, LAN, analog and digital I/O modules, remote terminal unit.

Unit II Programmable Logic Controllers 9 Hours

PLC an Overview- Parts and Architecture of PLC- Principles of Operation - I /O Specifications - Memory types-Programming devices- PLC vs Computers, PLC size and Applications, Advantages of PLC, selection of PLC.

Unit III Programming of PLC 9 Hours

Program scan - PLC Programming Languages-Simple process control programs using Relay Ladder Logic - Programming Timers : On delay timer, OFF delay timer-Programming counters: Up and Down counter – PLC arithmetic functions –Program Control Instructions-Math Instructions-data transfer operations-Data comparison instructions.

Unit IV Industry Networking and SCADA 9 Hours

PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet.SCADA-Channel scanning-conversion to engineering units-data processing –Distributed SCADA systems- HMI introduction.

Unit V Distributed Control System and Applications 9Hours

DCS: Evolution – Different architectures – local control unit – Operator interface – Displays – Engineering interface. Applications: Thermal power plant-cement plant-water treatment plant- Solar, windmill substation automation.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1.Identify the need for automation in industry	Apply
CO2.Describe the architecture and types of PLC used in industry automation	Understand
CO3.Develop the PLC based control logic program according to their application	Apply
CO4.Explain industry networking Protocols and SCADA programming	Understand
CO5.Identify the applications of DCS in various power plants	Apply

Text Book(s):

T1. Frank D Petruzella “Programmable Logic Controllers", McGraw Hill Education India Private Limited, 4th Edition, 2016.

T2. Bolton.W, “Mechatronics”, Pearson Education, 4th Edition,2014. Delhi, Third Edition, 2009.

Reference Book(s):

R1. John W Webb & Ronald A Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, 5th edition, 2006

R2. DobrivojiePopovic, Vijay P. Bhatkar, “Distributed Computer Control for Industrial Automation”, MarcelDekkar Inc., New York, 1st edition, 2011.

R3. Krishna Kant, „Computer based Industrial Control‟, Prentice Hall of India, 2nd edition, 2010.

R4. Rajesh Mehra and Vikrant Vij, “PLCs& SCADA- Theory and Practice”,Laxmi Publications, 1st edition, 2016.

Web References:

1. http://www.fieldbus.org
2. www.nptel.ac.in/downloads/108105063/
3. http://nptel.ac.in/courses/108105062/18

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1				1		1		3	2	2
CO2	2	1						1		1			2	2
CO3	3	2	1	1				1		1			2	2
CO4	2	1						1		1			2	2
CO5	3	2	1	1				1		1		3	2	2

High-3; Medium-2; Low-1

Course Code: 19EEEC1003	**Course Title: Virtual Instrumentation Common to : EC & EE**		
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- C Programming

Course Objectives

The course is intended to:

1. Discuss the importance of virtual instrumentation.
2. Develop virtual instruments.
3. Apply the concept of Arrays, Strings and File I/O tasks.
4. Select suitable Data acquisition system interfaces.
5. Examine DAQ hardware's and LabVIEW.

Unit I Graphical System Design 9 Hours

Graphical System Design Model – Virtual Instrumentation – Virtual Instrument and Traditional Instrument – Hardware and software in virtual instrumentation – Virtual instrumentation for test, control and Design – Conventional and Graphical programming.

Unit II LabVIEW Basics I 9 Hours

Front Panel and Block Diagram – Tools, Controls and Functions palette. Modular programming - SubVI. Structures – FOR, WHILE Loops, Case, Sequence, event structures, Formula node.

Unit III LabVIEW Basics II 9 Hours

Arrays, Clusters, Strings, File I/O, Time and Dialog controls, Waveform chart, Graph, XY Graph and operations Report generation, Web Publishing tool.

Unit IV Data Acquisition System 9 Hours

Instrument control: GPIB – VISA – Instrument drivers – Serial Port communication. Data Acquisition: Review of Transducers and signal conditioning, DAQ hardware – AI, AO, DIO. DAQ Assistant and configuration.

Unit V LabVIEW Applications 9Hours

LabVIEW RT, Process control applications, Physical applications, Speed control, Data visualization, Imaging and Sound. Level, flow, temperature process, biomedical application - Pulse rate

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1.Discuss the importance of virtual instrumentation using LABVIEW	Understand
CO2.Develop virtual instruments using LabVIEW graphical programming tools	Understand
CO3.Apply the concept of Arrays, Strings and File I/O tasks in Data Acquisition	Apply
CO4.Select suitable Data acquisition system interfaces based on the Requirement	Apply
CO5.Examine DAQ hardware‟s and LabVIEW in various real time Environments	Understand

Text Book(s):

T1. Jovitha Jerome,"Virtual Instrumentation using LabVIEW‟ PHI Learning Private Limited, New Delhi, 2nd Printing, 2011.

T2. Gary W Johnson, Richard Jennings, "LabVIEW Graphical Programming‟ 4th Edition, McGraw Hill, 2006.

Reference Book(s):

R1. Sanjay Gupta, Joseph John, „Virtual Instrumentation using LabVIEW‟ Tata McGrawHill, 5th Reprint, 2010.

R2. Robert H Bishop, Learning with LabVIEW 2009‟ Pearson Education, 2010.

Web References:

1. http://www.av.it.pt/conftele2009/Papers/125.pdf
2. https://www.researchgate.net/publication/3420671_What_is_virtual_ instrumentation
3. http://www.ni.com/pdf/manuals/374629c.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	3	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EIEC1001</td><td colspan="3">Course Title: Robotics and Automation
Common to : EI & EE</td></tr>
<tr><td colspan="3">Course Category: Professional Core</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Control Systems

Course Objectives

The course is intended to:

1. Describe the anatomy of Robot
2. Explain the sources used to rum the Robot
3. Analyze kinematics and dynamic of robot
4. Develop the program to smooth run of Robot
5. Understand Robot operation used in various Industry application

Unit I Basic Concepts 9 Hours

Automation and Robotics – Asimov's laws of Robotics – Robot Anatomy – Basic components of Robot System – classification of Robots by configuration – Robot Motion – Precision of movements – End effectors.

Unit II Power Sources, Sensors and Drive System 9 Hours

Actuators – Hydraulic, Pneumatic and Electric drives – Mechanical power transmission system: Bearings, Gears, Belt and Chains – Sensors: Position, Velocity, tactile sensors, Proximity and range sensor – Machine vision: Sensing and digitizing, Image processing and application

Unit III Kinematics and Dynamics 9 Hours

Solution for direct and inverse kinematic problem – Robot dynamics – Jacobian work envelop – Robot trajectories – Manipulator path control – Robot cycle time analysis.

Unit IV Robot Programming 9 Hours

Methods of Robot programming – lead through programming methods – Robot program as a path in space – Motion interpolation – Wait, signal and delay commands – Branching – Capabilities and limitations – Robot programming examples for pick and place application using VAL.

Unit V Case Studies 9Hours

Robots in manufacturing and non-manufacturing application – Robot Cell layout – Selection of Robot – Applications – Material handling, Processing operation, assembly and inspection.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1.Explain the various parts of robotics and its automation	Apply
CO2.Identify the sensors and systems for developing a robot	Understand
CO3.Derive kinematics and dynamic equation for functioning the robot	Apply
CO4.Program a Robot using lead through methods.	Understand
CO5.Describe the operations of Robot used in industrial automation	Apply

Text Book(s):

T1. Mikell P.Groover, Nichols G.Ordy, "Industrial Robotics, Technology, Programming and Applications" McGraw hill, 2005

T2. Fu K.S, Gonzalez and Lee C.S.G, "Robotics Control, Sensing, vision and Intelligence", McGraw hill, 2000.

Reference Book(s):

R1. Deb.S.R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2012

Web References:

1. www.nptel.ac.in
2. www.nptel.ac.in/downloads/108105063/
3. http://nptel.ac.in/courses/108105062/18

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1			1	2	1			2	1
CO2	1	1	1	1	1			1	2	1			2	1
CO3	1	1	1	1	1			1	2	1			2	1
CO4	1	1	1	1	1			1	2	1			2	1
CO5	1	1	1	1	1			1	2	1			2	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1038	Course Title: Industry 4.0		
Course Category: Professional Core		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Industrial IoT.

Course Objectives

The course is intended to:

1. Understand manufacturing systems in terms of material flow and storage
2. Illustrate the structure of specific factory model.
3. Provide knowledge on manufacturing and assembly line
4. Understand the planning and simulation of smart factory
5. Explain the sustainable and digital business model.

Unit I Factory Models 9 Hours

Introduction to Factory models, single workstation factory models, processing time variability, Single-Part-Type Systems, Multi-stage single product and multi-product systems.

Unit II Special Factory Models 9 Hours

Models of various forms of batching, WIP limiting control strategies, serial limited buffer models.

Unit III Manufacturing and Assembly Lines 9 Hours

Manual Assembly lines, Automated Production lines, Automated Assembly systems, Group technology and cellular manufacturing, Flexible manufacturing cells and systems, Toyota Production System.

Unit IV Smart Factory Planning 9 Hours

Material Requirements Planning, Multi-Stage Control and Reactive Scheduling, Simulation Techniques.

Unit V Sustainable and Digital Business Models 9Hours

Sustainability and Supply Chain– Industry 4.0 and Its Applications- Reflection of Sustainability on Business Models- Integration of I 4.0 with Sustainability- Scenarios Countering Strategies for Obsolescence.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1.Identify the manufacturing systems in terms of material flow and storage	Apply
CO2.Illustrate the structure of specific factory model.	Understand
CO3.Make use of manufacturing and assembly line	Apply
CO4.Understand the planning and simulation of smart factory	Understand
CO5.Explain the sustainable and digital business model	Understand

Text Book(s):

T1. M. P. Groover, Automation, “Production Systems and Computer-Integrated Manufacturing”, 4th Edition, Pearson Education, 2016

T2. Kaushik Kumar, Divya Zindani, J. Paulo Davim, “Industry 4.0 Developments towards the Fourth Industrial Revolution”, 1st Edition, Springer, 2019

Reference Book(s):

R1. Lucas Darnell , “The Internet of Things (A Look at Real World Use Cases and Concerns)”, Kindle Edition, 2016

R2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

R3. Vijay Madisetti and ArshdeepBahga ,”Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014.

Web References:

1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://nptel.ac.in/courses/117/104/117104020/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code: 19EEEN1041	Course Title: Fundamentals of Power Plant Instrumentation		
Course Category: Professional Core		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Generation, Transmission and Distribution

Course Objectives

The course is intended to:

1. Introduce the concept of different power generation techniques
2. Describe the various measurements in power plants.
3. Apply the different control schemes in boiler side
4. Apply the different control schemes in furnace side.
5. Illustrate the different control schemes in steam turbine.

Unit I Overview of Power Generation 9 Hours

Survey of methods of power generation – hydro, thermal, nuclear, solar and wind power – Importance of instrumentation in power generation – Thermal power plant – Building blocks – Boiler Accessories– sub critical and supercritical boilers – Condensers – Cooling towers.

Unit II Measurements in Power Plants 9 Hours

Measurement of feed water flow, air flow, steam flow and coal flow – Drum level measurement – Steam pressure and temperature measurement – Turbine speed and vibration measurement – Flue gas analyzer – Fuel composition analyzer.

Unit III Boiler Control – I 9 Hours

Combustion of fuel and excess air – Firing rate demand – Steam temperature control – Control of deaerator – Drum level control: Single, two and three element control – Furnace draft control – implosion – flue gas dew point control – Trimming of combustion air – Soot blowing

Unit IV Boiler Control – II 9 Hours

Burners for liquid and solid fuels – Burner management system – Furnace safety interlocks – Coal pulverizer control – Combustion control for liquid and solid fuel fired boilers – air/fuel ratio control – fluidized bed boiler – Cyclone furnace.

Unit V Control of Turbine 9 Hours

Types of steam turbines – impulse and reaction turbines – compounding – Turbine governing system – Speed and Load control – Transient speed rise – Free governor mode operation – Automatic Load Frequency Control – Turbine oil system – Oil pressure drop relay – Oil cooling system – Turbine run up system.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1.Explain overview of different methods of power generation and boiler process	Understand
CO2.Illustrate the various measurements involved in power generation plants.	Understand
CO3.Apply the different control schemes in boiler side	Apply
CO4.Apply the different control schemes in furnace side.	Apply
CO5.Elucidate the different control schemes to monitor turbine parameters.	Understand

Text Book(s):

T1. Sam Dukelow, Control of Boilers, Instrument Society of America, 1991.

T2. Krishnaswamy.K and Ponnibala.M., Power Plant Instrumentation, PHI Learning Pvt.

Reference Book(s):

R1. Liptak B.G., Instrumentation in Process Industries, Chilton Book Company,2005.

R2. Jain R.K., Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 1999

Web References:

1. nptel.ac.in/courses/108106074

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	2	1	-	-	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code: 19EEEN1043	Course Title: Industrial IoT		
Course Category: Professional Core		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Embedded systems

Course Objectives

The course is intended to:

1. Indicate the various industrial revolutions and need for industry 4.0
2. Illustrate the design architecture and components of IoT.
3. Provide knowledge on communication protocols used IoT based solutions
4. Realize the opportunities, challenges brought about by Industry4.0 and how organizations and individuals should prepare to reap the benefits
5. Demonstrate the application of IIoT

Unit I Introduction to IIoT 9 Hours

The Various Industrial Revolutions - Digitalization and the Networked Economy -Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0- Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

Unit II IoT Building Blocks 9 Hours

IoT Architecture, WoT and M2M - Physical & Logical IoT design Basics - IoT Enabling Technologies - IoT Levels and templates, System Design of Connected Devices: Embedded Devices, Embedded Hardware, Connected Sensors and Actuators, Controllers, Battery Life Conservation and designing with Energy Efficient Devices, SoCs, Single Chip Controllers with integrated Processing and Network Core with Hardware Crypto Engines.

Unit III IoT Communication Protocols 9 Hours

Understanding Internet Protocols: Simplified OSI Model, Network Topologies, Standards, Types of Internet Networking - Ethernet, WiFi, Local Networking, Bluetooth, Bluetooth Low Energy (BLE), Zigbee, 6LoWPAN, Sub 1 GHz, RFID,NFC, Proprietary Protocols, Simplicity, Networking Design - Push, Pull and Polling, Network APIs.

Unit IV Advanced Design and Challenges 9 Hours

IOT Specific Challenges and Opportunities - Advances Design Concepts for IOT - Software UX Design Considerations, Machine Learning and Predictive Analysis, Interactions, Inter-usability and Inter-operability considerations, Understanding Security in IOT Design, Design requirements of IOT Security Issues and challenges, Privacy, Overview of Social Engineering.

Unit V Case Studies 9Hours

Smart Manufacturing – IIoT in oil and gas industry - Smart Cities- Precision healthcare- Precision mining.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1.Describe various industrial revolutions and role of industry4.0	Understand
CO2.Summarize various components required to build IoT based application	Understand
CO3.Explain the communication protocols suitable for IOT	Understand
CO4.Describe the opportunities, challenges brought about by Industry 4.0	Understand
CO5.Relate the concepts of IIoT in various applications and submit the case study report	Understand

Text Book(s):

T1. Foundational Elements of an IOT Solution -The Edge, Cloud and Application

T2. Designing Connected Products, 1st Edition, Elizabeth Goodman, Alfred Lui, Martin

Reference Book(s):

R1. Lucas Darnell ,"The Internet of Things(A Look at Real World Use Cases and Concerns)",KindleEdition, 2016.

R2. Jan Höller,Vlasios Tsiatsis,Catherine Mulligan,Stamatis Karnouskos,Stefan Avesand David BoyleFrom Machine-to-machine to the Internet of Things: Introduction to a New Age of Intelligence: 2014.

R3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-On Approach", Orient Blackswan Private Limited, New Delhi, 1st Edition 2015.

R4. Giacomo Veneri,”Hands-On Industrial Internet of Things: Create a powerfull Industrial IoT” Packt Publishing,2018.

Web References:

1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://nptel.ac.in/courses/117/104/117104020/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	1	1	2	-	1	-	-	2	-
CO2	1	-	-	-	-	1	1	2	-	1	-	-	2	-
CO3	2	-	-	-	-	1	1	2	-	1	-	-	2	-
CO4	3	-	-	-	-	1	1	2	-	1	-	-	2	-
CO5	3	-	-	-	-	1	1	2	-	1	-	-	2	-

High-3; Medium-2; Low-1

Course Code:19EEEN1001		**Course Title: Renewable Energy Sources**	
Course Category: Professional Elective		**Course Level: Mastery**	
L : T : P (Hours/Week) 3 : 0 : 0	**Credits : 3**	**Total Contact Hours : 45**	**Max Marks :100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Study the solar thermal energy collection and solar photovoltaic energy conversion system
2. Understand the concepts of wind energy conversion and their applications
3. Gain knowledge on the conversion process of biomass and biogas into energy
4. Brief about the renewable sources like ocean thermal, geo thermal and hydel energy
5. Gain knowledge on new energy sources like hydrogen and fuel cell

Unit I Solar Energy 9 Hours

Solar radiation - its measurements - solar thermal flat plate collectors, concentrating collectors – Applications: heating, desalination, hydrogen production, cooking.Principle of photovoltaic conversion of solar energy- conversion efficiency and power output- solar cell module - Advantages, applications: battery charger, domestic lighting, street lighting and water pumping-power generation schemes- Current scenario.

Unit II Wind Energy 9 Hours

Principles of wind power -Wind Energy Conversion Systems – Wind data and energy estimation- site selection characteristics - Wind Energy generators and its performance - horizontal and vertical axis types - Wind Energy Storage – Applications – Hybrid systems-safety and environmental aspects -Current scenario

Unit III Bio-Energy 9 Hours

Principles of Bio-Energy – biomass conversion: Wet and dry process – Photosynthesis – Biogas Generation- factors affecting gas generation – Classification of biogas plants –Biogas from plant wastes- Urban waste to energy conversion –Design of community biogas plant –methods for maintaining bio gas production – Biomass as energy – thermal gasification – Pyrolysis- Current scenario.

Unit IV - OTEC, Tidal, Geothermal and Hydel Energy 9 Hours

Ocean energy resources - principles of ocean thermal energy conversion systems - ocean thermal power plants –Tidal power: Principals and components –Geothermal energy: Introduction, estimation, sources, exploration and environmental issues - Small hydroelectric: Development, Classification, limitations and advantages - Turbines and generators for hydroelectric power generation- Current scenario

Unit V - New Energy Sources 9 Hours

Hydrogen: Production, storage, transport and utilization–Safety and management- Applications: aircraft, fuel cells, motor vehicles- Fuel cell: Classification, fuels for fuel cells, efficiency, V-I characteristics, Fuel cell power plant, Environmental effects -Current scenario

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Organize the solar thermal energy collection and solar photovoltaic energy conversion system	Apply
CO2: Model the wind energy conversion	Apply
CO3: Describe the conversion process of biomass and biogas into energy.	Understand
CO4: Describe the renewable sources like ocean thermal, geo thermal and hydel energy.	Understand
CO5: Summarize the new energy sources like hydrogen and fuel cell	Understand

Text Book(s)

T1. G.D Rai, "Non-conventional Energy Sources", Khanna Publications, New Delhi, 5th Edition,2016.

T2. B.H.Khan, ”Nonconventional Energy Resources”, Tata McGraw Hill,1st Edition, 2006.

Reference Book(s)

R1. Kreith, F and Kreider, J. F., “Principles of Solar Engineering”, McGraw-Hill, 2nd Edition 2000.

R2. Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press, 3rd Edition, 2012.

R3. Sukhatme, S.P., “Solar Energy”, Tata McGraw Hill, Third Edition, 2009.

R4. Hart, A.B., and Womack, G. J., “Fuel Cells: Theory & Applications”, Prentice Hall,1997.

Web References

1. http://www.pveducation.org/

2. https://www.britannica.com/technology/solar-cell
3. https://www.renewableenergyhub.co.uk/main/wind-turbines/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1006	Course Title: Power Quality		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Power Electronics

Course Objectives

The course is intended to:

1. Learn the various categories of power quality problems and its sources
2. Acquire an in depth knowledge on voltage sag and interruptions
3. Acquire an in depth knowledge on transient over voltages
4. Provide deep insight to harmonics in power system
5. Learn about various aspects of power quality measurements

Unit I Power Quality 9 Hours

Power quality: definition and importance – Power quality issues defined by IEEE-1159: Short duration voltage variations, Long duration voltage variations, Transients, Waveform distortion, Voltage imbalance, Voltage fluctuation and Power frequency variations – Sources and Effects of power quality problems – Power quality terms – CBEMA and ITI curves – Overview of power quality standards.

Unit II Voltage Sags and Interruptions 9 Hours

Sources of sags and Interruptions – Estimating Voltage Sag Performance –Fundamental principle of protection – Solutions at end user level – Economic Evaluation of Different ride-through Alternatives - Motor Starting sag.

Unit III Transient Over voltages 9 Hours

Sources of Transient Overvoltage: Capacitor Switching, Lightning, Ferro resonance – Principle of Overvoltage Protection – Devices for Overvoltage Protection – Utility capacitor-switching Transients – Lightning Protection – Switching transients with load – Computer analysis tools for Transients: PSCAD, EMTP

Unit IV Harmonics 9 Hours

Harmonics: Types, Harmonic Distortion, Harmonic indices, Voltage Vs Current distortion, Harmonics Vs Transients, Harmonic Evaluation – Industrial and commercial harmonic sources, Locating harmonic sources - Effects of harmonic distortion – System response characteristics – Principles of controlling harmonics – Harmonic Filters: Passive and Active Power filters, design and case study - Harmonic Standards.

9 Hours

Unit V Power Quality Monitoring

Monitoring considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment - Assessment of PQ measurement data – Expert system for PQ monitoring - Planning, Conducting and Analyzing power quality survey – PQ monitoring standards.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Understand the power quality issues and its sources in electrical distribution network	Understand
CO2: Examine the severity of voltage sag and the solutions at end user level	Apply
CO3: Examine the severity of transients and its mitigation practices	Apply
CO4: Design a suitable filter for harmonic mitigation	Apply
CO5: Identify the power quality monitoring instruments used in power system.	Apply

Text Books

T1. Roger C. Dugan, Mark, F. McGranaghan and H.WayneBeaty, 'Electrical Power Systems Quality', 3rd Edition, McGraw-Hill, New York, 2009.

T2. Barry W. Kennedy, 'Power Quality Primer', McGraw-Hill, New York, 2000

Reference Books:

R1. Ewald Fuchs and Mohammad Masoum 'Power Quality in Power Systems and Electrical Machines, 2nd Edition, Academic press, 2015.

R2. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, 'Power Quality Problems and Mitigation Techniques', John Wiley and Sons Ltd, 2015

R3. Suresh Mikkili and Anup Kumar Panda, 'Power Quality Issues: Current Harmonics', CRC Press, 2016

R4. Surajit Chattopadhyay, Madhuchh and Mitra and Samarjit Sengupta, " Electric Power Quality" , Springer, 2011.

Web References:

1. https://nptel.ac.in/courses/108/106/108106025/
2. https://megger.com/products/resistance-battery-and-power-quality/power-quality
3. https://www.engineeringenotes.com/electrical-engineering/power-quality/measurement-of-power-quality-7-devices-electrical-engineering/32558

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	1	1	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1010		Course Title: Computer Aided Design of Electrical Apparatus	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- DC Machines and Transformer
- Synchronous and Induction Machines

Course Objectives

The course is intended to:

1. Explain the basics of computer aided design aspects
2. Formulate problems and governing equations for CAD design
3. Solve the problem for field computation using finite element analysis
4. Distinguish the linear and non-linear problems of electrostatic and magneto static fields
5. Design the electrical apparatus using finite element package

Unit I Introduction 9 Hours

Review on electromagnetic theory — Basic field equations, calculation of field distribution, inductance, capacitance, force and torque, Review on conventional electrical machine design methodology computer aided design aspects advantages.

Unit II CAD Packages 9 Hours

Numerical methods for solving field problems, recent developments, problem formulation — governing equations — modeling — boundary conditions and material characteristics.

Unit III Finite Element Analysis 9 Hours

Mathematical formulation for 2-D planar and axial symmetry problems discretization — shape functions — element and global matrices/vectors — solution post processing.

Unit IV Field Analysis using FEA 9 Hours

Electrostatics, Magneto statics — linear and non-linear problems, permanent magnet, eddy current analysis, calculation of force/torque.

Unit V Design Examples 9 Hours

Design of cylindrical magnetic devices, transformer, rotating machines

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Understand the basics of computer aided design aspects	Understand
CO2: Problems and governing equations for CAD design can be formulated	Apply
CO3: Solve the Problem for field computation using Finite Element analysis	Apply
CO4:Distinguish the linear and non-linear problems of electrostatic and magneto static fields	Apply
CO5:Design the electrical apparatus using finite element package	Apply

Text Book(s)

T1.Sheppard.J.Salon “Finite Element Analysis of Electrical Machines", Springer International Edition, 1st Indian Reprint, 2007

T2.Nicola Bianchi “Electrical Machine Analysis using Finite Elements", Taylor & Francis, 2005

Reference Book(s)

R1.K.J.Binns, P.J. Lawrenson, C.W. Trowbridge, “The analytical and numerical solution of electrical and magnetic fields”, John Wiley & Sons, 1993.

R2. Nathan Ida, Joao P A Bastos ,”Electromagnetics & Calculation of Fields”, Springer Verlag, 2nd Edition,1997.

R3. P P. Silvester, Ferrari, “Finite Elements for Electrical Engineers", Cambridge University Press,3rd Edition, 1996

R4. M V K Chari, P PSilvester, “Finite Elements in Electrical and Magnetic Field problems”, John Wiley, 1980.

R5. S.S.Rao, “The Finite Element Method in Engineering”, Elsevier,2011

R6. J.N.Reddy, "An Introduction to the Finite Element Method”, McGrawHill International Editions, Third illustrated edition, 2006.

Web References

1. http://nptel. iitm.cad.ac.in/course/108106023/
2. http://nptel.linear.ac.in/courses/108101090/
3. https://nptel.cad packages.ac.in/courses/108/107/108107127

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	3	2	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	2	1

High-3; Medium-2;Low-1

Course Code:19EEEN1012	Course Title: Electrical Energy Utilization and Conservation		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- DC Machines and Transformers

Course Objectives

The course is intended to:

1. Understand the need for traction system
2. Introduce the energy saving concept by different ways of illumination
3. Understand the different methods of electric heating and electric welding
4. Introduce knowledge on power factor improvement and tariff
5. Introduce concepts of energy audit

Unit I Electric Traction 9 Hours

Requirements of traction system - Systems of traction - Systems of track electrification - Speed-Time curves - Tractive effort - Power of traction motor - Specific energy consumption – Block Diagram of Modern Locomotive – Main and Auxiliary Power supply circuits – Current Collection Systems -Motors for traction - Starting and speed control - Electric braking.

Unit II Electric Heating and Welding 9 Hours

Electric heating: Merits, types: Resistance, Induction, Dielectric- Temperature control - induction furnace - Choice of voltage and frequencies for Dielectric heating. Welding: Equipment’s, types – Resistance, Arc, Laser, Ultrasonic.

Unit III Illumination 9 Hours

Nature of light - Luminous intensity - Illumination - Brightness - Lamp efficiency - Luminous efficiency - Laws of illumination - Electrical sources of light - Fluorescent lamp, Incandescent lamp, Sodium Vapour lamp, Mercury Vapour lamp, CFL and LED lighting systems - Polar curves - Calculation of illumination - Indoor and outdoor Lighting schemes-standards (IS).

Unit IV Economic Aspects of Utilization 9 Hours

PF improvement - Load curves - Load factors - Its improvement – Depreciation – Tariff: Types, time-of-use - Demand side Management –Peak clipping – Peak shifting – valley filling - Use of off-peak energy.

Unit V - Energy Management & Audit 9 Hours

Definition, Energy audit- need, Types of energy audit, - Energy management (audit) approach- standards(ISO)- understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. Overview of energy conservation practices.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
C01: Explain the concepts of Electric Traction	Understand
C02: Classify the different types of electric heating and welding.	Apply
C03: Compute the energy saving of various illumination systems	Apply
C04: Determine the electricity cost by different types of tariff	Understand
C05: Explain the concepts of energy management and audit	Understand

Text Books

T1. Uppal S.L, Rao.S" Electrical Power System", Khanna Publishers, New Delhi,15th Edition, 2009.

T2. F. Kerith, D.Y. Goswami, “Energy Management and Conservation Handbook”, CRC Press, 2008.

Reference Books

R1. Taylor E.O. and VVL Rao, “Utilization of Electric Energy”, Orient Longman, New Delhi,3rd Edition,2007

R2. Suryanarayanan, N.V., “Utilization of Electric Power Including Electric Drives and ElectricTraction”, New Age International Publishers, New Delhi,2nd Edition 2014

R3. Abbi Y P, Shashank Jain, “Handbook on Energy Audit and Environment Management”,Teri Press, New Delhi, 2006

R4. Wadhwa C L, “Generation, Distribution and Utilization of Electrical Energy” New Age International Publishers, New Delhi, fourth Edition, 2012.

Web References

1. https://nptel.ac.in/courses/108/104/108104140/
2. http://cleenet.org/index.php/en/online-courses/modul-2/126-energy-auditing-and-energy-efficiency-measures
3. https://beeindia.gov.in/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	3	3	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	3	3	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1013	Course Title: Protection and Switchgear		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- DC Machines and Transformers
- Synchronous and Induction Machines
- Generation, Transmission and Distribution

Course Objectives

The course is intended to:

1. Explain the various protection schemes.
2. Explain the types of relays and relay settings.
3. Explain the different types of protection for alternator and transformer
4. Explain the different types of protection for motor and line
5. Describe the different types of circuit breakers.

Unit I Introduction to Protective Schemes and OverVoltages 9 Hours

Principles and need for protective schemes - Nature and cause of faults - Types of fault - Power system earthing - Zones of protection and essential qualities of protection - Current limiting reactors - CTs and PTs and their applications in protection schemes.

Surge: Switching surges - Lightning phenomenon - Protections against lightning - Lightning arresters – Types: Rod arrester, Horn gap arrester, Multi gap arrester, Expulsion type lightning arrester, valve type lightning arrester - Surge absorbers.

Unit II Protective Relays 9Hours

Definition - Requirement of relays - Relay torque equation - Non directional and directional over current relays - Earth fault relays - Distance relays: Impedance, Mho and Reactance relays - Differential relays - Negative sequence relays - Under frequency relays - Introduction to static relays - Microprocessor and computer based protective relaying.

Unit III Alternator and Transformer Protection 9 Hours

Alternator: modified scheme of differentia relay, circulating current protection scheme, balanced earth fault protection. Transformer: differential protection, balanced earth fault protection, buchholz's relay.

Unit IV Motor and Line Protection 9 Hours

Bus bar: frame leakage protection, circulating current protection Motor protection: short circuit protection, stalling protection- Feeder Protection: Pilot (Translay) relay, Power line carrier communication, Carrier and Microwave pilot relays. Insulation coordination-BIL

Unit V Circuit Breakers and Arc Interruption 9 Hours

Functions of switchgear - Elementary principles of arc extinction - Arc control devices - Recovery voltage and restriking voltage - Current chopping and capacitance current breaking - Bulk oil, Low oil, Air break, Air blast, and Sulphur hexafluoride(SF6) and Vacuum circuit breakers - HVDC breakers – Rating - Testing of circuit breakers.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the various protection schemes for faults and overvoltages	Understand
CO2: Explain the types of relays and relay settings used in power system.	Understand
CO3: Explain the different types of protection for alternator and transformer	Understand
CO4: Explain the different types of protection for motor and line	Understand
CO5: Describe the different types of circuit breakers.	Understand

Text Book(s)

T1. Soni M L, Gupta P V, Bhatnagar U S and Chakrabarti A, "A Text Book on Power Systems Engineering", DhanpatRai& Co Ltd., Delhi, 2013.

T2. V.K.Mehta, Rohit Mehta," Principles of Power System", Fourth Edition,S Chand & Co Ltd, 2011

Reference Book(s)

R1. Sunil S Rao, "Switchgear Protection and Power Systems", thirteenth Edition, KhannaPublishers, Delhi, 2008.

R2. Wadhwa, C.L., "Electrical Power Systems", Sixth Edition, New age International, 2014

R3. Badri Ram, Vishwakarma D N, "Power System Protection and Switch

Gear", Tata McGrawHill Education Private Limited, New Delhi, 2011.

R4. Ravindranath B and Chander M, "Power System Protection and Switchgear", New Age International Ltd., New Delhi, 2011

R5. S.L.Uppal, "Electrical Power Systems", 15Th Edition, Khanna Publishers, 2009

Web References

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2. http://www.nptel.ac.in/downloads/108101039/
3. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Bombay
4. https://onlinecourses.nptel.ac.in/noc20_ee80
5. https://nptel.ac.in/courses/108/107/108107167

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-		1	1
CO3	2	1	-	-	-	-	-	1	-	1	-		1	1
CO4	2	1	-	-	-	-	-	1	-	1	-		1	1
CO5	2	1	-	-	-	-	-	1	-	1	-		1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1014	Course Title: Electrical Machine Design		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- DC Machines and Transformers
- Synchronous and Induction Machines

Course Objectives

The course is intended to:

1. Explain the design considerations for rotating and static electrical machines.
2. Apply the design procedure for DC machine.
3. Apply the design procedure for core, yoke and windings of transformer.
4. Apply the design procedure for tank and cooling tubes of transformer.
5. Calculate the design parameters of an induction motor.

Unit I Introduction 9 Hours

Considerations and limitations in design - concept of magnetic circuit – MMF calculation for various types of electrical machines – real and apparent flux density of rotating machines – leakage reactance calculation: transformers, induction and synchronous machine - insulation classes.

Unit II DC Machines 9 Hours

Output equation – main dimensions – choice of specific loadings - choice of number of poles – armature design – design of field poles and field coil.

Unit III Transformer Design I 9 Hours

Output rating: single phase and three phase transformers – optimum design of transformers – design of core, yoke and windings: core type and shell type.

Unit IV Transformer Design II 9 Hours

Cooling methods of transformer – heat dissipation methods - design of tanks – design of cooling tubes – No load current.

Unit V Three Phase Induction Motors 9 Hours

Output equation – main dimensions – choice of specific loadings - design of stator– design of rotor: squirrel cage and slip ring rotor.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Explain the design considerations for rotating and static electrical machines with particular reference to magnetic circuit and the thermal rating of machines	Understand
CO2. Apply the design procedure for armature and field system of DC machine	Apply
CO3. Apply the design procedure for core, yoke and windings of transformer	Apply
CO4. Apply the design procedure for tank and cooling tubes of transformer	Apply
CO5. Calculate the design parameters for stator and rotor of an induction motor	Apply

Text Book(s)

T1. A.K.Sawhney, ‘A Course in Electrical Machine Design’, Dhanpatrai and Sons, Delhi,2016

T2. R.K.Agarwal, ‘Principles of Electrical Machine Design’, S.K.Kataria and Sons, Delhi, 2020

Reference Book(s)

R1. Shanmugasundaram, A., Gangadharan G. and Palani R., ‘Electrical Machine Design Data Book’, New Age International Publishers, Delhi, 2015

R2. V.N. Mittle and A. Mittle, ‘Design of Electrical Machines’, Standard Publications distributors,Delhi, 2013

R3. V Rajini, VS Nagarajan.,‘Electrical Machine Design’, Pearson Education, First Edition 2018

Web References

1. https://nptel.ac.in/courses/108/106/108106023/
2. https://epd.wisc.edu/courses/ac-machine-design-fundamentals-induction-motors-pm-motors-mechanical-design-thermal-design-and-fea-examples/
3. https://cusp.umn.edu/electric-machines-drives/electric-machines-design

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1015	**Course Title: Flexible AC Transmission Systems**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Power system analysis and stability.
- Electron Devices

Course Objectives

The course is intended to:

1. Describe the needs and importance of FACTS devices.
2. Explain the working of static shunt compensators.
3. Analyze the operation of series compensation devices.
4. Derive the concept of static voltage and phase angle regulator.
5. Deduce the concept of special FACTS controllers.

Unit I Introduction **9 Hours**

Introduction of power flow in an AC system-Power flow in parallel paths-Power flow in meshed system-Power flow and dynamic stability considerations- Importance of controllable parameters-Basic types of FACTS controllers-Benefits from FACTS technology-Comparison of FACTS and HVDC

Unit II Static Shunt Compensation **9 Hours**

Objectives of shunt compensation- Methods of controllable VAR generation-Variable impedance type static VAR generators-Function and VI ratings of: TCR, FC-TCR, TSC-TCR - Control scheme for Static VAR Systems - Basic operating principles of switching device –STATCOM

Unit III Static Series Compensation **9 Hours**

Objectives of series compensation- Operating and VI ratings of GCSC, TSSC and TCSC –

control scheme for GCSC, TSSC, TCSC - Switching converter type series compensation-SSSC basic principle- V-I characteristics.

Unit IV Static Voltage and Phase Angle Regulators 9 Hours

Objectives of phase angle regulator - Power flow control by phase angle regulators – Thyristor controlled voltage and phase angle regulators - Switching converter-Based voltage and phase angle regulators.

Unit V Special Facts Controllers 9 Hours

Basic operating principles of UPFC- Conventional transmission control capability - Independent real and reactive power control – Control structure of UPFC - Working principle of IPFC - Control structure of IPFC - FPGA based GIS

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	Explain the necessity and benefits of FACTS controllers.	Understand
CO2	Model the static shunt compensators and controllable VAR generation.	Apply
CO3	Organize series compensation devices based on their operating characteristics.	Apply
CO4	Examine the operation of voltage and phase angle regulators.	Apply
CO5	Describe the concept of UPFC and IPFC controllers.	Understand

Text Book(s)

T1	Narain G. Hingorani & Laszlo Gyugyi, Understanding FACTS - Concepts & Technology ofFlexible AC Transmission Systems, Standard Publishers, New Delhi,2015.
T2	K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New AgeInternational(P) Ltd., Publishers New Delhi,2008.
T3	G. K. Dubey, Thyristerized Power Controller, New Age international (P) Ltd., NewDelhi 2016.

Reference Book(s)

R1.	R. Mohan Mathur and Rajiv K.Varma, Thyristor Based FACTS Controller forElectrical Transmission Systems, Wiley Interscience Publications, 2016

R2. A.T.John,“FlexibleA.C.TransmissionSystems”,InstitutionofElectricalandElectronic Engineers(IEEE), 1999.

R3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004,KluwerAcademic Publishers,2004.

Web References

1. https://nptel.ac.in/courses/108/107/108107114/
2. https://www.springer.com/gp/book/9781402078903
3. https://ieeexplore.ieee.org/book/5264253

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1020	Course Title: Deregulated Power System		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Generation, Transmission and Distribution

Course Objectives

The course is intended to:

1. Explain the concepts of vector differentiation and integration
2. Determine the solution of second and higher order ordinary differential equations
3. Construct analytic functions
4. Use the concept of complex integration to evaluate definite integrals
5. Apply Laplace transform techniques to solve ordinary differential equations

Unit I Introduction 9 Hours

Understanding the restructuring process – Different Entities in Deregulated Electricity markets – Background to Deregulation and the current situations around the world – Industrialized Countries - Developing Countries – Benefits from competitive electricity market – Effects of deregulation - Indian electricity scenario – Restructuring reforms in India – Electricity Acts 2003.

Unit II Power System Operation in Competitive Environment 9 Hours

Introduction - Role of Independent System Operator (ISO) - Operational planning activities of ISO – ISO in Pool Markets – Social Welfare Maximizing Market settlement – Double Auction Power Pools – Single Auction Power Pools – Case study - ISO in Bilateral Markets- Operational planning activities of Generator Company (Genco) – Genco in Pool Markets – Genco in Bilateral Market – Market Participation issues - Unit Commitments in Deregulated Environment

Unit III Transmission Open Access and Pricing Issues 9 Hours

Power wheeling – Types of transmission open access – Embedded cost based Transmission Pricing – Incremental cost based Transmission Pricing – Case study.

Unit IV Congestion Management 9 Hours

Introduction - Definition of congestion - Reasons for transfer capability limitation - Importance of congestion management in deregulated environment - Effects of congestion - Desired features of congestion management schemes - Classification of congestion management methods - Calculation of ATC - ATC calculation using PTDF and LODF based on DC model - Calculation of ATC using AC model.

Unit V Ancillary Service Management 9 Hours

Introduction – Types and Classification of Ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Issues in reactive power management - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the fundamental concepts of deregulated power system	Understand
CO2. Explain the power system operation in competitive market	Understand
CO3. Explain the types of pricing issues	Understand
CO4. Make use of the concept of congestion management	Apply
CO5. Make use of the concept of ancillary service management	Apply

Text Book(s)

T1. Kankar Bhattacharya, Math H J. Bollen and Jaap E. Daalder, “Operation of Restructured Power Systems”, Springer, 2012.

T2. M. Shahidehpour and M. Alomoush, “Restructured Electric Power Systems – Operations, Trading and Volatility”, CRC Press, 2017.

T3. S.K. Gupta,” Restructuring Electric Power Systems” I.K International Publishing House Pvt. Ltd, 2018.

Reference Book(s)

R1. Loi Lei Lai (Ed), “Power System Restructuring and Deregulation: Trading, performance and Information Technology,” John Wiley publications, 2001.

R2. Francisco D. Galiana , Marija D. Ilic , Lester H. Fink, “Power system Restructuring: Engineering and Economics”, Springer, 1st edition, 1998.

R3. S. A. Khaparde, A. r. Abhyankar, “Restructured Power Systems” Alpha Science,2011.

Web References:

1. https://nptel.ac.in/courses/108/101/108101005/
2. https://crescent.education/wp-content/uploads/2019/02/restructured-power-systems.pdf
3. https://www.lathamathavan.edu.in/lmgi/antiragging/RPS-EEE%20new.PDF

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	2	2	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1021		Course Title: Energy Storage Systems	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Numerical Methods and Linear Algebra

Course Objectives

The course is intended to:

1. Understand the basic principles of various types of batteries
2. Gain the fundamental knowledge about various fuel cell technologies.
3. Provide comprehensive and logical knowledge of hydrogen production, storage and utilization.
4. Provide the optimal solutions to a particular energy storage application/utility
5. Understand the numerical optimization of the systems utilized for the energy systems.

Unit I Batteries 9 Hours

Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium based batteries – Li-ion & Li-poly, Metal Air Battery, Zine Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System

Unit II Fuel Cells 9 Hours

History, Working principle of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits. Fuel Cell usage for domestic power systems, large scale power generation, Automobile, environmental analysis. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines

Unit III Hydrogen energy systems 9 Hours

Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production-Hydrogen production processes -general storage methods, compressed storage-composite cylinders, metal hydride storage, carbon based materials for hydrogen storage- Hydrogen safety aspects

Unit IV Design and Applications of Energy Storage 9 Hours

Renewable energy storage-Battery sizing and stand-alone applications, stationary (Power Grid application), Small scale application-Portable storage systems and medical devices, Mobile storage Applications- Electric vehicles (EVs), types of EVs, batteries and fuel cells, future technologies, hybrid systems for energy storage.

Unit V Numerical methods and modeling 9 Hours

Classes of simulation, flow diagrams, Sequential and simultaneous calculations, Newton-Raphson method-Optimization procedure, mathematical statement of the problem The Lagrange multiplier equations, Sensitivity coefficients- Single variable– Exhaustive, Dichotomous and Fibonacci, Multivariable unconstrained- Lattice, Univarable and Steepest ascent Dynamic Programming

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic principles of various types of batteries	Understand
CO2: Select and defend appropriate fuel cell technology for a given application	Apply
CO3: Design and develop suitable hydrogen storage system to be used along with fuel cell system.	Apply
CO4: Identify the optimal solutions to a particular energy storage application/utility	Apply
CO5: Apply various numerical methods for the optimization of the systems	Apply

Text Book(s):

T1. B.K. Hodge, Robert P. Taylor, "Analysis and Design of Energy Systems", Prentice Hall,1999.

T2. Ahmed F. Zobaa, "Energy Storage Technologies and Applications", Intech open. 2013.

Reference Book(s):

R1. Xianguo Li, "Principles of Fuel Cells", CRC Press, 2006.

R2. Christopher D. Rahn, Chao-Yang Wang, S.P. Wolsky, "Battery Systems Engineering",Wiley, 2013.

R3. Gerard M. Crawley, "Energy Storage" World Scientific, 2017.

Web References:

1. https://nptel.fuelcells.ac.in/courses/112/107/112107283/
2. https://nptel.batteries.ac.in/courses/112/107/112107283/

3. https://nptel.numericalmetods.ac.in/courses/112/107/112107283/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-		1	1
CO2	3	2	1	1	1	-	-	1	-	1	-		1	1
CO3	3	2	1	1	1	-	-	1	-	1	-		1	1
CO4	3	2	1	1	1	-	-	1	-	1	-	3	1	1
CO5	3	2	1	1	1	-	-	1	-	1	-		1	1

High-3; Medium-2;Low-1

Course Code:19EEEN1023		Course Title:Embedded System Design	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Microprocessor and Microcontroller

Course Objectives

The course is intended to:

1. Discuss the ARM Processor Architecture.
2. Design ARM processor Peripherals.
3. Examine the significance of operating systems
4. Select the suitable communication technique.
5. Analyze the system architecture.

Unit I Introduction to Embedded System and Arm Processor 9 Hours

Definition of Embedded System, Features of Embedded System ,Types of Embedded System , List of Embedded System Devices, LPC 2148 ARM Block diagram, Memory and on chip peripheral devices, ARM 7 TDMI-S, CPU registers, Modes of Operation, PSW, Instruction set, Assembly Language Program for Addition, Subtraction, Multiplication and Division.

Unit II ARM Processor Interfacing Techniques 9 Hours

GPIO register map – Pin Connect Block, 8 bit LEDs, 8bit Switches, Buzzer, Relay, Stepper Motor interfaces, Timer/Counter, Vector Interrupt Controller, PWM, ADC - Temperature sensor interfacing.

Unit III Real Time Operating Systems 9 Hours

Tasks and states, scheduling, Inter Process Communication- Semaphore(s), Shared data problem, Priority Inversion Problem and Deadlock Situations, Message Queues, Mailboxes, Pipes, Introduction to µC OS II, Porting of µC OS II, RTOS functions – OS_STK – OS_EVENT – OSInit() –OSStart() – OSTaskCreate() – OSTaskDel() – OSSemCreate() – OSSemPend() – OSSemPost() - OSTimeDly(), Application programs using the above Functions.

Unit IV Communication Devices and Bus Standards 9 Hours

I/O Devices: Types and Examples of I/O devices, Synchronous, Iso-synchronous and Asynchronous Communications from Serial Devices, Internal Serial-Communication Devices: SPI, UART - Timer and Counting Devices – Serial Communication using: ‘I2C’- ‘CAN’- Advanced I/O Serial high speed buses

Unit V System Design Techniques 9 Hours

Design Methodologies, Requirement Analysis, Specification, System Analysis and Architecture Design. Design Examples: Telephone PBX- System Architecture - Ink jet printer - Hardware Design and Software Design- Personal Digital Assistants- Set-top Boxes.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Discuss the ARM Processor architecture with programming concepts	Understand
CO2: Design ARM processor peripherals using Embedded 'C' Concept	Apply
CO3: Examine the significance of operating systems in embedded system design	Apply
CO4: Select the suitable communication technique to interface peripherals	Apply
CO5: Identify the system architecture using existing product design	Apply

Text Book(s)

T1. Rajkamal, “Embedded Systems Architecture, Programming and Design, Tata McGraw-Hill, First reprint 2003.

T2. Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design” Morgan Kaufman Publishers, 1^{st} Indian Reprint 2001.

Reference Book(s)

R1. David E. Simon, “An Embedded Software Primer”, Pearson Education Asia, First Indian Reprint, 2000.

R2. K.V.K.K.Prasad “Embedded /Real-Time Systems: Concepts, Design and Programming”, Dream Tech, Wiley 2003.

R3. Andrew N Sloss, Dominic Symes and Chris Wright, “ARM System Developer’s Guide Designing and optimizing system Software”, Morgan Kaufmann publisher, Elsevier-2004.

R4. Steve Furber, “ARM System –On –Chip architecture”, Addision Wesley, 2000.

R5. Dave, “Embedded Systems: Concepts Design and Programming”, 1st edition, Pearson Education, 2015.

Web References

1. http://www.nxp.com/documents/user_manual/UM10139.pdf
2. http://nptel.ac.in/courses/108102045
3. http://www.nptelvideos.in/2012/11/real-time-systems.html

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code :19EEEN1024</td><td colspan="2">Course Title: Digital Image Processing</td></tr>
<tr><td colspan="3">Core Category: Professional Elective</td><td>Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact hours: 45</td><td>Max Marks:100</td></tr>
</table>

Prerequisites

- Digital Signal Processing

Course Objectives

The course is intended to:

1. Learn and understand the fundamentals of Digital Image Processing
2. Acquire the basic knowledge on image enhancement
3. Gain familiarity on the image restoration techniques
4. Gain knowledge on image segmentation techniques
5. Explore the different compression schemes

Unit I Digital Image Fundamentals 9 Hours

Elements of digital image processing systems, Digital Camera, Elements of visual perception, brightness, contrast, hue, saturation, Mach band effect, Color image fundamentals-RGB,HSI models, Image sampling, Quantization, 2D transforms-DFT, DCT, KLT and SVD

Unit II Image Enhancement 9 Hours

Spatial Domain techniques: Intensity transformations, contrast stretching, Histogram equalization and specification techniques, Smoothing filters, sharpening filters, gradient and laplacian. Frequency domain techniques: Smoothening filters, sharpening filters and Homomorphic filtering.

Unit III Image Restoration 9 Hours

Model of Image restoration process- Noise models- Restoration in the presence of noise (both spatial and frequency domain) Linear Image restoration techniques: Inverse filtering- Wiener filtering. Restoration from projections: Projections and the Radon transform

Unit IV Image Segmentation 9 Hours

Edge detection, Edge linking-Region based segmentation–Region growing –Region splitting and Merging. Clustering techniques: K-means clustering. Basic Morphological operations for Image Processing

Unit V Image Compression 9Hours

Need for data compression- Classification of Image compression schemes- Run length coding Huffman coding - Arithmetic coding - LZW coding, Transform based compression – Image compression standards.

Course Outcomes	
At the end of the course, the students will be able to	
CO1. Apply the various 2D Image transforms for processing images.	Apply
CO2. Model the various filtering techniques in spatial domain and frequency domain for Digital Images.	Apply
CO3. Identify the different image segmentation techniques.	Apply
CO4. Identify the different image restoration techniques.	Apply
CO5. Distinguish loss and lossless compression methods.	Apply

Text Books

1. Rafael C.Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson Education, 2nd Edition,2010.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2009.

Reference Books

1. Dr. Jayaraman, S., Essakirajan, S., and Veerakumar, T.,"Digital Image Processing", Tata McGraw Hill, New Delhi, 2012.

2. David Salomon, “Data Compression – The Complete Reference”, Springer Verlag Newyork, 3rdEdition, 2004.
3. William K-Pratt, “Digital Image Processing”, 4thEdition, John Wiley and Sons, 2007.
4. Kenneth R.Castleman, “Digital Image Processing”, Pearson Education, 1996.

Web References

1. https://en.wikipedia.org/wiki/Digital_image_processing
2. www.tutorialspoint.com/dip/
3. www.imageprocessingplace.com/
4. nptel.ac.in/courses/117105079/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	3	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	1	1	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code:19EEEN1025	**Course Title:Communication Engineering**		
Course Category: Professional Elective		**Course Level: Practice**	
L:T:P(Hours/Week) **3: 0: 3**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Electron Devices
- Electronic Circuits

Course Objectives

The course is intended to:

1. Summarize the basic concepts of AM, FM transmission and reception.
2. Discuss the different types of transmission medium
3. Explain different digital modulation schemes
4. Illustrate the different network protocols used in communication systems
5. Describe the basic elements of optical fiber communication strategies

Unit I Modulation Systems 9 Hours

Need for Modulation - Principles of amplitude modulation – Frequency spectrum –– power relations – generation of AM – DSB, DSB/SC, SSB; Demodulation – Envelop/diode detector - Super het Receiver; Generation (Armstrong method) and detection (Foster Seely Discriminator) of FM and PM – Frequency spectrum – power relations

Unit II Transmission Medium 9 Hours

Transmission lines – Types, equivalent circuit, losses, standing waves, impedance matching, bandwidth; radio propagation – Ground wave and space wave propagation, critical frequency, maximum usable frequency, path loss, white Gaussian noise

Unit III Digital Communication 9 Hours

Pulse modulation: PAM, PWM, PPM; Concept of Sampling - Sampling theorem – PCM - Digital T carrier system - Digital Radio System - Digital modulation: ASK, FSK, PSK

Unit IV Data Communication and Network Protocol 9 Hours

Data Communication codes - Error detection and correction codes - Serial and parallel interface - Telephone network - Data modem - ISDN, LAN, ISO -OSI seven layer architecture for WAN

Unit V Optical Fiber Communication **9 Hours**

General Fiber optic communication system – Advantages – optical fiber waveguides – transmission theory, Principle of Light propagation through fiber- fiber profiles and configuration- Losses of optical fiber communication - Light sources and detectors-Transmission techniques – multichannel transmission technique, Power line carrier communications.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Summarize the basic concepts of AM, FM transmission and reception.	Understand
CO2. Discuss the different types of transmission medium.	Understand
CO3. Explain different digital modulation schemes.	Understand
CO4. Identify the different network protocols used in communication. systems	Apply
CO5. Describe the basic elements of optical fiber communication strategies.	Understand

Text Book(s)

T1. WayneTomasi, ‘Electronic Communication Systems’, Pearson Education, 3rd Edition,2001.

T2. Roy Blake, ‘Electronic Communication Systems’, Thomson Delmar, 2ndEdition, 2002.

Reference Book(s)

R1. William Schweber, ‘Electronic Communication Systems’, Prentice Hall of India, 2002.

R2. G. Kennedy, ‘Electronic Communication Systems’, McGraw Hill, 4thEdition, 2002.

R3. J.G.Proakis, M.Salehi, “Fundamentals of Communication Systems”, Pearson Education 2006.

R4. Gerd Keiser, “Optical Fiber Communication”, McGraw Hill ,3rdEdition 2000.

R5. Behrouz A. Forouzan, “Data Communication and Networking”, 4thEdition, TMH, 2011.

Web References

1.http://nptel.ac.in/courses/117105077/

2.http://nptel.ac.in/courses/117102059/

3.http://nptel.ac.in/courses/117101002/download/lec01.pdf

4.http://nptel.ac.in/courses/106105082

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19EEEN1026</td><td colspan="3">Course Title:Computer Architecture</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Practice</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 3</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Microprocessor & Microcontroller

Course Objectives

The course is intended to:

1. Understand the concepts of memory and IO operations and the addressing modes
2. Understand the operations performed in the arithmetic unit.
3. Understand the concepts and organization of the processing unit.
4. Understand the concepts and storage in the memory unit
5. Understand the concepts and organization of I/O

Unit I Basic Structure of Computers 9 Hours

Functional units- Basic Operational Concepts, Bus Structures, Software Performance – Memory locations and addresses – Memory operations – Instruction and instruction sequencing – addressing modes – assembly language – Basic I/O operations, Stacks and queues.

Unit II Arithmetic Unit 9 Hours

Addition and subtraction of signed numbers – Design of fast adders – multiplication of positive numbers- signed operand multiplication and fast multiplication – Integer division, Floating point numbers and operations.

Unit III Basic Processing Unit 9 Hours

Fundamental concepts – Execution of a complete Instruction – Multiple bus organization – Hardwired control – micro programmed control. Pipelining – Basic concepts – data hazards – instruction hazards – influence on Instruction sets – Data path and control consideration, Superscalar operation.

Unit IV Memory System 9 Hours

Basic concepts – semiconductor RAMs, ROMs – Speed, size and cost – cache memories - Performance consideration – Virtual memory- Memory Management requirements, Secondary storage.

Unit V I/O Organization 9 Hours

Accessing I/O devices – Interrupts – Direct Memory Access – Buses – Interface circuits – Standard I/O Interfaces (PCI, SCSI, and USB)

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
1. Discuss the basic structures of computer and its operation	Understand
2. Model the fixed and floating point arithmetic operations in ALU	Apply
3. Explain the execution of machine instruction and its behavior	Understand
4. Discuss memory hierarchy and the impact of memory latency	Understand
5. Identify the input and output devices based on their applications	Apply

Text Book(s)

T1. Carl Hamacher, ZvonkoVranesic and SafwatZaky, “Computer Organization”, Tata McGraw-Hill Education Pvt. Ltd, 5th Edition, 2011.

T2. William Stallings, “Computer Organization and Architecture – Designing for Performance”, Pearson Education, 8th Edition, 2010.

Reference Book(s)

1. David A.Patterson and John L.Hennessy, “Computer Organization and Design: The hardware / software interface”, Morgan Kaufmann,5th Edition, 2014.
2. Vincent P. Heuring, Harry F. Jordan, “Computer System Architecture”, Pearson Education, 2nd Edition, 2005.
3. Govindarajalu B, “Computer Architecture and Organization, Design Principles and Applications”, Tata McGraw Hill, New Delhi, 2nd Edition,2010.

4. AharonYadin, "Computer Systems Architecture", Chapman and Hall/CRC, 2016
5. Pankaj Sharma "Computer Architecture and Organization" 1st edition 2011

Web References

1. http://nptel.ac.in/courses/106102062/
2. https://www.cis.upenn.edu/~milom/cis501-Fall11/lectures/00_intro.pdf
3. https://inspirit.net.in/books/academic/Computer%20Organisation%20and%20Architecture%208e%20by%20William%20Stallings.pdf
4. http://www.nptelvideos.in/2012/11/computer-architecture.html
5. http://www.learnerstv.com/Free-Computer-Science-Video-lectures-ltv086-Page1.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-		1	1
CO2	3	2	1	1	-	-	-	1	-	1	-		1	1
CO3	2	1	-	-	-	-	-	1	-	1	-		1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-		1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1027	Course Title: Industrial Data Communication Network		
Course Category: Professional Elective		Course Level: Practice	
L:T:P(Hours/Week) 3: 0: 3	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Enumerate the layers of the OSI model and TCP/IP.
2. Summarize the different types of industrial Ethernet.
3. Describe the different standards of industrial protocol.
4. Explain the different types of field bus technology.
5. llustrate the wireless communication standards and Satellite networks.

Unit I OSI Reference Model 9 Hours

ISO-OSI model – Layers in the OSI model – Peer to Peer Process –TCP/IP Protocol Suite– TCP/IP comparison with OSI model – Types of TCP/IP addressing

Unit II Industrial Ethernet 9 Hours

Introduction – IEEE Standards – Ethernet MAC layer – IEEE 802.2 and Ethernet SNAP – OSI and IEEE 802.3 standard. Ethernet transceivers, Ethernet types, switches and switching hubs, 10 Mbps Ethernet, 100 Mbps Ethernet, Gigabit Ethernet.

Unit III Industrial Data Communication Protocol 9 Hours

Serial communication Standards: RS232, 422 and 485 – Protocol Structure Overview – Example Function codes. ASCII based protocol - Modbus protocol – Overview. HART Protocol – Overview – Layers

Unit IV Field Bus Technology 9 Hours

AS-i Bus - Protocol Stack - CAN bus – Overview – Layers - Profibus – Overview – Protocol Stack. FIP and World FIP - Foundation Field Bus – Layers – Error Detection and Diagnostics – Redundancy

Unit V Wireless Communication 9 Hours

Wireless LANs – IEEE 802.11 standard – Blue Tooth Communication - Wireless WANs – Cellular Telephony: 1G, 2G, 3G and 4G/LTEE – Satellite Networks.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Enumerate the layers of the OSI model and TCP/IP.	Understand
CO2. Summarize the different types of industrial Ethernet.	Understand
CO3. Describe the different standards of industrial protocol.	Understand
CO4. Explain the different types of field bus technology.	Understand
CO5. Identify the wireless communication standards and satellite Networks.	Apply

Text Book(s)

T1. Behrouz A Forouzan, 'Data Communications and Networking', Tata McGraw-Hill, 2013.

T2. William Buchanan, 'Computer Buses- Design and Application', CRC Press, 2000.

Reference Book(s)

R1. Theodore S Rappaport, 'Wireless Communications: Principles and Practice', Prentice Hall PTR, 2nd Edition, 2010.

R2. Stallings,W., "Wireless Communication and networks", 2nd Edition, Prentice Hall of India, 2005.

R3. Steve Mackay, Edwin Wright and Deon Reynders, 'Practical Industrial data Networks: Design, Installation and Trouble Shooting', Elsevier International Projects Ltd., 2004.

R4. Nader. F. Mir, "Computer and Communication Networks", Pearson Prentice Hall Publishers, 2010.

R5. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill Publisher, 2011.

Web References

1.http://nptel.ac.in/courses/106105082/

2.http://nptel.ac.in/downloads/106105080/

3.http://sine.ni.com/nips/cds/view/p/lang/en/nid/208382

4.http://www.fieldbusinc.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	3	1	1
CO2	2	1	-	-	-	3	3	1	-	1	-		1	1
CO3	2	1	-	-	-	3	3	1	-	1	-		1	1
CO4	2	1	-	-	-	-	-	1	-	1	-		1	1
CO5	3	2	1	1	-	3	3	1	-	1	-		1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19EEEN1029</td><td colspan="3">Course Title:VLSI Design</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td colspan="2">Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Digital Electronics
- Electronic Circuits

Course Objectives

The course is intended to:

1. Describe the VLSI design flow and fabrication Techniques
2. Explain the characteristics and operation of MOSFET
3. Design digital circuits with CMOS
4. Develop VHDL programs
5. Explain the different types of fault and testing principles

Unit I Introduction 9 Hours

VLSI Design process: Design specification- design entry – functional simulation – planning, placement and routing – timing simulation, fabricating into chip- CMOS processing technologies –nWell - pWell - Twin tub - Silicon on insulator.

Unit II MOS Transistors and Inverters 9 Hours

Basic MOS Transistors and Operation: NMOS enhancement transistor - PMOS enhancement transistor - Threshold Voltage-Derivation of drain current- Channel length modulation- Body Effect –Trans conductance – MOSFETs as Switches - CMOS Inverter – Latch-up in CMOS Circuit - Power dissipation in CMOS Circuits - Scaling of MOSFETs and its effects.

Unit III Logic design with CMOS 9 Hours

Combinational Circuit Design: Logic gates in static CMOS - Transistor sizing – Stick diagram, Layout diagrams and design rules – Ratioed circuits: Pseudo NMOS – cascade voltage switch logic - Dynamic CMOS logic: domino logic, dual rail domino logic –Transmission gate - pass-transistor circuits

Unit IV VHDL Programming for subsystem design 9 Hours

Introduction to VHDL: Entities, architectures, signals, variables and constants – inertial and transport delay - arrays–operators - functions – procedures – packages and libraries - Types of modeling: Structural, dataflow and behavioral modeling –VHDL programs for simple adders and multipliers –Test Bench - FPGA: Architecture and programming technologies.

9 Hours

Unit V - Testing of digital circuits

Need for testing – Failures and Faults – Modeling of faults : Stuck at faults – Bridging faults – Break and transistor stuck on / open faults– Delay faults –Temporary faults – Design for testability : Ad-hoc testing, Scan design, BIST, IDDQ testing, Boundary scan.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Explain the VLSI design flow and CMOS design processes with appropriate fabrication technologies.	Understand
CO2. Describe MOS transistors and CMOS inverter with relevant characteristics.	Understand
CO3. Design various digital circuits using appropriate CMOS logic styles.	Apply
CO4. Develop VHDL Programs for various digital logic circuits using data path elements.	Apply
CO5. Categorize the faults in VLSI circuits using suitable testing methods.	Apply

Text Book(s)

T1. Weste and Harris, “CMOS VLSI Design” Pearson Education, 3rd Edition, 2005.

T2. Charles H.Roth, “Digital System design using VHDL”, Thomson business information India Pvt Ltd, 2006.

T3. Neil H.E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, Pearson Education ASIA, 2nd Edition, 2000.

Reference Book(s)

R1. John P.Uyemura “Introduction to VLSI Circuits and Systems”, John Wiley and Sons, Inc., 2002.

R2. Eugene D.Fabricius, “Introduction to VLSI Design”, McGraw Hill International Edition, 1990.

R3. Pucknell, “Basic VLSI Design”, Prentice Hall of India Publication, 1995.

R4. Wayne Wolf, “Modern VLSI Design System on chip”, Pearson Education,2002.

R5. P.K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.

Web References

1. http://nptel.ac.in/courses/117106093/1
2. http://nptel.ac.in/courses/106103116/41
3. https://www.youtube.com/watch?v=VUSTLyPtPgk

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	2	1	2	-	1	1	1
CO2	2	1	-	-	-	-	-	2	1	2	-	1	1	1
CO3	3	2	1	1	-	-	-	2	1	2	-	1	2	2
CO4	3	2	1	1	2	-	-	2	1	2	-	1	2	2
CO5	3	2	1	1	-	-	-	2	1	2	-	1	2	2

High-3; Medium-2; Low-1

Course Code:19EEEN1032	Course Title:Low Power VLSI Design		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:2**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites:

- Nil

Course Objectives

The course is intended to:

1. Explain the sources and the effect of MOS device parameters on power dissipation
2. Discuss the circuit and logic level low power design techniques
3. Explain the power reduction design techniques in clock networks and busses
4. Explain the techniques involved in low power memory design
5. Explain the concepts of low power design using software

Unit I Introduction to Low Power Dissipation 9 Hours

Need for low power VLSI chips - Physics of power dissipation in CMOS devices - Sources of power dissipation in Digital Integrated circuits - Basic principles of low power design-probabilistic power analysis - random logic signal - probability and frequency - power analysis techniques - signal entropy.

.

Unit II Circuit and Logic Level Low Power Design Techniques 9 Hours

Circuit - transistor and gate sizing - pin ordering - network restructuring and reorganization - adjustable threshold voltages - logic-signal gates - logic encoding. Pre-computation logic.

Unit III Special Low Power VLSI Design Techniques 9 Hours

Power reduction in clock networks - single driver Vs distributed buffers - Zero skew Vs tolerable skew, chip and package co-design of clock network - CMOS floating node - low power bus - delay balancing - Switching activity reduction - parallel voltage reduction - operator reduction - Adiabatic computation.

Unit IV Low Power Memory Design 9 Hours

Basics of SRAM - Memory cell – Pre-charge and equalization circuit. Sense amplifier - Output latch - Low power SRAM technologies - types of DRAM - Basics of DRAM - Cell refresh circuit – HVG – BBG – BVG – RVG – VDC.

Unit V Software Design and Power Estimation 9 Hours

Low power circuit design style - Software power estimation – co- design for low power.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the sources and the effect of MOS device parameters on power dissipation.	Understand
CO2: Discuss the circuit and logic level low power design techniques.	Understand
CO3: Explain the power reduction design techniques in clock networks and busses	Understand
CO4: Design the low power memory with the appropriate techniques	Apply
CO5: Estimate the power for the circuit design using appropriate software.	Apply

Text Book(s)

T1. Kiat-Seng Yeo, Kaushik Roy, "Low Voltage Low Power VLSI Subsystems", Tata Mc-GrawHill, 2009.

T2. GaryYeap "Practical Low Power Digital VLSI Design", Springer US, Kluwer Academic Publishers, 2002.

T3. Kaushik Roy, Sharat C. Prasad, "Low power CMOS VLSI circuit design", Wiley Inter science Publications",2009.

Reference Book(s)

R1. Rabaey, Pedram, "Low power design methodologies" Kluwer Academic, 1997.

R2. Chandrasekaran, A.P., Broadersen.R.W, "Low Power Digital CMOS VLSI Design", Kluwer 1995.

R3. Dimitrios Soudris, Christians Pignet, CostasGoutis, "Designing CMOS Circuits for Low Power", Kluwer, 2002.

R4. Abdelatif Belaouar, Mohamed.I.Elmasry, "Low power digital VLSI design", Kluwer, 1995.

R5. James B.Kulo, Shih-Chia Lin, “Low voltage SOI CMOS VLSI devices and Circuits”, John Wiley and sons, inc. 2001.

Web References

1. nptel.ac.in/courses/106105034/12
2. www.nptelvideos.com/course.php?id=422
3. http://www.youtube.com/watch?v=ruclwamT-Ro&list

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-		1	1
CO2	2	1	-	-	-	-	-	1	-	1	-		1	1
CO3	2	1	-	-	-	-	-	1	-	1	-		1	1
CO4	3	2	1	1	-	-	-	1	-	1	-		1	1
CO5	3	2	1	1	1	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code:19EEEN1033		Course Title:Micro Electro Mechanical Systems	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

Nil

Course Objectives

The course is intended to:

1. Explain the characteristics of material and MEMS fabrication process
2. Describe the various electrostatic sensors and actuators
3. Describe the various piezoelectric sensors and actuators
4. Explain the process involved in micromachining
5. Explain the applications of MEMS in Optics and RF

Unit I Introduction 9 Hours

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication – Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

Unit II Sensors And Actuators- I 9 Hours

Electrostatic sensors – Parallel plate capacitors – Applications – Inter digitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Applications – Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

Unit III Sensors And Actuators- II 9 Hours

Piezoresistive sensors – Piezoresistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

Unit IV Micromachining 9 Hours

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies – Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process – Assembly of 3D MEMS – Foundry process.

Unit V Opticaland RF MEMS 9 Hours

Optical MEMS, - System design basics – Gaussian optics, matrix operations, resolution. Case studies, MEMS scanners and retinal scanning display, Digital Micro mirror devices. RF Memes – design basics, case study – Capacitive RF MEMS switch, performance issues.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the MEMS fabrication process and material characteristics	Understand
CO2: Describe the various electrostatic sensors and actuators	Understand
CO3: Describe the various piezoelectric sensors and actuators	Understand
CO4: Explain the process involved in micromachining	Understand
CO5: Identify the applications of MEMS in Optics and RF	Apply

Text Book(s)

T1. Stephen Santuria,” Microsystems Design”, Kluwer publishers, 2001.

T2. Foundations of MEMS by Chang Liu ,2nd edition, 2011.

Reference Book(s)

R1. Tai Ran Hsu,” MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2008

R2. Gabriel M. RebeizRfMems: Theory Design and Technology, John Wiley & Sons, 2003.

R3. Sergey Edward Lyshevski, “MEMS and NEMS: Systems, Devices, and Structures” CRC Press, 2002.

R4. NadimMaluf,” An introduction to Micro electro mechanical system design”, Artech House, 2000.

R5. Mohamed Gad-el-Hak, editor,” The MEMS Handbook”, CRC press Baco Raton, 2000.

Web References

1. http://nptel.ac.in/courses/117105082/
2. http://www.learnerstv.com/Free-engineering-Video-lectures-ltv122-Page1.htm
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-777j-%20design%20andfabrication-of-microelectromechanical-devices-spring-2007/lecture%20notes/07lecture02.%20Pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-		-	1	-	1	-	-	1	1
CO2	2	1	-	-	-		-	1	-	1	-	-	1	1
CO3	2	1	-	-	-		-	1	-	1	-	-	1	1
CO4	2	1	-	-	-		-	1	-	1	-	-	1	1
CO5	3	2	1	1	-		-	1	-	1	-	3	2	2

High-3; Medium-2;Low-1

Course Code: 19EEEN1034	Course Title: Hardware Description Language		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week): 3: 0: 0	Credits: 3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Digital Electronics

Course Objectives

The course is intended to:

1. Explain the Verilog overview and Hierarchical modeling concepts
2. Explain the basic concepts modules & ports
3. Discuss gate Level and data flow modeling
4. Explain behavioral modeling
5. Enlighten on overview of VHDL

Unit I Verilog Overview and Hierarchical Modeling Concepts 10 Hours

Evolution of Computer-Aided Digital Design- Emergence of HDLs- Typical Design Flow- Importance of HDLs-Popularity of HDL- Trends in HDLs. Top-down and bottom-up design methodology -Modules –Instances- Components of a simulation- Design block, Stimulus block

Unit II Basic concepts, Modules & Ports 8 Hours

Basic Concepts: Lexical conventions-data types- system tasks- compiler directives. Modules and Ports Module: Definition- port declaration- connecting ports-hierarchical name referencing.

Unit III Gate Level and Data flow Modeling 10 Hours

Gate-Level Modeling: Modeling using basic Verilog gate primitive- description of and/or and buf/not type gates- rise, fall and turn-off delays- min, max, and typical delays. Dataflow Modeling: Continuous assignments-delay specification-expressions-operators-operands-operator types.

Unit IV Behavioral Modeling 7 Hours

Structured procedures-initial and always- blocking and non-blocking statements - delay control- generate statement - event control - conditional statements - Multiway branching – loops - sequential and parallel blocks

Unit V Tasks ,Functions and Modeling Techniques 10 Hours

Differences between tasks and functions, declaration, invocation, automatic tasks and

Functions, Procedural continuous assignments, overriding parameters, conditional compilation and Execution, useful system tasks.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the Verilog Overview and Hierarchical Modeling Concepts	Understand
CO2: Implement the Basic concepts in simple circuits	Apply
CO3: Examine Gate Level and Data flow Modeling	Apply
CO4: Execute Behavioral Modeling in verilog	Apply
CO5: Describe on modeling techniques	Understand

Text Book(s):

T1. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Pearson Education, 2nd Edition 2003

T2. Kevin Skahill, “VHDL for Programmable Logic”, PHI/Pearson education, 2006.

Reference Book(s):

R1. Donald E. Thomas, Philip R. Moorby, “The Verilog Hardware Description Language”, Springer Science,Business Media, LLC,1996

R2. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL” Pearson (Prentice Hall), 2nd Edition.2011

R3. Padmanabhan, Tripura Sundari, “Design through Verilog HDL”, Wiley, 2016

Web References:

1. https://nptel.ac.in/courses/106/105/106105165/

2. https://cse.iitkgp.ac.in/~pallab/testing_and_verification

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	--	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code:19EEEN1035	Course Title:Illumination Engineering		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Understand the Laws of Illumination and operating characteristics of various electric light sources
2. Identify the criteria for the selection of lamps and lighting systems for an indoor or outdoor space
3. Perform calculations on photometric performance of light sources and luminaires for lighting design
4. Design different types of lighting for indoor applications
5. Design different types of lighting for outdoor applications

Unit I Importance of Lighting in Human Life 9 Hours

Optical systems of human eye ,Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting & perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification & Measurement of Light.

Unit II Light Sources 9 Hours

Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL) High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.

Unit III Electrical Control of Light Sources 9 Hours

Ballast, ignitors and dimmers for different types of lamps, Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures. Optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).

Unit IV Indoor Lighting Design 9 Hours

Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles and polar diagrams. Factors to be considered for design of indoor illumination scheme Indoor illumination design for following installations - Residential (Numerical) -Educational institute- Commercial installation : Hospitals - Industrial lighting Special purpose lighting schemes - Decorative lighting - Theatre lighting - Aquarium, swimming pool lighting-Green Building.

Unit V Outdoor Lighting Design 9 Hours

Road classifications according to BIS, pole arrangement, terminology, lamp and luminaire selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Outdoor illumination design for following installations - Road lighting (Numerical) -Flood lighting (Numerical) - Stadium and sports complex - Lighting for advertisement/hoardings.

Modern trends in illumination : LED luminary designs -Intelligent LED fixtures - Natural light conduiting- Organic lighting system- LASERS, characteristics, features and applications, non-lighting lamps - Optical fiber, its construction as a light guide, features and applications.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1:	Understand the properties of light, importance of lighting in various fields.	Understand
CO2:	Understand operating characteristics of various Electric light sources	Understand
CO3:	Compare the various electrical control techniques & employ lighting control methods.	Understand
CO4:	Design different types of lighting for indoor applications	Apply
CO5:	Design different types of lighting for outdoor applications	Apply

Text Book(s)

T1. D.C. Pritchard "Lighting", CRC Press, , 6 thEdition,2014

T2. M. A. Cayless,J R Coaton, A. M. Marsden, "Lamps and Lighting", CRC Press, 4 thEdition, 2012

Reference Book(s)

R1. Bean, A.R., and Simons, R. H.. Lighting Engineering: Applied Calculations. United Kingdom, CRC Press, 2008.

R2. BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", ManakBhavan, New Delhi,2010.

R3. Jack L. Lindsey ,Applied Illumination Engineering, 3rd Edition, Fairmont Press, 2016

R4. Phillips, Derek. Daylighting. N.P, Taylor & Francis, 2012.

R5. Solanki.C.S, 'Solar Photovoltaic Technology and Systems', PHI 2013.

Web References

1.https://pdhonline.com/courses/g378/g378_new.html

2.https://www.udemy.com/course/efficient-lighting-system/

3.https://www.classcentral.com/course/swayam-energy-efficiency-acoustics-and-daylighting-in-building-9822

4.https://www.cet.asn.au/Courses/NECA-EnergySmart/Energy-Efficient-Lighting

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code:19EEEC1002		Course Title: Automotive Electronics	
Course Category: ProfessionalElective		**Course Level: Practice**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Prerequisites:

- Electron devices
- Microprocessor and Microcontroller

Course Objectives

The course is intended to:

1. Inculcate knowledge of mechanical system in automotive systems.
2. Understand the electronic system in automobiles.
3. Know the X-by-wire concepts in automobiles.
4. Understand the embedded system applications in automobiles.
5. Disseminate the knowledge of communication protocols used in automobiles.

Unit I Automotive Mechanical Systems 9 Hours

Vehicle Systems: Power Train System (Air System, Fuel System (Carburettor& Diesel Fuel Injection, Ignition System, Exhaust System and other Auxiliary Systems (Cooling, Lubrications & Electrical Systems)), Transmission System (Front, Rear & 4 wheel Drive, Manual, Automatic Transmission, Differential). Braking System (Drum, Disc, Hydraulic, Pneumatic), Steering System (Rack and Pinion, Power Steering).

Unit II Electronics in Automotive Systems 9 Hours

Performance (Speed, Power, and Torque), Control (Emission, Fuel Economy, Drivability, and Safety) & Legislation (Environmental legislation for pollution & Safety Norms). Overview of Chassis subsystem (ABS, TCS, & ESP) – Comfort and safety subsystems (Night Vision, Airbags, Seatbelt Tensioners, Cruise Control-Lane-departure-warning, Parking).

Unit III Drive By Wire 9 Hours

Challenges and opportunities of X-by-wire: system & design requirements, steer-by-wire, brake-by-wire, suspension-by wire, gas-by-wire, power-by-wire, shift by wire- Future of

Automotive Electronics

Unit IV Embedded System in Automotive Applications 9 Hours

Gasoline / Diesel systems Sensors – Nox sensor, Knock Sensor, MAP Sensor, Oxygen sensor, Throttle Position Sensor- Actuators - Idle speed control valves, Exhaust gas recirculation valves Thermal actuators - Body electronics – Body electronics domain- Central locking and electric windows, Climatic Control - On-Board Diagnostics (OBD). Introduction to electric vehicles- Types of electric vehicles.

Unit V Vehicle Communication Protocols 9 Hours

SPI, I2C, USB communication protocols - Introduction to CAN, LIN, FLEXRAY, MOST, KWP2000. Introduction to AUTOSAR

Course Outcomes	
At the end of the course students will be able to:	**Cognitive Level**
CO1. Explain the mechanical systems of automobiles	Understand
CO2. Describe the electronic system in automobiles	Understand
CO3. Summarize the X-by-wire concepts in automobile	Understand
CO4.Identify the embedded system applications in automobiles	Apply
CO5.Identify the different communication protocols in embedded system for automobile	Apply

Text Books

1. Robert Bosch GmbH, "Bosch Automotive Handbook", 10th Edition, Wiley Publishers, 2019
2. William B. Ribbens, “Understanding Automotive Electronics”, 7th Edition, SAMS/Elsevier Publishing, 2012

Reference Books

1. Robert Bosch Gmbh, Automotive Electrics and Automotive Electronics, Systems and Components, Networking and Hybrid drive, 5th edition, Springer Vieweg, Wiesbaden 2014
2. Knowles.D, Automotive Electronic and Computer Controlled Ignition Systems, Reston

Pub Co,1990

3. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012
4. JoergSchaeuffele, Thomas Zurawka – Automotive Software Engineering – Principles, Processes, Methods and Tools, SAE, 2016

Web References

1. www.austincc.edu/autotech
2. www.austincc.edu
3. https://acconline.austincc.edu/webapps/portal/frameset.jsp

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO3	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code:19EEEN1040	Course Title: Quality Engineering		
Course Level: Professional Elective		**Course Category: Practice**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Prerequisites

- Instrumentation and Testing

Course Objectives

The course is intended to:

1. Explain the need of quality and customer satisfaction.
2. Explain the basics of Quality cost with classification
3. Explain the concept of total quality management relevant to both manufacturing and service industry.
4. Explain the various tools used in Quality Engineering and Management.
5. Explain the steps used for Designing for Quality.

Unit I Introduction 9 Hours

Introduction – Need for quality – Evolution of quality – Different Definitions and Dimensions of Quality– Concepts of Product and Service Quality– Contributions of Deming, Juran and Crosby – Barriers to Quality – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention – Costs of Poor quality.

Unit II Quality Costs 9 Hours

Basic Concept Quality Costs: Fitness for Use, Quality Characteristics, Parameters of Fitness for use-Quality functions, Concept of Quality assurance and Quality control, Quality costs concept, Quality cost categories, Examples of Quality cost studies, Securing the Cost figures, Pareto Analysis, Cost reduction Programs and economics of quality.

Unit III Total Quality Management 9 Hours

Total quality Management- Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Modern Quality Management Techniques-Benchmarking, QFD, Taguchi quality loss function TPM,Lean Manufacturing continuous improvement techniques, JIT systems, Cause and effect diagrams, Scatter diagram, Run charts, Affinity diagrams, Inter-relationship diagram, Process decision program charts, PDCA Concept

Unit IV Quality Engineering and Management Tools 9 Hours

Quality Engineering and Management Tools, Techniques & Standards: 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, SMED, Quality Circle, Cost of Quality Technique, Introduction to Quality Management Standards – ISO 9000, IATF 16949, ISO 14001, ISO 45001, ISO 50001 (Concept, Scope, Implementation Requirements & Barriers, and Benefits), Introduction to National and International Quality Awards.

Unit V Designing for Quality 9 Hours

Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, Methodology and Application (with case studies).Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitations – DOE

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Identify the need of quality and customer satisfaction.	Apply
CO2: Explain the basics of Quality cost with classification	Understand
CO3: Explain the concept of total quality management relevant to both manufacturing and service industry.	Understand
CO4: Identify the various tools used in Quality Engineering and Management.	Apply
CO5: Explain the steps used for Designing for Quality	Understand

Text Book(s)

T1 K C Jain and A K Chitale,"Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) ", Khanna Publishers,2003

T2 Dale H. Besterfield, Carol Besterfield- Michna, Glen H. Besterfield and Mary Besterfield-Sacre, "Total Quality Management ",Pearson Education,2003

T3 KanishkaBedi," Quality Management",Oxford University Press,2006

Reference Book(s)

R1 Juran and Gryna, "Quality planning and Analysis, "TMH, New Delhi

R2 B. L. Hanson & P. M. Ghare, "Quality Control & Application "Prentice Hall of India ,2009

R3 Dr. S. Kumar,"Total Quality Management",Laxmi Publication Pvt. Ltd,2013

R4 K C Arora, ,"Total Quality Management" , S K Kataria& Sons 2016.

R5 M. Mahajan,Statistical Quality Control DhanpatRai& Co. (P) Ltd,2016

Web References

1. http://www.nptel.ac.in
2. http://www.ocw.mit.edu

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO2	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO3	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	2	2	1	-	1	-	-	2	2
CO5	2	1	-	-	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2; Low-1

Course Code:19EEEC1005	**Course Title:Industrial Safety (Common to EC and EE)**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Impart knowledge on safety engineering fundamentals and safety management practices
2. Expose the basic concepts of chemical hazards
3. Explain industrial health hazards and environmental control for protection
4. Identify and prevent chemical, environmental mechanical, fire hazardthrough analysis
5. Apply proper safety techniques on safety engineering and management

Unit I Introduction 9 Hours

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure

Unit II Chemical Hazards 9 Hours

Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

Unit III Environmental Control 9 Hours

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection

Unit IV Hazard Analysis 9 Hours

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

Unit V **Safety Regulations** **9 Hours**

Explosions – Disaster management – catastrophe control, hazard control, Safety education and training - Factories Act, Safety regulations Product safety – case studies

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Understand safety engineering fundamentals and safety management practices	Understand
CO2. Understand the basic concepts of chemical hazards	Understand
CO3. Summarize industrial health hazards and environmental control for protection	Apply
CO4. Identify and prevent hazards through analysis	Apply
CO5. Apply proper safety techniques on safety engineering and management	Understand

Text Book(s)

T1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003

T2. Fordham Cooper, W., Electrical Safety Engineering, Butterworth and Company, London, 1986

Reference Book(s)

R1. Safety Manual, "EDEL Engineering Consultancy", 2000.

R2. Indian Electricity Act and Rules, Government of India.

R3. Power Engineers – Handbook of TNEB, Chennai, 1989.

R4. David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.

Web References

1.https://nptel.ac.in/courses/110/105/110105094/

2.http://ccc.chem.pitt.edu/wipf/Web/HCH.pdf

3.https://www.preventionweb.net/publications/view/61941

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19MEEC1014</td><td colspan="3">Course Title: Engineering Economics and Cost Analysis(Common to AU EC,EE,EI & ME)</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

- Process Engineering in Mechanical Part Assembly

Course Objectives

The course is intended to:

1. Calculate the breakeven point.
2. Apply different interest formulae and their application in decision making
3. Evaluate present value, future value and annual worth analysis
4. Discuss Replacement analysis of equipment.
5. Calculate depreciation of an equipment.

Unit I Introduction to Economics 8 Hours

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics - Elements of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis

Unit II Value Engineering 10 Hours

Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods with problems.

Unit III Cash Flow Management 9 Hours

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

Unit IV Replacement and Maintenance Analysis 9 Hours

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

Unit V Depreciation 9 Hours

Depreciation- Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset. Case study

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to	
CO1: Categorize different cost and calculate the breakeven point for a given business situation	Understand
CO2: Apply different interest formulae and their application in decision making process.	Understand
CO3: Evaluate present value, future value and annual worth analysis on one or more economic alternatives.	Understand
CO4: Determine the economic value of an asset and develop a better replacement policy for given equipment.	Understand
CO5: Evaluate the depreciation of equipment per period.	Understand

Text Book(s)

T1. Panneerselvam R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2014

T2. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2016.

Reference Book(s)

R1. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.

R2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2010.

Web References

1. https://en.wikipedia.org/wiki/Engineering_economics
2. https://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19MEEC1015</td><td colspan="3">Course Title: Principles of Management
(Common to EC,EE,EI, MC,ME)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

- Nil

Course Objectives

The course is intended to:

1. Describe the role of managers.
2. Explain the significance of planning, decision making and strategies for international business.
3. Explain the significance of organizing the tasks.
4. Explain the motivational theories.
5. Explain the control techniques**.**

Unit I Overview of Management 9 Hours

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business.

Unit II Planning 9 Hours

Nature and Purpose planning – Planning process – Types of plans – Objectives – Managing by objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision –Decision Making Process - Rational Decision Making Process – Decision Making under different conditions.

Unit III Organising 9 Hours

Nature and purpose of organizing – Organization structure – Formal and informal groups / organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recruitment – Orientation Career Development – Career stages – Training – Performance Appraisal.

Unit IV Directing 9 Hours

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – Organization Culture – Elements and types of culture – Managing cultural diversity

Unit V Controlling 9 Hours

Process of controlling – Types of control – Budgetary and non-budgetary control techniques – Managing Productivity – Cost Control – Purchase Control – Maintenance Control – Quality Control – Planning operations.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to	
CO1: Describe the role of managers with reference to an organization context and business.	Understand
CO2: Explain the significance of planning, decision making and strategies for international business to accomplish the organizational goal.	Understand
CO3: Explain the significance of organizing the tasks to accomplish the organizational goal.	Understand
CO4: Explain the motivational theories to increase the productivity and retention rate of employees.	Understand
CO5: Explain the control techniques such as budgetary, maintenance, quality to accomplish the organizational goal.	Understand

Text Book(s)

T1. Stephen P. Robbins, Rolf Bergman and Mary Coulter, “Management”, Prentice Hall of India, 8th edition, 2017.

T2. Charles W.L Hill, Steven L McShane, “Principles of Management”, Mcgraw Hill Education, 2008.

Reference Book(s)

R1. Hellriegel, Slocum & Jackson, “Management – A Competency Based Approach”, Thomson South Western, 10th edition, 2007.

R2. Harold Koontz, Heinz Weihrich and mark V Cannice, “Management – A global & Entrepreneurial Perspective”, Tata McGraw Hill, 12th edition, 2007.

R3. Andrew J. Dubrin, “Essentials of Management”, Thomson Southwestern, 7th edition, 2007.

Web References

1. http://www.managementstudyguide.com/all-subjects.htm

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEC1004	Course Title: Disaster Management (Common to EC,EE,EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- Communication Skills–I
- Communication Skills–II

Course Objectives

The course is intended to:

1. Distinguish the natural and manmade disasters.
2. Explain the environment hazards and level of toxicology.
3. Identify the causes and effects of Earthquake and Tsunami formation.
4. Identify the causes and effects of Cyclone formation.
5. Describe about modern technological tools in disaster management.

Unit I Introduction 9 Hours

Disaster- Disaster management- Disaster prevention and preparedness measures-Types of Disaster – Causal factor of Disaster – Natural, Manmade, creeping disaster-Disaster in the Indian context various measures – Disaster related policy goals – United Nations Development Program (UNDP) – United Nations Disaster Relief Organization (UNDRO) – Govt. of India.

Unit II Environmental Disaster 9 Hours

Environmental hazards – Typology – Assessment and response – the strategies– the scale of disaster – Vulnerability – Disaster trends – Paradigms towards a balanced view – Chemical hazards and Toxicology – Biological hazards –Hazard caused by world climate change – Risk analysis – other technological disasters.

Unit III Earthquake and Tsunami 9 Hours

Earthquake – Causes of earthquake – Earthquake scales – Measures of earth –quake – Magnitude and Intensity – Earthquake Recurrence hazard assessment –Seismic zoning – Earthquake disaster mitigation – Component research focus –Forecasting techniques and Risk analysis – Tsunami – Causes of Tsunami –Effects of Tsunami – Tsunami warning system –

Tsunami warning system in India – International status of Tsunami warning and communication system –Tsunami warning centers – Pacific Tsunami Warning Center (PTWC) – Pacific Tsunami Warning System (PTWS) components – Institutional arrangements and design criteria for Tsunami mitigation.

Unit IV Cyclone 9 Hours

Tropical cyclone - Warning system – Protection of buildings from cyclones - Precaution before and during cyclones – Tropical cyclone warning strategy in India – Cyclone related problems – aerial survey – Management strategy – risk reduction by public awareness and education.

Unit V Application of Technology In Disaster Management 9 Hours

Hazard map – Multi hazard mapping – Application of satellites in Disaster Management – Application of remote sensing in forecasting and disaster relief –Use of digital image processing in disaster management – GIS in disaster management – Spatial data – GIS data base design – Convention mapping concepts and Coordinate system – Methods of spatial Interpolation in GIS.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to	
CO1:Distinguish the natural and manmade disasters	Understand
CO2:Explain the environment hazards and level of toxicology	Understand
CO3:Identify the causes and effects of Earthquake and Tsunami formation	Apply
CO4: Identify the causes and effects of Cyclone formation	Apply
CO5:Describe about modern technological tools in disaster management	Understand

Text Book(s)

T1. Pardeep Sahni, Madhavi Malalgoda and Ariyabandu, “Disaster risk reduction in south Asia”, PHI Learning Pvt. Ltd., Jan 1, 2003

T2. AmitaSinhal, “Understanding earthquake disasters” TMH, 2010.

Reference Book(s)

R1. Jeff Groman, “The atlas of Natural Disasters”, Friedman/Fairfax publishing, 2002.

R2. Jai Krishna, Brijesh Chandra, Elements of Earthquake Engineering. South Asian Publishers Private, Limited, 2000

Web References

1. www.nptel.ac.in

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19MEEC1020	Course Title: Systems Approach For Engineers (Common to EE,ME)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- Process Engineering in Mechanical Part Assembly

Course Objectives

The course is intended to:

1. Explain system thinking and system engineering approaches.
2. Explain the various elements of a system
3. Establish the systems output
4. Document the details of the problem
5. Establish the relationship between the technical output and systems output.

Unit I Systems Engineering and Systems Thinking 9 Hours

Global economy and its impact on the workers – across the globe; & inside of India - Need of Engineers in Company - Introduction – System Definition by Experts – Principles of System – Systems with simple elements – Apparent and Subtle System - Systems Engineering - its Significance- Description of Industrial processes – Business Functions - Definition of Manufacturing System - Physical Processes Vs. Service Processes

Unit II System Approach Framework 9 Hours

Solutions - New Solutions Vs. Replication Solutions - System approach Frame work for Industrial Processes and their solutions – Need of System approach. Engineer as a "System thinker" and "Solution provider" - Industrial Organization and the various jobs or departments where engineers are required. Defining the problem or assignment as an "Input/Transformations/Output" system. Typical Input and output variables in any Company, Industry and process.

9 Hours

Unit III System Outputs

nputs– Machine Tool/Platform/Equipment (Fixed Cost) – Tooling / Consumables /Software (Variable Cost) - Component/ Application / End user need – Operational parameters / Constraints/Specifications

Transformation– Phenomenon in process - Quantification of the Transformation using the vital signs –Diagnostic tools and their use – Vital signs of the “transformation” and their recognition - Portable diagnostic tools – Benefits and exploitation of Digital data Outputs –Technical outputs - System outputs

Unit IV System Solution 9 Hours

Engineering the solution system– Levels of System thinking: Awareness, Analysis and Synthesis – System Documentation and its use – Vital signs and their use – Signature Analysis – Ability to change all four input groups simultaneously for large scale changes in the outputs.

Unit V System Approach – Case Studies 9 Hours

Engineer as Manager – Integration of Science, Engineering and Management pertinent to the chosen “transformation” Strategic aspects of any solution or the “system” – The relationship between the Technical and System Outputs– Case studies on System approach usage.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to	
CO1: Explain system thinking and system engineering approaches used to define a problem on hand comprehensively.	Understand
CO2: Explain a system by grouping its elements as inputs, transformation and outputs	Understand
CO3: Establish the stake holders and outputs of value to them (systems output).	Understand
CO4: Document the details of the problem on hand and the solution required as input, transformation and output system.	Understand
CO5: Establish the relationship between the technical outputs of the process and systems output	Understand

Text Book(s)

T1 .Dr. K. (Subbu) Subramanian, "Thriving in the 21st century economy – Transformational skills for Technical Professionals", ASME Press 2013.

Reference Book(s)

R1 .Donella H. Meadows, "Thinking in systems" Chelsea Green Publishing Co,2015

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1039</td><td colspan="3">Course Title: Discrete Mathematics</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Organize the concepts of propositional logic in programming languages.
2. Apply the theory of predicate calculus to test the validity of arguments.
3. Interpret the concept of various algebraic structures.
4. Classify several types of Graphs its algorithms in computer programs.
5. Categorize the different types of trees.

Unit I Propositional Logic 9 Hours

Propositions – Logical Connectives – Tautologies and Contradictions – Contra Positive – Logical Equivalences and Implications – Normal Forms – Principal Conjunctive and Disjunctive Normal Forms – Rules of Inferences

Unit II Predicate Calculus 9 Hours

Predicates – Quantifiers – Free and Bounded variables – Universe of Discourse – Rules of Universal Specification and Generalization – Validity of Arguments.

Unit III Groups 9 Hours

Algebraic Systems – Properties – Semigroups – Monoids – Homomorphism Sub semigroups and Submonoids– Cosets and Lagrange’s Theorem – Normal Subgroups .

Unit IV Graphs 9 Hours

Basic Definitions – Degree of Vertex –Matrix Representation of a Graphs - Paths Cycles and Connectivity – Eulerian and Hamiltonian Graphs.

Unit V Trees 9Hours

Introduction to Trees – Spanning Tree – Minimum Spanning Tree – Binary Trees –Rooted and Binary Trees– Tree Traversal – Expression Trees.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to	
CO1:Organize the concepts of propositional logic in programming languages. using logical connectivity	Apply
CO2:Apply the theory of predicate calculus to test the validity of arguments using quantifiers	Apply
CO3:Construct the concept of various algebraic structures using group and sub groups	Apply
CO4:Identify the types of graphs and its algorithms in computer program using fundamentals	Apply
CO5:Select the types of trees using concepts of graphs	Apply

Text Book(s)

T1. T.Veerarajan, “Discrete Mathematical Structures with Graph Theory and Combinatorics”, Tata McGraw–Hill Education Private Limited, New Delhi, 2011.

Reference Book(s)

R1. Kenneth H.Rosen, “Discrete Mathematics and its Applications”, Special Indian edition, Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 2007.

R2. Trembly J.P and Manohar R, “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw–Hill Pub. Co. Ltd, New Delhi, 2007

R3. Seymour Lipschutz and Mark Lipson, “Discrete Mathematics”,2nd Edition, Schaum’s Outlines, Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 2007.

Web References

1. http://nptel.ac.in/courses/111104026/
2. http://nptel.ac.in/courses/106106094/
3. http://nptel.ac.in/video.php?subjectId=106106094

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1058	Course Title: Operations Research		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Find the value of the given objective functions.
2. Solve transportation problems
3. Solve assignment problems.
4. Find shortest path and total project cost.
5. Calculate the sequence for the given sequencing models.

Unit I Linear Programming Problem 9 Hours

Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, big-M method.

Unit II Transportation Model 9 Hours

Transportation Problem. Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.

Unit III Assignment Model 9 Hours

Assignment model. Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem.

Unit IV Network Analysis 9 Hours

Network Techniques: Shortest path model, minimum spanning Tree Problem, Max-Flow problem and Min-cost problem. Project Management: Phases of project management, guidelines for network construction, CPM and PERT.

Unit V Sequencing Problem 9 Hours

Sequencing models. Solution of Sequencing Problem – Processing n Jobs through 2 Machines – Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines – Processing n Jobs through m Machines.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to		
CO1.	Find the value of the given objective functions using linear programming techniques	Apply
CO2.	Solve transportation problems using optimality tests to Minimize transportation cost.	Apply
CO3.	Solve assignment problems using Hungarian method to obtain Optimal solution.	Apply
CO4.	Find shortest path and total project cost using various network Techniques	Apply
CO5.	Calculate the sequence to optimize time and cost for the given sequencing models	Apply

Text Book(s)

T1. P. SankaraIyer,” Operations Research”, Tata McGraw-Hill, 2008.

T2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, “Operations Research”, Pearson Education, 2005.

Reference Book(s)

R.1 Wayne L. Winston, ”Operations Research” Thomson Learning, 2003

R2. Hamdy H. Taha, “Operations Research-An Introduction” Pearson Education. 7th edition 2002

Web References

1. http://nptel.ac.in/courses/112106131/1

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code:19CSEC1001	Course Title: Programming using JAVA Common to (EC, EE, & EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- C Programming
- Data Structures and Algorithms

Course Objectives

The course is intended to:

1. Describe the distinct properties and features of Java.
2. Implement name spaces, concurrency and handle exceptional conditions.
3. Employ Java standard library functions.
4. Apply Java utility, input/output functions and file manipulators.
5. Develop Java applications using user interfaces and database connectivity.

Unit I Introduction 9 Hours

Overview of Java – Data types, operators, control flows –Class fundamentals, objects and constructors –Method overloading- argument passing, Returning objects, recursion – Method Overriding and Dynamic Method dispatch- Abstract class.

Unit II Packages, Exceptions and Threads 9 Hours

Packages and access protection – Interfaces and extending interfaces – Exception fundamentals and types – Try, catch, throw, throws and finally; Chained Exceptions – Thread model, Creating threads and thread priorities – Synchronization –Inter thread communication.

Unit III JAVA Utilities 9 Hours

String Handling –String Buffer class and functions – Library Functions – Math – Process – Clone – System Functions.

Unit IV Collections and I/O Streams 9 Hours

Collections – Classes and Interfaces – Iterators and User defined collections – String Tokenizer – Java I/O classes and Interfaces - Streams – Byte Streams - Character Streams – File concepts.

Unit V Exploring Swing 9 Hours

Java Swing – Features –Components and Containers – Event handling – Exploring Swing – Menus – Java Database Connectivity.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Describe the distinct properties and features of Java.	Understand
CO2:Implement name spaces, concurrency and handle exceptional conditions in programs.	Apply
CO3:Employ Java standard library functions for solving complex problems.	Apply
CO4:Apply Java utility, input/output functions and file manipulators	Apply
CO5:Develop Java applications using user interfaces and database connectivity	Apply

Text Book(s)

T1. Herbert Schildt, "Java the Complete Reference", Mcgraw Hill Education,9th Edition, 2014

T2. Mahmoud Parsian, "JDBC Metada, MySQL and Oracle Recipes: A Problem-Solution Approach", Apress Publications, 2006

Reference Book(s)

R1. Bart Baesens, Aimee Backiel, SeppeVandenBrocke, "Beginning Java Programming: The Object Oriented Approach", John Wiley & Sons, 2015.

R2. Daniel Liang, "Introduction to Java Programming, Comprehensive Version", Pearson Education, 9th Edition, 2014.

R3. James M Slack, Programming and Problem solving with JAVA, Thomson Learning, 2002.

R4. C Thomas Wu, An Introduction to Object Oriented programming with Java,Tata McGrawHill, 2005.

R5. Cay S. Horstmann and Gary Cornell, "Core Java: Volume I – Fundamentals", 8th Edition, Sun Microsystems Press, 2008.

Web References

1. https://docs.oracle.com/javase/tutorial/java/index.html

2. http://javabeginnerstutorial.com/core-java/
3. http://www.w3schools.in/java/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	1	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code:19CSEC1002</td><td colspan="2">Course Title: Data Mining And Analytics
Common to (EC, EE, & EI)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- C Programming
- Data Structures and Algorithms

Course Objectives

The course is intended to:

1. Select the appropriate pre-processing technique.
2. Relate the techniques of association rule.
3. Evaluate the classification algorithms.
4. Apply the clustering algorithms.
5. Analyze the requirements for a big data analytics.

Unit I Data Preprocessing 9 Hours

Data Mining Overview – Data Objects and Attribute Types – Data Visualization. Data Pre-processing: Data Cleaning – Data Integration – Data Reduction – Data Transformation and Data Discretization.

Unit II Association 9 Hours

Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods –Basic Concepts – Frequent Item set Mining Methods – Pattern Evaluation Methods. Advanced Pattern Mining: Pattern Mining: A Road Map – Pattern Mining in Multilevel, Multidimensional Space.

Unit III Classification 9 Hours

Basic Concepts: Decision Tree Induction – Bayes Classification Methods – Rule Based Classification – Model Evaluation and Selection – Techniques to Improve Classification Accuracy.

Unit IV Clustering 9 Hours

Cluster Analysis: Partitioning Methods – Hierarchical Methods – Density Based Methods – Grid Based Methods – Evaluation of Clustering.

Unit V Introduction to Big Data 9 Hours

Introduction to Big Data: Classification of Digital Data – Characteristics, Evolution and Definition of Big data - Challenges with Big Data – Traditional Business Intelligence (BI) vs Big Data – The Big Data Technology Landscape: Hadoop. Introduction to Hadoop: Hadoop Overview – Hadoop Distributors - Hadoop Distributed File System.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO 1.	Choose the appropriate pre-processing technique to solve the given problem.	Apply
CO 2.	Apply the techniques of association rule to real world data.	Apply
CO 3.	Evaluate the classification algorithms with respect to their accuracy.	Apply
CO 4.	Apply the clustering algorithms to group the real world data.	Apply
CO 5.	Select the requirements for a big data analytics system for the organization.	Apply

Text Book(s)

T1. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining: Concepts and Techniques”, 3rd Edition, Elsevier, 2012.

T2. SeemaAcharya, SubhashiniChellappan, “Big Data and Analytics”, 1st Edition, Wiley India, 2015.

Reference Book(s)

R1. Jure Leskovec, AnandRajaraman, Jeffery David Ullman, “Mining of Massive Datasets”, 2nd Edition, Cambridge University Press, 2014.

R2. Ian H.Witten, Eibe Frank, Mark A.Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, 3rd Edition, Elsevier, 2011.

R3. EMC Education Services, “Data Science and Big Data Analytics”, Wiley, 2015.

R4. DT Editorial Services, “Black Book- Big Data (Covers Hadoop 2, MapReduce, Hive, Yarn, PIG, R, Data visualization)”, Dream tech Press edition 2016

R5. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Eastern Economy Edition, Prentice Hall of India, 2006.

Web References

1.http://hanj.cs.illinois.edu/bk3/bk3_slidesindex.html
2. http://www.mmds.org/
3. http://www.kdnuggets.com/tutorials/index.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	1	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code:19CSEC1003	Course Title: Software Testing Common to (EC, EE, & EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- C Programming
- Data Structures and Algorithms

Course Objectives

The course is intended to:

1. Describe the software testing principles and its characteristics.
2. Choose the appropriate testing for software development.
3. Design Test cases suitable for a software development in various domains.
4. Justify the importance of planning, documenting and validating the test plan.
5. Illustrate the need for automatic testing tools.

Unit I Testing Fundamentals 9 Hours

Introduction to testing as Engineering Activity –Testing Fundamentals: Basic Definitions- Testing principles-Tester's role –Defects, Hypotheses and Tests.

Unit II Levels of Testing 9 Hours

The need for levels of Testing- Unit Test: Functions, Procedures, Classes, and Methods as Units- Unit Test: The Need for Preparation- Unit Test Planning- Designing the Unit Tests- Running the Unit Tests and Recording Results- Integration Test: Goals- Integration Strategies for Procedures and Functions- Integration Strategies for Classes- Designing Integration Tests- Integration Test Planning- System Test: The Different Types- Regression Testing- Alpha, Beta, and Acceptance Tests.

Unit III Designing Test Cases 9 Hours

Test case design strategies-Using Black Box approach to Test Case design-Random Testing – Equivalence class partitioning –Boundary value Analysis-Cause effect testing and state transition testing-Error Guessing - Using White Box Approach to Test case design – Test Adequacy Criteria –Coverage and Control Flow Graphs – Covering Code Logic – Paths – Additional test design approaches- code complexity testing – Evaluating Test Adequacy Criteria.

Unit IV Test Management 9 Hours

Test Planning: Preparing a plan – scope management – deciding test strategy – responsibilities –resource requirements – test deliverables –testing tasks – Test management: standards – infrastructure management- People management – product release - Test Process – Test Reporting.

Unit V Test Automation 9 Hours

Test Automation – Terms – Skills required – Scope of automation- Design and Architecture for Automation – Process Model – Selecting Test tools – automation for extreme Programming-Test Metrics and Measurements.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the software testing principles and its characteristics.	Understand
CO2: Choose the appropriate testing during the phases of software development.	Apply
CO3: Design Test cases suitable for a software development in various domains.	Apply
CO4: Identify the importance of planning, documenting and validating thetest plan.	Apply
CO5: Organize the needs of automatic testing tools.	Apply

Text Book(s)

T1. Ilene Burnstein,"Practical Software Testing: A Process-Oriented Approach", Springer International Edition, 2013

T2. SrinivasanDesikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2006.

Reference Book(s)

R1. Ron Patton, "Software Testing", Sams Publishing, Pearson Education, 2ndEdition, 2009

R2. Boris Bezier, "Software Testing Techniques",Dreamtech,2nd Edition, Reprint 2009

R3. Aditya P. Mathur, "Foundations of Software Testing: Fundamental Algorithms and Techniques",Pearson Education, 2008.

R4. Edward Kit," Software Testing in the Real World – Improving the Process", Pearson Education, 1995.

R5. RenuRajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill, 2004.

Web References

1. http://nptel.ac.in/courses/106105150/
2. Lecturehttps://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-11/
3. http://www.testingtools.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	1	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	1	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code:19CSEC1004	Course Title: Database Management System Concepts Common to (EC, EE, & EI)		
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week)3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Pre-requisites

- C Programming
- Data Structures and Algorithms

Course Objectives

The course is intended to:

1. Construct the Entity Relationship Model.
2. Convert ER diagram to relational database schema.
3. Relate the normalization technique to obtain the relational database design.
4. Choose a query evaluation and optimization technique.
5. Execute the online transactions and control concurrency.

Unit I An Overview of Database Systems 9 Hours

Introduction – Database system applications, Database versus file systems, View of data, Data models, Database languages, Database users and administrators, Database system structure, Entity – Relationship Model – Basic concepts, Constraints, Keys, Design issues, ER diagram, Weak entity sets, Design of an ER database schema.

Unit II Data Models 9 Hours

Relational model - Structure of relational databases – The relational algebra –Tuple relational calculus, Domain relational calculus, SQL – Background, Basic structure, Set operations, Aggregate functions, Null values, Nested sub queries, Views, Joined relations, DDL, Embedded SQL, Dynamic SQL, Integrity and security – Domain constraints, Referential integrity, Assertions, Triggers.

Unit III Relational Databases Design 9Hours

Relational database design – First normal form, Second normal form - Pitfalls in relational database design, Functional dependencies, Decomposition, Desirable properties of decomposition, BCNF, Third normal form, Fourth normal form.

Unit IV Indexing and Querying 9 Hours

Indexing and hashing – Basic concepts, Ordered indices, B+ tree index files, B tree index files – Static hashing, Dynamic hashing, Comparison of ordered indexing and hashing, Multiple key access - Query Processing – Overview, Measures of query cost, Selection operation, Sorting, Join operation - Query Optimization – Overview, Estimating statistics of expression results, Transformation of relational expressions

Unit V Transaction and Concurrency Control 9 Hours

Transactions – Transaction concept, Transaction state, Implementation of atomicity and durability, Concurrent executions, Serializability, Recoverability, Testing for serializability - Concurrency control – Lock based protocols, Timestamp based protocols, Validation based protocols, Multiple granularity, Multiversion schemes.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Construct the Entity Relationship Model for obtaining the structure of a database	Apply
CO2: Convert ER diagram to relational database schema	Apply
CO3: Apply the normalization technique to obtain the relational database design.	Apply
CO4: Select a query evaluation and optimization technique for a given query.	Apply
CO5: Implement online transactions and control concurrency	Apply

Text Book(s):

T1. Silberschatz, Korth, Sudarshan, “Database System Concepts”, 6th Edition, McGraw Hill International Edition, New Delhi 2010

T2. Date C.J., Kannan A, Swaminathan S, “An introduction to database systems”, 8th Edition, Pearson Education, New Delhi, 2009.

Reference Book(s):

R1. Elmasri, R., Navathe, S.B., “Fundamentals of database systems”, 6th Edition, Pearson Education, New Delhi, 2010.

R2. Raghu Ramakrishnan, Johannes Gehrke. “Database Management Systems”, 3rd Edition, McGrawHill International Edition, New Delhi 2007.

R3. Bipin C Desai, “An Introduction to Database Systems”, 11th Edition, Galgotia Publications Pvt. Ltd., New Delhi, 2001.

R4. JefreyD.Ulman and Jenifer Widom, “A First Course in Database Systems”, 3rd Edition, Prentice-Hall, New Delhi, 2007.

R5. C.J.Date, A.Kannan and S.Swamynathan, “An Introduction to Database Systems”, 8th Edition, Pearson Education, 2006.

Web References:

1.https://onlinecourses.nptel.ac.in/noc16_ma05
2. http://codex.cs.yale.edu/avi/db-book/db6/slide-dir/
3. www.nptelvideos.in/2012/11/database-management-system.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2;Low-1

Course Code : 19EEEN1036		Course Title : Artificial Intelligence of Things	
Course Category: Professional Elective		Course Level: Mastery	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Prerequisites

- Nil

Course Objectives

The course is intended to

1. Apply the concepts of IoT in building solutions for real world problems
2. Develop applications with AI tools
3. Create data models & analyze the data obtained from IoT applications
4. Make use of the significance of artificial intelligence and machine learning
5. Apply artificial intelligence to IoT applications

Unit I Internet of Things Basics 9 Hours

Internet of Things Introduction -IIOT - IOT Applications- IOT Architecture & Deployment models - Building blocks of IoT: Smart Device - Gateway - Cloud IoT Platform - Communication Technology - Applications - IoT Design Methodology - Edge Computing and Analytics - Interfacing sensors & actuators with IoT development platforms - Firebase cloud integration

Unit II Internet of Things Advanced 9 Hours

Node MCU development Kit -HTML Coding Basics Creating a Web page - Creating a Server on Node MCU - Controlling of IO peripheral on Node MCU using Webpage - Introduction to MIT App Inventor - Building an Android App and Controlling IO Peripheral App building using Accelerometer and Text to Speech features - Working with IFTTT - MQTT Protocol -Using Adafruit IO - Getting Sensor Values and Updating It Live - Push notifications, Facebook/Twitter status update - Controlling of IO & Relays over the Internet

Unit III Data Science and Analytics 9 Hours

Concepts: Principles / Foundations of Data Science - Product development with IoT emphasis on analytics - Understanding and Managing data and models - Big Data and IoT -

Spark Streaming and NoSQL databases - Edge processing

Unit IV Artificial Intelligence and Machine Learning Basics 9 Hours

Introduction to AI / ML - Frameworks - Applications - Scaling and deployment - AI/ML System Design - Machine learning for Data Analysis: Decision Tree - K means cluster analysis - Applied Machine Learning with Python

Unit V Adding Intelligence to IoT 9 Hours

Case studies on enabling Intelligence in IoT solutions - Tesla motors self driving vehicles, Smart Thermostat solution from Nest Labs and Automated Vacuum cleaner iRobot Roomba - One on one mentoring session

Text Book(s)

1. Artificial Intelligence: A Modern Approach. S. Russell, and P. Norvig. Prentice Hall, 3rd Edition, (2010).

Reference Book(s)

1. Denis Rothman,” Artificial Intelligence by Example: Develop machine intelligence from scratch using real artificial intelligence use cases”,2018.
2. Tom Taulli,” Artificial Intelligence Basics: A Non-Technical Introduction”,Apress ,2019

Web References

1. https://onlinecourses.nptel.ac.in/noc21_cs63
2. https://www.tatvasoft.com/blog/an-introduction-to-key-aspects-of-internet-of-things-iot/
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-034-artificial-intelligence-fall-2010/

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1:Apply the concepts of IoT in building solutions for real world problems	Apply
CO2:Develop applications with AI tools	Apply
CO3:Create data models & analyze the data obtained from IoT applications	Apply
CO4:Make use of the significance of artificial intelligence and machine learning	Apply
CO5:Apply artificial intelligence to IoT applications	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	3	2	2

High-3; Medium-2;Low-1

Course Code: 19EEEN1037	**Course Title: Machine Learning Techniques**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Numerical Methods and Linear Algebra
- Probability and Statistics

Course Objectives

The course is intended to:

1. Introduce the basic concepts of Machine Learning.
2. Construct model using supervised learning methods
3. Apply neural network algorithms to train data
4. Develop model using ensemble and support vector machines
5. Develop model using clustering methods

Unit I Introduction 9 Hours

Machine Learning - Types of Machine Learning - Supervised Learning- Machine Learning Process-Terminology-Testing Machine Learning Algorithms-Turning Data Into Probabilities-Basic Statistics For Machine Learning- Bias-Variance Trade-off

Unit II Supervised Learning 9 Hours

Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning

Unit III Neural Networks 9 Hours

Basics of Neural Networks-Perceptron Network- Linear Separability- Multi-Layer Perceptron- Multi-Layer Perceptron In Practice –Deep Networks- Architectural principles of deep networks

Unit IV Ensemble Learning and Support Vector Machine 9 Hours

Ensemble Methods, Bagging, Boosting- Support Vector Machines- Optimal Separation- Kernels- Support Vector Machine Algorithm- Extensions to SVM

Unit V Unsupervised Learning 9 Hours

Clustering- K-means– EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Introduce the basic concepts of machine learning	Understand
CO2.	Construct model using supervised learning methods	Apply
CO3.	Apply neural network algorithms to train data	Apply
CO4.	Develop model using ensemble and support vector machines	Apply
CO5.	Develop model using clustering methods	Apply

Text Book(s)

T1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective" 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

T2. Tom M Mitchell, "Machine Learning",1st Edition, McGraw Hill Education, 2013

Reference Book(s)

R1. Anuradha Srinivasaraghavan, Vincy Joseph,"Machine Learning", 1st Edition, Wiley, 2019.

R2. Peter Flach,"Machine Learning: The Art and Science of Algorithms that Make Sense of Datall", 1st Edition, Cambridge University Press, 2012.

R3. Josh Patterson, "Deep Learning: A Practitioner's Approach", 1st Edition, O'Reilly Media,2017

R4. Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖”, 3rd Edition, MIT Press, 2014

Web References

1. https://in.mathworks.com/machinelearning
2. https://in.mathworks.com/discovery/deep-learning.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	2	2
CO2	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO3	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO4	3	2	1	1	-	-	-	1	-	1	-	-	2	2
CO5	3	2	1	1	-	-	-	1	-	1	-	-	2	2

High-3; Medium-2; Low-1

Course Code: 19EEEN1044	**Course Title: Powertrain Management System**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Electric & Hybrid Vehicles

Course Objectives

The course is intended to:

1. Understand the basic electronic components and its controls
2. Explain the operating conditions and control systems used in SI engine..
3. Explain the ignition and injection methods used in CI engine K
4. Describe the various emission systems and diagnostics procedure.
5. Illustrate the electronic diagnosis systems and transmission control system used in the digital dashboard unit.

Unit I Fundamentals of OBD Systems **ours**

Components for Electronic Engine Management System, Open and Closed Loop Control Strategies, PID Control, Look Up Tables, Introduction to Modern Control Strategies Fuzzy Logic. Switches, Active Resistors, Transistors, Current Mirrors/Amplifiers, Voltage and Current References, Comparator, Multiplier. Amplifier, Filters, A/D and D/A Converters. Actuators and its types.

Unit II SI Engine Management 9 Hours

Layout and Working of SI Engine Management Systems -Bosch Motronic (M, ME, MED) Engine Management, System Overview- System Structure. Electronic Control and Regulation Electronic Diagnosis-Electronic Control Unit and Development. ECU Operating Conditions, Design and Data Processing.

Unit III CI Engine Management 9 Hours

Fuel Injection System Parameters affecting Combustion, Noise and Emissions in CI Engines. Pilot, Main, Advanced Post Injection and Retarded Post Injection. Electronically Controlled Unit Injection System. Layout of the Common Rail Fuel Injection System. Working of Components

- Fuel Injector, Fuel Pump, Rail Pressure Limiter, Flow Limiter, EGR Valves

Unit IV Diagnosis and Control Systems 9 Hours

Electronic Control System Overview-Subsystems and Main Functions-Electronics Diagnosis Self-Diagnosis- Engine Diagnostics - Introduction to Diagnosis, Types of Engine Diagnostics, Need for OBD, Types Of OBD, General Requirements-Diagnosis System Management-Individual Diagnosis-Data Transfer Between Automotive Electronic System. Model Based Diagnostic Control- Various Engine Systems Diagnostic (Air System, Fuel System, Exhaust System)

Unit V Digital Engine and Vehicle Control Systems 9 Hours

EMS- Engine Functions and Control-General Terms and Performance – Engine Mapping, Control Strategy-Engine Control Sequence-Calibration Technique in EMS, VVT Control, Camless Control, Variable Swirl Mechanisms- Different Types of Automatic Transmission - Control System - Basics Of Driveline Control, Driveline Speed And Torque Control, Gear Shift Control, Anti-Jerk Control, Driveline Diagnostic System- CVT, Advancement in Driveline Control System.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Understand the basic electronic components and its controls	Understand
CO2.	Describe the operating conditions and control systems used in SI engine.	Understand
CO3.	Interpret the ignition and injection methods used in CI engine	Understand
CO4.	Identify the various emission systems and diagnostics procedure.	Apply
CO5.	Identify the electronic diagnosis systems and transmission control system used in the digital dashboard unit.	Apply

Text Book(s):

T1. William, B. Ribbens, ‘Understanding Automotive electronics’, Butterworth Heinemann, 2017

T2. Robert Bosch, ‘Diesel Engine Management ‘, SAE Publications, 3rd Edition, 2004

Reference Book(s):

R1. Robert Bosch, 'Gasoline Engine Management', SAE Publications, 2nd Edition, 2004

R2. Lino Guzzella and Christopher H. Onder, 'Introduction to Modeling and Control of Internal Combustion Engine Systems', Springer-Verlag, 2010.

R3. Lars Eriksson and Lars Nielsen, 'Modeling and Control of Engines and Drivelines', John Wiley & Sons, 2014.

R4. Rolf Isermann, 'Engine Modeling and Control - Modeling and Electronic Management of Internal Combustion Engines', Springer Verlag, 2014.

Web References:

1. https://www.hitachiastemo.com/en/products/powertrain/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1045	**Course Title: Vehicle Dynamics**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Engineering Graphics
- Engineering Mechanics

Course Objectives

The course is intended to:

1. Inculcate the knowledge of law of mechanics to understand the vehicle dynamics, road loads and equation of motions.
2. Illustrate the relationship between vehicle design variables and dynamic behavior
3. Understand the vibration and suspension of the vehicle
4. Apply the cornering model to design the steering system of vehicle control.
5. Disseminate the knowledge of tire dynamics

Unit I Introduction **9 Hours**

Vehicle and Earth fixed coordinate system, Euler angles, Longitudinal, lateral and vertical vehicle dynamics, Dynamic axle loads - static loads on level ground - low speed acceleration, Loads on Grades- Road loads - rolling resistance - grade resistance. Equation of motion for Forced Undamped and forced Damped Vibration, Single DOF, Two DOF and Multi DOF systems.

Unit II Performance Mode **9 Hours**

Acceleration - free body diagram of accelerating vehicle, maximum transferable tractive force and gradability. Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance and maximum braking force. Prediction of Vehicle performance. Antilock Brake Systems, Traction control.

Unit III Ride Mode **9 Hours**

Pitch and bounce motion, oscillation centers, active and semi active suspension, orthogonality of mode shapes, modal analysis. Spring System - Requirements, sprung mass and un-sprung mass, wheel hop, shimmy, wheel wobble, choice of suspension spring rate, calculation of effective spring rate. Tyres - mechanics, stability of vehicle on slope, on curve and banked road. Quartet car and Half car modeling.

Unit IV Handling Mode 9 Hours

Vehicle control-low speed cornering and static steering-Ackerman steering geometry, steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slipangle steer, steady state handling-lateral acceleration gain, characteristic speed, yaw velocity gain, critical speed, effect of braking on vehicle handling.

Unit V Tire Dynamics 9 Hours

Tire forces and moments, tire structure, longitudinal and lateral force at various slip angles, rolling resistance, tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on various road surfaces. Tire vibration.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the Mechanics of vehicle and to study its dynamics	Understand
CO2.	Demonstrate the relationship between vehicle design variables and dynamic behaviour of vehicle under acceleration and deceleration mode	Apply
CO3.	Summarize the vibration and suspension of the vehicle	Understand
CO4.	Illustrate the cornering model to design the steering system of vehicle control.	Apply
CO5.	Explain the knowledge of tire structure, performance and its ride properties	Understand

Text Book(s):

T1. Gillespie, Thomas. D., “Fundamentals of Vehicle Dynamics”, SAE USA 2010.

T2. Reza N.Jazar, “Vehicle Dynamics Theory and Application”, NY:Springer, 2017.

Reference Book(s):

R1. H.Pacejka, Tire and Vehicle Dynamics, Oxford: Butterworth-Heinemann Elsevier Ltd, 2012.

R2. Rao,Singiresu. S., “Mechanical Vibrations”, Pearson Education Publication, 2009.

R3. Giri, N. K., “Automobile Mechanics”, Khanna Publishers, New Delhi, 2006.

R4. Wong, J. Y., “Theory of Ground Vehicles”, John Wiley & Sons, New York, 2012.

R5. D. Karnopp, Vehicle Dynamics, Stability and Control, Boca Raton: CRC Press, 2013.

Web References:

1. https://nptel.ac.in/courses/107/106/107106080/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

Course Code: 19EEEN1046	**Course Title: Digital Control of Power Electronic Converter**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Pre-requisites

- Power Electronics
- Control System

Course Objectives

The course is intended to:

1. Explain basics of switching power converters.
2. Explain existing DPWM architectures inswitching power converters.
3. Explain mixed signal block diagram representation and loopgain analysis of switching Converter.
4. Explain advanced control techniques of Switching Converters.
5. Write VHDL codes for implementing control algorithms.

Unit I Modelling and Control in PWM Switching Converters **9 Hours**

Introduction to basic DC-DC converter topologies-buck converter-boost converter-buck/boost converters-PWM control techniques-voltage mode control (VMC), current mode control (CMC) CCM and DCM operating modes, Modeling of PWM DC-DC converters: State-space averaging technique, small-signal modeling, Control challenges, limitations of analog control techniques-Need for digital control in DC-DC converters.

Unit II Digital Pulse Width Modulator Architectures and Analysis **9 Hours**

DPWM architectures in DC-DC converters: Counter-based DPWM, tapped-delay line based DPWM, hybrid DPWM, segmented DPWM, Frequency domain analysis of digitally controlled DC-DC converters, Emphasis on effects of finite sampling and quantization-limit cycle oscillations, Discrete-time modeling and analysis for existence of sub-harmonic oscillations in DPWM DC-DC converters.

Unit III Compensation Techniques in Digitally Controlled DC-DC Converters **9 Hours**

Discrete time compensation techniques in digitally voltage mode control, current mode control, and state feedback control; Deadbeat control; Critical bandwidth formulation, compensator design for non-minimum phase converters, Auto-tuning in digitally controlled DC-DC converters-Ziegler-Nichols tuning, relay-based tuning, etc

Unit IV Advanced Control in DC-DC Converters 9 Hours

Sliding mode control in DC-DC converters, Time optimal control and physical limits in DC-DC converters

Unit V Embedded Control Implementation 9 Hours

Introduction to Verilog HDL, Controller implementation using fixed point arithmetic, Signal conditioning circuits: Selection of ADCs and DACs.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Model the periodically driven switched electronic systems	Apply
CO2.	Understand existing DPWM architectures in switching power converters	Understand
CO3.	Design of discrete time compensator using frequency domain specifications	Apply
CO4.	Design advanced control methods	Apply
CO5.	Analyze basics of Hardware Descriptive Language for implementing digital control algorithm.	Apply

Text Book(s):

T1. P. T. Krein, Elements of Power Electronics. New York: Oxford Univ. Press, 1998

T2. R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd Edition. Dordrecht, The Netherlands:Kluwer, 2001.

Reference Book(s):

R1. S. Banerjee and G. C. Verghese, Eds., Nonlinear Phenomena in Power Electronics: Attractors, Bifurcations,Chaos, and Nonlinear Control, New York: IEEE Press, 2001.

R2. Francesco Vasca, Luigi Iannelli, Eds., “Dynamics and Control of Switched Electronic Systems: AdvancedPerspectives for Modeling, Simulation and Control of Power Converters”, Springer, 1st Edition, 2012.

R3. Michael D. Ciletti, “Modeling, synthesis, and rapid prototyping with the Verilog HDL”, Prentice Hall, 1999.

Web References:

1. https://cusp.umn.edu/power-electronics/digital-control-power-electronics
2. https://onlinecourses.nptel.ac.in/noc20_ee28/preview

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1048</td><td colspan="3">Course Title: Advanced Electric Drives for Electric Vehicle</td></tr>
<tr><td colspan="3">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Electric drives for Electric vehicle

Course Objectives

The course is intended to:

1. Explain the various Stator-PM motor drives for Electric Vehicles
2. Explain the Vernier PM motor drives for Electric Vehicles
3. Explain the magnetic-geared motor drives for Electric Vehicles and its importance
4. Explain the advanced magnetless motor drives for Electric Vehicles
5. Explain the Integrated-Starter-Generator systems for Hybrid Electric Vehicles.

Unit I Stator-Permanent Magnet Motor Drives **9 Hours**

Stator-PM versus Rotor-PM - System Configurations - Doubly-Salient PM Motor Drives - Flux-Reversal PM Motor Drives - Flux-Switching PM Motor Drives -Hybrid-Excited PM Motor Drives -Flux-Mnemonic PM Motor Drives - Design Criteria of Stator-PM Motor Drives - Design Examples of Stator-PM Motor Drives - Potential Applications of Stator-PM Motor Drives in Electric Vehicles

Unit II Vernier Permanent Magnet Motor Drives **9 Hours**

System Configurations - Vernier PM Machines - Inverters for Vernier PM Motors - Vernier PM Motor Control -Design Criteria of Vernier PM Motor Drives - Design Examples of Vernier PM Motor Drives - Potential Applications of Vernier PM Motor Drives in Electric Vehicles

Unit III Magnetic-Geared Motor Drives 9 Hours

System Configurations-Magnetic Gears - Converted Magnetic Gears- Field-Modulated Magnetic Gears -MG Machines - Principle of MG Machines- Modeling of MG Machines - Inverters for MG Motors -MG Motor Control - Design Criteria of MG Motor Drives for EVs

Unit IV Advanced Magnetless Motor Drives 9 Hours

System Configurations -Synchronous Reluctance Motor Drives- Doubly-Salient DC Motor Drives - Flux-Switching DC Motor Drives -Vernier Reluctance Motor Doubly-Fed Vernier Reluctance Motor Drives - Axial-Flux Magnetless Motor Drives - Design Criteria of Advanced Magnetless Motor Drives for EVs 272- Design Examples of Advanced Magnetless Motor Drives for EVs - Potential Applications of Advanced Magnetless Motor Drives in EVs

Unit V Integrated-Starter-Generator Systems 9 Hours

Classification of HEVs -ISG System Configurations - ISG Machines- ISG Operations- Design Criteria of ISG Systems- Design Examples of ISG Systems- Application Examples of ISG Systems in HEVs

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the various stator-PM motor drives for EVs	Understand
CO2.	Discuss the Vernier PM motor drives for Electric Vehicle	Understand
CO3.	Describe the magnetic-geared motor drives for EVs	Understand
CO4.	Make use of the various advanced magnetless motor drives for EVs	Apply
CO5.	Make use of the integrated-starter-generator systems for HEVs	Apply

Text Book(s):

T1. K. T. Chau, " electric vehicle machines and drives design, analysis and application ", First Edition, Wiley Publishers, 2015

T2. James Larminie, “Electric Vehicle Technology Explained”, First Edition, Wiley Publishers , 2003

Reference Book(s):

R1. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, “Analysis of Electric Machinery”, McGraw-Hill Book Company,1995.

R2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall,2015.

R3. P. S. Bhimbra, “Generalized Theory of Electric Machines”, Khanna Publication,2018.

R4. B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education. s, Processes, Methods and Tools, SAE, 2016

Web References:

1. https://nptel.ac.in/courses/108/104/108104011/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2;Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1050</td><td colspan="2">Course Title: Testing and Certification of Electric Vehicle</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L: T:P (Hours/Week): 3:0:0</td><td>Credit :3</td><td>Total Contact Hours: 45</td><td>Total Marks: 100</td></tr>
</table>

Pre-requisites:

- Basics of Electrical, Automobile and Mechanical engineering

Course objectives:

The course is intended to

1. Define the parameters, instruments and types of testing of vehicles
2. Explain the static testing of vehicles
3. Describe the dynamic testing of vehicles
4. Enumerate various component Testing in vehicles
5. Indicate tests for retro-fitment and charging station

Unit I Introduction 9 Hours

Specification and Classification of Vehicles (M, N and O layout), Homologation and its Types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR), Type approval Scheme, Homologation for export, Conformity of Production, various Parameters, Instruments and Types of test tracks, Hardware in The Loop concepts for EV/HEVs.

Unit II Static Testing of Vehicle 9 Hours

Photographs, CMVR physical verification, Tyre Tread Depth Test, Vehicle Weightment, Horn installation, Rear view mirror installation, Tell Tales, External Projection, Wheel Guard, Arrangement of Foot Controls for M1 Vehicle, Angle & Dimensions Measurement of Vehicle, The Requirement of Temporary Cabin For Drive– Away – Chassis, Electric vehicle – Safety Norms, Energy consumption and Power test

Unit III Dynamic Testing of Vehicle 9 Hours

Hood Latch, Gradeability, Pass-by Noise, Interior Noise, Turning Circle Diameter & Turning Clearance Circle Diameter, Steering Effort, Constant Speed Fuel Consumption, Cooling Performance, Speedo-meter Calibration, Range Test, Maximum Speed, Acceleration Test, Coast-down test, Brakes Performance ABS Test, Broad band / Narrow band EMI Test, Electric vehicle – Range Test.

Unit IV Vehicle Component Testing 9 Hours

Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass, Rear View Mirror Test, Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic, Hinges and Latches Test, Tyre& Wheel Rim Test, Bumper Impact Test, Side Door Intrusion, Crash test with dummies, Demist test, Defrost Test, Interior Fittings, Steering Impact test (GVW<1500 kg), Body block test, Head form test, Driver Field Of Vision, Safety belt assemblies, Safety belt anchorages, Seat anchorages & head restraints test, Airbag Test, Accelerator Control System, Motor power, Safety Requirements of Traction Batteries, EMI-EMC (CI, BCI, RE,RI and CTE).

Unit V Tests for Hybrid Electric Vehicles, Retrofitment and Charging Station 9 Hours

Hybrid Electric Vehicles Tests (M and N category), Tests for Hybrid Electric System Intended for Retrofitment on Vehicles of M and N Category (GVW < 3500 kg), Test for Electric Propulsion kit intended for Conversion, Test for Electric Vehicle Conductive AC Charging System, and Test for Electric vehicle conductive DC charging system.

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	Define the parameters, instruments and types of testing of vehicles	Apply
CO2	Explain the static testing of vehicles	Apply
CO3	Describe the dynamic testing of vehicles	Apply
CO4	Enumerate various component Testing in vehicles	Apply
CO5	Identify tests for retro-fitment and charging station	Apply

Text Books

T1. Vehicle Inspection Handbook", JJ Keller and Associates ,Inc,2020

T2. Michael Plint& Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd Edition, 2007

Reference Books

R1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010

R2. Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007

R3. Arvey Segler, " Body Language: Discovering & Understanding the Psychological secrets behind reading & Benefiting from Body Language" Kindle Edition, 2016

R4. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1052	**Course Title: Image Processing and Computer Vision**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Engineering Mathematics

Course Objectives

The course is intended to:

1. Explain the fundamental techniques for image processing, video processing, and computer vision
2. Understand the image processing concepts
3. Introduce the image descriptors used to represent elementary characteristics of a image.
4. Understand the pattern reorganization methods
5. Explain the applications of computer vision system

Unit I Introduction To Computer Vision 9 Hours

Introduction and Goals of Computer Vision Image Formation and Radiometry - Geometric Transformation, Geometric Camera Models, Image Reconstruction from a Series of Projections

Unit II Image Processing Concepts 9 Hours

Fundamentals of Image Processing, Image Transforms, Image Filtering, Colour Image Processing. Mathematical Morphology, Image Segmentation

Unit III Image Descriptors and Features 9 Hours

Texture Descriptors, Colour Features, Edge Detection, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Speeded up Robust Features, Saliency

Unit IV Fundamental Pattern Recognition Concepts 9 Hours

Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Gaussian Classifier, Parameter Estimation, Clustering for Knowledge Representation, Dimension Reduction, Template Matching, Artificial Neural Network for Pattern Classfication, Convolutional Neural Networks, Auto encoder.

Unit V Applications of Computer Vision 9 Hours

Machine Learning Algorithms and their Applications in Medical Image Segmentation, Motion

Estimation and Object Tracking, Face and Facial Expression Recognition, Image Fusion, Gesture Recognition

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Identify basic concepts, terminology, theories, models and methods in the field of computer vision.	Apply
CO2.	Familiarize with image processing concepts	Understand
CO3.	Illustrate image Descriptors used to represent elementary characteristics of an image.	Apply
CO4.	Describe basic methods of pattern reorganization	Understand
CO5.	Make use of design of a computer vision system for a specific application	Apply

Text Book(s)

T1. Manas Kamal Bhuyan,, ‘Computer Vision and Image Processing Fundamentals and Applications, First edition, CRC Press, 2019.

T2. D. Forsyth and J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education ,2013.

Reference Book(s)

R1. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision Cengage Engineering” , 3rd Edition, 2013

R2. Rafael C. Gonzalez, RichardE. Woods, “Digital Image Processing”, 3rd Edition,2015

Web References

1. https://www.coursera.org/courses?query=computer%20vision
2. https://nptel.ac.in/courses/106/105/106105216/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEEN1053</td><td colspan="2">Course Title: Industry 4.0 – Smart Factories</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Industrial IoT

Course Objectives

The course is intended to:

1. Understand manufacturing systems in terms of material flow and storage
2. Illustrate the structure of specific factory model.
3. Provide knowledge on manufacturing and assembly line
4. Understand the planning and simulation of smart factory
5. Explain the sustainable and digital business model.

Unit I Factory Models 9 Hours

Introduction to Factory models, single workstation factory models, processing time variability, Single-Part-Type Systems, Multi-stage single product and multi-product systems.

Unit II Special Factory Models 9 Hours

Models of various forms of batching, WIP limiting control strategies, serial limited buffer models.

Unit III Manufacturing and Assembly Lines 9 Hours

Manual Assembly lines, Automated Production lines, Automated Assembly systems, Group technology and cellular manufacturing, Flexible manufacturing cells and systems, Toyota Production System.

Unit IV Smart Factory Planning 9 Hours

Material Requirements Planning, Multi-Stage Control and Reactive Scheduling, Simulation Techniques.

Unit V Sustainable and Digital Business Models 9 Hours

Sustainability and Supply Chain– Industry 4.0 and Its Applications- Reflection of Sustainability on Business Models- Integration of I 4.0 with Sustainability- Scenarios Countering Strategies for Obsolescence.

Course Outcomes At the end of this course, students will be able to:		Cognitive Level
CO1.	Identify the manufacturing systems in terms of material flow and storage	Apply
CO2.	Illustrate the structure of specific factory model.	Understand
CO3.	Make use of manufacturing and assembly line	Apply
CO4.	Understand the planning and simulation of smart factory	Understand
CO5.	Explain the sustainable and digital business model	Understand

Text Book(s)

T1. M. P. Groover, Automation, “Production Systems and Computer-Integrated Manufacturing”, 4th Edition, Pearson Education, 2016.

T2. Kaushik Kumar, Divya Zindani, J. Paulo Davim,”Industry 4.0 Developments towards the Fourth Industrial Revolution”, 1st Edition, Springer, 2019

Reference Book(s)

R1. Lucas Darnell , “The Internet of Things (A Look at Real World Use Cases and Concerns)”, Kindle Edition, 2016.

R2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

R3. Vijay Madisetti and ArshdeepBahga ,”Internet of Things (A Hands-on-Approach)”,1st Edition, VPT, 2014.

Web References

1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/117/105/117105135/
3. https://nptel.ac.in/courses/117/104/117104020/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO5	2	1	-	-	-	-	-	1	-	1	-	-	1	1

High-3; Medium-2; Low-1

<table>
<tr><td>Course Code: 19EEEN1054</td><td colspan="3">Course Title: Introduction to Big Data</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites : NIL

Course Objectives

The course is intended to:

1. Explain the Big Data Platform and Hadoop.
2. Provide an overview of Hadoop distributed system.
3. Provide overview on anatomy of map reduce,its types and formats.
4. Explain Hadoop ecosystem using PIG
5. Apply analytics using Machine Learning.

Unit I Introduction to Big Data And Hadoop 9 Hours

Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets

Unit II Hadoop Distributed File System 9 Hours

Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Unit III Map Reduce 9 Hours

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features

Unit IV Hadoop Eco System 9 Hours

Introduction to Pig, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive -Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL - Introduction

Unit V Data Analytics with R **9 Hours**

Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Identify Big Data and its Business Implications.	Apply
CO2: List the components of Hadoop and Hadoop Eco-System.	Understand
CO3: Access and Process Data on Distributed File System.	Apply
CO4: Manage Job Execution in Hadoop Environment.	Apply
CO5: Develop Big Data Solutions using Hadoop Eco System.	Apply

Text Book(s)

T1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012

T2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Book(s)

R1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.

R2. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press , 2013.

R3. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013).

Web References

1. https://www.researchgate.net/publication/327728739_A_Reference_Model_for_Big_Data_Analytics
2. https://www.techtarget.com/searchdatamanagement/definition/big-data
3. https://hpc.uva.nl/uploaded_files/inlineitem/Lecture_6_BigData.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1055	**Course Title: Data Acquisition Systems and Signal Processing**		
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Analog and digital electronics
- Sensors and transducers

Course Objectives

The course is intended to:

1. Inculcate knowledge of Data Acquisition Systems & Signal Conditioning
2. Understand the principle of Filtering and Sampling.
3. Introduce the principle of various types of Signal Conversion and Transmission.
4. Disseminate the knowledge of Digital Signal Transmission And Interfacing
5. Provide the basic concepts of virtual instrumentation.

Unit I Data Acquisition Systems & Signal Conditioning 9 Hours

Data Acquisition Systems - Introduction . Objectives of DAS. Block Diagram Description of DAS-General configurations - Single and multichannel DAS - Signal Conditioning: Requirements - Instrumentation amplifiers: Basic characteristics. Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Transmitters .Optical Fiber Based Signal Transmission-Piezoelectric Couplers- Intelligent transmitters.

Unit II Filtering and Sampling 9 Hours

Review of Nyquist.s Sampling Theorem- Aliasing. Need for Prefiltering-First and second order filters - classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters. Op-amp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

Unit III Signal Conversion and Transmission 9 Hours

Analog-to-Digital Converters -Multiplexers and demultiplexers - Digital multiplexer . A/D Conversion . Conversion Processes , Speed, Quantization Errors . Successive Approximation

ADC . Dual Slope ADC . Flash ADC . Digital-to-Analog Conversion . Techniques, Speed, Conversion Errors, Post Filtering- Weighted Resistor, R-2R, Weighted Current type of DACs-Multiplying Type DAC-Bipolar DACs- Data transmission systems-Schmitt Trigger-Pulse code formats- Modulation techniques and systems-Telemetry systems.

Unit IV Digital Signal Transmission and Interfacing 9 Hours

DAS Boards- Introduction. Study of a representative DAS Board-Interfacing Issues with DAS Boards, I/O vs Memory Addressing, Software Drivers, Virtual Instruments, Modular Programming Techniques for Robust Systems, Bus standard for communication between instruments - GPIB (IEEE-488bus) - RS-232C-USB-4-to-20mA current loop serial communication systems.Communication via parallel port . Interrupt-based Data Acquisition.Software Design Strategies-Hardware vs Software Interrupts-Foreground/ background Programming Techniques- Limitations of Polling. Circular Queues

Unit V Virtual Instrumentation 9 Hours

VI-Introduction, Block diagram and Architecture –VI for testing Real time process– Graphical programming using GUI – ADC/DAC – Digital I/O – Counter , Timer-I/O GUI-VI for Intelligent metering and control – Software and hardware of I/O communication blocks-peripheral interface

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Explain the concepts of Data Acquisition Systems & Signal Conditioning	Understand
CO2.	Describe the Filtering and Sampling.	Understand
CO3.	Summarize the X Signal Conversion and Transmission.	Understand
CO4.	Make use of the interfacing methods in digital signal transmission	Apply
CO5.	Utilize the concepts of virtual instrumentation.	Apply

Text Book(s)

T1. Nikolay V. Kirianaki, Sergey Y. Yurish, Nestor O. Shpak"Data Acquisition and Signal Processing for Smart Sensors", Wiley; 1st Edition, 2002

T2. Steve Lekas, “Signal Conditioning & PC-Based Data Acquisition Handbook: A Reference on Analog & Digital Signal Conditioning for Pc-Based Data Acquisition”, Elsevier Publishing, 2012

Reference Book(s)

R1. Maurizio Di Paolo E, Data Acquisition Systems: From Fundamentals to Applied Design, 5th Edition, Springer, 2013

R2. Denton.T , Automobile Electrical and Electronic Systems: Automotive Technology: Vehicle Maintenance and Repair, 2012

Web References

1. edn.com/data-acquisition-systems-and-socs-a-guide/
2. https://dewesoft.com/daq/what-is-data-acquisition
3. https://onlinelibrary.wiley.com/doi/book/10.1002/0470846100

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1056	Course Title: Database and Network Security		
Course Category: Professional Elective		Course Level: Introductory	
L:T:P (Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max. Marks:100

Pre-requisites

- **NIL**

Course Objectives

The course is intended to:

1. Understand the basic information architecture concepts with web 2.0.
2. Identify the research issues in information architecture.
3. Learn interaction design.
4. Understand the network security fundamentals
5. Understand and acquire knowledge of several Cryptographic Algorithms

Unit I Information Architecture and Web 2.0 9 Hours

Information architecture concepts - Definition- The evolution of the web and web design, Information architecture and web 2.0 - Changing the web world wide web -generations of web - web 2.0

Unit II Information Architecture and Research 9 Hours

Challenges and opportunities of IA and design community - Information architecture Research - Design and evaluation ,Organisation - Logical organisation - Semantic Organisation

Unit III Interaction Design 9 Hours

Navigation systems - User information behavior and design implications - Understanding user needs and information behavior - Theories and principles - Design implications, Design Components - Interaction design principles - Personalisation and customization

Unit IV Introduction to Network Security 9 Hours

Security Mechanisms - Security Services - Security Attacks - Model for Network Security - Classical Ciphers.

Unit V Cryptographic Algorithms 9 Hours

Number Theory - Modern Block Ciphers: DES, 3DES, AES, Blowfish, IDEA, CAST-128 - Stream Cipher - Public Key Cryptography : RSA, Diffie-Hellman, Elgamal, ECC.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Articulate the art and science of creating a model for information.	Understand
CO2: Take up research to resolve existing issues in Information Architecture.	Understand
CO3: Design an interactive Information Architecture.	Apply
CO4: Model network security.	Apply
CO5: Apply cryptographic algorithm.	Apply

Text Book(s)

T1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009

T2. Database Security, Castano, Second edition, Pearson Education. 2012

Reference Book(s)

R1. William Stallings, "Cryptography and Network Security", 5th Edition, Pearson, 2010.

R2. Bruce Schneir, "Applied cryptography", 2nd Edition , John Wiley, 1996

Web References

1. https://www.researchgate.net/publication/301277002_Database_Security_-_Attacks_and_Control_Methods
2. https://www.intechopen.com/chapters/37306

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO2	2	1	-	-	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19EEEN1057	**Course Title: Smart Sensor Technologies**		
Course Category: Professional Elective	**Course Level: Mastery**		
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- Communication Engineering

Course Objectives

The course is intended to:

1. Explain the structure of Smart Sensors
2. Describe the data acquisition through the sensor
3. Summarize the various communication protocol used for data processing
4. Elucidate wireless technology used in sensor system.
5. Provide knowledge on inbuilt sensors in Smart devices.

Unit I Introduction to Smart Sensors 9 Hours

Mechanical to Electronic transition in Sensing – Nature of Sensor – Integration of Micromachining and Microelectronics - Evolution of Smart Sensors - Components of Smart Sensors – General Architecture of Smart Sensors

Unit II Sensor Based Data Acquisition 9 Hours

Amplification and Signal Conditioning: Instrumentation amplifier – Sleep mode operational amplifier - Rail to Rail operational amplifier - 4-20ma Signal transmitter – Digital conversion: sampling, Quantizing and encoding – MCU control and sensor interface – Techniques and system integration: Linearization – PWM Control – Auto zero and Auto range – Diagnostics – Reducing EMC and RFI

Unit III Communication For Smart Sensor 9 Hours

Overview of Communication Organization and standards – Automotive protocols: CAN – LIN – Media Oriented Systems Transport – Flex ray - Industrial usage of CAN – MCU with integrated CAN – LonTalk Protocol – MI bus – Other aspects of Network communications

Unit IV Wireless Sensing 9 Hours

Introduction of RF and Spread spectrum – Wireless data and communication – Zigbee – ANT+ - 6LoWPAN – NFC – Zwave – Dust networks – RF Sensing: Surface acoustic waves - RADAR – LIDAR – GPS – Remote emission sensing – Intelligent transportation system - RFID - Telemetry.

Unit V Smart Sensor Devices 9 Hours

Case Study: Sensors in Mobile phones: Touch sensor, Proximity Sensor, Ambient light sensor, Hall sensor and Finger print sensor – Sensors in Automotive vehicles: Air flow sensor, Engine speed sensor, Manifold Absolute Pressure Sensor, Spark Knock Sensor, Fuel Temperature Sensor and Voltage Sensor - Sensors in Wearables: Electro-chemical Bio Sensor, Wearable electrodes, Stain, temperature and pressure sensors

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1.	Organize the structure of Smart Sensors and build the sensor	Apply
CO2.	Identify the data acquisition methods from sensor to other devices	Apply
CO3.	Make use of the various communication protocol used for data processing	Apply
CO4.	Identify wireless technology used in sensor system	Apply
CO5.	Interpret the sensors used in various smart devices	Apply

Text Book(s)

T1. Randy Frank “Understanding Smart Sensors” 3rd Edition, CRC Press, 2014

T2. Krzysztof Iniewski “Smart Sensors for Industrial applications” CRC Press, 2013

Reference Book(s)

R1. Kevin Yallup, Krzysztof Iniewski “Technologies for Smart Sensors and Smart fusion” CRC Press, 2014

R2. Gerard Meijer, Kofi Makinwa, MichielPertijs “Smart Sensor Systems: Emerging Technologies and applications” John wiley and Sons Ltd, 2014

R3. S.C.Mukhopadhyay, G.S.Gupta “Smart Sensors and Sensing Technology” Springer, 2008

Web References

1. https://new.abb.com/motors-generators/service/advanced-services/smart-sensor
2. https://www.intersil.com/en/applications/industrial/smart-sensor.html
3. http://www.smartsensors.com/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO2	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO3	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO4	3	2	1	1	-	-	-	1	-	1	-	-	1	1
CO5	3	2	1	1	-	-	-	1	-	1	-	3	1	1

High-3; Medium-2; Low-1

Course Code: 19MEEC1025	**Course Title: Fundamentals of Entrepreneurship (common to all B.E/B.Tech programmes)**		
Course Category: Professional Elective		**Course Level : Introductory**	
L: T: P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the types, characteristics of entrepreneurship and its role in economic development.
2. Define the types of entrepreneurship.
3. Explain the appropriate form of business ownership in setting up an enterprise.
4. Disseminate the support and management to entrepreneurs in the growth strategies in enterprise.

5.Explain the techniques involved in development of industries

Unit I Entrepreneurship 9 Hours

Entrepreneur – Characteristics – Entrepreneurial Decision Process-Types of Entrepreneurs – Difference between Entrepreneur and a manager-Intrapreneur-Social Entrepreneur –Entrepreneurial Growth- Role of Entrepreneurship in Economic Development.

Unit II Types of Entrepreneurship 9 Hours

Women Entrepreneurship-Rural Entrepreneurship-Tourism Enterprise, Entrepreneurship-Policy Measure of Tourism Entrepreneurship-Eco-Tourism/Nature Tourism/Rural Tourism-Need, Opportunities, Challenges for Developing Agri-preneurship-Social Entrepreneurship.

Unit III Start-Up 9 Hours

Small Enterprises-Micro and Macro Units-Essentials, Features and Characteristics-Relationship between Micro and Macro Enterprises-Scope of Micro and Small Enterprises-Enterprise and Society-Package for Promotion of Micro and Small-Scale Enterprises-Problems of Micro and Small Enterprises- Identification of Business Opportunity-Steps in

Setting Up of a Small Business Enterprise – Content of Business Plan- Significance of Business Plan, Formulation of Business Plan – Guidelines for Formulating Project Report–Project Appraisal.

Unit IV Support and Management 9 Hours

Institutional Finance-Types of Lease Agreements-Lease Financing-Concept and Procedure for Hire-Purchase-Institutional Support to Small Entrepreneurs-Tax Benefits-Depreciation, Rehabilitation Allowance- Investment Allowance-Expenditure to Scientific Research-Tax Concession in Rural and Backward Areas-Difference between Management and Administration-Management of Working Capital-Methods of Inventory Management-Production Design-Market Segmentation-Marketing Mix

Unit V Development 9 Hours

Accounting for Small Enterprise-Types of Growth Strategies-Signal and Symptoms, Causes and Consequences of Industrial Sickness-Forms of Export Business-Types of Documents-E-Commerce Suitability for Small Enterprises-Types of Franchising-Evaluation of Franchise Arrangement-Corporate Citizenship.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the types, characteristics of entrepreneurship and its role in economic development.	Apply
CO2: Classify various types of entrepreneurship and highlight the opportunities to improve the economy of India.	Apply
CO3: Select the appropriate form of business ownership in setting up an enterprise.	Apply
CO4: Determine the financial planning to become an entrepreneur and manage tax benefits that can be provided to the small Entrepreneurs	Analyze
CO5: Identify the techniques involved in the development of the small enterprise for the growth of industries.	Apply

Text Book(s):

T1. S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi,2020.

Reference Book(s):

R1. Charantimath, P. M., "Entrepreneurship Development and Small Business Enterprises", Pearson, 2006.

R2. Mathew J Manimala," Entrepreneurship theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.

R3. Rabindra N. Kanungo, "Entrepreneurship and innovation", Sage Publications, New Delhi, 2003.

Web References:

1. https://nptel.ac.in/courses/127105007
2. https://ncert.nic.in/ncerts/l/lebs213.pdf

R4. Singh, A. K., "Entrepreneurship Development and Management", University Science Press, 2009.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2		2				3	3					
CO3				2						2		
CO4					3			3			3	
CO5			2						2			

High-3; Medium-2; Low-1

Course Code: 19MEEC1026		Course Title: Design Thinking and Innovation (common to all B.E/B.Tech programmes)	
Course Category: Professional Elective		Course Level: Introductory	
L: T: P(Hours/Week) 3: 0: 0	Credits:3	L: T: P(Hours/Week) 3: 0: 0	Credits:3

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Disseminate the fundamental concepts and principles of design thinking
2. Explain the design thinking methods in each stage of the problem
3. Conceptualize innovative ideas using prototypes
4. Explain the significance of Evaluating and Testing Ideas
5. Describe the design thinking approach to real world problems

Unit I Introduction to Design Thinking 9 Hours

Design thinking overview - Impact of Design Thinking - Design Process – Principles of Design Thinking – Creating Ideal Conditions – Case Study: Identify problem in AI

Unit II Understand the Problem 9 Hours

Information Gathering – Analysis – Storytelling tool- Innovation- Ideation Finding and Evaluating Ideas –Mind Mapping Tool. Case Study: Analysis of the Identified Problem.

Unit III Defining Prototypes 8 Hours

Tasks in Prototyping – Understanding Different Prototypes - Developing different prototypes – Demonstration – Prototyping Tools. Case Study: Prototype the solution.

Unit IV Evaluating and Testing Ideas 10 Hours

Finding Ideas – Developing Ideas Intuitively and Creatively - Selecting Evaluation method – Evaluating Ideas with checklist –Testing Ideas and Assumptions – Tasks in the Test Phase – Testing with Interviews – Testing with Online Studies – Case Study: Evaluate the solution.

Unit V Applications 9 Hours

Politics and Society – Business – Strategic technology Plan – Creativity – Visioning, Listening and Diagramming - HealthCare and Science – Approach to treat Cancer – Law – Problem Definition – Alternatives.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the key concepts of design thinking	Apply
CO2: Relate design thinking in all stages of problem solving	Apply
CO3: Identify the diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices	Analyze
CO4: Determine the significance of testing and evaluating the solution	Analyze
CO5: Apply design thinking skills to solve real time user experience problems	Apply

Text Book(s):

1. Muller-Roterberg "Design thinking for dummies" John Wiley & Sons,2020.(Unit-I,III & IV)

2. Andrew Pressman "Design Thinking A Guide to Creative Problem Solving for Everyone", Routledge Publication, 2019.(Unit-II & V)

Reference Book(s):

1. Robert Curedale, "Design Thinking Process & Methods" Design Community College, 5th Edition, 2019.

2. Alyssa Gallagher and Kami Thordarson, "Design Thinking in Play: An Action Guide for Educators", ASCD Book, 2020

3.Brown.T, "Change by design: How design thinking transforms organizations and inspires innovation", HarperCollins,2009.

Web References:

1. https://www.open.edu/openlearn/science-maths-technology/design-innovation/design-thinking/content-section-6
2. https://www.interaction-design.org/literature/topics/design-thinking
3. https://venturewell.org/class-exercises/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2		2				3	3					
CO3				2						3		
CO4					3			3			3	
CO5			2						2			

High-3; Medium-2; Low-1

Course Code: 19ITEN1029	**Course Title: Intellectual Property Rights (common to all B.E/B.Tech programmes)**		
Course Category: Professional Elective		**Course Level : Introductory**	
L: T: P(Hours/Week) **3: 0: 0**	**Credits:3**	**Total Contact Hours:45**	**Max. Marks:100**

Pre-requisites

- Nil

Course Objectives

The course is intended to:

1. Describe the basic concepts of Intellectual Property Law.
2. Explain the classification of Patents and its Rights and Limitations.
3. Explain the Patent Searching Process and Application Filling Process.
4. Describe the concepts and principles of Trademark.
5. Explain the principles of copyright and its sources.

Unit I Intellectual Property: An Introduction 9 Hours

Intellectual Property Law: Patent Law-Copyright Law-Trademark Law- Trade secret Law-Right of Publicity-Paralegal tasks in Intellectual Property Law-Ethical obligations of the paralegal in Intellectual Property Law-Trade secrets: Protectible as a trade secret-Maintaining trade secrets-Protecting an Idea

Unit II Patents: Rights and Limitations 9 Hours

Sources of patent law-Subject matter of Patents: Utility Patents-Plant Patents-Design Patents- Design Patents and copyright-Design Patents and trademarks-Computer Software, Business methods and Patent Protection-Rights under Patent Law-Patent Requirements-Limitations on Patent Rights-Patent Ownership

Unit III Patents: Research, Applications, Disputes, and International Considerations 9 Hours

Patent Search Process-Patent Application Process-Patent Infringement-Patent Litigation, International Patent laws

Unit IV Principles of Trademark 9 Hours

Trademarks and Unfair Competition-Acquiring Trademark Rights-Types of Marks, Strong Marks Versus Weak Marks-Selecting and Evaluating a Trademark-International Trademark Laws

Unit V Principles of Copyrights 9 Hours

Sources of Copyright Law- The Eight Categories of Works of Authorship-Derivative Works and Compilations- Rights and Limitations :Grant of Exclusive Rights–Copyrights Ownership-International Copyright Laws

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO6: Describe the basics of Intellectual Property Law	Apply
CO7: Identify the Rights and Limitations of various patents	Apply
CO8: Apply the process of patent search and application filling process	Apply
CO9: Explain the concept of trademark and its types	Apply
CO10: Classify the concepts of copyrights and its limitations	Apply

Text Book(s):

T2. Richard Stim, “Intellectual Property: Copyrights, Trademark and Patents”, Cengage learning, 2nd edition 2012.

Reference Book(s):

R5. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Edition, 2013.

R6. Prabuddha Ganguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2017.

Web References:

1. https://ipindia.gov.in/writereaddata/Portal/ev/sections-index.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2						2
CO2	2			2								
CO3		3	3								2	
CO4								2	2			
CO5					2		2					2

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19SCEC2001</td><td colspan="2">Course Title: Cyber Security
(common to all B.E/B.Tech programmes)</td></tr>
<tr><td colspan="2">Course Category: Professional Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Discuss the various concepts in Cyber security and infrastructures involved.
2. Describe the cyber-crimes, reporting procedures and legal remedies.
3. Explain various social media related security issues and reporting flaws.
4. Explain various settings related to E-Commerce and Digital payments.
5. Demonstrate the security aspects related to digital devices and technology.

Unit I Introduction to Cyber Security 9 Hours

Defining Cyberspace and Overview of Computer and Web-technology - Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Unit II Cyber crime and Cyber law 9 Hours

Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber crimes, Remedial and mitigation measures, Legal perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organizations dealing with Cyber crime and Cyber security in India, Case studies.

Unit III Social Media Overview and Security 9 Hours

Introduction to social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

Unit IV E-Commerce and Digital Payments 9 Hours

Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act, 2007.

Unit V Digital Devices Security, Tools and Technologies for Cyber Security 9 Hours

End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Describe the concept of Cyber Security and infrastructure involved.	Understand
CO2: Develop procedures for reporting various cyber-crimes through available platforms.	Apply
CO3: Demonstrate various social media related security issues and reporting flaws.	Apply
CO4: Illustrate various settings in e-commerce and digital payment applications.	Apply
CO5: Demonstrate the digital devices security, tools and technologies for cyber security.	Apply

Text Book(s)

T1. Cyber Crime Impact in the New Millennium, R. C Mishra. Auther Press.T2, 2010

T2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, 1st Edition, Wiley India Pvt. Ltd, 2011.

T3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by

Henry A. Oliver, Create Space Independent Publishing Platform, PearsonEducation, 2001.

Reference Book(s)

R1. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition,Wiley India Pvt. Ltd, 2001

R2. Security Fundamentals of Network by E. Maiwald, McGraw Hill ,2014

R3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K,Dominant Publishers, 2011.

Web Reference(s):

1. https://unacademy.com/content/upsc/study-material/science-and-technology/initiatives-taken-by-indian-government-for-cyber-security/
2. https://cybercrime.gov.in/
3. https://www.meity.gov.in/cyber-security-division
4. https://intellipaat.com/blog/what-is-cyber-security/

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	3	3	-	1	-	-	3	-
CO2	-	-	-	2	-	3	3	3	3	2	-	-	3	-
CO3	-	-	-	2	-	3	3	3	3	2	-	-	3	-
CO4	1	-	1	3	2	3	2	3	3	2	-	2	3	3
CO5	1	-	1	3	2	3	2	3	-	1	-	3	3	3

High-3; Medium-2;Low-1

OPEN ELECTIVES

<table>
<tr><td colspan="2">Course Code:19EEOC1001</td><td colspan="2">Course Title: ELECTRIC AND HYBRID VEHICLES</td></tr>
<tr><td colspan="2">Course Category: Open Elective</td><td colspan="2">Course Level: Mastery</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- DC Machines and Transformers
- Synchronous and Induction Machines

Course Objectives

The course is intended to:

1. Categorize the need and performances of Electric vehicles.
2. Identify the types of Architectures in Electric & Hybrid Vehicles.
3. Discuss the electric propulsion system and motor controlling techniques.
4. Describe the energy storage system and generators in electric hybrid vehicle.
5. Explain the construction and working of fuel cells & solar cars.

Unit I Electric Vehicles 9 Hours

Layout of an electric vehicle, performance of electric vehicles – Traction motor characteristics, Tractive effort, Transmission requirements, Vehicle performance, Energy consumption, Advantage and limitations, Specifications, System components, Electronic control system.

Unit II Hybrid Vehicles 9 Hours

Concepts of hybrid electric drive train, Architecture of series and parallel hybrid electric drive train, Merits and demerits, Series and parallel hybrid electric drive train design.

Unit III Electric Propulsion System And Motor Control 9 Hours

DC motors, AC motors, Permanent magnet motors, Brushless DC and Reluctance motors, Characteristics ,Regenerative braking, Control system principles, Speed and torque control – DC motors and AC Motors.

Unit IV Energy Storages & Generators 9 Hours

Electromechanical batteries – Types of batteries – Lead acid batteries, Nickel based batteries, Lithium based batteries, Electrochemical reactions, Thermodynamic voltage, Specific Energy, Specific Power, Energy efficiency, Ultra capacitors – DC Generators, AC Generators, Voltage and frequency regulations.

Unit V Fuel Cells & Solar Cars 9 Hours

Fuel cell, Construction, Working, Equations, Possible fuel sources, Fuel reformer, Design, Solar cars, Photovoltaic cells, Tracking, Efficiency and cost comparison, Plug In Vehicles (PIV).

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Categorize the need and performances of Electric vehicles.	Apply
CO2: Classify the various architectures of electric hybrid vehicles.	Apply
CO3: Exemplify the electric propulsion system and motor controlling Techniques.	Apply
CO4: Describe the energy storage system and generators in electric hybrid Vehicle.	Understand
CO5: Explain the construction and working of fuel cells & solar cars.	Understand

Text Book(s)

T1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, " Modern Electric, Hybrid, Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC press, 2004

T2. James Larminie and John Loury, " Electric Vehicle Technology – Explained", John Wiley & Sons . McGraw-Hill Book company,1994.

Reference Book(s)

R1. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002.

R2. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.

R3. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design" Butterworth –Heinemann, 2001.

Web References

1. http://nptel.ac.in/courses/108103009/1
2. http://nptel.ac.in/courses/108103009/4
3. http://nptel.ac.in/courses/108103009/9
4. http://nptel.ac.in/courses/108103009/32
5. http://www.engnetbase.com/books/4675/3154fm.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19EEOC1002	**Course Title: Energy Auditing And Conservation**		
Course Category: Open Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites

- NIL

Course Objectives

The course is intended to:

1. Understand the basic principles of energy management material, energy balance.
2. Study the financial and project management techniques for energy management.
3. Gain knowledge in energy conservation of thermal utilities
4. Gain knowledge in energy conservation of electrical utilities
5. Analyze the performance of thermal and electrical utilities

Unit I Energy Management & Audit 9 Hours

Energy Scenario-Basics of Energy and its various forms-**Energy Management & Audit:** Definition, Energy audit- need, Types of energy audit ,Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments-**Material and Energy balance:** Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.

Unit II Financial& Project Management 9 Hours

Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs. **Project Management:** Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification

Unit III Energy Efficiency In Thermal Utilities 10 Hours

Boilers: Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities. Steam System: Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Waste Heat Recovery: Classification, Advantages and applications, Commercially viable waste heat recovery devices, Saving potential-Introduction to cogeneration & furnaces

Unit IV Energy Efficiency Electrical Utilities 12 Hours

Electric motors: Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Energy saving opportunities with energy efficient motors. **Compressed air system:** Types of air compressors, Compressor efficiency, Capacity assessment, Leakage test, Factors affecting the performance and efficiency, **Fans and blowers**: Types, Performance evaluation, **Pumps and Pumping System**: Types, Performance evaluation, **Cooling Tower:** Types and performance evaluation, **Lighting System:** Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues.

Unit V Energy Performance Assessment Case Studies 5 Hours

Boilers-Heat Exchangers-Electric Motors –Fans and Motors-Compressors.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the basic principles energy management and material, energy balance	Understand
CO2: Explain the financial and project management techniques for energy management	Understand
CO3: Identify the opportunities for energy conservation in thermal utilities	Apply
CO4: Identify the opportunities for energy conservation in electrical utilities	Apply
CO5: Identify the improvement measures in the performance of thermal and electrical utilities.	Apply

Reference Book(s)

R1. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.

R2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford,1981

R3. I.G.C. Dryden, "The Efficient Use of Energy" Butterworths, London, 1982

R4. W.C. turner, "Energy Management Hand book" " Wiley, New York,1992

R5. Cay S. Horstmann and Gary Cornell, "Core Java: Volume I – Fundamentals", Eighth Edition, Sun Microsystems Press, 2008.

Web References:

1.http://www.em-ea.org/gbook1.asp

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 19EEOC1003		Course Title: Solar Energy System	
Course Category: Open Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Pre-requisites The student should have undergone the course(s):

- NIL

Course Objectives

The course is intended to:

1. Understand the importance of solar radiation and its measurement techniques.
2. Understand the principles of solar Cooking, Distillation and Heating Systems.
3. Study the basic principles of solar photovoltaic (PV) cell and the factors affecting its electricity generation.
4. Understand the Balance of systems associated with PV power plants.
5. Design stand alone and grid connected Solar PV systems.

Unit I Solar Radiation And Measurements 9 Hours

World solar energy - Indian solar energy scenario-The sun and the earth-Sun earth movement-Angle of sunrays on solar collector-Sun tracking-Estimation of solar radiation empirically-Measurement of solar radiation.

Unit II Solar Thermal Technologies 9 Hours

Solar thermal energy systems-Absorption and radiation-Solar cooking systems-Principle -Types of solar cooker-Solar distillation system-Operation and design-Solar heating systems.

Unit III Solar Photovoltaic Technologies 9 Hours

Solar photovoltaic(PV) energy conversion - Principles - Physics and operation of solar cells-Solar cell types and technologies-Factors affecting electricity generated by solar cell-Solar PV modules-Ratings of PV module-Standard PV module parameters- Factors affecting electricity generated by PV module-Measuring module parameters-Solar arrays-Connection of modules in series, parallel and Series-parallel.

Unit IV Balance Of Systems 9 Hours

Batteries-Types-Parameters-Comparison of various rechargeable batteries-Selection of batteries-Batteries for PV systems-Estimation of number of batteries required in series, parallel and series parallel for an application-Power converters-Types-Charge Controllers-Function-Working-types-features-Typical Specifications-Maximum power point tracking.

Unit V Solar PV System Design And Integration 9 Hours

Types of Solar PV systems-Design methodology for standalone Solar PV system-Configuration of grid connected solar PV system-Components of grid connected solar PV system-Design of grid connected solar PV systems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the importance of solar radiation and its measurement techniques.	Understand
CO2: Describe the principles of solar Cooking, Distillation and Heating Systems.	Understand
CO3: Explain the basic principles of solar photovoltaic (PV) cell and the factors affecting its electricity generation.	Understand
CO4: Describe the Balance of systems associated with PV power plants.	Understand
CO5: Design Stand alone and grid connected Solar PV systems.	Apply

Text Book(s)

T1. Solar Photovoltaic Technology and Systems A manual for Technicians, Trainers, and Engineers **-**Chetan Singh Solanki-PHI Learning Private Limited-2013

T2. Solar Energy Utilisation, G.D.Rai, Khanna Publishers, 1993

Reference Book(s)

R1. Solar Photovoltaics: Fundamentals, Technologies And Applications By Chetan Singh Solanki- PHI Learning Private Limited-2015

R2. Solar Energy by S P Sukhatme, J K Nayak, Tata McGraw Hill Publishing, 2008

R3. Renewable Energy Technologies: A Practical Guide for Beginners By Chetan Singh Solanki- PHI Learning Private Limited-2009

Web References

1. http://www.pveducation.org/
2. http://www.ese.iitb.ac.in/~chetan/PVmaterial.html
3. https://pveducation.com/
4. http://www.ncpre.iitb.ac.in/
5. https://mnre.gov.in/file-anager/UserFiles/support_hrd_coursematerial_iti.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 19EEOC1004</td><td colspan="2">Course Title: Control Systems for Engineers</td></tr>
<tr><td colspan="2">Course Category: Open Elective</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
1:2:0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- Electric Circuits

Course Objectives

The course is intended to:

1. Model electrical and mechanical systems.
2. Determine the time response and time domain specifications.
3. Analyze the given first order and second order systems
4. Analyze the system stability.
5. Analyze the state variable methods.

Unit I Control System Modeling 3+6 Hours

Basic Elements of Control System – Open loop and Closed loop systems - Transfer function, Modelling of Electrical systems, mechanical systems: Translational and rotational systems-Block diagram reduction Techniques

Unit II Time Response Analysis 3+6 Hours

Standard test signals - Time response of first order systems - Impulse and Step Response analysis of second order systems – Time Domain specifications – Effects of P, PI, PD and PID Controllers on the system's response

Unit III Frequency Response Analysis 3+6 Hours

Frequency Response – Bode Plot: Gain margin, Phase margin, gain & phase crossover frequency-Polar Plot: Gain margin, Phase margin.

Unit IV Stability Analysis 3+6 Hours

Stability, Routh-Hurwitz Criterion, Concept of Root Locus Technique, Construction of Root Locus.

Unit V Analysis using State Variable Methods 3+6 Hours

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability.

Course Outcomes		Cognitive Level
At the end of this course, students will be able to:		
CO1.	Model electrical and mechanical systems using transfer function	Apply
CO2.	Determine the time response and time domain specifications of first order and second order systems	Apply
CO3.	Analyze the given first order and second order system with their frequency domain specifications.	Apply
CO4.	Analyze the stability of the given system.	Apply
CO5.	Analyze the control system using state variable methods.	Apply

Text Book(s)

T1. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 6th Edition 2017.

T2. Benjamin C. Kuo, 'Automatic Control systems',10th Edition Pearson Education, New Delhi, 2017.

Reference Book(s)

R1. Norman S. Nise, 'Control Systems Engineering', Fifth Edition, John Wiley, New Delhi, 2018.

R2. Samarajit Ghosh, 'Control systems Theory and Applications ',2nd Edition Pearson Education, New Delhi, 2012.

R3. M. Gopal, 'Control Systems, Principles and Design', 4th Edition Tata McGraw Hill, New Delhi, 2012.

R4. K. Ogata, 'Modern Control Engineering', Pearson Education India, 5th Edition New Delhi, 2015.

R5. Richard C.Dort and Robert H.Bishop, "Modern Control Systems ", Pearson Prentice Hall, 13th Edition 2016.

Web References

1. http://nptel.ac.in/courses/108101037/
2. https://www.tutorialspoint.com/control_systems/control_systems
3. http://lpsa.swarthmore.edu/Root_Locus/RLocusExamples.html
4. https://in.mathworks.com/help/control/examples/compensator-design-for-systems-represented-by-frequency-response-data.html

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	1	-	1	-	3
CO2	3	2	1	1	-	-	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	-
CO5	3	2	1	1	3	-	-	1	-	1	-	-

High-3; Medium-2;Low-1