



# Dr. MAHALINGAM

## COLLEGE OF ENGINEERING AND TECHNOLOGY

Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'

Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)

Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 [www.mcet.in](http://www.mcet.in)

### **Curriculum and Syllabi**

### **B.E. Mechanical Engineering**

### **Semesters I to VIII**

### **Regulations 2019**

## **Department of Mechanical Engineering**

### **Vision**

To transform students from background into professional leaders of tomorrow in the field of mechanical engineering with strong sense of social commitment

### **Mission:**

- To impart quality –engineering education leading to specialization in the energy areas of CAD/CAM/CAE, Energy Engineering and Materials Technology.
- To provide continually updated and intellectually stimulating environment to pursue research and consultancy activities.

**Programme: B.E. Mechanical Engineering**

**Programme Educational Objectives (PEOs) - Regulation 2019**

B.E. Mechanical Engineering graduates will:

**PEO1.Technical Expertise:** Actively apply technical and professional skills in engineering practices towards the progress of the organization or the entrepreneurial venture in competitive and dynamic environment.

**PEO2.Lifelong Learning:** Own their professional and personal development by continuous learning and apply the learning at work to create new knowledge.

**PEO3.Ethical Knowledge:** Conduct themselves in a responsible, professional and ethical manner supporting sustainable economic development which enhances the quality of life.

**Programme Outcomes (POs) - Regulations 2019**

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

**PO1.** Apply knowledge of basic sciences and engineering concepts to solve complex mechanical engineering problems.

**PO2.** Identify, formulate, and analyze engineering problems using scientific principles and concepts.

**PO3.** Design products, manufacturing processes and facilities that deliver the requirements of the target customers and desired quality functions.

**PO4.** Conduct experiments, analyze and interpret data to provide solutions for engineering problems.

**PO5.** Use appropriate tools and techniques to solve engineering problems.

**PO6.** Apply contextual knowledge to make informed decisions in societal, health, safety, legal, entrepreneurial and cultural issues.

**PO7.** Demonstrate the knowledge of need for sustainable development in providing engineering solutions in global, environmental and societal contexts.

**PO8.** Practice Ethical responsibility.

**PO9.** Work effectively in teams and build/manage interpersonal relationships.

**PO10.** Communicate effectively through oral, non-verbal and written means.

**PO11.** Apply management principles to manage individual and team work for executing projects in a multidisciplinary environment.

**PO12.** Articulate and engage in pursuit of career and life goals through continuous Learning.

**Programme Specific Outcomes (PSOs) - Regulations 2019**

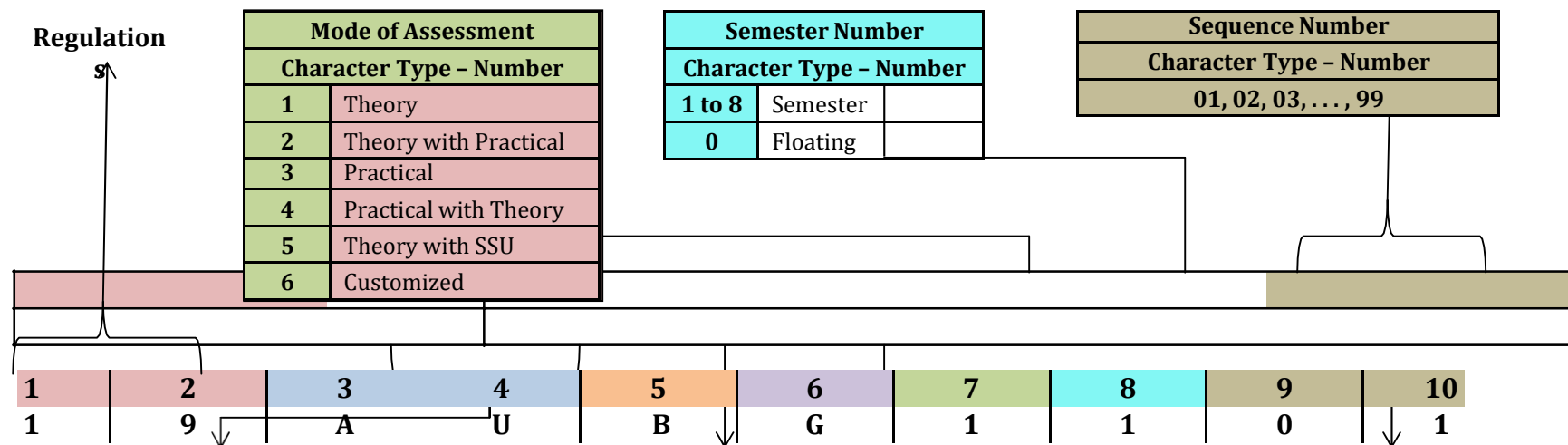
On successful completion of B.E. Mechanical Engineering programme, graduating students/graduates will be able to:

**PSO 1:**Demonstrate functional competencies for roles in design, manufacturing and service by learning through centers of excellence and industrial exposure.

**PSO 2:**Demonstrate behavioral competencies required for roles in design, manufacturing and service by learning through structured professional skills training.

# Dr. Mahalingam College of Technology, Pollachi

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



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

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

Common to any Programme	
Character Type - Alphabet	
<b>G</b>	Generic
<b>C</b>	Common
<b>N</b>	Non-Common

**Programme: B.E Mechanical Engineering**  
**2019 Regulations**  
**Curriculum for Semesters I to II**

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

**Semester I (2019 Batch)**

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1101	Matrices and Calculus	3	1	0	4	100	AU, CE, MC, ME, EC, EI, EE
19ENHG2101	Communication Skills - I	2	0	2	3	100	All
19PHBC2101	Physics for Mechanical Sciences	3	0	2	4	100	AU, ME, MC,
19CSC2001	C Programming	3	0	2	4	100	AU, ME, MC
19MESC4001	Engineering Drawing	1	0	3	2.5	100	AU, ME, MC, CS, IT, EC, EI
19PSHG3001	Wellness for Students	0	0	2	1	100	All
<b>Total</b>		<b>12</b>	<b>1</b>	<b>11</b>	<b>18.5</b>	<b>600</b>	

**Semester II (2019 Batch)**

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1201	Ordinary Differential equation and Complex Variables	3	1	0	4	100	AU, CE, MC, ME, EC, EI, EE
19ENHG2201	Communication Skills - II	2	0	2	3	100	All
19CHBC2201	Chemistry for Mechanical Sciences	3	0	2	4	100	AU, ME, MC
19MESC2001	Introduction to Engineering	2	0	2	3	100	AU, MC, ME, EC, EI, EE
19MESC2201	Engineering Materials	2	0	2	3	100	AU, MC, ME
19MECC3201	Engineering Practices Laboratory	0	0	3	1.5	100	AU, ME, MC
19PSHG3002	Personal Effectiveness	0	0	2	1	100	All
19CHMG6201	Environmental Science	1	0	0	-	-	All
<b>Total</b>		<b>13</b>	<b>1</b>	<b>13</b>	<b>19.5</b>	<b>700</b>	



**Programme: Mechanical Engineering**

**2019 Regulations**

**Curriculum for Semesters I to VIII**

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

**Semester I (2020 Batch)**

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1101	Matrices and Calculus	3	1	0	4	100	AU, CE, MC, ME, EC, EI, EE
19ENHG2101	Communication Skills - I	2	0	2	3	100	All
19PHBC2101	Physics for Mechanical Sciences	3	0	2	4	100	AU, ME, MC
19CSSC2001	C Programming	3	0	2	4	100	AU, CE, MC, ME, EC, EI, EE
19MESC4001	Engineering Drawing	1	0	3	2.5	100	AU, ME, MC, CS, IT, EC, EI
19PSHG6001	Wellness for Students*	0	0	2	-	-	All
<b>Total</b>		<b>12</b>	<b>1</b>	<b>11</b>	<b>17.5</b>	<b>500</b>	

**Semester II (2020 Batch)**

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1201	Ordinary Differential equations and Complex Variables	3	1	0	4	100	AU, CE, MC, ME, PR, EC, EI, EE
19ENHG2201	Communication Skills - II	2	0	2	3	100	All
19CHBC2201	Chemistry for Mechanical Sciences	3	0	2	4	100	AU, CE, ME, MC, PR, EE
19MESC2001	Introduction to Engineering	2	0	2	3	100	AU, MC, ME, PR, EC, EI, EE
19MESC2201	Engineering Materials	2	0	2	3	100	AU, MC, ME, PR
19MECC3201	Engineering Practices Laboratory	0	0	3	1.5	100	AU, ME, MC, PR
19PSHG6001	Wellness for Students*	0	0	2	1	100	All
19CHMG6201	Environmental Sciences	1	0	0	-	-	All
<b>TOTAL</b>		<b>13</b>	<b>1</b>	<b>13</b>	<b>19.5</b>	<b>700</b>	

\*Annual Pattern



### Semester III

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MABC1301	Numerical Methods	3	1	0	4	100	AU, ME
19MESC1301	Engineering Mechanics	3	1	0	4	100	AU, ME, MC
19MECC2301	Fluid Mechanics and Hydraulic Machinery	3	0	2	4	100	AU, ME, MC
19MECN2301	Metrology and Measurement	3	0	2	4	100	-
19MECN1301	Manufacturing Processes	3	0	0	3	100	-
19MECN3301	Computer Aided Modeling and Drafting Laboratory	0	0	3	1.5	100	-
19MECN3302	Manufacturing Processes Laboratory	0	0	3	1.5	100	-
XXXXXXXXXX	One Credit Course	0	0	2	1	100	-
<b>Total</b>		<b>15</b>	<b>2</b>	<b>12</b>	<b>23</b>	<b>800</b>	

### 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	AU, ME, CS, IT, EC, EE, CE
19MECC2401	Strength of Materials	3	0	2	4	100	AU, ME, MC
19MECN2401	Theory of Machines	2	1	2	4	100	-
19MECN1401	Manufacturing Technology	3	0	0	3	100	-
19MECN3401	Manufacturing Technology Laboratory	0	0	3	1.5	100	-
19PSHG6002	Universal Human Values 2: Understanding Harmony	2	1	0	3	100	All
19MEPN6401	Mini-Project	0	0	4	2	100	
XXXXXXXXXX	One Credit Course	0	0	2	1	100	-
<b>Total</b>		<b>13</b>	<b>3</b>	<b>9</b>	<b>22.5</b>	<b>700</b>	

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

\*Refer to clause:4.8 in UG academic regulations 2019

### Semester V

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MECC1501	Mechanical Design	3	1	0	4	100	MC,ME
19MECN2501	Applied Thermodynamics	3	0	2	4	100	-
19MECN2502	Electrical and Electronics Engineering	3	0	2	4	100	-
19MECC2501	Problem solving using PYTHON for Mechanical Sciences	2	0	2	3	100	AU, MC, ME
19MEEXXXXX	Professional Elective -I	3	0	0	3	100	-
19MEEXXXXX	Professional Elective -II	3	0	0	3	100	-
19MEOCXXXX	Open Elective - I	3	0	0	3	100	-
19MECN3501	Computer Aided Machine Drawing Laboratory	0	0	3	1.5	100	-
19PSHG6501	Employability Skills 1 : Teamness and Interpersonal Skills	0	0	2	1	100	All
<b>Total</b>		<b>20</b>	<b>1</b>	<b>11</b>	<b>26.5</b>	<b>900</b>	

### Semester VI

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MECC1601	Finite Element Analysis	3	1	0	4	100	AU, ME
19MECN2601	Heat and Mass Transfer	2	1	2	4	100	-
19MECC1602	Data Science for Engineers	3	0	0	3	100	AU, MC, ME
19MEEXXXXX	Professional Elective -III	3	0	0	3	100	-
19MEEXXXXX	Professional Elective -IV	3	0	0	3	100	-
19MEOCXXXX	Open Elective -II	3	0	0	3	100	-
19PSHG6601	Employability Skills 2 : Campus to Corporate	0	0	2	1	100	All
19MEPN6601	Innovative and Creative Project	0	0	4	2	100	-
<b>Total</b>		<b>18</b>	<b>1</b>	<b>8</b>	<b>23</b>	<b>800</b>	

Course Code	Course Title	Duration	Credits	Marks
XXXXXXXXXX	Internship or Skill Development*	2/4 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			
19MECN1701	Mechatronics	3	0	0	3	100	-
19MECC1701	Artificial Intelligence and Machine Learning	3	0	0	3	100	AU, MC, ME
19MECN1702	CNC Programming and Robotics	3	0	2	4	100	-
19MEEXXXXX	Professional Elective - V	3	0	0	3	100	-
19MEEXXXXX	Professional Elective - VI	3	0	0	3	100	-
19MEOCXXXX	Open Elective - III	3	0	0	3	100	-
19MECC3701	Simulation and Analysis Laboratory	0	0	3	1.5	100	MC, ME
19MECN3701	Mechatronics Laboratory	0	0	3	1.5	100	-
<b>Total</b>		<b>21</b>	<b>0</b>	<b>8</b>	<b>22</b>	<b>800</b>	

### Semester VIII

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
19MEPN6801	Project	0	0	16	8	200	-
<b>Total</b>		<b>0</b>	<b>0</b>	<b>16</b>	<b>8</b>	<b>200</b>	-

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

\*Refer to clause: 4.8 in UG academic regulations 2019

**Total Credits (2019 Batch only): 169**

**Total Credits (2020 Batch onwards):168**

### PROFESSIONAL ELECTIVES

Course Code	Course Title	Hours / Week			Credit s	Marks	Common to Programmes
		L	T	P			
DESIGN ELECTIVES							
19MEEC1001	Product Life Cycle Management	3	0	0	3	100	AU, MC, ME
19MEEC1002	Design for Manufacture, Assembly and Environment	3	0	0	3	100	AU, MC, ME
19MEEC1003	Vibration and Noise Engineering	3	0	0	3	100	MC, ME
19MEEC1004	Computational Fluid Dynamics	3	0	0	3	100	MC, ME
19MEEN1001	Mechanical System Design	3	0	0	3	100	-
19MEEC1005	Design of Transmission Systems	3	0	0	3	100	MC, ME
19MEEC1006	Automotive Engine and Its Systems	3	0	0	3	100	MC, ME
19MEEN1003	Motor Cycle Dynamics	3	0	0	3	100	-
19MEEC1007	Design for Sheet Metal	3	0	0	3	100	AU, ME
19MEEN1004	Design for Welding	3	0	0	3	100	-
19MEEC1008	Composite Materials	3	0	0	3	100	AU, MC, ME
19MEEN1020	Fluid Power System	3	0	0	3	100	-
19MEEC1023	Model Based Systems Engineering	3	0	0	3	100	AU, ME
19MEEC1024	New Product Development	3	0	0	3	100	AU, ME
MANUFACTURING ELECTIVES							
19MEEC1009	Additive Manufacturing	3	0	0	3	100	AU, MC, ME
19MEEN1005	Process Planning and Cost Estimation	3	0	0	3	100	-
19MEEN1006	Advanced Manufacturing Processes	3	0	0	3	100	-
19MEEC1010	Flexible Manufacturing Systems	3	0	0	3	100	MC, ME
19MEEC1011	Non Destructive Testing Methods	3	0	0	3	100	AU, MC, ME
19MEEN1007	Supply Chain Management	3	0	0	3	100	-
19MEEN1008	Nanomaterials Synthesis and Characterization	3	0	0	3	100	-
19MEEC1012	Lean Manufacturing	3	0	0	3	100	AU, ME
19MEEC1013	Logistics Engineering	3	0	0	3	100	AU, ME
19MEEN1010	Manufacturing Systems Engineering	3	0	0	3	100	-
19MEEC1014	Engineering Economics and Cost Analysis	3	0	0	3	100	AU, ME
19MEEN1022	Advanced Computer Integrated Manufacturing	3	0	0	3	100	-

## ELECTIVES

Course Code	Course Title	Hours /Week			Cred its	Mark s	Common to Programme s
		L	T	P			
THERMAL AND QUALITY ELECTIVES							
19MEEC1015	Principles of Management	3	0	0	3	100	MC, ME
19MEEN1011	Operations Research	3	0	0	3	100	-
19MEEC1016	Quality Engineering	3	0	0	3	100	AU, MC, ME
19MEEN1012	Total Productive Maintenance	3	0	0	3	100	-
19MEEC1017	Industrial Safety Management	3	0	0	3	100	AU, MC, ME
19MEEN1013	Power Plant Engineering	3	0	0	3	100	-
19MEEC1018	Automobile Engineering	3	0	0	3	100	MC, ME
19MEEN1014	Refrigeration and Air-Conditioning	3	0	0	3	100	-
19MEEN1015	Solar and Wind Energy Engineering	3	0	0	3	100	-
19MEEN1016	Battery System for Electric Vehicles	3	0	0	3	100	-
19MEEC1020	Systems Approach for Engineers	3	0	0	3	100	EE, ME
19MEEC1025	Systems Engineering	3	0	0	3	100	AU, ME
EMERGING TECHNOLOGY & PROGRAMMING ELECTIVES							
19MEEC1019	Industrial IoT	3	0	0	3	100	AU, MC, ME
19AUUEC1002	Fleet Management	3	0	0	3	100	AU, ME
19AUUEC1003	In-Vehicular Networks	3	0	0	3	100	AU, ME
19AUUEC1004	Automotive Infotronics	3	0	0	3	100	AU, ME
19MEEN1017	Embedded System for Automobiles	3	0	0	3	100	-
19MEEC1021	Java Programming For Mechanical Sciences	3	0	0	3	100	AU, ME
19MEEC1022	Data Structures and Object Oriented Programming with C++	3	0	0	3	100	AU, ME
INDUSTRY ORIENTED ELECTIVES							
	Embedded System Design and Development	3	0	0	3	100	ME,CS,EE,EC, MC
	Prototype Development	3	0	0	3	100	ME,CS,EE,EC, MC

## OPEN ELECTIVES

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
19MEOC1001	Automation systems	3	0	0	3	100
19MEOC1002	Entrepreneurship Development	3	0	0	3	100
19MEOC1003	Telematics for Transport	3	0	0	3	100
19MEOC1004	Industrial Automation and Robotics	3	0	0	3	100
19MEOC1005	Vehicular Communication Electronics	3	0	0	3	100
19MEOC1006	Total Quality Management	3	0	0	3	100
19MEOC1007	Industrial Safety Engineering	3	0	0	3	100
19MEOC1008	Industrial Engineering	3	0	0	3	100
19MEOC1009	Renewable Sources of Energy	3	0	0	3	100

<b>Course Code: 19SHMG6101</b>	<b>Course Title: INDUCTION PROGRAM (common to all B.E/B.Tech programmes)</b>
<b>Course Category: Mandatory Non-Credit Course</b>	<b>Course Level: Introductory</b>
<b>Duration: 3 Weeks</b>	<b>Max. Marks:100</b>

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

High-3; Medium-2;Low-1

### Assessment Pattern

Component	Marks	Details
Attendance	10	Minimum 80% and 1 mark for every 2% observed
Knowledge Test	40	Objective type questions
Work plan for future	50	Career plan developed consulting mentor
<b>Total</b>	<b>100</b>	

### Non-letter Grades

Marks Scored	Performance Level
70 & above	Good
30 - 69	Average
< 30	Fair





**UNIT IV                      Multivariable Differentiation****9+3**

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**

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

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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. Erwin kreyzig, "Advanced Engineering Mathematics", 10<sup>th</sup> edition, John Wiley & Sons, 2015.
- T2. Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2011.
- T3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1<sup>st</sup> edition, 2017.

**Reference Book(s):**

- R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9<sup>th</sup> edition, Pearson, Reprint, 2010.

R2. N.P.Bali and Manish Goyal, "A Text book of Engineering Mathematics", Laxmi Publication, 9<sup>th</sup> edition, 2010.

R3. B.S.Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43<sup>rd</sup> Edition, 2014.

#### Web References:

1. [https://onlinecourses.nptel.ac.in/noc16\\_ma05](https://onlinecourses.nptel.ac.in/noc16_ma05)
2. <https://nptel.ac.in/courses/122101003/2>

#### 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

#### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



## UNIT III      Reading

15

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

Writing Simple 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.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
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, 2<sup>nd</sup> Edition, 2014
- T2. Wood Ian, Williams Anne, Cowper Anna, Pass Cambridge BEC Preliminary, Cengage Learning, 2<sup>nd</sup> 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, 2<sup>nd</sup> Edition, CUP 2000.
- R2. Hewings Martin - Advanced Grammar in use - Upper-intermediate Proficiency, CUP, 3<sup>rd</sup> Edition, 2013

### Web References:

- 1. <http://www.grammarinenglish.com>
- 2. [https://www.northshore.edu/support\\_centre/pdf/listen-notes.pdf](https://www.northshore.edu/support_centre/pdf/listen-notes.pdf)
- 3. [http://www.examenenglish.com/BEC/BEC\\_Vantage.html](http://www.examenenglish.com/BEC/BEC_Vantage.html)

### Course Articulation Matrix

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

High-3; Medium-2;Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2,3,4	50	30
	CCET 2	1,2,3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	1,2,3,4	50	
	Tutorial	1,2	30	10
	Quiz			
	Assignment			
End Semester Examination	ESE	1,2,3,4	100	60
Total				100



**UNIT III            Physics of Sound****9**

Classification of sound - decibel- Weber-Fechner law - Sabine's formula- derivation using growth and decay method - Absorption Coefficient and its determination - factors affecting acoustics of buildings and their remedies. Methods of sound absorptions: absorbing materials, paints - noise and its measurements, sound insulation and its measurements, impact of noise in machineries.

**UNIT IV            Thermal Physics****9**

Thermal conductivity, Specific heat capacity, Thermal shock resistance, Thermal stability, Thermal Expansion, Thermal insulation and Heat resistance.

Conduction - Co-efficient of the thermal conductivity - Cylindrical flow of heat - determination of thermal conductivity of bad conductor - Lee's disc method: theory and experiment - Conduction through compound media (series and parallel)

**UNIT V            Elements of Thermodynamics****9**

Concept of temperature - heat - thermodynamics - work - heat in thermodynamics - comparison of heat and work - internal energy - first law of thermodynamics - applications of the first law- second law of thermodynamics - the Carnot cycle - heat engine - heat pump - refrigerators - third law of thermodynamics.

**LIST OF EXPERIMENTS****30**

1. Determination of Thermal Conductivity of the insulator - Lee's Disc.
  2. Determination of velocity and compressibility of the given liquid - Ultrasonic Interferometer.
  3. Determination of Young's modulus - Cantilever bending.
  4. Determination of Rigidity modulus of the metallic wire - Torsional Pendulum.
  5. Determination of Wavelength of laser and determination of particle size using laser.
  6. Verify the triangular law of forces - Lami's theorem.
-



Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Use the laws of mechanics to determine the equilibrium condition of particles and rigid bodies.	Understand
CO2: Explain the motion of a particle.	Understand
CO3: Explain the properties of acoustics and their applications.	Understand
CO4: Explain the thermal properties of materials.	Understand
CO5: Explain the principles of thermodynamics.	Understand

#### Text Book(s):

- T1. R. C. Hibbeler, "Engineering Mechanics: Combined Static and Dynamics", Prentice Hall, 2010.
- T2. V. Rajendran, "Engineering Physics", Tata McGraw Hill Publishing Company limited. New Delhi, 2017.
- T3. M.N.Avadhanulu and P.G.Kshirsagar, "Text Book of Engineering Physics", S. Chand & Company Ltd., New Delhi, 2018.

#### Reference Book(s):

1. Balasubramaniam "Callister's Material Science and Engineering", John Wiley and Sons Inc., Second Edition, 2015.
2. Brijlal & N. Subramaniam, "Heat & Thermodynamics", S.Chand & Co., 2008.
3. A.Marikani, "Engineering Physics", PHI Learning Pvt. Ltd., 2013.

#### Web References:

1. <http://www.physicsclassroom.com/class/thermal>
2. <http://nptel.ac.in/course.php?disciplineld=115>

### 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

### Assessment pattern

Continuous Comprehensive Evaluation	Component	CO .No.	Unit No.	Marks	Scaletto	Total
	CCET 1	1,2	1,2	50	20	40
	CCET 2	3,4	3,4	50		
	Retest	1,2,3,4	1,2,3,4	50		
	CCET 3	5	5	50		
	Continuous Evaluation of Laboratory Experiments	1,2,3,4,5	1,2,3,4,5	20	20	
End Semester Examination	ESE	1,2,3,4,5	1,2,3,4,5	100	60	60
Total	100					



## **UNIT IV                      Pointers, Structures & Union**

**9**

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 & Pre-Processor Directives**

**9**

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.

## **LIST OF EXPERIMENTS**

**30**

1. Programs to process data types, operators and expression evaluation (any1).
  - 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
<b>At the end of this course, students will be able to:</b>	
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", 3<sup>rd</sup> Edition, Pearson Education, 2015.

#### **Reference Book(s):**

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

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

R3.Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", 2<sup>nd</sup> 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	-	-	2	-	-	-	2	-	-	-	-	-
CO2	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO3	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO4	3	2	1	2	2	-	-	-	2	-	-	-	-	-
CO5	3	2	1	2	2	-	-	-	2	-	-	-	-	-

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	20
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Continuous Evaluation of Laboratory Experiments	1,2,3,4,5	10	20
	Final Assessment of Laboratory Experiments	1,2,3,4,5	10	
End Semester Examination	ESE	1,2,3,4	100	60
Total				100



Principles of isometric projection – Isometric scale –Isometric projections of simple solids and truncated solids.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Sketch the orthographic projections of the given pictorial view of the object using first angle projection.	Apply
CO2: Sketch the projections of simple solids such as prism, pyramid, cylinder and cone using rotating object method.	Apply
CO3: Sketch the projections of simple sectioned solids with all necessary dimensions meeting the standards.	Apply
CO4: Sketch the lateral surface of simple solids using straight line and radial line development methods.	Apply
CO5: Sketch the isometric view of simple solids and truncated solids using principles of isometric projection.	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<sup>th</sup> edition, 2017.
- T2. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, Gujarat, 53<sup>rd</sup> edition, 2015.
- T3. K. V. Natrajan, "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 48<sup>th</sup> edition, 2018.

**Reference Book(s):**

- R1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill India, New Delhi, 2<sup>nd</sup> edition, 2013.
- R2. John K.C., "Engineering Graphics", PHI Learning, Delhi, 1<sup>st</sup> edition, 2009.
- R3. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD", Tata McGraw India, New Delhi, 3<sup>rd</sup> edition, 2008.



## **PUBLICATIONS OF BUREAU OF INDIAN STANDARDS**

1. IS 10711 - 2001: Technical products Documentation - Size and lay out of drawing 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](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	3	2	-	1	-	-
CO2	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO3	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO4	3	2	2	2	-	-	-	2	3	2	-	1	-	-
CO5	3	2	2	2	-	-	-	2	3	2	-	1	-	-

High-3; Medium-2; Low-1

### **Assessment pattern**

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	75
	Cycle Test 1	50	25
	Cycle Test 2	50	
	Total Marks		100

<b>Course Code: 19PSHG3001</b>	<b>Course Title: WELLNESS FOR STUDENTS</b> (Common to all B.E/B.Tech Programmes) <b>(2019 Batch Only)</b>		
<b>Course Category: Humanities</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 0: 0: 2</b>	<b>Credits:1</b>	<b>Total Contact Hours:30</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. Articulate the importance of wellness for success in life.
2. Understand the dimensions of wellbeing and relevant practices
3. Guide in adopting such practices to improve wellness
4. Reflect the impact of changes sensed on personal and social effectiveness

**UNIT I Wellness - Importance And Dimensions**

Values and aspirations - goals - SMART Goals - means for achieving goals - job Vs career - success in life - attributes of successful persons. Maslow's Hierarchy of needs motivation - 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 - Guna - causes and impact - multiple dimensions of human structure (physical, astral, causal bodies) - human-panchaboortha relationship.

**UNIT II Practices for Physical Wellness through Yoga**

Simplified Physical Exercises: Hand, Leg, Neuromuscular breathing, eye exercises, kapalabathy, makarasanam 1 & 2, body massage, 14-points acupressure - Suryanamaskar - relaxation. Simple asanas.

**UNIT III Practices for Physical Wellness through Exercises**

Fitness as a subset of Wellness - health related physical fitness - skill related physical fitness. Exercises related ailment and injuries - safety and precautions - first aid.

Fitness development: Muscular strength - exercises (calisthenics): pull-up, sit-up, push-up and weight training; Explosive power – exercises: vertical jump, long jump; Cardio respiratory endurance- exercises: walking, jogging, treadmill, stair climbing, bicycling, skipping; Flexibility - exercises: stretching.

Speed, agility, balance and coordination - exercises: sprint, cone drill, ladder drill, hurdle drill, ball throw - mental agility exercises.

#### **UNIT IV Practices for Mental Wellness**

Meditation: Mind and its functions - mind wave frequency - Agna, Thuriyam and Shanthi meditation – introspection: analysis of thoughts, moralization of desire, neutralization of anger and eradication of worries - simple mindfulness exercises.

#### **UNIT V Practices for Social and Spiritual Wellness**

Kayakalpa yoga - youthfulness and life force - cultural education – greatness of guru – universal compassion - fivefold culture. 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.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the concept of wellness and its importance to be successful in career and life	Understand
CO2: Explain the dimensions of wellness and practices that can promote wellness	Understand
CO3: Demonstrate the practices that can promote wellness	Understand
CO4: Sense and improve the wellness periodically and its impact on personal effectiveness	Understand
CO5: Maintain harmony with self, family, peers, society and nature	Understand

**Text Book(s):**

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

**Reference Book(s):**

R1.Vethathiri Maharishi Institute for Spiritual and Intuition Education, Aliyar , "Value education for harmonious life (Manavalakalai Yoga)", Vethathiri Publications, Erode, 1<sup>st</sup> Ed. 2010.

R2.Dr.R.Nagarathna, Dr.H.R.Nagendra, "Integrated approach of yoga therapy for positive health", Swami Vivekananda Yoga Prakashana, Bangalore, 2008.

R3.Tony Buzan, Harper Collins, The Power of Physical Intelligence (English).

**Course offering:**

Orientation programme (3 days)	CO1 and CO2
Student practice (weekly review classes)	CO3
Student journal writing (interim reviews)	CO4 and CO5

**Evaluation:**

Continuous assessment: 75 marks

Yoga:

Physical Exercises, KayaKalpa	= 15 marks
Meditation	= 15 marks
Assessment of student's workbook	= 10 marks
Total	= 40 marks

Sports:

Physical Exercises, KayaKalpa	= 20 marks
Assessment of student's workbook	= 15 marks
Total	= 35 marks

End Semester Examination (combined for yoga and sports):

Written test (MCQ and short answers) = 30 marks

Physical exercises = 50 marks

Viva-voce = 20 marks

Total = 100 marks

End semester mark out of 100 is reduced to 25 marks. The student should get a total of 50 marks put together for a pass.

**Scheme of wellness measurement:**

#	Wellbeing Dimensions	Sub-dimensions	Wt. in total score	Measurement	Sub-dim score
1	Physical Wellbeing (40%)	BMI	16	weight & height	16
		Flexibility	12	Sit & reach test	12
		Endurance (Energy)	12	12 min Cooper run test	12
2	Mental wellbeing (30%)	Attention/ Concentration	12	Stroop test	15
		Memory	9	Digit Forward and Backward Test.	15
3	Social wellbeing (20%)	Inter-personal	10	IDEA & General Health Questionnaire	10
		Emotional wellbeing	5	IDEA questionnaire	5
		Self concept	5	IDEA questionnaire	5
4	Spiritual Wellbeing (10%)	Guna	10	Guna Questionnaire	
		Total	100%		100

## Semester II

<b>Course Code: 19MABC1201</b>		<b>Course Title: ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES</b> (Common to AU, CE, MC, ME, EC, EI, EE)	
<b>Course Category: Basic Science</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 3: 1: 0</b>	<b>Credits:4</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- **Matrices and Calculus**

### Course Objectives:

The course is intended to:

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

<b>UNIT I</b>	<b>Vector Calculus</b>	<b>9+3</b>
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Gradient, Divergence, Curl, Line integrals, Surface integrals, Volume integrals, Theorems of Green, Gauss and Stokes (without proof) , Simple applications involving cubes, spheres and rectangular parallelepipeds.

<b>UNIT II</b>	<b>Complex Variables (Differentiation)</b>	<b>9+3</b>
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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.

<b>UNIT III</b>	<b>Complex Variables (Integration)</b>	<b>9+3</b>
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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**

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****9+3**

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.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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.Erwin kreyzig, "Advanced Engineering Mathematics", 10<sup>th</sup> edition, John Wiley & Sons, 2015.
- T2.Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2011.
- T3.Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1<sup>st</sup> edition, 2017.

**Reference Book(s):**

R1.G.B.Thomas and R.L Finney, "Calculus and Analytic Geometry", 9<sup>th</sup> edition, Pearson, Reprint, 2010.

R2.N.P.Bali and Manish Goyal, "A Text book of Engineering Mathematics", Laxmi Publication, 9<sup>th</sup> edition, 2010.

R3.B.S.Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43<sup>rd</sup> edition, 2014.

**Web References:**

1. [https://onlinecourses.nptel.ac.in/noc16\\_ma05](https://onlinecourses.nptel.ac.in/noc16_ma05)

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

**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

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100





**UNIT III          Reading****15**

Reading strategies - Scanning - Inferring - Barriers to reading - sub vocalisation, Eye fixation, Regression - Speed Reading Techniques - read different texts and their context with speed - Note making - Reading a review - Paraphrasing - Read and comprehend.

**UNIT IV          Writing****15**

Reported speech& Concord (Subject - verb Agreement) - structure of the report - Report writing- Proposal -Plagiarism -references -appendices - Techniques for report writing - Registers.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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 with speed, different 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<sup>nd</sup> 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,

**Web References:**

1. <http://www.grammarinenglish.com>
2. [https://www.northshore.edu/support\\_centre/pdf/listen-notes.pdf](https://www.northshore.edu/support_centre/pdf/listen-notes.pdf)
3. [http://www.examenglish.com/BEC/BEC\\_Vantage.html](http://www.examenglish.com/BEC/BEC_Vantage.html)

**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	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO3	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO4	-	-	-	-	-	-	-	2	1	3	-	1	-	1
CO5	-	-	-	-	-	-	-	2	1	3	-	1	-	1

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2,3,4	50	30
	CCET 2	1,2,3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	1,2,3,4	50	
	Tutorial	1,2	30	10
	Quiz			
	Assignment			
End Semester Examination	ESE	1,2,3,4	100	60
Total				100



**UNIT IV Polymers, Plastics and Composites****9**

Polymers – homo polymer and copolymer. Thermoplastics - thermosetting plastics - thermoplastic elastomers (TPE). Engineering plastics - PA, PC, PVC and Nylon 6, 6 – synthesis, properties and applications. Polymer Additives and Reinforcements-Thermal and light stabilizers, antioxidants, and flame retardants - Polymer composites – FRP and ceramic matrix composites.

**UNIT V Fuels and Lubricants****9**

Automotive fuels - Petrol, Diesel, CNG, Blended fuels - composition, properties and uses. Gross calorific and Net calorific value. Knocking in petrol and diesel engines – octane number and cetane number. Lubricants - importance of lubrication - Classification of lubricants - properties of liquid lubricants and its significance - Total Acid number and Total Base Number. Greases – common grease types and properties. Components of grease - Base Oil, Additives and Thickener. NLGI consistency number.

**LIST OF EXPERIMENTS**

1. Estimation of Hardness of water by EDTA method.
2. Determination of corrosion rate by weight loss method.
3. Estimation of  $\text{Fe}^{2+}$  by potentiometric titration
4. Determination strength of acid by pH metry.
5. Conductometric titration of strong acid against strong base.
6. Determination of molecular weight of polymer by Viscometric method.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Calculate hardness of water based on water quality parameters associated with water conditioning methods.	Understand
CO2: Explain batteries based on their characteristics, construction, working principle and applications.	Understand
CO3: Explain the mechanism of corrosion and its control techniques.	Understand
CO4: Identify a suitable plastic for a specific engineering application.	Understand
CO5: Describe the characteristics of fuel and lubricants based on their composition and applications.	Understand

**Text Book(s):**

- T1.Jain &Jain, "Engineering Chemistry" 17<sup>th</sup> edition, Dhanpat Rai Publishing Company Ltd, New Delhi, 2018.
- T2.Wiley Engineering Chemistry, 2<sup>nd</sup> edition, Wiley India Pvt Ltd, New Delhi. 2011.

**Reference Book(s):**

- R1. Dara S.S.,and Umare S.S., "A Text book of Engineering Chemistry" ,S.Chand & Co Ltd,New Delhi, 2014.
- R2. V.R.Gowariker ,N.V.Viswanathan and Jayadev Sreedhar,||Polymer Science,|| New Age International (P) Ltd, Chennai, 2006.
- R3. Renu Bapna and Renu Gupta, "Engineering Chemistry" ,Macmillan India Publisher Ltd, 2010.
- R4. Jeffery G.H.,BassettJ.,Mendham J.and Denny R.C.,Vogel's "Text Book of Quantitative Chemical Analysis" ,Oxford, ELBS ,London, 2012.
- R5. Shoemaker D.P. and C.W.Garland.,|| Experiments in Physical Chemistry||, Tata McGraw-Hill Pub.Co.,Ltd., London, 2009.

**Web References:**

1. <http://nptel.ac.in/courses/122101001/downloads/lec.23.pdf>
2. <http://nptel.ac.in/courses/118104004/>
3. <http://nptel.ac.in/courses/104105039/>

**Course Articulation Matrix**

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

High-3; Medium-2;Low-1

**Assessment pattern**

Continuous Comprehensive Evaluation	Component	CO .No.	Marks	Total
	CCET 1	1,2	50	20
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Continuous Evaluation of Laboratory Experiments	1,2,3,4,5	10	20
	Final Assessment of Laboratory Experiments	1,2,3,4,5	10	
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MESC2001</b>		<b>Course Title: INTRODUCTION TO ENGINEERING</b> (Common to AU, MC, ME, EC, EI & EE)	
<b>Course Category: Engineering Science</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 2: 0: 2</b>	<b>Credits: 3</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Nil

**Course Objectives:**

The course is intended to:

1. Explain the career opportunities in engineering.
2. To acquire engineering competencies for students.
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                      Careers Opportunities In Engineering                      5**

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**

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                      7**  
**/Environmental Versatility**

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                      4**  
**Engineering Perspective And Inquisitiveness**

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                      6**  
**Resources And Infrastructure**

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

**UNIT VI                      Unsafe Conditions And Acts And Follows                      3**  
**Environment Friendly Practices**

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.

**List of Experiments:****30 Hours**

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.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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", WILYS 5th Edition, 2013
- R2. C. Mason, "How things work", Usborne Publishing Ltd 2009.
- R3. D.K. Publishing, "How things work encyclopedia", 2009.
- R4. R. J. Segalat, "How things work", Edito-Service Vol.I-IV, 1990.

**Web References:**

1. [https://en.wikibooks.org/General\\_Engineering\\_Introduction/Engineering\\_Science](https://en.wikibooks.org/General_Engineering_Introduction/Engineering_Science)
2. <https://science.howstuffworks.com/engineering-channel.html>

**Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	2	1	3	1	-	1	-	2
CO2	2	1	-	-	-	2	2	1	3	1	-	1	-	2
CO3	2	1	-	--	-	2	2	1	3	1	-	1	-	2
CO4	3	2	1	1	-	2	2	1	3	1	-	1	-	2
CO5	2	1	-	--	-	2	2	1	3	1	-	1	-	2
CO6	2	1	-	-	-	2	2	1	3	1	-	1	-	2

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,4	50	20
	CCET II	2,3	50	
	CCET III	5,6	50	
	Continuous Assessment – Practical	1,2,3,4,5,6	75	10
	Final Assessment – Practical	2,4	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MESC2201</b>	<b>Course Title: ENGINEERING MATERIALS</b> (Common to AU,MC, ME )		
<b>Course Category: Engineering Science</b>		<b>Course Level: Introductory</b>	
<b>L:T:P(Hours/Week) 2: 0: 2</b>	<b>Credits:3</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. Calculate the crystal parameters.
2. Understand the phase diagram.
3. Understand the behaviour of ferrous and nonferrous alloy.
4. Understand the powder metallurgy technique.
5. Understand the heat treatment processes.

**UNIT I                      Crystal Physics**

**9**

Introduction: Crystalline and Non crystalline materials. Single crystal , Polycrystalline materials  
Anisotropic crystal parameters: Atomic radius, Number of atoms per unit cell, Coordination number, atomic packing factor for SC , BCC , FCC and HCP- Crystal planes: Miller indices, Braggs law . Interplanar distance- Polymorphism and allotropy. Crystal imperfections: Point , line , surface and volume , grain boundary and its role in mechanical properties.

**UNIT II                      Constitution of Alloys and Phase Diagrams**

**9**

Constitution of alloys- Solid solutions- Substitutional and Interstitial. Phase diagrams- Interpretation of Phase diagram, Lever rule, Gibbs phase rule. cooling curve for pure metal, binary solid solution and binary eutectic system. Iron – Iron Carbide equilibrium diagram. Micro constituents in Fe<sub>3</sub>C diagram (Austenite, Ferrite, Cementite, Pearlite, Martensite, Bainite), Pearlite transformation.

9

Ferrous alloy: Effect of alloying elements on properties of steel (Mn, Si, Cr, Mg, V and W).  
Properties and applications of stainless steel and Tool steel, Cast Iron-White, Malleable, Grey and Spheroidal Cast Iron-Properties and Applications

Non Ferrous alloy: Aluminium and its alloys, Copper and its alloys, Magnesium and its alloys, Titanium and its alloys, Nickel and its alloys- Composition, Properties and Applications.

Industrial standards for alloys and other materials - alloying elements and inclusion of ceramics materials.

9

Need of powder metallurgy products-Advantages and limitation of P/M-Stages in P/M-Need for additives in P/M-secondary process of P/M products-mechanical-physical-chemical methods of powder production-compaction and sintering techniques of P/M-particle size analysis

9

Heat treatment process-purpose heat treatment – Process parameters. Bulk treatment: Annealing, Normalizing, Tempering, Quenching (Process parameter, application). Isothermal transformation Diagram (TTT Diagram). Cooling curves superimposed on TTT diagram.CCR. Harden ability- Definition. Method to determine Harden ability- Jominy end quench test.

15

1. Determine the hardness of the given specimen.
2. Determine the toughness of the given specimen.
3. Draw the microstructure of cast iron, steel and aluminum using Metallurgical microscope.
4. Prepare a specimen using mounting press for metallographic examination.
5. Microstructure characterization of the polished specimen.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the crystal parameters for different crystal structure and its influences on mechanical properties of bulk materials.	Understand
CO2: Explain the changes of phase diagram with respect to an alloy by Gibbs phase rule and infer its property for a given composition.	Understand
CO3: Understand the behaviour changes of Ferrous and Non Ferrous alloy for a suitable application.	Understand
CO4: Understand the powder metallurgy technique, based on the functional requirement of the product.	Understand
CO5: Understand the heat treatment process for the given ferrous alloy such as steel, cast iron for a suitable application.	Understand

#### Text Book(s):

- T1. William D Callister – Material Science and Engineering, John Wiley and Sons, 2014.  
T2. Sidney H Avner – Introduction to Physical Metallurgy, Tata McGRAW-Hill, 2017.  
T3. Anup Goel, SS Sabharwal, – Engineering Materials and Metallurgy, Technical Publication, 2014.

#### Reference Book(s):

- R1. Raghavan.V – Materials Science and Engineering, Prentice Hall of India Pvt., Ltd., 2015.  
R2. Dieter G. E., – Mechanical Metallurgy, McGraw Hill Book Company, 2013.  
R3. Kenneth G. Budinski. – Engineering Materials, Prentice Hall of India, New Delhi 2010.  
R4. Y. Lakhtin, – Engineering Physical Metallurgy, CBS Publisher, New Delhi, 2012.

#### Web References:

1. <http://nptel.ac.in/courses/113106032/>
2. <http://www.nptel.ac.in/courses/112108150/>
3. [https://en.wikipedia.org/wiki/Materials\\_science](https://en.wikipedia.org/wiki/Materials_science)

### Course Articulation Matrix

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

High-3; Medium-2;Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,4	50	20
	CCET 2	2,3	50	
	Retest	1,2,3,4	50	
	CCET 3	5,6	50	
	Continuous Evaluation of Lab	1,2,3,4,5	20	20
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECC3201</b>	<b>Course Title : ENGINEERING PRACTICES LABORATORY</b> (Common to AU, ME, MC)		
<b>Course Category: Professional Core</b>	<b>Course Level: Practice</b>		
<b>L:T:P (Hours/Week) 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### Pre-requisites

- NIL

### Course Objectives

The course is intended to:

1. Draw the basic symbols of electrical and electronic components and identify the elements.
2. Execute soldering practice for electrical and electronic circuits.
3. Demonstrate the basic carpentry, fitting, plumbing, sheet metal and welding operations.

### List of Experiments:

#### [A] Electrical & Electronics :

- 1) Symbols of electrical and electronic components and study of electrical drawing.
- 2) Insulation Testing using Megger.
- 3) Soldering practice of simple circuit and testing.
- 4) Fluorescent tube, staircase and house wiring.
- 5) Verification of Kirchhoff's current and voltage law.

#### [B] Civil & Mechanical :

- 1) Make a wooden Tee joint to the required dimension.
- 2) Make a "V" filling to the required dimension using fitting tools.
- 3) Make a tray in sheet metal to the required dimension.
- 4) Assemble the pipeline connections with different joining components for the given layout.
- 5) Weld a butt joint using welding process to the required dimension.



Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Draw the basic symbols of electrical and electronic components from a given circuit.	Apply
CO2: Connect the electrical and electronic components and other house holding items as per the given circuit.	Apply
CO3: Verify the Kirchhoff's laws as per the given circuit.	Apply
CO4: Make a wooden 'T' joint, metal 'V' joint, sheet metal 'TRAY', pipeline with various joining components and a permanent joint using various workshop tools as per the given dimensions.	Apply

### Reference(s):

- R1. Jeyachandran.K, Natarajan.S & Balasubramanian.S, 'A Primer on Engineering Practices Laboratory', Anuradha Publications, TamilNadu (India), 2016.
- R2. 19EPL21 - Engineering practices laboratory Manual.

### Course Articulation Matrix

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

High-3; Medium-2;Low-1

<b>Course Code: 19PSHG3002</b>		<b>Course Title: PERSONAL EFFECTIVENESS</b> <b>(Common to all B.E/B.Tech Programmes)</b> <b>(2019 Batch Only)</b>	
<b>Course Category: Humanities</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 0: 0: 2</b>	<b>Credits:1</b>	<b>Total Contact Hours:30</b>	<b>Max.Marks:100</b>

### **Pre-requisites**

➤ NIL

### **Course Objectives**

The course is intended to:

1. Set SMART goals for academic, career and life.
2. Identify strength, weaknesses and opportunities.
3. Plan for achieving the goals.
4. Apply time management techniques.
5. Create time and pursue activities of self interest.

### **UNIT I            The Importance of Envisioning**

Importance of positive self-perception – Principle of dual creation (Everything gets created twice – Envisioning) - Understanding Vision and mission statements - Writing personal mission statements – ‘Focus’ as a way of life of most successful people – Importance of goal setting -Importance of planning and working to time.

### **UNIT II            Fundamental Principles of Goal Setting and Working to Time**

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.

### **UNIT III            Goal Setting and Action Orientation**

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 - Importance of action orientation - Converting goals to actionable tasks – Establishing road map – Using Gantt chart for planning and progress.

## **UNIT IV          Time Management - Tools and Techniques**

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 V          Putting into Practice**

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

### **Course Outcomes:**

At the end of the course, the students will be able to:

CO1: Identify the strengths, weaknesses and opportunities.

CO2: Set well-articulated goals for academics, career, and personal aspirations.

CO3: Establish the road map to realize the goals.

CO4: Apply time management techniques to complete planned tasks on time.

CO5: Create time and pursue activities of self-interest that add value.

### **Text book(s):**

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

### **References:**

R1. Stephen R Covey, "First things first", Simon & Schuster U.K, Aug 1997.

R2. Sean Covey, "Seven habits of highly effective teenagers", Simon & Schuster U.K, 2004.

### **Course offering:**

Orientation programme (2 days)	CO1 and CO2
Student practice (weekly review classes)	CO3
Student journal writing (interim reviews)	CO4 and CO5

<b>Course Code: 19PSHG6001</b>	<b>Course Title: WELLNESS FOR STUDENTS</b> (Common to all B.E/B.Tech Programmes) <b>(2020 Batch Only)</b>		
<b>Course Category: Humanities</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 0: 0: 2</b>	<b>Credits:1</b>	<b>Total Contact Hours:30</b>	<b>Max.Marks:100</b>

### **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
5. Demonstrate the practices that can promote wellness

### **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

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

#### **Text book(s):**

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

**Reference(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 Intuition Education, Aliyar, "Value education for harmonious life (Manavalakalai Yoga)", Vethathiri Publications, Erode, 1<sup>st</sup> Ed. (2010).

**Course offering: (Annual Pattern)**

CO1, CO2 and CO5	Can be conducted in Odd semester
CO3, CO4 and CO5	Can be conducted in Even semester
Student journal writing (interim reviews)	CO1 to CO5

**Evaluation:**

Continuous assessment: 75 marks

**Personal Effectiveness** = 35 marks (Odd Sem)

**Yoga and physical Exercise (Even Sem)**

Physical Exercises = 20 marks

Meditation = 10 marks

Assessment of student's workbook = 10 marks

End Semester Examination (combined for yoga and sports):

Written test (MCQ and short answers) = 30 marks

Physical exercises = 50 marks

Viva-voce = 20 marks

Total = 100 marks

End semester mark out of 100 is reduced to 25 marks.

The student should get a total of 50 marks put together for a pass.



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
<b>At the end of this course, students will be able to:</b>	
CO1: Create awareness for conservation and equitable use of natural resources.	Understand
CO2: Explain the measures of prevention of pollution and disaster management.	Understand
CO3: State the importance of environmental legislation in India.	Understand
CO4: Expose the general environmental issues relevant to human health.	Understand
CO5: Explain the innovative measures for day to day environmental issues.	Understand

**TEXTBOOKS:**

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, 3<sup>rd</sup> edition, 2014.

**REFERENCES:**

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	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	-	-	-	3	3	1	-	1	-	1	-	-
CO2	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO3	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO4	2	1	-	-	-	3	3	1	-	1	-	1	-	-
CO5	2	1	-	-	-	3	3	1	-	1	-	1	-	-

## ASSESSMENT PATTERN

- Attendance : 10 Marks
- Knowledge Test : 40 Marks
- Activity(ies) : 50 Marks

**Total Marks : 100**

## RUBRICS FOR ATTENDANCE

Component	Marks	Details
Attendance	10	Minimum 80%, 1 mark for each 5% observed
Knowledge Test	40	40 objective type questions from Induction Program
Activity(ies)	50	Rubrics based assessment

## NON-LETTER GRADES

Marks Scored	Performance Level
70 & above	Good
30 - 69	Average
< 30	Fair

### Semester III

<b>Course Code: 19MABC1301</b>		<b>Course Title: NUMERICAL METHODS</b> (Common to AU & ME)	
<b>Course Category: Basic Science</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 3: 1: 0</b>	<b>Credits:4</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

#### Pre-requisites:

- Matrices and Calculus

#### Course Objectives:

The course is intended to:

1. Solve the system of linear equations and calculate dominant Eigen value.
2. Solve the non-linear equations and apply the principle of least squares to fit a curve to the given data.
3. Interpolate the given data and calculate the numerical derivatives and integration.
4. Solve the initial value problems using numerical techniques.
5. Solve the boundary value problems using numerical techniques.

#### **UNIT I            Solution of System of Linear Equations and Eigen value            9+3**

Solution of system of linear equations - Gauss elimination method - Crout's method - Iterative methods of Gauss Jacobi and Gauss Seidal method - Eigen values of matrix by Power method.

#### **UNIT II            Solution of Non-Linear Equations and Curve Fitting            9+3**

Solution of non-linear equations: Method of false position - Newton Raphson method - Order of convergence. Curve fitting: Method of least square - Fit a straight line - Fitting a curve.

#### **UNIT III            Interpolation, Polynomial Approximation and Numerical Integration            9+3**

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal interval - Lagrange's interpolation - Numerical differentiation - Numerical integration - Trapezoidal rule, Simpson's rule - Double integration using Trapezoidal rule.

**UNIT IV      Initial Value Problem for Ordinary Differential Equations      9+3**

Single step methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods - Milne's and Adams method.

**UNIT V      Boundary Value Problems in Ordinary and      9+3**  
**Partial Differential Equations**

Solution of two dimensional Laplace's and Poisson's equations - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Determine the solution of system of linear equations and also calculate the dominant Eigen value of a matrix.	Apply
CO2: Determine the solution of non-linear equations using numerical techniques.	Apply
CO3: Interpolate the given data and obtain the derivatives and integral at the required points.	Apply
CO4: Determine the solution of initial value problems using numerical techniques.	Apply
CO5: Determine the solution of boundary value problems using numerical techniques.	Apply

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**Text Book(s):**

- T1. Erwin kreyzig, "Advanced Engineering Mathematics", 10<sup>th</sup> edition, John Wiley & Sons, 2015.
- T2. Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2011.
- T3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1<sup>st</sup> edition, 2017.

**Reference Book(s):**

- R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9<sup>th</sup> edition, Pearson, Reprint, 2010.
- R2. N.P.Bali and Manish Goyal, "A Text book of Engineering Mathematics", Laxmi Publication, 9<sup>th</sup> edition, 2010.
- R3. B.S.Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43<sup>rd</sup> Edition, 2014.

**Web References:**

1. [https://onlinecourses.nptel.ac.in/noc16\\_ma05](https://onlinecourses.nptel.ac.in/noc16_ma05)
2. <https://nptel.ac.in/courses/122101003/2>

**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	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

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



**UNIT IV Introduction to Mechanisms****9+3**

Mechanism and structure - links - pairs - chains - four bar and slider crank mechanisms - degrees of freedom of linkages - Gruebler's criterion - Grashof's condition of rotatability - transmission angle and mechanical advantage - special lower pair mechanisms: Peaucellier straight line mechanism, Ackermann steering mechanism, pantograph, Geneva mechanism.

**UNIT V Kinetics of Rigid Body****9+3**

Dynamic equilibrium of rigid bodies - Planar kinetics of rigid body - Force and Acceleration, Work and energy, Impulse and momentum.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop the free body diagram of particles and rigid bodies such as beams, frames and machines under static and dynamic conditions.	Apply
CO2: Determine various forces on rigid bodies such as beams, frames and machines under static conditions.	Apply
CO3: Calculate centroid, center of gravity and moment of inertia of simple shapes.	Apply
CO4: Determine the degrees of freedom of given mechanism.	Apply
CO5: Calculate the kinetic parameters of rigid bodies for dynamic equilibrium.	Apply

**Text Book(s):**

T1 R C Hibbeler, "Engineering mechanics – Statics and Dynamics", 14<sup>th</sup> Edition, Pearson, New Delhi, 2017.

T2 F.P. Beer and Jr. E.R. Johnston, "Vector Mechanics for Engineers - Statics and Dynamics", 10<sup>th</sup> Edition Tata McGraw Hill publishing company, New Delhi, 2017.

T3 S.S. Rattan, "Theory of Machines", McGraw Hill Education, 4<sup>th</sup> Edition. 2017.

**Reference Book(s):**

R1. James L. Meriam and L. Glenn Kraige, "Engineering mechanics (Statics and Dynamics)", 8<sup>th</sup> Edition. John Wiley & Sons, 2016.

R2. R.S. Khurmi, J.K. Gupta, "Theory of Machines", S.Chand, 14<sup>th</sup> Edition. 2005.

R3. Irving H. Shames, "Engineering mechanics – Statics and Dynamics", 14<sup>th</sup> Edition, Pearson, New Delhi, 2014.

#### Web References:

1. <http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>
2. <https://nptel.ac.in/courses/122104015/>

#### 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	1	1	-	-	-	1	-	1	-	1	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

#### Assessment pattern:

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	-	30	10
	Quiz	1,2,3,4,5		
	Assignment	1,2,3,4,5		
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code: 19MECC2301</b>	<b>Course Title: FLUID MECHANICS AND HYDRAULIC MACHINERY</b> (Common to AU, ME & MC)		
<b>Course Category: Professional Core</b>	<b>Course Level: Practice</b>		
<b>L:T:P (Hours/Week) 3: 0: 2</b>	<b>Credits:4</b>	<b>Total Contact Hours:75</b>	<b>Max Marks:100</b>

### **Prerequisites**

- Physics for Mechanical Sciences

### **Course Objectives**

The course is intended to:

1. To predict the properties and characteristics of a fluid using mathematical knowledge.
2. To calculate major and minor losses associated with pipe flow.
3. To predict the nature of physical quantities using mathematically.
4. To select suitable hydraulic pump for customer needs.
5. To select a suitable hydraulic turbine for specific parameters.

### **UNIT I      Fluid Properties and Flow Characteristics**

**9**

Fluid: definition, classification of fluids, units and dimensions. Properties of fluids: density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, capillarity and surface tension.

Flow characteristics, Continuity equation and Bernoulli's equation in 1-D, Hydraulic and energy gradient. Application of Bernoulli's equation to flow through pipes, venturi meters, orifice meters and Pitot tube.

### **UNIT II      Flow Through Circular Conduits**

**9**

Laminar and Turbulent flow through circular conduits, boundary layer concepts, boundary layer thickness. Darcy-Weisbach equation, Friction factor and Moody diagram, Minor and Major losses, Flow through pipes in series and in parallel.

### **UNIT III      Dimensional Analysis**

**9**

Need for dimensional analysis, methods of dimensional analysis, Buckingham's  $\pi$  theorem. Similitude, types of similitude, Dimensionless parameters, application of dimensionless parameters, Model analysis.

**UNIT IV          Pumps****9**

Centrifugal pump: working principle and working principle, velocity triangles, Euler pump equation, various efficiencies and performance curves.

Reciprocating pump: classification, working principle, indicator diagram, work saved by air vessels - performance curves.

**UNIT V          Hydraulic Turbines****9**

Classification of turbines, heads and efficiencies, velocity triangles, Euler turbine equation. Pelton, Francis and Kaplan turbines, working principle and construction, work done by water on the runner, draft tube, performance curves, governing of turbines.

**List of Experiments****30**

1. Determination of coefficient of discharge of given Orifice meter.
2. Determination of coefficient of discharge of given Venturimeter.
3. Determination of friction factor of given set of pipes.
4. Performance study of Centrifugal pumps
5. Performance study of reciprocating pumps.
6. Performance characteristics of a Pelton wheel.
7. Performance test on a Francis Turbine.
8. Performance test on a Kaplan Turbine

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Apply mathematical knowledge to predict the properties and characteristics of a fluid.	Apply
CO2: Analyze and calculate major and minor losses associated with pipe flow in piping networks.	Apply
CO3: Mathematically predict the nature of physical quantities.	Apply
CO4: Select a suitable hydraulic pump for the customer provided site conditions.	Apply
CO5: Select a suitable hydraulic turbine for the given rated parameters.	Apply

**Text Book(s):**

T1.Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5<sup>th</sup> edition, Laxmi Publications (P) Ltd., New Delhi, 2014.

T2.Vasandani, V.P., "Hydraulic Machines - Theory and Design", 4<sup>th</sup> edition Khanna Publishers, 2014.

**Reference Book(s):**

R1. White, F.M., "Fluid Mechanics", 5<sup>th</sup> Edition Tata McGraw-Hill, New Delhi, 2013

R2. Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", 9<sup>th</sup> Edition McGraw-Hill education, 2017.

R3. Kumar, K.L., "Engineering Fluid Mechanics", 7<sup>th</sup> edition Eurasia Publishing House (P) Ltd., New Delhi, 2014.

**Web References:**

<http://nptel.ac.in/courses/112107147/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



**UNIT III                      Measurement System Analysis                      9**

Static characteristics of measuring instruments- Accuracy, precision, sensitivity Threshold, Resolution, Repeatability, Reproducibility, Dead zone, backlash, hysteresis, Dynamic characteristics of an instrument- Speed of response, Fidelity, Lag, Dynamic error, Error, Classification of errors, Error Analysis, Calibration of an instrument.

**UNIT IV                      Measuring Instruments for physical parameters                      9**

Flow and pressure measurement - Rotameter – Viscometer – pressure gauge. Vibration Measurement – Accelerometer. Speed measurement - Speedometer - Tachometer. Infrared thermometer - Principle and working. Electrical measurement instruments - Multimeter - Clampmeter. Light Measurement - Lux meter. Sound measurement - Sound meter.

**UNIT V                      Advanced Measuring Instruments                      9**

Introduction - Mechanical Measuring Instruments - Coordinate Measuring Machine (CMM) - Importance - Types - Application. Roundness test - Importance - 3 Point Method - Rotational drum method. Roughness test - Terms of surface texture - Importance - Roughness tester. 2D Microhite - Applications. Metallurgical Instruments - Spectrometer. Laser interferometer - Laser metrology - Laser interferometer.

**List of Experiments                      30**

1. Measure the dimension of the given component using Vernier caliper
2. Determine the diameter of a cylindrical component of accuracy 0.01 mm using micrometer
3. Measure the thickness of gear tooth using gear tooth Vernier
4. Measure the height of the given component using Vernier height gauge
5. Measure thread parameter using profile projector.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain tolerances and fits required to specify parts and their assembly.	Understand
CO2: Select appropriate measuring instruments for the given parts, dimensions and tolerance.	Apply
CO3: Conduct measurement system analysis for the chosen measuring instruments.	Apply
CO4: Explain general measuring instruments for physical parameters.	Understand
CO5: Explain advanced measuring instruments based on the application.	Understand

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**Text Book(s):**

- T1.Jain R.K., "Engineering Metrology", 21<sup>st</sup> Edition, Khanna Publishers, 2018.  
T2. Bewoor, Vinay A Kulkarni, "Metrology and Measurements", 1<sup>st</sup> Edition, Mc Graw Hill, 2009.  
T3.K.R.Gopalakrishna, "Machine Drawing" Subhas Publication, 2007.

**Reference Book(s):**

- R1.P.S. Gill "Geometric Dimensioning and Tolerancing", 2<sup>nd</sup> Edition, S.K. Kataria & Sons 2019.  
R2.Gupta S.C, "Engineering Metrology", 21<sup>st</sup> Edition, Dhanpat rai Publications, 2017.  
R3.Beckwith, Marangoni, Lienhard, "Mechanical Measurements", 2<sup>nd</sup> Edition, Pearson Education, 2006.

**Web References:**

1. <https://nptel.ac.in/courses/112106179/>
2. [https://www.engineersedge.com/video/Geometric Dimensioning and Tolerancing/](https://www.engineersedge.com/video/Geometric_Dimensioning_and_Tolerancing/)

**Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
C01	2	1	-	-	-	-	-	1	3	1	-	1	-	-
C02	3	2	1	1	-	-	-	1	3	1	-	1	-	-
C03	3	2	1	1	-	-	-	1	3	1	-	1	-	-
C04	2	1	-	-	-	-	-	1	3	1	-	1	-	-
C05	2	1	-	-	-	-	-	1	3	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code: 19MECN1301</b>		<b>Course Title: MANUFACTURING PROCESSES</b>	
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Physics for Mechanical Sciences
- Chemistry for Mechanical Sciences
- Engineering Practice Laboratory

**Course Objectives:**

The course is intended to:

1. Explain about metal casting and forging processes.
2. Explain about Plastic Moulding Processes.
3. Explain about metal forming and joining processes.
4. Explain about metal cutting processes.
5. Explain about metal Finishing processes.

**UNIT I                      Metal Casting and Forging processes                      10**

Introduction to metal casting processes, Pattern and its types, allowances for pattern, Sand casting process, Centrifugal casting process, Die Casting process, Furnace and its types, Defects in castings processes.

Introduction to Forging processes, Forging operations, Types of forging, forging machines, Defects in forgings processes, Rolling process and defects, Extrusion process, Wire and Rod drawing.

**UNIT II                      Plastic Moulding Processes                      8**

Introduction to plastic moulding process, Thermoplastics and thermosetting plastics, Compression moulding, Transfer moulding, Injection moulding, Blow Moulding, Moulding faults, causes and remedies.

**UNIT III                      Metal Forming and Joining Processes                      10**

Introduction to sheet metal process, Sheet metal forming process - Bending, Drawing, Blanking, Coining, Embossing, Flanging, Rolling Processes - Sheet metal cutting process – Piercing, Trimming, Shaving process. Tubular forming and tubular cutting processes with applications, Types of dies, Defects in sheet metal forming process.

Introduction to welding process, Nomenclature of weld bead, Classification of welding, Types of welding joints, symbols and Positions, Types of welding - SMAW, GMAW (MIG / MAG), SAW and TIG, Electric resistance welding process - Spot, seam and projection welding, Gas welding process, Soldering and Brazing, Defects of welding with causes and remedies.

#### **UNIT IV Metal Cutting Process**

**10**

Introduction to metal cutting processes, Cutting tool and its types, Types of Tool wear, Merchant's Circle, Lathe and its operations, Drilling machine – Types and operations, milling machine – Types and operations, Cutting fluids and its application.

#### **UNIT V Metal Finishing Processes**

**7**

Introduction to Metal Finishing Processes, Grinding process - Cylindrical grinding, Surface grinding, Centre less grinding, Grinding wheel specifications, Super finishing processes - Need and its types with applications, Lapping, Honing, Burnishing, Buffing and Sandblasting processes.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain various types of metal casting and forging processes.	Understand
CO2: Explain various types of Plastic Moulding Processes.	Understand
CO3: Explain various types of metal forming and joining processes.	Understand
CO4: Explain various types of metal cutting processes.	Understand
CO5: Explain various types of metal Finishing processes.	Understand

#### **Text Book(s):**

- T1.Serope Kalpakjian, "Manufacturing engineering and Technology", 7<sup>th</sup> Edition, Pearson Publishers, 2018.
- T2.Chapman, W.A.J., "Workshop Technology, Vol - II", 4<sup>th</sup> Edition, Oxford & IBH Publishing Co. Ltd., 2007.
- T3.Choudhry, S.K.H., "Elements of Work Shop Technology, Vol I", 15<sup>th</sup> Edition Media Promoters & Publishers, 2010.
- T4.Allen; W. S. and Baker; P. N., "Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]", 1<sup>st</sup> Edition, CBS Publishers and Distributors, New Delhi, 2004.

**Reference Book(s):**

R1. Production Technology by HMT, Tata McGraw Hill Education, 2017.

R2. Er. R.K. Rajput, "A Textbook of Manufacturing Technology (Manufacturing Process)", 2<sup>nd</sup> Edition, Laxmi Publications, 2017.

R3. William F. Hosford & Robert M. Caddell, "Metal forming (Mechanics & Metallurgy)", 4<sup>th</sup> Edition, Prentice Hall Publishing Co., 2014.

**Web References:**

1. <http://www.efunda.com/home.cfm>

2. <https://www.magicmarks.in/>

3. <https://www.accessengineeringlibrary.com/front>

4. <https://nptel.ac.in/courses/112105127/>

**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	-	2	2	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN3301</b>	<b>Course Title: COMPUTER AIDED MODELING AND DRAFTING LABORATORY</b>		
<b>Course Category: Professional Core</b>	<b>Course Level: Practice</b>		
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours:45</b>	<b>Max Marks:100</b>

### Pre-requisites

- Engineering Drawing

### Course Objectives

The course is intended to:

1. Create a CAD model as per the given part/assembly drawing.

### LIST OF EXPERIMENTS

1. Construction of 2D sketches using AutoCAD.
2. Construction of 2D sketches with dimensions using AutoCAD.
3. Construction of simple 3D models with basic features using a CAD tool.
4. Construction of 3D models with advanced features such as holes, pattern, swept, and etc. using a CAD tool.
5. Develop the part drawing of 3D models using a CAD tool.
6. Develop the production drawing of given machine component using a CAD tool.
7. Develop the assembly drawing of given machine component using a CAD tool.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Create a CAD model as per the given part/assembly drawing with appropriate dimensions and tolerance using appropriate template.	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<sup>th</sup> Edition, 2017.
- T2.Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, Gujarat, 53<sup>rd</sup> edition, 2015.

T3.K. V. Natrajan, "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 48<sup>th</sup> edition, 2018.

**Reference Book(s):**

R1 Louis Gary Lamit, "PTC Creo Parametric 3.0", Global engineering, Cengage learning, USA.

R2 John K.C., "Engineering Graphics", PHI Learning, Delhi, 1<sup>st</sup> edition, 2009.

R3 Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD", Tata McGraw India, New Delhi, 3<sup>rd</sup> edition, 2008.

**Web References:**

1. [https://en.wikipedia.org/wiki/Engineering\\_drawing](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	-	1	1	-

High-3; Medium-2; Low-1

**Assessment pattern**

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	

<b>Course Code: 19MECN3302</b>	<b>Course Title: MANUFACTURING PROCESSES LABORATORY</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours:45</b>	<b>Max Marks:100</b>

### Course Objectives

The course is intended to:

1. Make a cast component
2. Machine a given workpiece
3. Make a forged component
4. Make a sheet metal component

### LIST OF EXPERIMENTS

1. Preparation of sand mould using single piece / double piece pattern
2. Forging of round rod to square rod
3. Forming of cup using hydraulic press
4. Exercise on Turning of Shaft
5. Exercise on Key Way Milling of Shaft
6. Exercise on Gear Milling / Gear Shaping
7. Exercise on Grinding of Cylindrical Shaft
8. Exercise on Key Way Slotting in Gear
9. Exercise on Surface Grinding
10. Exercise on Drilling and Tapping
11. Exercise on Machining a Bolt using Capstan & Turret lathe

### Course Outcomes

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1:Make a cast component using single piece / double piece pattern for the given design requirement.	Apply
CO2:Machine the given work piece using lathe, milling and drilling based on given drawing.	Apply
CO3:Make a forged component by hand forging process for the given design requirement.	Apply
CO4: Make a sheet metal component by forming process for the given design requirement.	Apply

## Course Articulation Matrix

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

High-3; Medium-2; Low-1

## Assessment pattern

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	

**End of Semester III**

## Semester IV

<b>Course Code: 19MABG1401</b>	<b>Course Title: PROBABILITY AND STATISTICS</b> (Common to EE,EC,AU,CS,ME,IT & CE)		
<b>Course Category: Basic Science</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 3: 1: 0</b>	<b>Credits:4</b>	<b>Total Contact Hours:60</b>	<b>Max Marks:100</b>

### 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**

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+3**

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

### Unit III      **Two Dimensional Random Variables**      **9+3**

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

### Unit IV      **Testing of Hypotheses**      **9+3**

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**

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):**

T1.Veerajan T, "Probability, Statistics and Random process", 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi, 2017.

T2.Dr.J.Ravichandran, "Probability and Statistics for Engineers", 1<sup>st</sup> Edition, Wiley India Pvt.Ltd.,2010.

**Reference Book(s):**

R1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> Edition Pearson Education, Asia, 2013.

R2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum's Outlines Probability and Statistics", 4<sup>th</sup> Edition Tata McGraw Hill edition, 2012.

R3. Morris DeGroot, Mark Schervish, "Probability and Statistics", Pearson Educational Ltd, 4<sup>th</sup> Edition, 2014.

**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

### Assessment Pattern:

	Assessment Component	CO .No.	Marks	Total
Continuous Assessment	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial / Quiz / Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECC2401</b>	<b>Course Title: STRENGTH OF MATERIALS</b> (Common to AU, ME & MC)		
<b>Course Category: Professional Core</b>	<b>Course Level: Practice</b>		
<b>L:T:P(Hours/Week) 3: 0: 2</b>	<b>Credits: 4</b>	<b>Total Contact Hours:75</b>	<b>Max Marks:100</b>

### Pre-requisites

- Physics for Mechanical Sciences
- Engineering Mechanics

### Course Objectives

The course is intended to:

1. Characterize materials and determine the axial stresses and strains developed
2. Calculate the principal stresses and planes for 2-D state of stress in bars and thin walled pressure vessels.
3. Compute the stress distribution and slope-deflection in beams.
4. Calculate the shear stress distribution in solid and hollow shafts and design helical springs and leaf springs.
5. Compute the diameter of shafts subjected to combined bending, twisting and axial loads.

### Unit I Deformation of Solids

**9**

Mechanical properties of metals - Rigid and deformable bodies. Stress and Strain - tensile, compressive and shear, stress-strain diagram - Hooke's law - Factor of Safety - Poisson's ratio - relationship between elastic constants. Deformation of simple and compound bars under axial load. Strain energy - resilience, proof resilience and modulus of resilience - Strain energy due to axial load. Stresses due to gradual load, sudden load and impact load. Thermal stresses.

### Unit II Bi-axial State of Stress

**9**

Biaxial state of stresses - Principal planes and stresses - Maximum shear stress and planes of maximum shear stress - Mohr's circle for biaxial stresses. Stresses in thin walled pressure vessels.

### **Unit III          Flexure In Beams and Deflection of Beams**

**9**

Theory of simple bending – Bending stress and Shear stress variation in beams of standard section like 'I', 'L' and 'T'.

Evaluation of beam deflection and slope for cantilever and simply supported beams- Macaulay and Moment-area methods.

### **Unit IV          Torsion of Shafts and Springs**

**9**

Theory of torsion and assumptions - torsion equation- polar moment of inertia and polar modulus - Shear stress distribution in solid and hollow circular shafts.

Helical compression springs - terminology, styles of end - stress and deflection equation. Multi-Leaf springs - terminology - stress and deflection equation - Nipping of leaf springs

### **Unit V          Theories of failure**

**9**

Introduction to theories of failure - Maximum Principal Stress theory - Maximum Principal Strain theory - Maximum Strain Energy Theory - Maximum Distortion Energy theory - Maximum Shear Stress theory. Stresses in circular shaft with combined bending, axial loading and torsion. Equivalent bending moment and equivalent twisting moment.

### **List of Experiments:**

**30**

1. Conduct tensile test on Mild Steel rod.
2. Conduct shear test on Mild steel and Aluminum rods by Double shear.
3. Calculate the modulus of rigidity of mild steel rod by Torsion test.
4. Determine the toughness of the given mild steel specimen using IZOD and CHARPY impact test.
5. Determine the Hardness Number of metals by Brinell and Rockwell Hardness tester after the Heat Treatment.
6. Estimate the stiffness and modulus of rigidity of the helical spring by Compression test.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Characterize materials and determine the axial stresses and strains developed due to mechanical and thermal effects	Apply
CO2: Calculate the principal stresses and planes for 2-D state of stress in bars and thin walled pressure vessels using analytical and graphical methods.	Apply
CO3: Compute the stress distribution and slope-deflection in beams subjected to static loads.	Apply
CO4: Calculate the shear stress distribution in solid and hollow shafts subject to pure torsion and design helical springs and leaf springs subject to compressive loads.	Apply
CO5: Compute the diameter of shafts subjected to combined bending, twisting and axial loads using various theories of failure.	Apply

#### Text Book(s):

- T1. Hibbeler RC, "Mechanics of Materials", 9<sup>th</sup> Edition Prentice-Hall of India, New Delhi, 2013.
- T2. James M Gere, "Mechanics of Materials", 9<sup>th</sup> Edition Cengage Learning, India, 2019.

#### Reference Book(s):

- R1. Rattan SS "Strength of Materials" 3<sup>rd</sup> Edition Tata McGraw-Hill Education Pvt Ltd., New Delhi, 2017.
- R2. Beer F. P. and Johnston R, "Mechanics of Materials", 7<sup>th</sup> Edition McGraw-Hill Book Co, Third Edition, 2017.
- R3. Egor P. Popov, "Mechanics of Materials", 2<sup>nd</sup> Edition, Pearson Co, 2015.

#### Web References:

1. <http://nptel.ac.in/courses/112107147/>

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment Pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



in different planes - balancing of reciprocating masses-balancing of primary and secondary unbalanced forces of reciprocating masses. Partial balancing in IC engines.

**Unit IV                      Kinematics of spur gear and gear trains                      6+3**

Types of gears - spur gear terminology - law of gearing - conjugate profile - cycloidal and involute tooth profile - length of path of contact - length of arc of contact - contact ratio - interference - number of teeth on pinion to avoid interference.

Classification of gear trains - calculation of velocity ratio of simple, compound and epicyclic (tabular column method) gear trains.

**Unit V                      Longitudinal vibrations                      6+3**

Types of vibrations - basic elements of vibrating system - Degrees of Freedom - free longitudinal vibration of Single Degree of Freedom (SDOF) system: governing equation and natural frequency using equilibrium method and energy method - equivalent springs and dampers - free damped vibration of SDOF system: governing equation - under damped, critical damped and over damped systems - damping ratio - logarithmic decrement - force damped vibration - magnification factor - vibration isolation and transmissibility.

**List of Experiments:                      30**

1. Balancing of reciprocating masses and rotating masses.
2. Compound gear train.
3. i) Single degree of freedom system- spring mass system.  
ii) Vibration table.
4. Whirling of the shaft.
5. Torsional vibration - two rotor system.



Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Calculate position, velocity and acceleration of four bar and slider crank mechanisms using algebraic method and graphical method.	Apply
CO2: Calculate the static and dynamic forces for equilibrium of the given a slider crank or a four bar mechanism.	Apply
CO3: Calculate the balance masses required and its location in revolving & reciprocating applications	Apply
CO4: Calculate the kinematic parameters of spur gear and velocity ratio of simple, compound and epicyclic gear trains.	Apply
CO5: Analyze single degree of freedom longitudinally vibrating systems for free and forced vibrations with undamped and damped conditions.	Apply

#### Text Book(s):

T1 S.S. Rattan, "Theory of Machines", McGraw Hill Education, 4<sup>th</sup> Edition. 2017.

T2 Norton, R.L., "Kinematics and Dynamics of Machinery", Tata McGrawHill Education Pvt. Ltd., New Delhi, SI Edition 2014.

#### Reference Book(s):

R1 Gordon R. Pennock & Joseph E. Shigley John J. Uicker, "Theory Of Machine And Mechanisms Si Edition", Oxford University Press, 4<sup>th</sup> Edition 2014.

R2 Sadhu Singh, "Theory of Machines: Kinematics and Dynamics", Pearson Education India; 3<sup>rd</sup> Edition 2011.

R3 R.S. Khurmi, J.K. Gupta, "Theory of Machines", S.Chand, 14<sup>th</sup> Edition. 2005.

#### Web References:

1. <https://nptel.ac.in/courses/112104121/>
2. <https://nptel.ac.in/courses/112101096/>

## 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	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

## Assessment pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN1401</b>	<b>Course Title: MANUFACTURING TECHNOLOGY</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Physics for Mechanical Sciences
- Chemistry for Mechanical Sciences
- Engineering Practice Laboratory

**Course Objectives:**

The course is intended to:

1. Select appropriate manufacturing methods.
2. Understand the feasibility and economics.
3. Impart basic knowledge about the process planning.
4. Understand the concept of inspection procedure and corrective actions.
5. Explain advances in manufacturing technology.

**UNIT I Selection of manufacturing processes**

**9**

Physical, mechanical and metallurgical properties of parts produced by different manufacturing processes, Selection of manufacturing process based on size, geometry, process complexity, functionality of parts and types of loads acting on parts. Selection of tools, tool holding devices and work holding devices. Selection of manufacturing process for general engineering applications - Case studies.

**UNIT II Economics in the manufacturing process**

**9**

Inhouse manufacturing technology - Concept of Production volume, Delivery schedule. Cost and delivery time analysis- Cost calculation procedure for machining & welding process. Parameters and calculation of forces during forging processes. Calculation of cutting speed, feed, depth of cut, machining time and Material removal rate for machining operation. Parameters and calculation of forces during forming and rolling processes.

**UNIT III Process Planning**

**9**

Process planning, Factors affecting process planning, Role of process planning in the production cycle, Route sheet and operations sheet, Contents of a process planning sheet,

Preparation of a process planning sheet, Assembly practice – Manufacturing and assembly, Selective assembly, Process planning in assembly, Handling and transportation of assembly.

**UNIT IV      Product Inspection Procedure and Corrective actions      9**

Raw material Inspection procedure - Physical distortions (bending, twisting, scratch, surface corrosion). Chemical composition, Physical verification procedure - parts, sub assembly and assembly. Functional inspection - Testing procedure of sub-assembly with corrective action, Case studies on development of various new products based on the need of customer.

**UNIT V      Advances in Manufacturing Technology      9**

Unconventional machining processes – Classification, Working principle of AWJM, EDM, LBM and application. Additive manufacturing - Classification, Working principle of SLS, SLA and FDM, Application with case studies. Introduction on MEMS, NEMS, Electronics manufacturing technology and IIoT.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Choose appropriate manufacturing methods for given parts based on part functions, applications, geometry, and materials.	Apply
CO2: Evaluate the manufacturing process based on feasibility and economics to achieve part specification.	Apply
CO3: Prepare process planning sheet for given parts.	Apply
CO4: Analyze the deviation on the parts and decide the corrective action.	Apply
CO5: Explain various advanced technologies for current manufacturing scenario	Understand

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**Text Book(s):**

- T1.Serope Kalpakjian, "Manufacturing engineering and Technology", 7<sup>th</sup> Edition, Pearson Publishers, 2018.
- T2.Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", 7<sup>th</sup> edition, Wiley Publishers, 2019
- T3.Rao P N, "Manufacturing Technology, Vol 2, Metal Cutting and Machine Tools", 2<sup>nd</sup> Edition, Tata McGraw Hill, New Delhi, 13<sup>th</sup> reprint 2012.

**Reference Book(s):**

- R1.Kapil Gupta, "Advanced Manufacturing Technologies: Modern Machining, Advanced joining and sustainable Manufacturing" Springer Publisher, 2017.
- R2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016
- R3.Prasad R., "Surface Mount Technology - Principles and practice", 2<sup>nd</sup> Edition, Chapman and Hall, 1997,

**Web References:**

1. <http://www.efunda.com/home.cfm>
2. <https://www.magicmarks.in/>
3. <https://www.accessengineeringlibrary.com/front>
4. <https://nptel.ac.in/courses/112105127/>

**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	2	1	-	-	-	-	-	1	-	1	-	2	2	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:19MECN3401</b>	<b>Course Title: MANUFACTURING TECHNOLOGY LABORATORY</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours:45</b>	<b>Max Marks:100</b>

#### **Pre-requisites**

- Manufacturing Processes Laboratory

#### **Course Objectives**

The course is intended to:

1. Develop a process plan for manufacturing of components.
2. Use various manufacturing process to complete the given components/assembly.

#### **LIST OF EXPERIMENTS**

1. Prepare a process plan for the selected product from the product bank.
2. Calculate different process parameters, forces and levels for manufacturing the component.
3. Manufacture the components of the product using various manufacturing processes.
4. Prepare an inspection sheet for the component.
5. Analyze the deviation and perform the corrective action.

#### **Course Outcomes**

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Develop a process plan to manufacture the components of selected product.	Apply
CO2: Use Lathe, Drilling, Milling, Slotting and grinding machines to manufacture a component.	Apply

## Course Articulation Matrix

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

High-3; Medium-2; Low-1

## Assessment pattern

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	



<b>Course Code: 19PSHG6002</b>	<b>Course Title: UNIVERSAL HUMAN VALUES 2</b> <b>:UNDERSTANDING HARMONY</b> (Common to all B.E/B.Tech Programmes)		
<b>Course Category: Humanities</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 2: 1: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### Pre-requisites

- 19SHMG6101- Induction Program (UHV1)

### 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**

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**

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**

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**

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**

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

<b>Course Outcomes</b>	<b>Affective Level</b>
At the end of this course, students will be able to:	
CO1.Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO2.Appraise physical, mental and social well being of self and practice techniques to promote well being.	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: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, 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:**

- <https://aktu.ac.in/hvpe/ResourceVideo.aspx>
- <http://hvpenotes.blogspot.com/>
- <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

**Assessment Pattern**

	Assessment component	CO No.	Marks	Total marks weightage
Continuous assessment	Socially relevant project/Group Activities/ Assignments	1,2,3,4,5	20	75%
	Assessment by faculty mentor		10	
	Self-assessment		10	
	Assessment by peers		10	
End Semester Examination	Part A - Objective type - 20x1=20 marks Part B - Short answer questions - 15x 2 = 30 marks Part C - Descriptive Type Questions (Either or Pattern) - 5 x 10 = 50 marks	1,2,3,4,5	100	25%
Total				100%

<b>Course Code: 19MEPN6401</b>	<b>Course Title: MINI-PROJECT</b>		
<b>Course Category: Project</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 0: 0: 4</b>	<b>Credits: 2</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

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

The objective of Project I is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2: Work collaboratively on a team to successfully complete a design 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
C01	3	3	3	3	3	3	3	-	-	-	3	3	2	1
C02	-	-	3	-	-	-	-	3	3	-	3	3	2	1
C03	-	-	-	-	-	-	-	3	-	3	-	3	2	1

High-3; Medium-2; Low-1

<b>Course Code: 19MEPN6001</b>	<b>Course Title: INTERNSHIP OR SKILL DEVELOPMENT</b>		
<b>Course Category: Project</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 2 Weeks</b>	<b>Credits: 1</b>	<b>Total Contact Hours: Nil</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. Understand industry-specific terminology and practices
2. Solve simple industrial problems
3. Work collaboratively on a team
4. Effectively communicate the activities of internship in a written and oral format

Minimum of two weeks in an Industry in the area of Mechanical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Understand industry-specific terminology and practices	Apply
CO2: Solve simple industrial problems	Understand
CO3: Work collaboratively on a team	Apply
CO4: Effectively communicate the activities of internship in a written and oral format	Understand

**End of Semester IV**

## Semester V

<b>Course Code: 19MECC1501</b>	<b>Course Title: MECHANICAL DESIGN</b> (Common to MC & ME)		
<b>Course Category: Professional Core</b>		<b>Course Level: Mastery</b>	
<b>L:T:P(Hours/Week) 3: 1: 0</b>	<b>Credits:4</b>	<b>Total Contact Hours: 60</b>	<b>Max Marks:100</b>

### Pre-requisites

- Strength of Materials

### Course Objectives

The course is intended to:

1. To design the machine elements subjected to static loads.
2. To design the machine elements against fluctuating and impact loads.
3. To calculate the design parameters for power transmitting element.
4. To determine the design parameters of helical and leaf spring.
5. To design/select a suitable bearing.

### **UNIT I                      DESIGN FOR STATIC LOAD OR STEADY STRESSES                      9+3**

Design Processes and its types, factor of safety - selection. Preferred numbers, Selection of materials and its properties, Fits and Tolerances - eccentric loading-stress due to eccentric loading, curved beams - problems.

### **UNIT II                      DESIGN FOR FLUCTUATING AND IMPACT LOADS                      9+3**

Fatigue, types, Endurance limit, modifying factors, relation between endurance limit, ultimate tensile strength and yield strength, problems on different fatigue loading conditions. Stress concentration, stress concentration factor, causes of stress concentration, method of reducing stress concentration, stress concentration factor for different material configuration. Notch sensitivity, factors affecting of notch sensitivity. Impact loading, shock loading, simple problems.

**9+3**

### **UNIT III                      DESIGN OF SHAFTS, KEYS, AND COUPLINGS**

Difference between shaft, axle and spindle, Shaft materials, criteria of shaft design, different transmitting elements on a shaft, shaft design against static loading for given application.

Shaft design for fatigue loading. Keys, types of keys, stresses developed in the key. Spline, stresses in spline shaft, design of shank key and spline.

Couplings, types of coupling, design of coupling based on given speed and load conditions, Design of flexible coupling based on given speed and load conditions.

#### **UNIT IV                      DESIGN OF SPRINGS**

**9+3**

Springs, types of springs, applications, spring terminology. Stresses in helical springs, Design of helical and concentric spring for given loading. Leaf springs, NIP in leaf springs Design of leaf spring for given application.

#### **UNIT V                      DESIGN OF BEARING**

**9+3**

Bearings, bearing types, Parts of the bearing, rolling contact bearing, its applications. Load carrying capacity, equivalent load, Life of bearing, Load life relationship, Problems. Selection of ball bearings from manufacturing catalogue. Sliding contact bearings, types and Nomenclature. Hydrodynamic bearing, load carrying capacity, lubrication, selection of lubricant, equivalent load, minimum oil film thickness- length to diameter ratio- bearing pressure, radial clearance. McKee's equation, Sommerfeld equations - Bearing characteristic number problems.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Design the machine elements subjected to simple and combined static loads.	Apply
CO2: Design the machine elements against fluctuating loads and impact loads.	Apply
CO3: Calculate the design parameters for power transmitting element such as shaft, key, and coupling.	Apply
CO4: Determine the design parameters of helical and leaf spring for given application.	Apply
CO5: Design/Select a suitable bearing for the given application.	Apply



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**Text Book(s):**

T1.V.B. Bhandari. "Design of Machine Elements" Tata McGraw Hills Education, 5<sup>th</sup> edition, 2020.

T2.Shigley J.E and Mischke C.R., "Mechanical Engineering Design", Sixth Edition, Tata McGraw Hill, 2012.

**Reference Book(s):**

R1. P. C Sharma and A. K Agarwal. "Machine Design" (SI units). S.K. Kataria & Sons, Reprint 2013.

R2. Ugural A.C, "Mechanical Design - An Integral Approach", McGraw-Hill Book Co., 2010.

R3. Spotts M.F., Shoup T.E "Design and Machine Elements" Pearson Education, 2012

**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	-	2	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

Continuous Comprehensive Evaluation	Assessment Component	CO .No.	Marks	Total
	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN2501</b>		<b>Course Title: APPLIED THERMODYNAMICS</b>	
<b>Course Category: Professional Core</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 2</b>	<b>Credits:4</b>	<b>Total Contact Hours:75</b>	<b>Max Marks:100</b>

### **Prerequisites**

- Fluid Mechanics and Hydraulic Machinery
- Physics for Mechanical Sciences

### **Course Objectives**

The course is intended to:

1. Evaluate the thermodynamic characteristics of IC engines.
2. Calculate the performance characteristics of steam boiler and condenser.
3. Analyze the performance characteristics of steam nozzles and steam turbines.
4. Evaluate the performance characteristics of air compressors.
5. Calculate the performance of refrigeration and air-conditioning systems.

### **UNIT I      GAS POWER CYCLES AND PERFORMANCE OF IC ENGINES      9**

Air standard cycles- Otto, Diesel, Dual, Brayton cycles. Calculation of mean effective pressure and air standard efficiency. Engine tests - performance, heat balance, retardation and Morse test.

### **UNIT II      STEAM BOILERS AND CONDENSERS      9**

Steam boilers- Definition, Types – Fire tube and water tube, Mountings and Accessories, performance calculations, Indian Boilers Regulation (IBR) Act, Energy conservation opportunities in boiler. Steam condensers-Functions, elements of a condensing plant, types, estimation of cooling water requirement, condenser efficiency.

### **UNIT III      STEAM NOZZLES AND TURBINES      9**

Steam nozzles- flow through steam nozzles, effect of friction, critical pressure ratio and super saturated flow, nozzle design calculations. Steam turbines- impulse and reaction turbines, compounding, velocity diagram, governing of turbines.

### **UNIT IV      AIR COMPRESSORS      9**

Introduction to air-compressors - Reciprocating air compressor, performance characteristics, effect of clearance volume, free air delivery and displacement, intercooler, after cooler - Rotary compressor - vane type, centrifugal and axial, flow performance characteristics, Application of various types of compressors.

Fundamentals of refrigeration – COP - vapour compression refrigeration system - cycle, p-h chart, vapour absorption system- comparison, properties of refrigerants, performance calculations.

Fundamentals of air conditioning system, simple cooling and heat load estimation. Air-conditioners -window, split, summer and winter, centralized air-conditioning systems.

**List of Experiments****30**

1. Valve timing and Port timing diagrams.
2. Performance test on single cylinder, 4-stroke diesel engine.
3. Performance test on centrifugal air blower.
4. Performance test on two stage reciprocating air compressor.
5. Determination of COP of refrigeration system.
6. Determination of viscosity of lubricating oil using Redwood viscometer.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Evaluate the thermodynamic characteristics of IC engines using air-standard cycles.	Apply
CO2: Calculate the performance characteristics of steam boiler and condenser.	Apply
CO3: Analyze the performance characteristics of steam nozzles and impulse, reaction steam turbines using velocity diagrams.	Apply
CO4: Evaluate the performance characteristics of reciprocating and rotary air compressors.	Apply
CO5: Calculate the performance of refrigeration and air-conditioning systems using psychrometric chart.	Apply

**Text Book(s):**

T1.Kothandaraman C.P, Domkundwar and A.V. Domkundwar, "A Course in Thermal Engineering", Dhanpat Rai & Sons, 5<sup>th</sup> edition, 2016.

T2. Rajput R.K. "Thermal Engineering", Laxmi Publications (P) Ltd., New Delhi, 10<sup>th</sup> edition, 2018.

### Reference Book(s):

R1. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, 3<sup>rd</sup> edition, 2013.

R2. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw-Hill, New Delhi, 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	3	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

### Assessment pattern

Continuous Assessment	Assessment Component	CO. No.	Marks	Total
	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN2502</b>	<b>Course Title: ELECTRICAL AND ELECTRONICS ENGINEERING</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 3: 0: 2</b>	<b>Credits: 4</b>	<b>Total Contact Hours: 75</b>	<b>Max Marks:100</b>

#### **Prerequisites**

➤ Nil

#### **Course Objectives**

The course is intended to:

1. Explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
2. Explain the fundamentals of semiconductor and applications.
3. Explain the principles of digital electronics.
4. Impart knowledge of communication.
5. Explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.

#### **UNIT I      ELECTRICAL CIRCUITS & MEASUREMENTS      9**

Fundamental laws of electric circuits- Steady State Solution of DC Circuits - Introduction to AC Circuits -Sinusoidal steady state analysis- Power and Power factor - Single Phase and Three Phase Balanced Circuits. Classification of instruments - Operating Principles of indicating Instruments

#### **UNIT II      ELECTRICAL MACHINES      9**

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor.

#### **UNIT III      SEMICONDUCTOR DEVICES AND APPLICATIONS      9**

Introduction - Characteristics of PN Junction Diode - Zener Effect - Zener Diode and its Characteristics - Half wave and Full wave Rectifiers - Voltage Regulation.

Bipolar Junction Transistor - CB, CE, CC Configurations and Characteristics - Elementary Treatment of Small Signal Amplifier.

**UNIT IV DIGITAL ELECTRONICS****9**

Binary Number System - Boolean Algebra theorems- Digital circuits - Introduction to sequential Circuits- Flip-Flops - Registers and Counters - A/D and D/A Conversion - digital processing architecture.

**UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING****9**

Introduction - Elements of Communication Systems- Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Digital Communication - Communication Systems: Radio, Antenna, TV, Fax, ISDN, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

**List of Experiments****30**

1. Conduct load test on DC shunt motor and draw the speed-torque characteristics.
2. Verify the working of half-wave rectifier and draw the waveforms.
3. Draw the VI characteristics of PN Junction diode.
4. Verify the working of basic logic gates.
5. Verify the truth table of D and T flipflops.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Able to identify the electrical components and circuits.	Understand
CO2: Able to explain the characteristics of electrical machines.	Understand
CO3: Identify electronics components and understand their characteristics.	Understand
CO4: Explain the principles and functions of digital electronic components.	Understand
CO5: Explain the functions of elements in communication systems.	Understand

**Text Book(s):**

T1.D P Kothari and I.J Nagarath, "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, 4th edition 2019.

T2.S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson India, 2017.

### Reference Book(s):

- R1. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009.
- R2. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007.
- R3. Leonard S Bobrow, "Foundations of Electrical Engineering", Oxford University Press, 2013.

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECC2501</b>	<b>Course Title: PROBLEM SOLVING USING PYTHON FOR MECHANICAL SCIENCES</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 2: 0: 2</b>	<b>Credits:3</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. To develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs.
2. To structure simple Python programs for solving problems.
3. To decompose a Python program into functions.
4. To represent compound data using Python lists, tuples, dictionaries.
5. To read and write data from/to files in Python Programs.

**UNIT I ALGORITHMIC PROBLEM SOLVING**

**6**

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list.

**UNIT II DATA, EXPRESSIONS, STATEMENTS**

**6**

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.

**UNIT III CONTROL FLOW, FUNCTIONS**

**6**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation.



## UNIT IV LISTS, TUPLES, DICTIONARIES

6

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Illustrative programs: selection sort, histogram.

## UNIT V FILES, MODULES, PACKAGES

6

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

### List of Experiments

30

1. Program to calculate the linear stress, strain, Young's modulus & other elastic moduli and strain energy of the bar of user specified dimensions and load.
2. Program to calculate the Thermal efficiency of Otto Engine & COP of the heat engine for the user specified inputs.
3. Program to calculate the diameter of the shaft for the user specified inputs.
4. Program to find the dimensions of a Flexible Flange Coupling.
5. Program to plot the equation of the motion of a simple pendulum.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Develop algorithmic solutions to simple computational problems Read, write, execute by hand simple Python programs.	Understand
CO2: Structure simple Python programs for solving problems.	Apply
CO3: Decompose a Python program into functions.	Understand
CO4: Represent compound data using Python lists, tuples, dictionaries.	Understand
CO5: Read and write data from/to files in Python Programs.	Understand

### Text Book(s):

T1.Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2<sup>nd</sup> edition, Updated for Python 3, Shroff/O\_Reilly Publishers, 2016 (<http://greenteapress.com/wp/thinkpython/>).

T2.Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

### Reference Book(s):

R1. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013.

R2. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

### 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	3	1	-	2	-	-
CO2	3	2	1	1	1	1	1	1	3	1	-	2	-	-
CO3	2	1	-	-	1	1	1	1	3	1	-	2	-	-
CO4	2	1	-	-	1	1	1	1	3	1	-	2	-	-
CO5	2	1	-	-	1	1	1	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN3501</b>	<b>Course Title: COMPUTER AIDED MACHINE DRAWING LABORATORY</b>		
<b>Course Category: Professional Core</b>	<b>Course Level: Practice</b>		
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours: 45</b>	<b>Max Marks:100</b>

### **Pre-requisites**

- Engineering Drawing

### **Course Objectives**

The course is intended to

1. Develop part models.
2. Prepare assembly drawings.

### **List of Experiments**

1. Preparation of Knuckle joint part drawing.
2. Preparation of Flange coupling part drawing.
3. Preparation of Plummer Block part drawing.
4. Preparation of Screw Jack part drawing.
5. Preparation of Piston and Connecting rod part drawing.
6. Preparation of Knuckle joint assembly drawing .
7. Preparation of Flange coupling assembly drawing.
8. Preparation of Plummer block assembly drawing.
9. Preparation of Screw Jack assembly drawing .
10. Preparation of Piston and Connecting rod assembly drawing .

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Develop part models of machine components as per the design specification to prepare the assembly.	Apply
CO2: Prepare assembly drawings of machine components to disseminate how the parts fit together.	Apply

**Reference Book(s):**

- R1. Gopalakrishna, K. R., "Machine Drawing", Subhas Publishing House, 20<sup>th</sup> Edition, 2017.
- R2. Cecil Jensen, Jay D. Helsel, Dennis R. Short, "Engineering Drawing & Design", McGraw-Hill Higher Education, 7th edition, 2007.

**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	-	1	2	-
CO2	3	2	2	2	2	-	-	2	3	2	-	1	2	-

High-3; Medium-2; Low-1

**Assessment pattern**

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	

<b>Course Code: 19PSHG6501</b>	<b>Course Title: EMPLOYABILITY SKILLS 1 : TEAMNESS AND INTERPERSONAL SKILLS</b> (Common to all B.E/B.Tech Programmes)		
<b>Course Category: Humanities</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 2</b>	<b>Credits:1</b>	<b>Total Contact Hours: 30</b>	<b>Max Marks:100</b>

### Pre-requisites

- Nil

### Course Objectives

The course is intended to

1. Enrich effective communicative attributes as part of the skills 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 & PRESENTATION SKILLS

6

Barriers of Communication - Fear of English - Handling Social Factors - Handling Psychological Factors - Handling Practical Problems - Do's & Don'ts- 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 & HANDLING REJECTIONS

6

A,B,C's of Attitude - Influencing Factors - Individual Factors - Character Comparison - Strategies to Handle ourselves- Benefits of Positive Attitude – Do's& Don'ts – Handling Rejections- Identifying Negativities – How to handle it ??- Necessary changes - To do List - Creating One's self - Self Qualifiers.

**UNIT III INTERPERSONAL SKILLS****6**

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

**UNIT IV BODY LANGUAGE, DRESSING & GROOMING****6**

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**

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.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Enriches effective communicative attributes as part of their skills and Facilitates with Presentation & Public speaking skills.	Apply
CO2: Be aware of negativities and handle them to explore the true self.	Apply
CO3: Enables them with necessity of Interpersonal skills to groom as a professional.	Apply
CO4: Educates them about importance of Nonverbal skill set to attain perfection.	Understand
CO5: Provides them with teamness and its ethics as it is the core of corporate working.	Apply

**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.

### Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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

### Assessment details

#### Mode of Delivery:

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

Assessment	Details	Weight (%)	Remarks
Continuous Assessment	Diagnostic assessment of a student's communication skills, cognitive abilities, and behavioural traits during the course	25	Continuous
Final Assessment	MCQs/Diagnostic tests and Viva-voce	25	Two per semester - After CCET1 and after CCET2
Final Assessment	MCQs/Diagnostic tests and Viva-voce	50	End of Semester

End of semester V

## Semester VI

<b>Course Code: 19MECC1601</b>	<b>Course Title: FINITE ELEMENT ANALYSIS</b> (Common to AU & ME)		
<b>Course Category: Professional Core</b>	<b>Course Level: Mastery</b>		
<b>L:T:P(Hours/Week) 3: 1: 0</b>	<b>Credits:4</b>	<b>Total Contact Hours:60</b>	<b>Max Marks:100</b>

### Pre-requisites

- Fluid Mechanics and Hydraulic Machinery
- Strength of Materials

### Course Objectives

The course is intended to:

1. Convert physical problems into mathematical model.
2. Solve the one dimensional structural problems.
3. Solve the 2D vector variable problems .
4. Solve the 1D and 2D scalar variable problems.
5. Determine the shape function, Jacobean matrix, element stiffness matrix for 2D Quadrilateral element.

### UNIT I FINITE ELEMENT FORMULATION

**9+3**

Finite element methods - general applicability of the methods, general finite element procedure, discretization of the domain, degree of freedom, basic element shapes and nodes, numbering of element and nodes, displacement models, local, global coordinates, Spring element - derivation of element stiffness matrices, global stiffness matrix and force vector using minimum potential energy principle, incorporation of boundary conditions and convergence criteria, solution of numerical problems.

### UNIT II ONE DIMENSIONAL VECTOR VARIABLE PROBLEMS

**9+3**

Finite element modeling - Natural Coordinates and shape functions - linear bar element, - total potential energy approach - element stiffness matrix and force vector – global stiffness matrix and force vector - boundary condition – problems- quadratic element, Plane Trusses - development of shape function - element equations , element stiffness matrix and force vector - global stiffness matrix and force vector – boundary condition- problems, beam element -finite element formulation - Load vector -boundary condition- problems.



**UNIT III                      TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS  
USING                      CONSTANT STRAIN TRIANGLES**

**9+3**

Finite element modeling - constant strain triangular element - Iso-parametric representation - Potential Energy approach - Element stiffness matrix and force vector - global stiffness matrix and force vector -Boundary condition – Problems, Axisymmetric solids subjected to Axisymmetric loading - axis symmetric formulation - Element stiffness matrix and force vector - global stiffness matrix and force vector -Boundary condition - Problems.

**UNIT IV    HEAT TRANSFER / SCALAR VARIABLE PROBLEM 1 D & 2D**

**9+3**

Scalar variable problems- steady state heat transfer- 1D,2D conduction & convection - Global stiffness matrix and global thermal load vector - Boundary condition - Problems.

**UNIT V                      TWO DIMENSIONAL VECTOR VARIABLE PROBLEM USING  
QUADRILATERAL ELEMENTS**

**9+3**

Iso parametric elements – the four node quadrilateral- derivation of shape function, element stiffness matrix, element force vector- global stiffness matrix and force vector- Boundary condition-problems, element quality.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Convert physical problems into mathematical model using finite element procedure and solve simple problem using spring element	Apply
CO2: Solve the one dimensional structural problems such as bar, truss and beam using natural co ordinate system.	Apply
CO3: Solve the 2D vector variable problems by applying plane stress, strain and axi-symmetric conditions using CST element.	Apply
CO4: Solve the 1D and 2D scalar variable problems such as conduction and convection.	Apply
CO5: Determine the shape function, Jacobean matrix, and element stiffness matrix for 2D Quadrilateral element and find out the coordinates of a point in a element by applying interpolation technique.	Apply

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**Text Book(s):**

T1.Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", Prentice-Hall of India, 4<sup>th</sup> Edition, Eastern Economy Editions, 2012.

T2.Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd, 6<sup>th</sup> Edition. 2016.

**Reference Book(s):**

R1. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition, 2005.

R2. J.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions (Engineering Mechanics Series), 2005.

**Web References:**

1. <http://textofvideo.nptel.iitm.ac.in/105106051/lec1.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	-	2	-	-
CO2	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

**Assessment pattern:**

Continuous Comprehensive Evaluation	Assessment Component	CO .No.	Marks	Total
	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
Tutorial/Quiz/Assignment		1,2,3,4,5	30	10
End Semester Examination		ESE	1,2,3,4,5	100
Total				100

<b>Course Code: 19MECN2601</b>	<b>Course Title: HEAT AND MASS TRANSFER</b>		
<b>Course Category: Professional Core</b>	<b>Course Level: Mastery</b>		
<b>L:T:P(Hours/Week) 2: 1: 2</b>	<b>Credits:4</b>	<b>Total Contact Hours:75</b>	<b>Max Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Physics for Mechanical Sciences
- Fluid Mechanics & Machinery
- Applied Thermodynamics

### **Course Objective**

The course is intended to

1. Solve one dimensional steady state conduction heat problems.
2. Solve forced and natural convection heat transfer for fluid flows.
3. Design a heat exchanger using LMTD and NTU methods.
4. Calculate radiation heat transfer between different sections
5. Solve diffusion mass transfer through plane membrane.
6. Describe the different applications of heat transfer.

## **UNIT I ONE DIMENSIONAL STEADY STATE CONDUCTION**

**6+3**

Basic concepts-Modes of heat transfer – Conduction, Convection and Radiation- Cartesian coordinate- Simple geometries-Plane wall, Cylinder, Sphere, Composite wall , cylinder and Sphere – simple problems.

Fins – Short fin end insulated, Short fin end not insulated and long fin – Simple problems. Internal heat generation - Plane wall and cylinder - Simple problems. One dimensional Unsteady state heat conduction (Qualitative treatment only)

## **UNIT II CONVECTION**

**6+3**

Basics - dimensionless numbers, boundary layer concepts- external flow - flow over plates, cylinders and spheres - bank of tubes - Simple problems, internal flow - flow through cylinders – simple problems.

Free convection - flow over horizontal plate, flow over vertical plate and flow through cylinders and spheres - simple problems.

### **UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 6+3**

Phase change heat transfer - boiling- pool and flow boiling - condensation - simple problems.

Heat exchangers - Classifications - parallel flow, counter flow and cross flow- LMTD and NTU methods -simple problems.

### **UNIT IV RADIATION 6+3**

Basic concepts - absorptivity, reflectivity and transmissivity - black body and grey body concepts - Laws of radiation - Stefan Boltzmann law, Kirchoff's law, Planck's law, Wien's law and Lambert's cosine law - shape factor algebra - between plates and discs - simple problems, Radiation shield - single and 'n' number of shields - simple problems.

### **UNIT V DIFFUSION MASS TRANSFER AND HEAT TRANSFER APPLICATIONS 6+3**

Basic concepts - properties of mixtures - mass concentration and mass fraction - mole concentration and mole fraction - diffusion mass transfer - Fick's law of diffusion - diffusion through plane membrane- simple problems.

Applications of heat transfer - domestic applications - Refrigerator, Air conditioning, process industrial applications- Food industry, Sugar Industry and automotive applications - Engine, radiators.

**NOTE: (Use of Steam table & Heat & Mass Transfer Datebook are permitted)**

### **List of Experiments 30**

1. Thermal conductivity measurement for composite wall.
2. Thermal conductivity measurement of pipe insulation using lagged pipe approach.
3. Thermal conductivity measurement of insulating powder using concentric sphere.
4. Determination of heat transfer coefficient under natural convection and forced convection.
5. . Determination of Stefan Boltzman constant.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Solve one dimensional steady state heat conduction problems in simple geometries and fins with and without internal heat generation.	Apply
CO2: Solve forced and natural convection heat transfer problems for external and internal fluid flows in simple geometries.	Apply
CO3: Design a heat exchanger using LMTD and NTU methods with and without phase change.	Apply
CO4: Calculate radiation heat transfer between different geometries using shape factor concept.	Apply
CO5: Solve diffusion mass transfer through plane membrane.	Apply
CO6: Describe the different applications of heat transfer.	Apply

#### Text Book(s):

T1.Kothandaraman C.P – Fundamentals of Heat and Mass Transfer|| New Age International, New Delhi, 2012.

T2.Sachdeva R C, – Fundamentals of Engineering Heat and Mass Transfer|| New Age International, 2017.

#### Reference Book(s):

R1. Yadav R – Heat and Mass Transfer|| Central Publishing House, 1995.

R2. Nag P.K, – Heat Transfer||, Tata McGraw-Hill, New Delhi, 2011.

R3. Ozisik M.N, – Heat Transfer||, McGraw-Hill Book Co., 1994.

#### Web References:

1. <http://nptel.ac.in/courses/112101097/>
2. [http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Heat%20and%20Mass%20Transfer/New\\_index1.html](http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Heat%20and%20Mass%20Transfer/New_index1.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	1	-	2	-	-
CO2	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO3	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO4	3	2	1	1	1	-	-	1	3	1	-	2	-	-
CO5	3	2	1	1	1	-	-	1	3	1	-	2	-	-

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECC1602</b>	<b>Course Title: DATA SCIENCE FOR ENGINEERS</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Core</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Problem solving using PYTHON

### **Course Objective**

The course is intended to

1. To understand the importance of data science and Python in Engineering.
2. To develop algorithmic solutions to simple computational problems.
3. To apply basic statistic tools and techniques.
4. To perform data analytics process using python.
5. Analyze relevant data using basic statistic tools.

## **UNIT I                      INTRODUCTION TO DATA SCIENCE AND PYTHON                      9**

Data, types of data, data sets, data frames, Importance of data applications, Introduction to data science, data science in various fields, anaconda, IDE, Jupyter Notebooks, Microsoft visual studio code, Python-Introduction, Application and Installation procedures. Creation of root path, conda activation, Import sample excel sheet and access using Jupyter Note book. Keys steps of the data analysis process.

## **UNIT II                      BASICS OF PYTHON PROGRAMMING                      9**

Ipython, Introduction to NumPy, NumPy Basics: Arrays and Vectorized Computation, Getting started with Pandas, data manipulation with pandas, Perform the entire data analysis process on a dataset, Visualization with Matplotlib, Learn to use NumPy and Pandas to wrangle, explore, analyze, and visualize data.

## **UNIT III                      ROLE OF STATISTICS AND PROBABILITY IN DATA SCIENCE                      9**

Central tendency and dispersion, Introduction to probability, Probability distributions, Random variables and expectation, sampling and sampling distribution, Distribution of Sample Means, population, and variance, confidence interval estimation, Hypothesis and Hypothesis testing, Errors, Two sample T test, F test, ANOVA, Pearson correlation, Goodness of Fit, Simple Linear, Multiple and Logistic Regression.

**UNIT IV DATA ANALYTICS USING PYTHON****9**

Data Loading, Storage, and File Formats, Data Cleaning and Preparation, Data Wrangling, Gathering Data, Assessing Data, Cleaning Data, Join, Combine, and Reshape, Plotting and Visualization, Data Aggregation and Group Operations, Data assembly and Missing data handling, Time Series, Machine Learning.

**UNIT V DATA ANALYSIS PROCESS****9**

Linear Algebra for Data Science, Introduction to Vectors and Matrices using Python, Python demo for distributions and statistics analysis using python, use Seaborn for statistical plots, Use SciKit-Learn for Machine Learning Tasks, Data Visualization in Data Analysis and Data Presentation.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Understand the importance of data science and Python in Engineering.	Understand
CO2: Develop algorithmic solutions to simple computational problems	Understand
CO3: Apply basic statistic tools and techniques	Understand
CO4: Perform data analytics process using python	Understand
CO5: Analyze relevant data using basic statistic tools and techniques	Understand

**Text Book(s):**

- T1. Jake VanderPlas – Python Data Science Handbook: Essential Tools for Working with Data|| O'Reilly Media, Inc, 1<sup>st</sup> edition, 2017.
- T2. Daniel Y. Chen, (2018) – Pandas for Everyone: Python Data Analysis|| Pearson Education, 1<sup>st</sup> edition, 2018.
- T3. McKinney, W. – Python for data analysis: Data wrangling with Pandas, NumPy, and IPython|| O'Reilly Media, 2017.
- T4. Douglas C. Montgomery, George C. Runger – Applied Statistics & Probability for Engineering|| John Wiley & Sons, 6<sup>th</sup> edition, 2016.
- T5. Jay L. Devore, – Probability and Statistics for Engineering and the Sciences||, Cengage Learning, 9<sup>th</sup> edition, 2020.



**Reference(s):**

R1. Swaroop, C. H. "A Byte of Python" Python Tutorial, 2003.

R2. Anirban Das Gupta "Probability for Statistics and Machine Learning" Springer link, 2011.

R3. Anderson Sweeney Williams "Statistics for Business and Economics, Cengage Learning, 2011.

**Web References:**

1. <https://jakevdp.github.io/PythonDataScienceHandbook/index.html>

2. <https://towardsdatascience.com/>

3. [https://www.practicaldatascience.org/html/pandas\\_dataframes.html](https://www.practicaldatascience.org/html/pandas_dataframes.html)

4. <https://hadrienj.github.io>

**Course Articulation Matrix**

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

High-3; Medium-2;Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19PSHG6601</b>	<b>Course Title: EMPLOYABILITY SKILLS 2 : Campus To Corporate</b> (Common to all B.E/B.Tech Programmes)		
<b>Course Category: Humanities</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 2</b>	<b>Credits:1</b>	<b>Total Contact Hours: 30</b>	<b>Max Marks:100</b>

### **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 positives to 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**

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**

**6**

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

### **UNIT III GROUP DISCUSSION**

**6**

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)****6**

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& TIME MANAGEMENT****6**

**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 this course, students will be able to:	
CO1:Enables them to understand the emotions and necessity to handle it to evolve as an effective social animal.	Understand
CO2:Effective resumes to project the positives to be employable.	Understand
CO3:Facilitates for a collaborative work environment and to engage in healthy agreements for building person's professional facet.	Understand
CO4:Enlightens the growth attribute to outperform, initiate and grow in professional arena.	Understand
CO5:Practices effective handling of time and discarding the unprofessional habits.	Understand

**Text Book(s):**

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

**Reference Book(s):**

- 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.

**Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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

**Assessment details****Mode of Delivery:**

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

Assessment	Details	Weight (%)	Remarks
Continuous Evaluation	Diagnostic assessment of a student's communication skills, cognitive abilities, and behavioural traits during the course	25	Continuous
Formative Assessment	MCQs/Diagnostic tests and Viva-voce	25	Two per semester - After CCET1 and after CCET2
Final Assessment	MCQs/Diagnostic tests and Viva-voce	50	End of Semester

<b>Course Code: 19MEPN6601</b>	<b>Course Title: INNOVATIVE AND CREATIVE PROJECT</b>		
<b>Course Category: Project</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 0: 0: 4</b>	<b>Credits:2</b>	<b>Total Contact Hours:60</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

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

The objective of Project I is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1:Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2:Work collaboratively on a team to successfully complete a design 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	-	-
CO2	-	-	-	-	-	-	-	3	3	-	3	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	3	-	-

High-3; Medium-2; Low-1

**End of semester VI**

## Semester VII

<b>Course Code: 19MECN1701</b>	<b>Course Title: MECHATRONICS</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Mastery</b>	
<b>L:T:P(Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max Marks:100</b>

### Prerequisites

The student should have undergone the courses:

- Electrical and Electronics Engineering

### Course Objective

The course is intended to

1. Explain the fundamentals of mechatronics systems
2. Select sensors for various measurements
3. Write logic programs
4. Design Virtual Instruments for signal acquisition
5. Explain the application of mechatronics systems

### UNIT I INTRODUCTION

9

Introduction to Mechatronics- Systems- Concepts of Mechatronics approach-Need for Mechatronics- Emerging area of Mechatronics- Classification of Mechatronics - Control system- Open Loop and Feedback Control -PID Control.

### UNIT II SENSORS AND SIGNAL CONDITIONING

9

Introduction - Performance Terminology- Potentiometers-LVDT- Capacitance sensors- Strain gauges- Eddy current sensor-Hall effect sensor- Temperature sensors-Pressure sensors-Flow sensors- Light sensors- Selection of sensors- Signal processing.

### UNIT III PROGRAMMABLE LOGIC CONTROLLERS

9

Introduction- Basic structure- Input and output processing- PLC Programming - Timers, Counters and internal relays- Data handling and manipulation – subroutine – Master control reset- Selection of PLC, HMI

**UNIT IV SYTEM DESIGN USING VIRTUAL INSTRUMENTATION****9**

Front Panel and Block Diagram – Tools, Controls and Functions palette. Modular programming – SubVI. Structures – FOR, WHILE Loops, Case, Sequence, event structures, Formula node. DAQ hardware – AI, AO, DIO. DAQ Assistant and configuration Applications - Speed, Vibration, strain & temperature Measurement

**UNIT V DESIGN OF MECHATRONICS SYSTEMS****9**

Pick and place Robot- Autonomous mobile robot-Wireless surveillance balloon- Engine Management system- Automatic car park barrier.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the fundamentals of mechatronics systems such as the components and control schemes with block diagrams	Understand
CO2: Select sensors for various measurements including pressure, temperature, flow, level and light used in different systems	Apply
CO3: Write logic programs for real time applications such as home automation, machine tool control, process control using PLC	Apply
CO4: Design user interface for arithmetic, logical, sequencing data acquisition operations in analog and digital modes using virtual instrumentation.	Apply
CO5: Explain the different mechatronics systems used in various applications	Understand

**Text Book(s):**

T1 Bolton,W, "Mechatronics", Pearson Education, 6<sup>th</sup> edition, 2019.

T2 Jovitha Jerome, "Virtual Instrumentation using Lab VIEW", PHI Learning Private Limited, New Delhi, Second Printing, 2011.

**Reference(s):**

R1. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.

R2. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company 2007.



R3. Nitaigour Premchand Mahalik, Mechatronics Principles, Concepts and Applications|| Tata McGraw-Hill Publishing company Limited, 2017.

### Web References

1. <https://en.wikipedia.org/wiki/Mechatronics>
2. <http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html>
3. <http://nptel.ac.in/courses/112103174/>

### 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	-	1	1	-

High-3; Medium-2;Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECC1701</b>	<b>Course Title: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING</b> (Common to AU,ME &MC)		
<b>Course Category: Professional Core</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Nil

### **Course Objective**

The course is intended to

1. Explain the basics of Artificial Intelligence and applications.
2. Explain search methods to achieve a goal.
3. Explain first-order logic to represent knowledge.
4. Explain the basics of machine learning and applications.
5. Explain the various machine learning techniques.

## **UNIT I ARTIFICIAL INTELLIGENCE – INTRODUCTION**

**9**

AI - definition. Foundations of AI - History, trends and future. Intelligent Agents - agents and environments, the concept of rationality, the nature of environments, the structure of agents and types-case studies of Artificial Intelligence.

## **UNIT II PROBLEM SOLVING BY SEARCH**

**9**

Problem solving agents, searching for solutions- Infrastructure for search algorithms, measuring problem-solving performance. Uninformed search strategies- Breadth-first search, Depth-first search, Iterative deepening search, Uniform-cost search, Bidirectional search, Comparing uninformed search strategies. Heuristic functions, Informed (heuristic) search strategies- Best first search.

## **UNIT III KNOWLEDGE REPRESENTATION**

**9**

Introduction to Knowledge Representation- Hypothesis, Reasoning, Representing Knowledge, Syntax and semantics of Knowledge Representation language,

Propositional- Logic. First-order logic: syntax and semantics of first-order logic, knowledge engineering in first-order logic, inference in first-order logic.

#### **UNIT-IV INTRODUCTION TO MACHINE LEARNING**

**9**

Introduction: Basic definitions, types of learning, hypothesis, space and inductive bias, evaluation, cross-validation- Linear regression- R programming, Decision trees, over fitting-Instance based learning, Feature reduction, Collaborative filtering based recommendation- Probability and Bayes learning.

#### **UNIT-V MACHINE LEARNING TECHNIQUES**

**9**

Introduction: Neural network - Perceptron, multilayer network, back propagation. Introduction to deep neural network- Computational learning theory, PCA learning model, Ensemble learning- Clustering: k-means, adaptive hierarchical clustering.-case studies on Machine Learning.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the basic concept, and application of Artificial Intelligence.	Understand
CO2: Explain uninformed and informed search methods for problem solving.	Understand
CO3: Explain knowledge representation using first order logic.	Understand
CO4: Explain the basic concept, and application of Machine Learning.	Understand
CO5: Explain the classification and clustering techniques for decision making.	Understand

#### **Text books:**

- T1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence- A Modern Approach", Fourth Edition, Pearson Series, 2021.
- T2. Tom M. Mitchell, "Machine Learning", McGraw hill, 2013.

**Reference books:**

- R1. George Luger, .AI-Structures and Strategies for and Strategies for Complex Problem solving, Sixth Edition, 2009, Pearson Educations.
- R2. E. Rich and K. Knight, "Artificial intelligence", McGraw Hill, 3rd ed., 2017.
- R3. Robin R Murphy, Introduction to AI Robotics PHI Publication, 2<sup>nd</sup> edition, 2019.
- R4. Nils.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

**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	-
CO2	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO3	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO4	2	1	-	-	1	-	-	1	-	1	-	1	1	-
CO5	2	1	-	-	1	-	-	1	-	1	-	1	1	-

High-3; Medium-2;Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MECN1702</b>	<b>Course Title: CNC PROGRAMMING AND ROBOTICS</b>		
<b>Course Category: Professional Core</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 2</b>	<b>Credits:4</b>	<b>Total Contact Hours:75</b>	<b>Max Marks:100</b>

### **Prerequisites**

- Manufacturing Technology

### **Course Objectives**

The course is intended to:

1. Distinguish different CNC machines.
2. Explain the different part program of CNC Turning centre.
3. Explain the different part program of CNC Machining centre.
4. Explain different parts of Robot.
5. Explain the Robot programming language

## **UNIT I INTRODUCTION AND FEATURES OF CNC MACHINES 9**

CNC Machine Tools - principles, features, advantages, applications. CNC and DNC concept. Turning centre, machining centre. Types of control systems, CNC controllers, main drive, timing belts and pulleys, spindle bearings, Re-circulating ball screws, linear motion guide ways, tool turrets, tool magazines, ATC, APC, chip conveyors, encoders, hard jaws and soft jaws.

## **UNIT II PART PROGRAMMING OF CNC TURNING CENTRE 9**

Process planning, Co-ordinate systems, structure of a part program, typical tools for turning centre and machining centre, Machine datum and work piece datum, absolute and incremental programming, G and M Codes, tool offset information, tool nose radius compensation, canned cycle, facing cycle, turning cycle, threading cycle, peck drilling cycle, part programming examples.

## **UNIT III PART PROGRAMMING OF MACHINING CENTRE 9**

Co-ordinate systems, Cutter radius compensation, Tool length compensation, main program and sub program, canned cycle drilling cycle, tapping cycle, boring cycle, programming for pattern operations, part programming examples. CAD/CAM based NC

programming, features of CAM packages, generation of CNC codes from CAM packages.

#### **UNIT IV INTRODUCTION AND FEATURES OF ROBOT**

**9**

Robotics and automation, laws of robotics, robot definition, types and components of a robot, classification of robots, kinematics systems; definition of mechanisms and manipulators, degrees of freedom various manipulator. power transmission systems and control systems, robot drive mechanisms, mechanical transmission method, end effectors and its types, sensors and actuators.

#### **UNIT V KINEMATICS OF ROBOT MANIPULATOR**

**9**

Co-ordinate and vector transformation using matrices, rotation matrix, inverse transformations, homogenous transformations, Robotic manipulator joint coordinate system, Euler Angle & Euler transformations, Roll Pitch Yaw (RPY) transformation, D-H representation & displacement matrices for standard configurations, Robot programming and interlock for robotic applications.

#### **List of Experiments**

**30**

1. Develop a CNC Program and produce a part using CNC turning centre.
2. Develop a CNC Program and produce a part using CNC milling machine.
3. Develop a CNC Program and produce a hole using CNC drilling machine.
4. Develop a Robot program and perform the process of material handling in robot.
5. Develop a Robot program and perform the welding operation by using robot.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
At the end of this course, students will be able to:	
CO1: Explain the construction and features of CNC machines.	Understand
CO2: Develop a part program to produce a component by CNC lathe.	Apply
CO3: Develop a part program to produce a component by CNC machining centre.	Apply
CO4: Explain the construction and features of Robot.	Understand
CO5: Develop a Robot program to handle a process.	Apply

**Text Book(s):**

- T1 Radhakrishnan .P, "Computer Numerical Control CNC Machines|| New central books, 2013.
- T2 Mikell .P. Groover, Mitchell weiss, Roger N Nagel G Odrey, "Industrial Robotics||, Mc-Graw Hill, 2012.
- T3 Saha, S.K., "Introduction to Robotics, 2<sup>nd</sup> Edition, McGraw-Hill Higher Education, New Delhi, 2014.

**Reference(s):**

- R1. Yoram Koren, "Computer Control of Manufacturing Systems||, Mc-Graw Hill, 1<sup>st</sup> Edition, 2017.
- R2. Richard D Klafter, "Robotic engineering: an integrated approach, Prentice Hall Pvt. Ltd., 2011.
- R3. Ghosal Ashitava., "Robotics - Fundamental Concepts and Analysis||, Oxford Higher Education, New Delhi, 2006.

**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	1	1
CO2	3	2	1	1	1	-	-	1	1	2	-	2	2	1
CO3	3	2	1	1	1	-	-	1	1	2	-	2	2	1
CO4	2	1	-	-	-	-	-	1	1	2	-	2	1	1
CO5	3	2	1	1	1	-	-	1	1	2	-	2	2	1

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO. No.	Marks	Total
Continuous Assessment	CCET I	1,2	50	20
	CCET II	3,4	50	
	Retest	1,2,3,4	50	
	CCET III	5	50	
	Continuous Assessment - Practical	1,2,3,4,5	75	10
	Final Assessment - Practical	1,2,3,4,5	50	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code: 19MECC3701</b>		<b>Course Title: SIMULATION AND ANALYSIS LABORATORY</b>	
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours: 45</b>	<b>Max Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Numerical Methods
- Strength of Materials
- Theory of Machines

### **Course Objective**

The course is intended to

1. Apply finite element simulation software
2. Write programs in a mathematical simulation software

### **Simulation Lab**

1. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as input to get COP using Simulation software.
2. Simulation of free vibration characteristics of spring, mass and damper system using Simulation software.
3. Simulation of Hydraulic / Pneumatic cylinder using Simulation software.
4. Simulation of cam and follower mechanism using Simulation software.

### **Analysis (Simple Treatment Only)**

1. Stress analysis of beams (Cantilever, Simply supported)
2. Stress analysis of rectangular L bracket
3. Stress analysis of an Axi-symmetric component
4. Mode frequency analysis of a 2 D component
5. Mode frequency analysis of beams(Simply supported, Fixed ends)
6. Harmonic analysis of a 2D component
7. Thermal stress analysis of a 2D component
8. Conductive and Convective heat transfer analysis of a 2D component
9. Stress analysis of an 3 D component

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply finite element simulation software to solve simple problems such as structural, thermal and vibration problems in Mechanical Engineering.	Apply
CO2: Write programs in a mathematical simulation software to solve mathematical model of mechanical engineering applications	Apply

### 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	-	-	3	-
CO2	3	2	2	2	2	-	-	2	3	2	-	-	3	-

High-3; Medium-2; Low-1

### Assessment pattern

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	

<b>Course Code: 19MECN3701</b>	<b>Course Title: MECHATRONICS LABORATORY</b>		
<b>Course Category: Professional Core</b>		<b>Course Level: Practice</b>	
<b>L:T:P: 0: 0: 3</b>	<b>Credits:1.5</b>	<b>Total Contact Hours:45</b>	<b>Max Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Electrical and Electronics Engineering

### **Course Objective**

The course is intended to

1. Design a Pneumatic circuit for cylinder actuation.
2. Develop logic Program for real time interfacing
3. Develop a user interface for measurements

### **List of Experiments**

1. Design a Pneumatic circuit for speed regulation of double acting.
2. Design a Pneumatic circuit for actuation of single and double acting cylinder using Mechanical actuation.
3. Design a Pneumatic circuit for actuation of single and double acting cylinder using Electrical actuation.
4. Develop a CASCADE circuit for given sequence operation (two and three cylinders).
5. Basics logic using PLC Programming - AND, OR, Latch, Interlock
6. Control of multiple actuators in Hydraulic and pneumatic System by using PLC TIA portal V14
7. Control of Bottle filling system using PLC
8. Creating simple VIs, Editing and Debugging
9. Creating Sub VI using Lab VIEW
10. Temperature signal interface using Lab VIEW
11. Vibration Measurement using Lab VIEW

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Design a Pneumatic circuit for actuation of single and double acting cylinder using Mechanical and Electrical actuators	Apply
CO2: Develop a logic Programme for real time interfacing using plc for fluid power system, logic function and bottle filling.	Apply
CO3: Develop a user interface for temperature and vibration measurement using	Apply

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

Continuous comprehensive Evaluation	Assessment component	Marks	Total Marks
	Each Lab Experiment	75	100
	Cycle Test 1	50	
	Cycle Test 2	50	

## SEMESTER VIII

<b>Course Code: 19MEPN3801</b>	<b>Course Title: PROJECT</b>		
<b>Course Category: Project</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 0: 0: 16</b>	<b>Credits:8</b>	<b>Total Contact Hours:240</b>	<b>Max. Marks:100</b>

### Pre-requisites:

- Nil

### Course Objectives:

The course is intended to:

1. Take up any challenging practical problems and find solution by formulating proper methodology.
2. Work collaboratively on a team to successfully complete a design 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 investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department.
5. Final Seminar, as oral Presentation before a departmental committee.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1:Take up any challenging practical problems and find solution by formulating proper methodology.	Apply
CO2:Work collaboratively on a team to successfully complete a design project	Create
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	-	-
CO2	-	-	-	-	-	-	-	3	3	-	3	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	3	-	-

High-3; Medium-2; Low-1

<b>Course Code: 19MEPN3802</b>	<b>Course Title: INTERNSHIP</b> (Common to all B.E/B.Tech Programmes)		
<b>Course Category: Project</b>		<b>Course Level: Practice</b>	
<b>L:T:P (Hours/Week) 8/16 Weeks</b>	<b>Credits: 4</b>	<b>Total Contact Hours: Nil</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. Understand industry-specific terminology and practices
2. Solve simple industrial problems
3. Work collaboratively on a team
4. Effectively communicate the activities of internship in a written and oral format

Minimum of 8/16 weeks in an Industry in the area of Mechanical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Understand industry-specific terminology and practices	Understand
CO2: Solve simple industrial problems	Apply
CO3: Work collaboratively on a team	Create
CO4: Effectively communicate the activities of internship in a written and oral format	Apply

**End of Semester VIII**

## ELECTIVES

<b>Course Code:19MEEEC1001</b>	<b>Course Title: PRODUCT LIFE CYCLE MANAGEMENT</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### Pre-requisites:

➤ Nil

### Course Objectives:

The course is intended to:

1. To explain the fundamentals of PLM
2. To provide an in-depth understanding of business processes in the PLM.
3. To explain the management concept for product development in PLM.
4. To explain the importance of Digital Manufacturing in PLM.
5. To explain the use case scenarios through various customer case studies.

### UNIT I BUSINESS STRATEGY IN THE PLM

**9**

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Views, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment, Assessment of Current Systems and Applications.

### UNITII BUSINESS PROCESSES IN THE PLM

**9**

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM. Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.



**UNIT III PRODUCT DEVELOPMENT CONCEPTS IN THE PLM****9**

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM, Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral.

**UNIT IV DIGITAL MANUFACTURING IN THE PLM****9**

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

**UNIT V CUSTOMER USE CASES OF THE PLM****9**

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, Sunseeker International and Xtrac

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Understand PLM strategy based on the business needs	Understand
CO2: Explain various business processes in the PLM	Understand
CO3: Understand the product development concepts involved in the PLM	Understand
CO4: Explain the use of Digital Manufacturing environment in the PLM.	Understand
CO5: Understand the various customer use cases of the PLM	Understand

**Text Book(s):**

- T1. John Stark, "Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation", Springer International Publishing Switzerland, 3<sup>rd</sup> edition, 2015.
- T2. Grieves Michael, "Product Lifecycle Management- Driving the Next Generation of Lean Thinking", McGraw-Hill, 2010.
- T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

**Reference(s):**

R1. Elangovan, U., "Product Lifecycle Management (PLM)". Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. Antti Saaksvuori, "Product Life Cycle Management" - Anselmi Immonen, Springer, 1st Edition, 2003.

**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	2	1
CO2	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO3	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO4	2	1	-	-	1	-	-	1	-	1	-	1	2	1
CO5	2	1	-	-	1	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1002</b>	<b>Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Machine Design

### **Course Objectives**

The course is intended to:

1. Explain the design principles for manufacturability.
2. Describe the factors influencing form design.
3. Explain the machining consideration while design.
4. Optimize the given casting part.
5. Explain the environmental consideration in design.

### **UNIT I INTRODUCTION**

**9**

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits -Datum features - Tolerance stacks, GD & T.

### **UNIT II FORM DESIGN OF CASTINGS, FORGINGS AND WELDMENTS**

**9**

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

### **UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION**

**9**

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

**UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION****9**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.

**UNIT V DESIGN FOR THE ENVIRONMENT AND DFMA TOOLS****9**

Introduction - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Example application - Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability - Design for remanufacture - Design for energy efficiency - Design to regulations and standards.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.	Understand
CO2: Describe the factors influencing form design of castings, forgings and welding.	Understand
CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.	Understand
CO4: Explain the given casting part by applying design principles.	Understand
CO5: Explain the environmental consideration in design while using DFMA tools.	Understand

**Text Book(s):**

T1.Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , "Product Design for Manufacture and Assembly", Third Edition, T&F INDIA, 2019

T2.Boothroyd, G, "Design for Assembly, Automation and Product Design", Marcel Dekker, New York 2005

**Reference(s):**

- R1. Harry Peck , "Designing for Manufacture", Pitman Publishing, 1973.
- R2. Dickson, John. R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1999.
- R3. Fixel, J. "Design for the Environment" McGraw hill., 2011.

**Web References:**

1. <http://www.nptel.ac.in/courses/112101005/>
2. <https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics -Frequency Measuring Instruments.

#### **UNIT IV BASICS OF NOISE**

**9**

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise level, legislation, measurement and analysis of noise, measurement environment and equipment, frequency analysis, tracking analysis, sound quality analysis.

#### **UNIT V INDUSTRIAL NOISE AND CONTROL**

**9**

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise. Introduction to - Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Calculate the natural frequency of the given systems.	Apply
CO2: Calculate natural frequency of continuous system using approximate methods like Rayleigh's energy method, Rayleigh-Ritz method and Dunkerleys method.	Apply
CO3: Identify the required measuring instruments for vibration analysis in engine system.	Apply
CO4: Calculate the basic noise parameters from the given condition.	Apply
CO5: Analyze the industrial noise and apply the control techniques in automobile.	Apply

#### **Text Book(s):**

T1.Ambekar A.G. - Mechanical Vibrations and Noise Engineering|| Prentice Hall of India Pvt. Ltd, 2008.

T2.SingiresuS.Rao - Mechanical Vibrations|| - Pearson Education, 6<sup>th</sup> edition, 2018.

**Reference(s):**

- R1 Rao V. Dukkupati & Srinivas J. "Mechanical Vibrations" - Prentice Hall of India Pvt. Ltd, 2008.
- R2 Kewal Pujara "Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
- R3 W.T. Thomson, "Theory of Vibrations with applications", CBS Publishers, 2002.
- R4 Rao, J.S., & Gupta, K. "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1999.
- R5 Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.

**Web References:**

1. <http://nptel.ac.in/courses/112107088/>
2. <http://nptel.ac.in/courses/112104040/>
3. <http://www.journals.elsevier.com/journal-of-sound-and-vibration/most-downloaded-articles/>
4. <http://www.kineticsnoise.com/industrial/>
5. <http://www.nerc.ac.uk/about/policy/safety/procedures/procedure-vibration/>
6. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/290397/sp4-079-tr-1-e-e.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290397/sp4-079-tr-1-e-e.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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1



**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1004</b>		<b>Course Title: COMPUTATIONAL FLUID DYNAMICS</b> (Common to MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Physics for Mechanical Sciences
- Heat and Mass Transfer

### **Course Objectives**

The course is intended to:

1. Explain the governing equations and partial differential equation.
2. Discretize governing equations using finite difference method.
3. Discretize governing equations using finite volume method.
4. Solve incompressible viscous flow problems.
5. Discuss basics of turbulence.

## **UNIT I GOVERNING EQUATIONS**

**9**

Introduction to fluid mechanics - Reynolds Transport Theorem- Continuity Equation - Momentum Equation - Energy Equation - Classification of PDE's - Initial and Boundary conditions.

## **UNIT II FINITE DIFFERENCE METHOD**

**9**

Taylor's Series - Forward, Backward and Central differencing schemes - FDM Formulation - Explicit scheme - FTCS and Dufort-Frankel method - Implicit scheme - Laasonen and Crank Nicolson method - 1D Heat conduction - Problems - Errors (Qualitative).

**UNIT III FINITE VOLUME METHOD****9**

Introduction - 1D Steady state diffusion - 2D Steady state diffusion - 1D Steady state convection-diffusion - Central differencing schemes -UPWIND Scheme - Problems.

**UNIT IV VISCOUS FLOW****9**

Incompressible flow using MAC and Simple algorithm - Stream function and Vorticity formulation for viscous incompressible flow. Two dimensional incompressible viscous flow.

**UNIT V TURBULENCE AND ITS MODELLING****9**

Introduction to turbulence- Turbulence models- One equation model - Mixing length model - Two equation model - K- $\epsilon$  Model - Implementation of boundary condition in practical applications

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Solve the governing equations, classification of partial differential equation, initial and boundary conditions.	Apply
CO2: Discretize governing equations using finite difference method.	Apply
CO3: Discretize governing equations using finite volume method.	Apply
CO4: Solve incompressible viscous flow problems using MAC and SIMPLE algorithms.	Apply
CO5: Discuss basics of turbulence, its modeling and boundary conditions in real life problems.	Apply

**Text Book(s):**

T1.Anderson D.A., Tannehil J.C, Pletcher R.H, "Computational Fluid Mechanics & Heat Transfer", CRC Press; 4<sup>rd</sup> edition, 2021.

T2.Versteeg H.K, Malalasekara W, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Publishers,2<sup>nd</sup> edition, 2008.

**Reference(s):**

R1. Klaus A. Hofmann, Steve T. Chiang, "Computational Fluid Dynamics", Fourth Edition, Engineering Education System, 2000.

R2.John D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", First Edition, McGraw-Hill Education, 2012

R3.Murlidhar.K.,Sunderrajan.T, "Computational Fluid Mechanics and Heat Transfer", Narosa Publishing House, 2008.

#### Web References:

1. <http://nptel.ac.in/courses/112105045/>
2. <http://www.cfd-online.com/>

#### Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C01	3	2	1	1	-	-	-	1	-	1	-	1	-	-
C02	3	2	1	1	-	-	-	1	-	1	-	1	-	-
C03	3	2	1	1	-	-	-	1	-	1	-	1	-	-
C04	3	2	1	1	-	-	-	1	-	1	-	1	-	-
C05	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

#### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



### **UNIT III MATHEMATICAL FORMULATION IN MECHANICAL DESIGN 9**

Mathematical Formulation in System Design-Linear Programming Problem- Graphical method, Simplex method, Network Flow analysis- critical path method, and probability of completion time. Optimization Concepts-optimization in engineering applications, ingredients and classifications, statement of optimization, design vector, constraints, objective function, Optimization concept in single variable optimization and multi variable optimization problem.

### **UNIT IV DECISION ANALYSIS AND SYSTEM SIMULATION 9**

Decision analysis-Elements of decision problem, decision making under certainty, decision making under uncertainty, decision models- quantitative methods, decision tree. System Simulation concepts- types of simulation models, simulation programs and languages, Monte Carlo simulation , waiting line simulation.

### **UNIT V SYSTEM EVALUATION 9**

System evaluation-Request for proposals, Evaluation factors, stage of evaluation, Needs and benefits, Feasibility assessment, planning horizon. Financial analysis of system performance-Average rate of return method, Payback period, Balance sheet-profit and loss statement, a case study.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the engineering process and system approach to formulate a problem.	Understand
CO2: Explain the system theories and system modeling concepts to study the system behavior.	Understand
CO3: Apply the mathematical formulation in system design and optimization concepts to optimize the system.	Apply
CO4: Apply the decision analysis principles and system simulation concepts optimize the system.	Apply
CO5: Apply the financial analysis to evaluate the system performance.	Apply

**Text Book(s):**

- T1. R.C Mishra and Simant, "Mechanical System Design: PHI learning, New Delhi, 2017.
- T2. K.U. Siddiqui and Manojkumarsingh, "Mechanical system Design"-New Age international Publishers, 2<sup>nd</sup> edition 2010.

**Reference(s):**

- R1. S.S.Rao "Engineering Optimization-Theory and Practice" New Age international Publishers, 2009.
- R2. S.Kalavathy "Operations Research" 4th Edition Vikas Publishing House, 2013.
- R3. Ramachandran Aryasry & VV.Ramana Murthy, "Engg Economics & Financial Accounting", Tata McGraw-Hill Company, 3<sup>rd</sup> Edition, NewDelhi, 2009.

**Web References:**

1. [http://content.asce.org/files/pdf/team20102Mechanical\\_systems\\_designpresentation.pdf](http://content.asce.org/files/pdf/team20102Mechanical_systems_designpresentation.pdf)
2. <http://www.engr.mun.ca/~yuri/Courses/MechanicalSystems/Design.pdf>
3. <http://www.coursera.org>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code: 19MEEEC1005</b>	<b>Course Title: DESIGN OF TRANSMISSION SYSTEM</b> (Common to MC & ME)		
<b>Course Category: Professional Elective</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Theory of Machines

### **Course Objective**

The course is intended to

1. Design a suitable flexible element.
2. Design a spur gear and helical gear drives.
3. Design bevel and worm gear drives.
4. Design a multi stage sliding mesh gear box.
5. Design single, multi plate clutch and brakes.

## **UNIT I                      SELECTION OF FLEXIBLE ELEMENT DRIVES                      9**

Mechanical drives-types of drives -power and motion transmission drives-stepped and steeples transmission-speed ratio-under direct and over drives and its applications-reversible and irreversible drives and its applications-belt drives and its applications-Select suitable flat belt and V-belt drives and pulleys for industrial applications-chain drives-hoisting and hauling chains -Conveyor Chains -Power transmitting chains-block chain- roller chain-silent chain-select suitable roller chains and sprockets for industrial applications.

## **UNIT II      DESIGN OF SPUR GEAR AND HELICAL GEAR DRIVES                      9**

Toothed gearing and its applications- gear tooth terminology- failures in gears- gear materials- law of gearing- tooth forces and stresses- Design of spur gear for given situations, helical gear - Tooth terminology - equivalent number of teeth – Design of Helical Gear drives for given situations, Cross helical: Terminology (Qualitative Treatment only).

**UNIT III DESIGN OF BEVEL AND WORM GEAR DRIVES****9**

Types of bevel gear - Tooth terminology - equivalent number of teeth gear, Design the bevel gear, Materials- Worm Gear terminology , Types of worm gears - equivalent number of teeth, gear Materials, Thermal capacity, Efficiency - Tooth forces and stresses of worm gears, Design of worm gear drives.

**UNIT IV DESIGN OF SLIDING MESH GEAR BOX****9**

Preferred numbers- Geometric progression- standard step ratio- kinematic layout- ray diagram- Design 3, 6, 9 and 12 sliding mesh speed gear box.

**UNIT V DESIGN OF CLUTCHES AND BRAKES****9**

Needs and role of clutch- types of clutch-positive clutch- square jaw clutch- spiral jaw clutch- friction clutch- types of friction clutch-plate clutches- cone clutch- centrifugal clutch- Design of plate clutches- needs and role of brakes- types of brakes -single block or shoe brake- pivoted block or shoe brake- double block or shoe brake- simple band brake- differential band brake- band and block brake- internal expanding brake- Design of shoe brake, band and block brake, internal expanding brake, Disc Brake.

**NOTE: (Use of approved Data Book is permitted in the End semester examination)**

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Design a suitable flexible element drives such as flat belt, V-belt and chain drives for power transmitting applications.	Apply
CO2: Design a spur gear and helical gear drives considering the tooth bending and surface strength for given application.	Apply
CO3: Design and analyze a bevel and worm gear drives for strength and surface durability.	Apply
CO4: Design a single/multi stage sliding mesh gear box having maximum of 12 speeds and calculate the output speeds for machine tool applications.	Apply
CO5: Design single, multi plate clutch and brakes such as shoe brake, band brake, block brake, disc brake and internal expanding type brakes for given applications.	Apply

**Text Book(s):**

- T1. Shigley J.E and Mischke C.R, "Mechanical Engineering Design" 9<sup>th</sup> Edition, Tata McGraw-Hill, 2011.
- T2. Bhandari V.B, "Design of Machine Elements" 5<sup>th</sup> edition, Tata McGraw-Hill, 2020.

**Reference(s):**

- R1. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
- R2. GitinMaitra, L. Prasad "Hand book of Mechanical Design", 2nd Edition, Tata McGraw-Hill, 2001.
- R3. Sundararamamoorthy T.V, Shanmugam N, "Machine Design", Anuradha Publications, Chennai, 2003.

**Web References:**

1. <http://nptel.ac.in/courses/112106137/>
2. <http://nptel.ac.in/courses/112102014/38>
3. <http://dunloptransmissions.com/>
4. <http://www.renold.in/Products/TransmissionChainSprockets/TransmissionChainIndexPage.asp>
5. <http://khkgears.net/gear-knowledge/>

**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

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial/ Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1006</b>		<b>Course Title: AUTOMOTIVE ENGINE AND ITS SYSTEMS</b> (Common to MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Thermal Engineering

### **Course Objectives**

The course is intended to:

1. Explain the construction details of the power train.
2. Describe the combustion and emission characteristics of IC engines.
3. Describe the functions of various engine subsystems.
4. Interpret the performance characteristics of the vehicle.
5. Examine various advanced engines and alternate fuels.

## **UNIT I INTRODUCTION TO POWER TRAIN**

**9**

Power train – Types – Engine (SI and CI) – Torque converter – Valve train layout & crank train layout- valve timing and timing chain layout – Piston components – importance of B/S and L/r – Crank offset.

## **UNIT II COMBUSTION AND EMISSION IN IC ENGINES**

**9**

Chemistry of combustion, Stoichiometric equations of combustion - Introduction to SI and CI combustion – Engine knocking – Combustion chamber and its types – Combustion chamber design – Temperature – Fuel (include load /speed) – Fuel properties/characteristics (temperatures, Octane, Cetane no. etc) - Emission norms (Indian, European - US emission norms - Emission testing and certification) - Fuel Norms(BS1, BS2) - Environmental effects of Emissions - Emission relation with AFR - After treatment devices (include SAI,2WC ), Chemical reactions involved in after treatment.

### **UNIT III ENGINE SUBSYSTEMS**

**9**

Energy balance and cooling load estimation - Typical operating temperatures of engine parts - Types of cooling system - Cooling system design (Air cooled and water cooled) - Schematic layout of Cooling system for a two wheeler engine - Engine friction - Lubrication requirements of engine - Functions of Lubricating oil - Parts to be lubricated and not to be lubricated - Schematic layout of lubricating system - Oil filtering - Lubricating oils, types and properties - Functions of induction system - Schematic layout (2W and 4W) - Air Filtering and its importance - Exhaust and after treatment - Functions of exhaust system - Muffler layout - Schematic layout of exhaust system (2W and 4W)..

### **UNIT IV PERFORMANCE CHARACTERISTICS**

**9**

Volumetric efficiency - Factors affecting volumetric efficiency, ram effect, engine tuning, Fuel control systems (Carburetor, Fuel Injection) - Meeting demands of Vehicle (drivability, emissions and fuel economy) by controlling air and fuel - sensors - Vehicle performance characteristics, Road resistance, Wheel force in different gears, predict acceleration from engine performance graph - Various relations between AFR, Ignition timing and injection timing - Emission, performance (fuel consumption) - Sensors and devices used for performance and emission measurements.

### **UNIT V ADVANCED ENGINE CONCEPTS**

**9**

Engines (Wankel, six stroke, lean burn, GDI, HCCI etc.) Hybrid vehicles - VVT, Turbo/super charging - Benefits of different engine concepts - Alternate fuels, compare performance - Fuel economy & emission with fuels (alcohol, vegetable oils, LPG, CNG etc.) - Limiting factors and practical problems.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the construction details of the power train such as Valve & crank train layout used in four stroke IC engines.	Understand
CO2: Describe the combustion characteristics such as chemistry, knocking, temperature & fuel and emission characteristics such as norms, environmental effects, after treatment devices of four stroke IC engines.	Understand
CO3: Describe the functions of various engine subsystems such as cooling system, induction system and exhaust system of an automobiles.	Understand
CO4: Interpret the performance characteristics like volumetric efficiency, ram effect, engine tuning, Fuel control systems of the vehicle considering the relationship between volumetric efficiency of engine and emission norms.	Understand
CO5: Examine various advanced engines like Wankel, lean burn, GDI, HCCI and alternate fuels like alcohol, vegetable oils, LPG, CNG used in automobiles.	Understand

### **Text Books:**

T1. Edward F. Obert, "Internal Combustion Engines and Air Pollution" First Edition, Addison-Wesley Educational Publishers, Incorporated, reprint, 2012.

T2. V. Ganesan, "Internal Combustion Engines" McGraw-Hill, reprint 2012.

### **Reference Books:**

R1. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill, reprint 2012.

R2. Richard Stone, "Introduction to Internal Combustion Engines", Third edition, Society of Automotive Engineers, Incorporated 1999.

### **Web References:**

1. [https://en.wikibooks.org/wiki/Automotive\\_Systems](https://en.wikibooks.org/wiki/Automotive_Systems)
2. <https://bajatutor.net/online-baja-crash-course-for-atv-enthusiasts/>

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100





**UNIT IV TYRE DYNAMICS****9**

Introduction to tyre - Types of tyres - Tyre characteristic curve, vertical, cornering, camber stiffness, rolling resistance, magic formula.

**UNIT V ERGONOMICS AND AERODYNAMICS****9**

Introduction and importance – Elements of ergonomics – Riding posture design, H<sub>1</sub> point, seat design. Aerodynamics - Introduction – Definitions – Aerodynamics parameters – Effect on vehicle performance

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Determine the magnitude of design parameters in a braking system of motorcycle such as friction force and stopping distance.	Apply
CO2: Determine the magnitude of design parameters in a suspension system such as type of springs, spring stiffness and pitch.	Apply
CO3: Determine the magnitude of design parameters for stability and maneuverability such as geometrical, mass and structural stiffness.	Apply
CO4: Choose a suitable tyre for a given condition based on the characteristics of tyres such as vertical, cornering, camber stiffness, rolling resistance.	Apply
CO5: Determine the impact of aerodynamic parameters on the motorcycle performance.	Apply

**Text Book(s):**

T1.Tony Foale, "Motorcycle Handling and chassis design" Tony Foale designs, 2006.

T2.V Cossalter, "Motorcycle Dynamics", Published by Race dynamics, 8421 Midland Dr., Greendale, 2002.

**Reference Book(s):**

R1.Tom Birch, Thomas Wesley Birch, "Automotive Chassis Systems", Delmar, Thomson Learning, 1999.

### 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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



### **UNIT III PRESS MACHINES**

**8**

Presses - Types of Press machines based on Source of Power, Press tonnage, Slide Actuation & Capacity and its merits & demerits and application of presses and Material handling devices or equipment's and its types- Economic factor & selection of press.

### **UNIT IV TUBE BENDING PROCESS AND EQUIPMENTS**

**9**

Tube bending process -Types of tube bending operation - Equipment's of Tube bending - Conventional type pipe bending machine - clamp - wiper shoe - Bend form - Mandrel, pipe bending machine. Compression Bending, Rotary Draw Bending, Press Bending, Roll Bending, Single or double bend ,3D Bend, Tube on Tube bend, Tube bending related to shapes & size-Round, Rectangular & Square, Materials used Tube bending parts.

### **UNIT V TOOL COSTING AND SELECTIONS**

**11**

Cost drivers for formed part – Tool cost estimation - Trial & Inspection cost overhead cost & profit. Calculation of cost drivers of formed parts. Determination of Sequence and Tool selection - Sequence of operation available in the given part - Blanking tool & Piercing tool design - Draw the component drawing & Strip layout - Draw the assembly of tool drawing & BOM - Draw the individual tool elements part drawing for Manufacturing. Prepare the process planning chart. Inspection, trials and Troubleshooting - checklist for tool in static condition - checklist for tool in Dynamic condition - general inspection methods. Specific inspection methods (Panel checker/acceptance gauge). Design of form blocks and rubber press forming for aerospace application and stretch forming.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Calculate the forces involved in bending and drawing operations such as bending force, drawing force and blank holding forces.	Apply
CO2: Select appropriate press tools for forming processes based on the geometry and material of the given part.	Apply
CO3: Select appropriate press machines for forming processes based on the geometry and material of the given part.	Apply
CO4: Suggest a suitable bending process based given part geometry and material.	Apply
CO5: Estimate the cost required for forming and bending for the given part.	Apply

#### **Text Book(s):**

- T1.Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", 7<sup>th</sup> edition, Pearson Education, 2018.
- T2.S.K. HajraChoudhury and A.K. HajraChoudhury, "Elements of Work shop Technology", Vol - I Manufacturing Processes, Media Promoters and Publishers Pvt. Ltd, 2018.

#### **Reference Book(s):**

- R1. S.L. Semiatin "ASM Handbook Volume 14B: Metalworking: Sheet Forming", 2006.
- R2. Schuler "Metal Forming Handbook", Springer-Verlag Berlin Heidelberg 1998
- R3. Kurt Lange, "Handbook of Metal Forming", Society of Manufacturing Engineers, 1985

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1004</b>		<b>Course Title: DESIGN FOR WELDING</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Engineering Metrology and Measurements
- Engineering Materials

### **Course Objectives**

The course is intended to:

1. Choose a suitable welding process.
2. Identify the potential failure modes of a weld joint.
3. Explain the types of fixtures used in welding processes.
4. Design a suitable welding fixture.
5. Explain inspection, maintenance and calibration procedure.

## **UNIT I INTRODUCTION**

**9**

Fundamentals of welding Process - Arc welding processes - Principle and operation - Advantages and limitations of welding processes - Power sources of arc welding process and their influence on the process behavior - MIG / MAG Welding - Metal transfer in MIG welding processes-Process requirements of GMAW process - Impact of Process parameters - Defects of GMAW, Causes and their remedies - Resistance Welding Processes - Various types of Resistance welding process and its applications - Process requirements of Resistance Welding process - Impact of Process parameters – Resistance welding defects, causes and their remedies.

## **UNIT II DESIGN OF WELD JOINTS**

**9**

Types of Weld Joints and their applications - Styles and practices of Edge preparation - Representation of Weld symbols - Loads acting on the Weld Joints - Calculation of Stresses in Weld Joints - Determination of Weld size for Fatigue Applications -Effect of Temperature on Metallurgical properties - Causes of Distortion - Causes for Residual



Stresses - Quality requirement for Welders - Qualification Tests for welder - Optimization of Weld Process - Estimation of Welding Costs for a given application.

### **UNIT III INTRODUCTION TO WELDING FIXTURES 9**

Fixtures and its types - Datum and its importance of the Part - Location and its importance of the Part - Orientation and its importance of the Part - Resting & Clamping and its importance of the Part - Elements of the welding fixture - Different fixture accessories used for welding fixture assembly - Different types of welding fixtures for Resistance welding Process- Different types of welding fixtures for Arc welding Process. [SMAW&MIG].

### **UNIT IV DESIGN OF FIXTURES FOR WELD PARTS 9**

Critical & Major dimension of the fixture part - Datum and its classifications - Location, orientation & clamping for the weld part - Design of fixture elements for the given weld joint - Design of FMEA for the pre designed concept fixture -Welding distortion control by using fixture clamping - Design of welding fixture drawing for a given part.

### **UNIT V INSPECTION AND VALIDATION OF WELDING FIXTURES 9**

Inspection procedure for welding fixtures - Critical fit function of fixture hold part - Need of tolerance in fixture assembly-Possible failure modes while inspection of fixtures – Need of Fixture Maintenance and Calibration-Fixture maintenance procedure - Different fixture maintenance tools - Fixture calibration procedure.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Choose suitable welding processes.	Apply
CO2: Identify the potential failure modes of a weld joint.	Apply
CO3: Explain the types of Fixtures used in welding process.	Understand
CO4: Design the welding fixtures for the given weld parts.	Apply
CO5: Explain the inspection, maintenance and calibration procedure of welding fixtures.	Understand

**Text Book(s):**

T1.O.P Khanna "A Textbook of Welding Technology", Dhanpat Rai & Sons, Twentieth Reprint, 2011.

T2.Omer. W.Blodgett, James F. Lincoln, "Design of Welded Structures,rc Welding Foundation", 1st Edition 1996.

T3.Prakash Hiralal Joshi, "Welding and Assembly Fixtures", McGraw-Hill Professional, 2010.

**Reference Book(s):**

R1. S.J Maddox, "Fatigue Strength of Welded Structures", Woodhead Publishing, 1991.

R2. T.R Gurney, Tim Gurney, "Fatigue Strength of Transverse Fillet Welded Joints: A Study of the Influence of Joint Geometry", Woodhead Publishing, 1991.

**Web References:**

1. <https://ocw.mit.edu/courses/materials-science-and-engineering/3-37-welding-and-joining-processes-fall-2002/lecture-notes/>
2. [http://www.esabna.com/euweb/awtc/lesson1\\_1.htm](http://www.esabna.com/euweb/awtc/lesson1_1.htm)

**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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1008</b>		<b>Course Title: COMPOSITE MATERIALS</b> (Common to AU, MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Material Science
- Strength of Materials

### **Course Objectives**

The course is intended to:

1. Explain the properties of matrices and reinforcements.
2. Explain the various types of composite materials.
3. Explain the fabrication and testing of composites.
4. Explain the mechanics and lamination theory of fiber reinforced composites.
5. Explain the load bearing behaviour of composite and composite structures.

## **UNIT I      MATRICES AND REINFORCEMENTS**

**9**

Definition – Functions of a Matrix, desired Properties of a Matrix, Classifications of Matrix - Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.: Role and selection of reinforcement materials, Classifications of Reinforcements/Fibers - Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers etc., Mechanical properties of fibres.

## **UNIT II      TYPES OF COMPOSITES**

**9**

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

**UNIT III FABRICATION AND TESTING OF COMPOSITES****9**

Fabrication methods: hand layup, Autoclave, filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer. Mechanical testing of composites - tensile testing, Compressive testing, Flexural testing, Shear testing and Impact testing.

**UNIT IV MECHANICS AND LAMINATION THEORY OF COMPOSITES****9**

Rule of mixture -volume and mass fractions - density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi - Empirical model - Longitudinal Young's modulus-transverse Young's modulus - major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina – laminates – lamination theory, Maximum stress and strain criterion- Tsai-Hill, Tsai-Wu, Inter laminar stresses- Impact resistance- Fracture resistance- Fatigue resistance.

**UNIT V COMPOSITE STRUCTURES****9**

Fatigue – S-N curves – Fatigue behaviors of CMCs – Fatigue of particle and whisker reinforced composites. Introduction to structures - selection of material, manufacturing and laminate configuration -design of joints - bonded joints - bolted joints - bonded and bolted. Case studies in design and development of composite parts, boats, pressure vessels, automotive parts, aerospace parts, electronics parts and composites for space vehicles.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the properties of matrices and reinforcements	Understand
CO2: Explain the various types of composite materials	Understand
CO3: Explain the fabrication and testing of composites.	Understand
CO4: Explain the mechanics and lamination theory of fiber reinforced composites.	Understand
CO5: Explain the load bearing behavior of composite and composite Structures	Understand

**Text Book(s):**

T1.Krishnan K.Chawla, "Composite Materials Science and Engineering", Springer-Verlag New York, 3rd Edition, 2012.

T2.Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", CRC Press; 3rd edition, 2007.

**Reference Book(s):**

R1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 2012.

R2. Gibson, R.F., "Principles of Composite Material Mechanics", McGraw-Hill, 2011.

R3. Srinivasan K, "Composite Material", Narosa Publication, 2009.

**Web References:**

1. <http://nptel.ac.in/courses/101104010/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1020</b>		<b>Course Title: FLUID POWER SYSTEMS</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Fluid Mechanics and Hydraulic Machinery

### **Course Objectives**

The course is intended to:

1. Explain the fluid power systems.
2. Explain construction and working of hydraulic components.
3. Develop a hydraulic circuit.
4. Explain construction and working of pneumatic components.
5. Develop a pneumatic circuit.

## **UNIT I FLUID POWER SYSTEM AND FUNDAMENTALS**

**9**

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components -Pneumatic system components - Application of Pascal's Law in hydraulics- Advantages of fluid power system -Applications of Fluid power system -Properties of hydraulic fluids - Types of fluids.

## **UNIT II HYDRAULIC SYSTEM AND COMPONENTS**

**9**

Pumping theory - Pump classification - Construction and working of gear pumps, Vane pumps, Piston pumps - Construction and working of linear actuators - Special cylinder - Rotary actuator – Construction and operation of direction control valves (DCV), Pressure control valve, Flow control valve – Construction and operation of accumulators, Intensifiers..

## **UNIT III HYDRAULIC CIRCUITS**

**9**

Hydraulic symbols - Hydraulic circuits for linear actuators - Hydraulic circuits using different actuating devices - Speed control circuits - Sequencing circuit - Synchronizing circuit - Regenerative circuit - Accumulator circuit – Application of

intensifier - Hydraulic circuit for Milling operation, Grinding Machine - Hydraulic braking in Automobile.

#### **UNIT IV PNEUMATIC SYSTEM AND COMPONENTS**

**9**

Properties of air - Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Constriction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols.

#### **UNIT V PNEUMATIC CIRCUITS**

**9**

Pneumatic circuits for single acting cylinder, Double acting cylinder - Pneumatic circuits using manual, mechanical, electrical actuating devices - Cascade method for sequencing: two and three Cylinders - Step counter method- Hydro-Pneumatic circuit - Material handling system circuit - Multiple operation Machining.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Explain the construction and working of hydraulic system components.	Understand
CO2: Develop a hydraulic circuit for milling, grinding and automobile braking application.	Apply
CO3: Explain the construction and working of pneumatic system components.	Understand
CO4: Develop a pneumatic circuit for material handling and machining application.	Apply
CO5: Explain the construction and working of hydraulic system components.	Understand

#### **Text Book(s):**

T1.Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2015.

T2.Majumdar, S.R., "Oil Hydraulic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2010.



**Reference Book(s):**

R1. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, 2011.

R2. Andrew Parr, "Hydraulics and Pneumatics, A technician's and engineer's guide", Third Edition, Butterworth-Heinemann, 2011.

R3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2012.

**Web References:**

1. <http://www.nptel.ac.in/courses/112106175/>

2. <http://www.nptel.ac.in/courses/112105046/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1023</b>	<b>Course Title: Model Based Systems Engineering</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Introductory</b>	
<b>L:T:P(Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

➤ Nil

### **Course Objective**

The course is intended to

1. Explain the basis of system modeling
2. Explain the system specification
3. Develop a system architecture
4. Develop a handoff to downstream engineering
5. Demonstration of meeting needs

### **UNIT I BASICS OF SYSTEMS MODELING**

**9**

Concept Generation and Selection-Product Architecture - Design for Manufacturing and Product Development- Managing backlog - Managing risk- Product roadmap- Release plan – Iteration plan – Estimating effort – Work item prioritization- Organizing your models.

### **UNIT II SYSTEM SPECIFICATION**

**9**

Functional analysis with scenarios, activities, state machine and user stories- Model based safety and threat analysis- specific logical system interfaces – Creating the logical data schema- Technological forecasting.

### **UNIT III DEVELOPING SYSTEM ARCHITECTURES**

**9**

General architectural guidelines - Architectural merging - Pattern driven architecture - Subsystem and component architecture - Architectural allocation - Creating subsystem interfaces.

**UNIT IV    HANDOFF TO DOWNSTREAM ENGINEERING****9**

Preparation for handoff - Federating models for handoff - Logical to physical interfaces -  
Deployment architecture - Allocation to engineering facets - Interdisciplinary interfaces.

**UNIT V    VERIFICATION AND VALIDATION****9**

Demonstration of meeting needs- Model simulation – Model based testing –  
Computable constraint modeling - Traceability - Effective reviews - Test driven  
models.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the concept generation and selection of model based systems engineering.	Understand
CO2: Design the logical data schema based on the systems specifications using functional analysis.	Apply
CO3: Design the systems architectures for proper interface between sub systems and components.	Apply
CO4: Design the handoff using transformation of logical to physical interfaces and interdisciplinary interfaces.	Apply
CO5: Design the verification and validation phases for effective traceability and reviews.	Apply

**Text Book**

T1.Bruce Powel Douglass, ||Agile Model-Based Systems Engineering Cookbook|| ,Packt Publishing Ltd, UK, 1<sup>st</sup> edition, 2021.

T2.Tim Weikiens, Jesko G Lamm, Stephan Roth, Markus Walker ,||Model-Base Systems Architecture || , John Wiley & Sons, Inc., Hoboken, New Jersey, 1<sup>st</sup> edition, 2016.

**References**

R1. John Holt,|| Systems Engineering Demystified|| ,Packt Publishing Ltd, UK, 1<sup>st</sup> edition, 2021.

R2. Andrew P Sage and James E Armstrong,|| Introduction to Systems Engineering||, John Wiley & Sons, Inc., Hoboken, New Jersey, 1<sup>st</sup> edition, 2017.

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:19MEEEC1024</b>		<b>Course Title: NEW PRODUCT DEVELOPMENT</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the courses:

- Manufacturing Technology
- Design of Machine Elements

### **Course Objectives**

The course is intended to:

7. Understand the need of product development.
8. Identify the customer needs.
9. Select appropriate materials for a new product.
10. Select appropriate processes for a new product.
11. Understand the value analysis in costing.
12. Understand the Product Teardown.

## **UNIT I     PRODUCT DEVELOPMENT**

**9**

Need for developing products, the importance of engineering design, types of design, the design process. product lifecycle- relevance of product lifecycle issues in design, design using codes and standards. societal considerations in engineering design, fisher product classification, generic product development process, various phases of product development, planning for products, establishing markets, market segments, relevance of market research- market requirement specification and product requirement specification.

## **UNIT II     PRODUCT MORPHOLOGY METHODS AND ANALYSIS**

**9**

Identifying customer needs -voice of customer -customer populations- hierarchy of human needs-need gathering methods - affinity diagrams - needs importance- identify the technical requirement of customer need - establishing engineering characteristics. competitive benchmarking- quality function deployment- house of quality. product design specification- generating design concepts -systematic methods for design-

functional decomposition – physical decomposition -functional representation.  
morphological methods and analysis -TRIZ- axiomatic design.

### **Unit III MATERIAL, AND MANUFACTURING PROCESS SELECTION 9**

Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability, surface wear and Corrosion resistance- Functional relation between materials and processing. Manufacturing Processes - advantages and limitations. Selection of Processes- Process Capabilities - Design Guidelines. Product Design- Manufacturing Perspective.

### **UNIT IV VALUE ENGINEERING 9**

Value Engineering Function- Approach of Function, Evaluation of Function, Determining Function, Classifying Function. Evaluation of costs- Evaluation of Worth, Evaluation of Value, FAST Diagram, categories of cost – overhead costs – activity based costing – methods of developing cost estimates - manufacturing cost -value analysis in costing.

### **UNIT V PRODUCT TEARDOWN 9**

Teardown Process- List Design Issues-Prepare for Product Teardowns, Examine the Distribution and Installation-Disassemble, Measure and Analyse Data by Assemblies, Form a Bill of Materials. Teardown methods-Subtract and Operate Procedure, Force Flow (Energy Flow Field) Diagrams, Measurement and Experimentation, product verification and validation, Case studies.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Design the various phases of product development based on the relevance of market research	Apply
CO2: Design the House of Quality to identify the customer needs and product design specification for a new product development.	Apply
CO3: Identify the appropriate materials and manufacturing process for a new product development based on manufacturing perspective.	Apply

CO4: Integrate the various functions of value engineering in new product development.	Apply
CO5: Examine the types Teardown process and methods using in new product development.	Apply

### Text Book(s):

T1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, Product Design and Development, 6th Edition, 2019, Tata McGraw-Hill Education.

T2. Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

T3. Anil Kumar Mukhopadhyaya, "Value Engineering: Concepts Techniques and applications", SAGE Publications 2020.

### Reference Book(s):

R1. Clive L. Dym, Patrick Little, Engineering Design: A Project-based Introduction, 3rd Edition, John Wiley and Sons, 2019.

R2. George E. Dieter, Linda C. Schmidt, Engineering Design, McGraw-Hill International Edition, 4th Edition, 2009.

R3. Yousef Haik, T. M. M. Shahin, Engineering Design Process, 2nd Edition Reprint, Cengage Learning, 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	-	1	-	2	2	1
CO2	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO3	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO4	3	2	1	1	1	1	1	1	-	1	-	2	2	1
CO5	3	2	1	1	1	-	-	1	-	1	-	2	2	1

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100





Process, Information Management Process, Measurement Process and Quality Assurance Process.

#### **UNIT IV PROJECT ENABLING PROCESSES**

**9**

Life Cycle Model Management Process, Infrastructure Management Process, Portfolio Management Process, Human Resource Management Process, Quality Management Process, Knowledge Management Process, Acquisition Process and Supply Process.

#### **UNIT V CROSS CUTTING SYSTEMS ENGINEERING METHODS**

**9**

Modelling and Simulation – Model Based Systems Engineering, Functions based Systems Engineering Method, Object Oriented Systems Engineering Method, Prototyping, Interface Management, Integrated Product and Process Development. Lean Systems Engineering and Agile Systems Engineering.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the overview of Systems Engineering, its goals and value of using Systems Engineering throughout the system life cycle.	Understand
CO2: Break down the various stages of Technical processes are used to define the requirements for a system, to transform the requirements into an effective product.	Apply
CO3: Implement the processes like planning, assessment, decision making, configuration, information, measurement and quality assurance for Technical management.	Apply
CO4: Evaluate the project enabling processes and their interfaces to meet specific strategic and provide support of the system projects.	Apply
CO5: Choose the different methods that can apply across all processes, reflecting various aspects of the iterative and recursive nature of System Engineering.	Apply

**Text Book(s):**

T1. Garry J. Roedler, Kevin J. Forsberg, R. Douglas Hamelin, Thomas M. Shortell, *Systems Engineering Handbook*, 4<sup>th</sup> Edition, WILEY, 2015.

T2. [James N Martin](#), *Systems Engineering Guidebook*, 1<sup>th</sup> Edition, CRC Press, 2020.

**Reference Book(s):**

R1. Alexander Kossiakoff, William N. Sweet and Samuel J. Seymour, *Systems Engineering Principles and Practice*, WILEY, 2011

R2. Benjamin S. Blanchard and John E. Blyler, *System Engineering Management*, WILEY, 2016.

**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

R2.

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:19MEEEC1009</b>	<b>Course Title: ADDITIVE MANUFACTURING</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Elective</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Manufacturing Processes

**Course Objectives:**

The course is intended to:

1. Apply the concept of design and process optimization.
2. Select suitable materials for additive manufacturing.
3. Explain the concept of photo polymerization and extrusion process system.
4. Explain the concept of Powder bed fusion and direct energy system.
5. Apply the architecture of IoT in additive manufacturing.

**UNIT I DESIGN FOR ADDITIVE MANUFACTURING**

**9**

Introduction of AM - Basic principle-Generic AM process - DFAM concepts and objectives-AM unique capabilities -Exploring design freedoms - Design tools for AM-Guidelines for process selection.

**UNIT II MATERIALS FOR ADDITIVE MANUFACTURING**

**9**

Classification of polymer and metallic materials -Properties of AM materials – Application of AM material - Atomic structure and bonding-ceramics - polymer-powdered materials- composites- Multiple materials in AM - Multiple - discrete - porous - blended.

**UNIT III PHOTOPOLYMERIZATION PROCESSES AND EXTRUSION BASED SYSTEM**

**9**

Photopolymerization materials – Reaction Rates – Vector scan SL - SL Resin Curing Process - SL Scan Patterns - Vector Scan Microstereolithography - Mask Projection

Photopolymerization Technologies and Processes - Two-Photon SL - Extrusion-Based Systems - Basic Principles - Plotting and Path Control - Fused Deposition Modeling - Materials - Limitation - Bio extrusion - FDM of Ceramics.

#### **UNIT IV POWDER BED FUSION AND DIRECT ENERGY SYSTEM 9**

SLS process - Powder Fusion Mechanisms - Powder Handling - Process parameters - Materials - Application - SLM Process - Process parameters - Materials - Application - DMLS process - Process parameters - materials - application - EBM process - process parameters - materials - application - LENS process - process parameters - materials - application.

#### **UNIT V ARTIFICIAL INTELLIGENT IN ADDITIVE MANUFACTURING 9**

Overview of AI – Types of intelligent agents – AI model – AI enabled AM - AM-based product development - Intelligent agents for product design - Intelligent agents for process design - Intelligent agents for production - Global methods - Framework of smart AM - Artificial Intelligence Applications in 3D Printing.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Apply the concept of design and process optimization for Additive manufacturing	Apply
CO2: Select suitable materials in additive manufacturing for various applications.	Apply
CO3: Explain the concept of photo polymerization and extrusion process system	Understand
CO4: Explain the concept of Powder bed fusion and direct energy system.	Understand
CO5: Apply the architecture of IoT in various additive manufacturing process and application	Apply

**Text Book(s):**

T1.Ian Gibson, David W.Rosen, Brent Stucker, "Additive Manufacturing Technologies", Springer, 3rd edition, 2020.

T2.Patri.K.Venuvinod and Weiyin Ma. "Rapid Prototyping" Springer science+ business Media, LLC, 2004.

**Reference(s):**

R1. Andreas Gebhardt, Hanser "Rapid Prototyping", Gardener Publications, 2003

R2. LiouW.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.

R3. Chua C.K. Leong K.F., and Lim C.S., "Rapid prototyping: Principles and application", Second edition, World Scientific Publishers, 2010.

**Web references:**

1. <https://nptel.ac.in/courses/112/104/112104265/>

**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	2	1	-	-	-	-	-	1	-	1	-	2	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	2	-	-
CO5	3	2	1	1	-	-	-	1	-	1	-	2	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:19MEEN1005</b>		<b>Course Title: PROCESS PLANNING AND COST ESTIMATION</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>
<b>Pre-requisites:</b>			

- Manufacturing Processes
- Manufacturing Technology

### **Course Objectives:**

The course is intended to:

1. Explain the basic concepts of process planning.
2. Apply manual and computer aided process planning.
3. Explain both direct and indirect costs.
4. Analyze various cost calculation methods.
5. Explain the Break Even Analysis & Cost Management.

## **UNIT I      PROCESS PLANNING, DESIGN AND CONCEPTS OF PROCESS PLAN**

**9**

Introduction- Place of process planning-economics- Process & Production Planning, Process Planning & Concurrent Engineering-Types of production- standardization- Production design & selection. Selection of processes, tools, cutting parameters & machine tools- Jigs and Fixtures - Grouping of processes- Sequencing of operations- Selecting primary manufacturing processes for rough & refined needs- Process capability, Process Charts.

## **UNIT II      MANUAL AND COMPUTER AIDED PROCESS PLANNING & ESTIMATION**

**9**

Retrieval type/variant approach, group technology - generative approach, logics decision trees and tables, axiomatic approach - AI expert systems - feature recognition - applications Concepts, differences. Concepts, differences, different costing methods - classification of costs - cost grid-problems.

**UNIT III DIRECT AND INDIRECT COST COMPONENTS****8**

Labour cost-direct, indirect-estimation-labour norms-time study rating - labour cost variances; material cost-direct, indirect-estimation-material issue valuation - material cost variances-problems. Overhead cost - Elements - factory, administrative, sales and distribution expenses-methods of absorbing overheads - Direct Labour, Direct Material Machine Hour Rate methods - depreciation - methods - accounting for service department expenses - problems.

**UNIT IV COST CALCULATIONS****10**

Machined components-welded components, forged components, powder metallurgy parts, calculation of sales cost, case studies, use of computers in cost estimation, cost of rejection.

OPTIMUM MACHINING CONDITIONS: Taylor's equation, deriving the equation for optimum economic cutting velocity- selection of cutting speed for optimum cost, problems process capability analysis.

**UNIT V BREAK EVEN ANALYSIS & COST MANAGEMENT****9**

Concept, make or buy decision, assumptions, merits and demerits of break even analysis, applications. Linear, multi product break-even analysis Learning curves, product life cycle cost analysis -Tools and techniques-activity based costing - concepts, cost drivers; introduction to target costing - need and applications.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Understand the basic concepts of process planning.	Understand
CO2: Evaluate the various approaches of manual and computer aided process planning and costing.	Apply
CO3: Understand the different components involved in direct and indirect costs.	Understand
CO4: Analyze the cost calculation methods of different manufacturing process.	Apply
CO5: Understand the concept of Break Even Analysis & Cost Management.	Understand



**Text Book(s):**

T1.Kannappan D, "Mechanical Estimating and Costing", Tata McGraw Hill, New Delhi, 2003.

T2.Banga T R and Sharma S C, "Mechanical Estimating and Costing", Khanna Publishers, 16<sup>th</sup> Edition, 2011.

**Reference(s):**

R1. Russell R.S and Taylor B.W, "Operations Management", PHI, 4th Edition, 2003.

R2. Chitale A.V and Gupta R.C, "Product Design and Manufacturing", PHI, 2nd Edition, 2002.

R3. Kesavan R "Process Planning and Cost Estimation", New Age International Pvt. Ltd., Chennai, 2005.

**Web References:**

1. <https://en.wikipedia.org/wiki/Planning>
2. [http://nptel.ac.in/courses/Webcourse-contents/IITDelhi/Computer%20Aided%20Design%20&%20ManufacturingII/Module%20G/Module%20G\(5\)/p3.htm](http://nptel.ac.in/courses/Webcourse-contents/IITDelhi/Computer%20Aided%20Design%20&%20ManufacturingII/Module%20G/Module%20G(5)/p3.htm)
3. [https://en.wikipedia.org/wiki/Cost\\_estimate](https://en.wikipedia.org/wiki/Cost_estimate)

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1006</b>		<b>Course Title: ADVANCED MANUFACTURING PROCESSES</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Manufacturing Processes.

### **Course Objective**

The course is intended to:

1. Describe the applications of advanced unconventional machining processes.
2. Explain the basic concepts of advanced casting processes.
3. Select suitable welding process and technique to join a given material.
4. Explain well-founded and realistic process models within metal forming process.
5. Understand E manufacturing, micro and nano materials manufacturing process.

## **UNIT I      ADVANCED UNCONVENTIONAL MACHINING PROCESS      9**

Introduction- Shaped tube electro-chemical machining and electro-chemical spark machining, Plasma Arc Cutting, Magnetic abrasive finishing, Magnetorheological abrasive flow finishing, Electric Discharge Grinding, Electric Discharge Diamond Grinding Electrochemical Grinding, Electrostream Drilling, Chemical machining, Photo Chemical Machining, and Bio-Chemical Machining processes.

## **UNIT II      ADVANCED CASTING PROCESSES      9**

Special casting process-Shell Moulding, Investment casting, centrifugal casting, Die casting and continuous casting. Low pressure die casting, Squeeze casting, Full mould casting process – Permanent Mould Casting -Metal mould casting- Continuous casting- Squeeze casting-Vacuum mould casting- Evaporative pattern casting- Ceramic shell casting.

## **UNIT III      ADVANCED WELDING PROCESSES      9**

Electron beam welding - laser beam welding - ultrasonic welding processes- Friction stir welding- Explosive welding-Diffusion bonding-High frequency Induction welding-

Magnetic arc welding- gas metal Welding- Narrow gap welding techniques- Plasma key hole welding.

#### **UNIT IV ADVANCED METAL FORMING PROCESSES**

**9**

High energy rate forming process- Electro-magnetic forming, Explosive Forming- Electro-hydraulic forming- Stretch forming- Contour roll forming - High energy rate forming - Magnetic Pulse forming - Electro hydraulic forming - Cold Roll Forming, Incremental Press Forming and Millipede forming..

#### **UNIT V MICRO AND NANO MATERIALS, ELECTRICAL PARTS MACHINING PROCESSES**

**9**

Micro machining centers- E-Manufacturing, nanotechnology, and micromachining, High speed Machining Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, PCB Manufacturing, surface mount technology.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the appropriate advanced unconventional machining processes based upon applications	Understand
CO2: Explain the importance of advanced casting processes for the production of complex engineering components.	Understand
CO3: Design the welding processes for applying suitable standards and procedures as per the control plan for the required specification.	Apply
CO4: Select suitable forming processes and procedures to manufacture intricate, complex shape parts and difficult to machine materials.	Apply
CO5: Explain appropriate manufacturing processes for micro and nano materials and electrical and electronics component production.	Understand

#### **Text Book(s):**

T1.E. P. DeGarmo, J. T Black, R. A. Kohser "Materials and Processes in Manufacturing" (8th Edition), Prentice Hall of India, New Delhi (ISBN 0-02-978760).

T2.Ghosh, and A. K. Mallik "Manufacturing Science", Affiliated East-West Press Pvt. Ltd. New Delhi.

T3.Serope Kalpakjian and Steven R. Schmid, "Manufacturing Process for Engineering Materials", 5th Edition, Pearson Education, 2014.

**Reference(s):**

R1. V. K. Jain, "Advanced Machining Processes", 1st edition, Allied Publishers Pvt. Ltd, 2007. ISBN: 978-8177642940.

R2. H. Abdel and G. El-Hofy, "Advanced Machining Processes: Nontraditional and Hybrid Machining Processes", 1st edition, McGraw-Hill Professional, 2005. ISBN: 978- 0071453349.

R3. G.F. Benedict, "Nontraditional Machining Processes", 1st edition, Marcel Dekker Inc. 2002.

**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	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	2	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	2	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	2	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	2	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



**UNIT III MANAGEMENT TECHNOLOGY****9**

Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS

**UNIT IV GROUP TECHNOLOGY****9**

Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT

**UNIT V DESIGN OF FMS****9**

Performance Evaluation of FMS, Analytical model and Simulation model of FMS, Application of simulation – model of FMS- simulation software – limitation – manufacturing data systems - data flow - FMS database systems - planning for FMS database

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Classify and distinguish FMS and other manufacturing systems	Understand
CO2: Explain processing stations and material handling systems used in FMS environments	Understand
CO3: Understand tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS	Understand
CO4: Understand the concepts of group technology in FMS	Understand
CO5: Design and analyze FMS using simulation and analytical techniques	Apply

**Text Book(s):**

T1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 2015.

T2. Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt.Ltd. New Delhi 2009.

**Reference(s):**

R1. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 2012.

R2. John E Lenz "Flexible Manufacturing" Marcel Dekker Inc New York, 2010.

**Web References**

1. <https://nptel.ac.in/courses/112107143/36>

2. <https://nptel.ac.in/courses/112104228/31>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code: 19MEEEC1011</b>		<b>Course Title: NON-DESTRUCTIVE TESTING METHODS</b> (Common to AU, MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Metrology and Measurements.

### **Course Objectives**

The course is intended to:

1. Explain the testing procedure for Visual Inspection and Eddy Current Testing Method.
2. Explain testing procedure for Magnetic Particle Testing Method.
3. Explain testing procedure for Liquid Penetrant Testing Method.
4. Plan inspection sequence for Ultrasonic Testing Method.
5. Plan inspection sequence for Radiographic Testing Method.

## **UNIT I VISUAL INSPECTION AND EDDY CURRENT TESTING METHOD 9**

Scope and advantages of NDT-Compare NDT with DT-Principle of Visual Inspection theory- Optical aids used for Visual Inspection-Microscope, Boroscope, Endoscope, Flexiscope, Telescope and Holography- Principles of Eddy Current Theory-surface mounted coils-Encircling coils-types of Probes-Eddy current sensing Probes-Flux leakage sensing Probes-Eddy Current Techniques, Advanced Eddy Current Techniques-applications, Limitations and standards.

## **UNIT II MAGNETIC PARTICLE TESTING METHOD 9**

Basic Principle of magnetic particle testing(MPT)-induced magnetic fields-circular and longitudinal fields-Hysteresis curve-magnetic flux strips and coils-residual fields and demagnetization-MPT techniques-magnetization using a permanent magnet, magnetization using a Electro magnet, contact current flow method, wet and dry particle inspection methods, remote magnetic particle inspection, probe power inspection, light weight UV lamps inspection, semi automatic inspection, applications and limitations of MPT.

### UNIT III LIQUID PENETRANT TESTING METHOD

9

Physical properties of liquid penetrant-penetrant testing materials-penetrants, cleaners, emulsifiers developers, lint free cloth-Basic Principle, applications and limitations of liquid penetrant testing(LPT)-different LPT methods-Post-Emulsification

Fluorescent penetrant process, Reverse Fluorescent Dye penetrant process, Visible Dye penetrant process, Water-Emulsification visible Dye penetrant process, solvent clean visible Dye penetrant process.

### UNIT IV ULTRASONIC TESTING METHOD

9

Basic properties of sound beam-sound waves-velocity of ultrasonic waves, Acoustic Impedance behaviour of ultrasonic waves-ultrasonic transducers-characteristics of ultrasonic beam, Flaw sensitivity, Beam divergence, Attenuation-Principle of ultrasonic testing methods, applications and limitations-Ultrasonic testing method-normal incident pulse echo inspection method, normal incident through transmission testing method, angle beam pulse echo inspection method.

### UNIT V RADIOGRAPHIC TESTING METHOD

9

Basic Principle of Radiography-Electromagnetic radiation sources-X ray source, Gamma ray source-properties of X and Gamma rays-Radiographic Imaging-Geometrical factors- radiographic film-film density-Radiographic sensitivity-Penetrimeter-Radiographic Inspection Techniques-single wall single image technique, wall penetration technique, Latitude technique-Applications and Limitations of Radiographic Inspection Techniques.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the testing procedure for Visual Inspection and Eddy Current Testing Method in Quality Assurance.	Understand
CO2: Explain testing procedure for Magnetic Particle Testing Method for Quality Assurance.	Understand
CO3: Explain testing procedure for Liquid Reentrant Testing Method for Quality Assurance.	Understand
CO4: Plan inspection sequence for Ultrasonic Testing Method for Quality Assurance.	Understand
CO5: Plan inspection sequence for Radiographic Testing Method for Quality Assurance.	Understand

**Text Book(s):**

T1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, "Practical Non-Destructive Testing", Narosa Publishing House, 2009.

T2. J. Prasad, C. G. K. Nair, "Non-Destructive Testing and Evaluation of Materials", Tata McGraw-Hill Education Private Limited, 2003.

**Reference(s):**

R1. Ravi Prakash, "Non-Destructive Testing Techniques", 1<sup>st</sup> revised edition, New Age International Publishers, 2010.

R2. American Metals Society, "Non-Destructive Examination and Quality Control", Metals Hand Book, Vol. 17, 9<sup>th</sup> Edition, Metals Park, 1989.

R3. Paul Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2<sup>nd</sup> Edition, New Jersey, 2005.

**Web References:**

1. [https://www.nde-ed.org/index\\_flash.htm](https://www.nde-ed.org/index_flash.htm)
2. <http://117.55.241.6/library/E-Books/NDT%20Notes.pdf>
3. <http://www.slideshare.net/ndtindia123/introduction-uses-of-non-destructive-testing-24377016>
4. <http://www.eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf>
5. <http://www.hse.gov.uk/comah/sragtech/ndt2.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	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1007</b>		<b>Course Title: SUPPLY CHAIN MANAGEMENT</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course:

- Manufacturing Processes
- Manufacturing Technology

### **Course Objectives**

The course is intended to:

1. Assess the potential failure modes in material storage and handling between.
2. Apply REBA/RULA techniques in storage and material handling design.
3. Design part quality for the point of consumption.
4. Design material storage and handling system.
5. Apply standardization in storage and handling work procedures.

## **UNIT I MATERIAL HANDLING - SYSTEMS AND FACILITIES 9**

**Material Handling System** - Need, scope, definitions and terminologies, types, elements, Organization for logistics management and control. Introduction Process flow charting/mapping techniques.

**Material Handling Facilities** - Types of Material Handling Equipments (AGVs, Fork lift, prime movers, stackers, lifts etc), selection criteria for MHES. Design considerations, selection of materials. Estimation of number of facilities required; cost estimation and control. Introduction to thermoforming/injection molded crate design and manufacturing for kitting of the parts.

## **UNIT II ERGONOMICS IN DESIGN 9**

Application of RULA & REBA in MHF design, MHF design considerations for plastic parts, painted Parts, machined parts, fragile parts, c class parts, inter-plant material movement, and in-direct areas.

**UNIT III MEASURES OF MATERIAL HANDLING SYSTEM****9**

Reliability, maintainability, serviceability, availability factors, Supply supports, TPM for MHF, manufacturing consideration: processes, methods and tools, assembly and dismantling of MHF, system feasibility analysis, system operational requirements, Supportability analysis, functional analysis, MTBF and MTTR for MHFs, flexibility in MHFs, traceability of MHFs and MHEs, salvaging of MHFs and MHEs

**UNIT IV STORAGE SYSTEMS****9**

Creation of modern stores and storage systems: concept of stores, types of stores, storage facilities, considerations for creation of stores, estimation of docks, truck turn-around time, truck window time, inventory and types, WIP, material retention point, model store concept

**UNIT V ANALYSIS OF MATERIAL TRANSPORT SYSTEMS****9**

Analysis of Vehicle based system- determination of number of vehicles in AGVs and determination of delivery distance. Conveyor analysis - single direction, continuous loop and re-circulating conveyors.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Identify the potential failure modes in material storage and handling between POM/POS to POC.	Understand
CO2: Use REBA/RULA tools and techniques to study ergonomics in storage and material handling design.	Understand
CO3: Verify produced part quality is delivered to the point of consumption.	Understand
CO4: Design material storage and handling system to prevent potential failure modes.	Apply
CO5: Develop standardized storage and handling work procedures.	Apply

**Text Book(s):**

T1.Mikel P.Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", PHI Publishers, 3rd Edition 2016.

T2.Blanchard and Benjamin S, "Logistics Engineering and Management", 6th International Edition, Prentice Hall Inc, 2015.

**Reference(s):**

R1. Christopher M, "Logistics and Supply Chain Management - Creating Value Adding Networks", Prentice Hall, 2010.

R2. James M. Apple, "Plant Layout and Material Handling" John Wiley, 7th Edition, 2000.

R3. Prauss L, "The Green Multiplier - a Study of Environmental Protection and Supply Chain", Antonn Rauss Limited, Palgrave Macmillan, 2005.

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1008</b>	<b>Course Title: NANOMATERIALS SYNTHESIS AND CHARACTERIZATION</b>		
<b>Course Category: Professional Elective</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Material Science

### **Course Objectives**

The course is intended to:

1. Explain the basic of nano technology and describe various dimensional structures of nano materials.
2. Explain the chemical synthesis of nanostructures.
3. Explain physical synthesis of nanostructures.
4. Describe the SEM and TEM process and its inferences.
5. Analyze the crystal parameters using X-Ray diffraction and describe the AFM process and its inferences.

## **UNIT I INTRODUCTION TO NANO TECHNOLOGY AND NANOSTRUCTURES CLASSIFICATION 9**

History of nano science- Terminologies used in nano science- Influence of size reduction on thermal, electrical, mechanical, optical and magnetic properties of nanomaterials- surface area and aspect ratio of nanomaterials. Classifications of nanomaterials- Zero dimensional, one-dimensional, two dimensional and three dimensional nanostructures – Core shell nanoparticles – Kinetics in nanostructured materials- multilayer thin films and nanocomposites.

## **UNIT II CHEMICAL SYNTHESIS OF NANOSTRUCTURES 9**

Sol gel processing- Precipitation, Solvothermal, hydrothermal, spray pyrolysis, Electro spraying and spin coating methods of synthesis of different nanostructures- surfactant assisted synthesis of nanostructures.

## **UNIT III PHYSICAL SYNTHESIS OF NANOSTRUCTURES 9**

Ball milling- Vapour deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD)- pulsed laser deposition, Magnetron sputtering- Lithography:



Photo/UV/EB/ FIB techniques, Dip pen nanolithography.

#### **UNIT IV ELECTRON MICROSCOPY**

**9**

Scanning Electron Microscopy (SEM): Basic Design of the scanning electron microscopy- Modes of operation- Backscattered electrons- Secondary electrons- X-rays- specimen preparation- Application of SEM. Transmission Electron Microscopy (TEM): Basic principles- Modes of operation- specimen preparation- Diffraction in imperfect crystals- Dislocations- Structure of grain boundaries and interfaces- HRTEM use in nanostructures

#### **UNIT V X- RAY DIFFRACTION AND ATOMIC FORCE MICROSCOPY**

**9**

Bragg's law- D Spacing- X- Ray Powder Diffraction- Single Crystal Diffraction Techniques- Determination of Accurate Lattice Parameters- Structure Analysis- Particle Size Analysis using Scherer Formula. Basic concepts- Interaction force- AFM and the optical lever- Scale drawing- AFM tip on nanometer scale structures- Force curves, measurements and manipulations- Feedback control- Different modes of operation- Contact, non-contact and tapping mode.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the properties of nanomaterials based on size reduction and identify the structure of nanomaterials and examine its kinetics.	Understand
CO2: Compare the different chemical synthesis techniques of nanostructure formation in materials	Understand
CO3: Describe the various physical methods of nanostructure formation.	Understand
CO4: Analyze the morphological behaviour of nanomaterials based on SEM and TEM.	Apply
CO5: Analyze the crystal parameters and determine the particle size of nanomaterials by X-ray diffraction techniques and also calculate the roughness of the materials based on atomic force microscopy results	Apply

#### **Text Book(s):**

T1.T.Pradeep, Nano – The essentials understanding nanoscience and nanotechnology, McGraw Hill, 2009.

T2.Javier Garcia- Martinez, "Nanotechnology for the energy challenge", Wiley- VCH verlag GmbH & Co, 2010.

### Reference(s):

- R1. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.
- R2. A.S. Edelstein and R C. Cammarata, Nanomaterials: "Synthesis, Properties & Applications", Institute of Physics Pub., 1998.
- R3. B.D Cullity "Elements of X-ray Diffraction", 4<sup>th</sup> Edition, Addison Wiley, 2001.
- R4. J. Goldstein, D.E. Newbury, D.C. Joy "Scanning Electron Microscopy and X-ray Microanalysis", 2003.

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1012</b>		<b>Course Title: LEAN MANUFACTURING</b> (Common to AU & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Manufacturing Processes

**Course Objectives:**

The course is intended to:

1. Understand the Lean Manufacturing principles.
2. Apply various Lean tools.
3. Apply value stream management.
4. Apply the lean principles in manufacturing and service industries.
5. Evaluate various lean metrics.

**UNIT I INTRODUCTION TO LEAN MANUFACTURING**

**7**

Manufacturing systems-Types-Ford Production System, Lean Manufacturing Paradigm-History of Lean Manufacturing-Traditional Vs Lean Manufacturing, TQM vs. Lean, Toyota Production System. Lean Principles-Value Added Activities-Non-Value Added Activities-Necessary Non-Value added Activities- 3Ms-Muda, Mura and Muri-Types of wastes, Lean objectives-Need for lean manufacturing.

**UNIT II LEAN TOOLS AND METHODOLOGIES**

**9**

Problem solving tools-Cause and Effect Diagram, Pareto analysis, FMEA, Work cell and equipment management tools- Process Mapping, Spaghetti diagram, U shaped Layout, Poke Yoke, Kanban , Andon, SMED, One Piece Flow , GenchiGenbutsu, Milk run , Visual workplace, Quality at the source Methodologies-Pillars of Lean Manufacturing-Just in Time, Jidoka, 5S, TPM, Six sigma, DFMA, Kaizen.

### **UNIT III      VALUE STREAM MANAGEMENT**

**10**

Value stream Mapping-Value stream icons-Road map-Current State, Future State-Demand stage-Market Dynamics, Customer Demand; PQ Analysis; PR Analysis; Takt Time; Pitch; Finished Goods Stock, Cycle Stock Buffer Stock; Safety Stock-Flow Stage-Continuous flow, work cells, Line balancing, Standardized work, Quick change over, Autonomous maintenance, In process Super markets, Kanban systems, FIFO Lanes, Production Scheduling, Leveling Stage-Paced Withdrawal, Heijunka(Load Leveling), Heijunka Box, The Runner-a Case Study.

### **UNIT IV      LEAN IMPLEMENTATION**

**10**

Training Stage-Management Commitment, Identify the value stream manager/Champion and core Implementation team Members, Training of team members, Planning stage-Customer Focus, Go to the floor, Hosin Planning, Brain storming, Prepare Tree Diagram, Select the cross functional team, Prepare project plan, Improvement stage-Production and Productivity-Operator, Process, Machinery and Equipment, Work place Organization, Inventory management, Planning and Procurement of Materials, A case study on Lean implementation in manufacturing and service industries.

### **UNIT V      LEAN METRICS**

**9**

Lean Metrics-the fundamentals, steps in identifying Lean Metrics, WIP inventory, Total Product cycle time, Total value stream lead time, On time delivery, Defective PPM, Uptime, OEE, Throughput rate, Through put yield, Utilization rate, Lean Manufacturing assessment-Radar Chart- a case study.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the Lean Manufacturing principles such as -Value Added Activities-Non-Value Added Activities-Necessary Non-Value added Activities- 3Ms-Muda, Mura and Muri to eliminate the waste	Understand
CO2: Design manufacturing solutions based on various Lean tools and methodologies such as Process Mapping, Spaghetti diagram, U shaped Layout, Poke Yoke, Kanban , Andon, SMED, One Piece Flow .	Apply
CO3: Prepare value stream maps such Current state, Future state mapping, Standardized work, Quick change over, Autonomous maintenance to eliminate the non value added activities.	Understand
CO4: Design manufacturing solutions for manufacturing and service industries based on Hosin Planning.	Apply
CO5: Compare various lean metrics such as Lead time, Cycle Time, through put time, PPM, Uptime, OEE, Throughput rate, Through put yield for Lean assessment.	Understand

#### **Text Book(s):**

T1.Don Tapping, Tom Luyster, and Tom Shuker, "Value stream Management Eight steps to planning", Mapping and sustaining Lean Improvements in Administrative Areas, Taylor & Francis ,2018.

T2.N.Gopalakrishnan, "Simplified Lean Manufacture Elements, Rules", Tools and implementation, PHI Learning, New Delhi, 2010.

#### **Reference(s):**

R1. James P. Womack, Daniel T Jones, Daniel Ross "The Machine That Change the world", Free Press trade paperback edition, U.S.A, 2007.

R2. Ronald G. Askin& Jeffrey B.Goldberg, "Design and Analysis of Lean Production Systems",2003, John Wiley & Sons,2003.

R3. Rother M. and Shook J, "Learning to See: Value Stream Mapping to Add Value and Eliminate Muda", Lean Enterprise Institute, Brookline, MA,1999.

**Web References:**

1. [https:// www.learning -to-see.co.uk](https://www.learning-to-see.co.uk).
2. <https://www.lean.org>.
3. <https://www.leanproduction.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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



### UNIT III SYSTEM OUTPUTS

9

Inputs- 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

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

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
<b>At the end of this course, students will be able to:</b>	
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(s):**

R1. Donella H. Meadows, "Thinking in systems" published by Chelsea Green Publishing, 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	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1013</b>		<b>Course Title: LOGISTICS ENGINEERING</b> (Common to AU & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Manufacturing Processes

**Course Objectives:**

The course is intended to:

1. Assess the potential failure modes in material storage and handling between POM/POS to POC.
2. Apply REBA/RULA tools and techniques in storage and material handling design.
3. Verify produced part quality is delivered to the point of consumption.
4. Design material storage and handling system to prevent potential failure modes.
5. Develop standardized storage and handling work procedures.

**UNIT I MATERIAL HANDLING - SYSTEMS AND FACILITIES 9**

**Material Handling System** - Need, scope, definitions and terminologies, types, elements, Organization for logistics management and control. Introduction Process flow charting/mapping techniques.

**Material Handling Facilities** - Types of Material Handling Equipments (AGVs, Fork lift, prime movers, stackers, lifts etc), selection criteria for MHES. Design considerations, selection of materials. Estimation of number of facilities required; cost estimation and control. Introduction to thermoforming/injection molded crate design and manufacturing for kitting of the parts.

**UNIT II ERGONOMICS IN DESIGN 9**

Application of RULA & REBA in MHF design, MHF design considerations for plastic parts, painted Parts, machined parts, fragile parts, c class parts, inter-plant material movement, and in-direct areas.

**UNIT III MEASURES OF MATERIAL HANDLING SYSTEM****9**

Reliability, maintainability, serviceability, availability factors, Supply supports, TPM for MHF, manufacturing consideration: processes, methods and tools, assembly and dismantling of MHF, system feasibility analysis, system operational requirements, Supportability analysis, functional analysis, MTBF and MTTR for MHFs, flexibility in MHFs, traceability of MHFs and MHEs, salvaging of MHFs and MHEs

**UNIT IV STORAGE SYSTEMS****9**

Creation of modern stores and storage systems: concept of stores, types of stores, storage facilities, considerations for creation of stores, estimation of docks, truck turn-around time, truck window time, inventory and types, WIP, material retention point, model store concept

**UNIT V ANALYSIS OF MATERIAL TRANSPORT SYSTEMS****9**

Analysis of Vehicle based system- determination of number of vehicles in AGVs and determination of delivery distance. Conveyor analysis – single direction, continuous loop and re-circulating conveyors.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Identify the potential failure modes in material storage and handling between POM/POS to POC.	Understand
CO2: Use REBA/RULA tools and techniques to study ergonomics in storage and material handling design.	Understand
CO3: Verify produced part quality is delivered to the point of consumption.	Understand
CO4: Design material storage and handling system to prevent potential failure modes.	Apply
CO5: Develop standardized storage and handling work procedures	Apply

**Text Book(s):**

T1.Mikel P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", PHI Publishers, 3rd Edition 2016.

T2. Blanchard and Benjamin S, "Logistics Engineering and Management", 6th International Edition, Prentice Hall Inc, 2015.

**Reference Book(s):**

R1. Christopher M, "Logistics and Supply Chain Management - Creating Value Adding Networks", Prentice Hall, 2010.

R2. James M. Apple, "Plant Layout and Material Handling" John Wiley, 3rd Edition, 1977.

R3. Prauss L, "The Green Multiplier - a Study of Environmental Protection and Supply Chain", Antonn Rauss Limited, Palgrave Macmillan, 2005.

R4. Taylor G.D, "Logistics Engineering handbook", CRC Press, 2008.

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1010</b>	<b>Course Title: MANUFACTURING SYSTEMS ENGINEERING</b>		
<b>Course Category: Professional Elective</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Manufacturing Processes

**Course Objectives:**

The course is intended to:

1. Explain the components of manufacturing systems engineering.
2. Identify seven types of wastes.
3. Describe flow production and level production using "JIT".
4. Differentiate appropriate performance metrics.
5. Develop cell level standardized work procedures.

**UNIT I                      PRODUCTION SYSTEM                      7**

Generalized model of production systems- types of production systems and its impact on system design- lifecycle concepts of production systems- Basic IE tools.

**UNIT II              PRODUCTION AND JIT PRODUCTION MANAGEMENT              8**

Approach to production management- Introduction & overview of JIT production system- Relations among sales price- cost and profit, ten arguments against the JIT production revolution- Wastology- types of waste- waste removal and secrets for not creating waste- the 5s approach – theory of constraints.

**UNIT III      FLOW PRODUCTION AND MULTI PROCESS OPERATION              10**

Introduction to flow production- principle of flow analysis- flow production within factories & between factories- precautions and procedures for developing multi-process operations- level production,-various ways to create production schedules- leveling techniques-difference between shish-kabob production and level production.

**UNIT IV BASICS OF KANBAN, KAIZEN AND JIDOKA****10**

Differences between kanban and conventional systems -functions and rules of kanban- variety and quantity of kanban, administration of kanban, visual controls – andons, changeover improvement kaizen- seven rules for improving changeover- steps toward jidoka -difference between jidoka and automation - functions of jidoka, extension of jidoka to the assembly lines - labour cost reduction steps.

**UNIT V STANDARD OPERATIONS, MAINTENANCE AND SAFETY****10**

Overview of standard operation, establishment of standard operation and charts- overall plan for achieving zero defects- the poka-yoke system- types of maintenance- CCO - three lessons in maintenance- importance of safety- waste related forms -5s forms.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1:Explain the components and characteristics of manufacturing systems engineering.	Understand
CO2:Identify seven types of waste through value added and non value added analysis.	Understand
CO3:Describe flow production and level production using "JIT" tools (Kanban, flow, level, synchronization).	Understand
CO4:Differentiate appropriate performance metrics of different manufacturing systems.	Understand
CO5:Develop cell level standardized work procedures by applying concepts of JIT.	Apply

**Text Book(s):**

T1.Chase, Jacobs, Aquilano, "Production and Operations Management" 8<sup>th</sup> Edition, Tata McGraw Hill Companies Inc, 2008.

T2.PaneerSelvam R "Production and Operations Management" Prentice Hall of India, 2012.

T3.Hiroyuki Hirano, "JIT Implementation Manual", English Translation Copy Right Productivity Press, 2009.

**Reference Book(s):**

- R1. Kotsundo Hitomis's, "Manufacturing System Engineering", Second Edition, Taylor & Francis, 1996.
- R2. Adam Jr, Everette E. and Ebert, "Production and Operations Management- Concepts; Models and Behavior" 5<sup>th</sup> Edition, Prentice-Hall of India, 2012.
- R3. Chary "Theory and Problems in Production and Operations Management" Tata Mc-Hraw Hill, 2009.

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1014</b>	<b>Course Title: ENGINEERING ECONOMICS AND COST ANALYSIS</b> (Common to AU & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Manufacturing Technology

### **Course Objective**

The course is intended to

1. Calculate the breakeven point.
2. Application of interest formula.
3. Comparison of economic alternatives.
4. Replacement analysis of equipment.
5. Calculate depreciation of an equipment.

## **UNIT I INTRODUCTION TO ECONOMICS**

**8**

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**

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

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

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

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
<b>At the end of this course, students will be able to:</b>	
CO1: Categorize different cost and calculate the breakeven point for a given business situation	Apply
CO2: Apply different interest formulae and their application in decision making process.	Apply
CO3: Evaluate present value, future value and annual worth analysis on one or more economic alternatives.	Apply
CO4: Determine the economic value of an asset and develop a better replacement policy for given equipment.	Apply
CO5: Evaluate the depreciation of equipment per period.	Apply

**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(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](https://en.wikipedia.org/wiki/Engineering_economics)  
[https://en.wikipedia.org/wiki/Cost%E2%80%93benefit\\_analysis](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	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

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
<b>Total</b>				<b>100</b>

<b>Course Code: 19MEEN1022</b>		<b>Course Title: ADVANCED COMPUTER INTEGRATED MANUFACTURING</b>	
<b>Course Category: Open Elective</b>		<b>Course Level: Introductory</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Manufacturing technology

### **Course Objectives**

The course is intended to:

1. Write NC, DNC and CNC program in CIM.
2. Design manufacturing solution based on CAD System in CIM.
3. Select Materials handling and Storage in CIM.
4. Write coding for Group Technology in CIM
5. Design automated manufacturing based on Artificial Intelligent system, Expert system and FMS in CIM.

### **UNIT I INTRODUCTION TO CIM 9**

Automated Manufacturing system – Needs, Types.CIM - CIM wheel - Components, Evolution, needs, Benefits. NC system - Components, NC motion control system, application, advantages and disadvantages. Computer Numerical control System – Components, functions, advantages. Direct Numerical Control System - Components, functions, advantages.

### **UNIT II COMPUTER AIDED DESIGN 9**

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate. - typical CAD command structure - Types CAD modeling - wire frame modeling, surface modeling and solid modeling.

### **UNIT III MATERIAL HANDLING AND STORAGE SYSTEMS 9**

Materials handling and Storage Systems - Automated storage and retrieval systems, carousel storage systems - Interfacing of Handling and Storage with

Manufacturing system. AGVs - types, advantages and application. Robot – Basic concepts, applications.

#### **UNIT IV GROUP TECHNOLOGY**

**9**

Group Technology – Role of G.T in CAD/CAM Integration, part families, part Classification and coding-DCLASS and MICLASS and OPITZ coding systems - facility design using G.T, benefits of G.T -Cellular Manufacturing.

#### **UNIT V ARTIFICIAL INTELLIGENT SYSTEM, EXPERT SYSTEM AND FMS**

**9**

Artificial Intelligence System, Basic concepts of Artificial intelligence, Intelligent systems and expert systems. Flexible manufacturing systems – Configurations, workstations, planning, applications and benefits - Automated inspection and testing - Machine vision.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Write program for NC, DNC and CNC in Automated Manufacturing systems such as CIM	Apply
CO2: Design manufacturing solution with the features of CAD System such as Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate in design and modeling for CIM.	Apply
CO3: Select appropriate Materials handling and storage systems such as AGVs, AS/RS and Robots for material handling and Storage System in CIM.	Apply
CO4: Write codes using DCLASS, MICLASS and OPITZ for Group Technology in CIM.	Apply
CO5: Design Automated Manufacturing based on Artificial Intelligent system, Expert system and FMS to gradually convert Traditional Manufacturing environment in CIM.	Apply

#### **Text Books**

T1. Mikell. P. Groover –Automation, Production Systems and Computer Integrated Manufacturing||, Pearson Education 2015.

T2. Mikell. P. Groover and Emory Zimmers Jr., "CAD/CAM", Prentice hall of India Pvt. Ltd., 2013.

### **References**

- R1. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2015.
- R2. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2010.
- R3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd., 2005.

### **Web References**

1. [https://en.wikipedia.org/wiki/Computer-integrated\\_manufacturing](https://en.wikipedia.org/wiki/Computer-integrated_manufacturing)

### **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	2	1
CO2	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO3	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO4	3	2	1	1	-	-	-	1	-	1	-	1	2	1
CO5	3	2	1	1	-	-	-	1	-	1	-	1	2	1

High-3; Medium-2; Low-1

### **Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1015</b>	<b>Course Title: PRINCIPLES OF MANAGEMENT</b> (Common to MC & ME)		
<b>Course Category: Professional Elective</b>	<b>Course Level: Mastery</b>		
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

➤ 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**

Organization - Management - Role of managers - Evolution of Management thought - Organization and the environmental factors - Managing globally - Strategies for International Business.

### **UNIT II      PLANNING      9**

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**

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**

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**

Process of controlling - Types of control - Budgetary and non-budgetary control techniques – Managing Productivity – Cost Control – Purchase Control – Maintenance Control - Quality Control - Planning operations.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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(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
<b>CO1</b>	2	1	-	-	-	-	-	1	-	1	2	1	-	-
<b>CO2</b>	2	1	-	-	-	-	-	1	-	1	2	1	-	-
<b>CO3</b>	2	1	-	-	-	-	-	1	-	1	2	1	-	-
<b>CO4</b>	2	1	-	-	-	-	-	1	-	1	2	1	-	-
<b>CO5</b>	2	1	-	-	-	-	-	1	-	1	2	1	-	-

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100





**UNIT IV NETWORK MODELS****9**

Maximal flow problem – Shortest route problem – Minimal spanning tree problem - Project networks, CPM, PERT, Crashing of networks- L P model for crashing , project costing and control.

**UNIT V QUEUING AND REPLACEMENT MODELS****9**

Queuing theory terminology - Single server, multi server, Limited queue capacity - applications - Markov chains. Replacement models - Money value, present worth factor and discount rate.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Solve linear programming problems with simplex and graphical methods after formulation and assumption of required parameters.	Apply
CO2: Select the optimal solution for transportation and assignment problems, based on cost, using Northwest, Least Cost, Vogals Approximation and Hungarian methods.	Apply
CO3: Calculate EOQ and EBQ for manufacturing and purchase models operating with or without shortage.	Apply
CO4: Select critical paths using CPM and PERT in projects based on minimum duration of activities	Apply
CO5: Select the replacement policy and shortest queuing time based on economic cost for various replacement and queuing models. them in domain specific situations.	Apply

**Text Book(s):**

T1.Hillier and Lieberman "Introduction to Operations Research", TMH, 2015.

T2.R.Panneerselvam, "Operations Research", PHI, 2006.

**Reference(s):**

R1. Philips, Ravindran and Solberg, "Operations Research", John Wiley,2002.

R2. Hamdy A Taha, "Operations Research – An Introduction", Prentice Hall India,2003.

R3. Ronald L Rardin, "Optimization in Operations Research", Pearson, 2003.

**Web References:**

1. <http://nptel.ac.in/courses/112106134/1>
2. <http://www.mit.edu/~orc/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1016</b>		<b>Course Title: QUALITY ENGINEERING</b> (Common to AU, MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Metrology and Measurements.

### **Course Objectives**

The course is intended to:

1. Describe the need of quality and customer satisfaction.
2. To explain the basics of Quality cost with classification.
3. To explain the concept of total quality management relevant to both manufacturing and service industry.
4. Describe the various tools used in Quality Engineering and Management.
5. Describe the steps used for Designing for Quality.

## **UNIT I INTRODUCTION**

**9**

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**

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**

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**

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**

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

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the need of quality and customer satisfaction.	Understand
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: Explain the various tools used in Quality Engineering and Management.	Understand
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, 2008.

T2.Dale H. Besterfield , –Total Quality Management¶ Pearson Education, 2018.

**Reference(s):**

R1. Juran and Gryna –Quality planning and Analysis¶, TMH, New Delhi,2010.

R2. B. L. Hanson & P. M. Ghare, –Quality Control & Application¶, Prentice Hall of India, 2001.

**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	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1012</b>		<b>Course Title: TOTAL PRODUCTIVE MAINTENANCE</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Manufacturing Processes

**Course Objectives:**

The course is intended to:

1. To describe modern maintenance concepts and practices.
2. To apply analytical tools in maintenance management.
3. To apply Reliability Centered Maintenance for industrial systems.
4. Describe TPM and global trends in maintenance management.
5. Demonstrate simple instruments used for condition monitoring.

**UNIT I            MODERN MAINTENANCE CONCEPTS AND PRACTICES            9**

Maintenance definition -Maintenance management – Maintenance Concepts: Objectives, Organization and Functions of Maintenance, Maintenance strategies, Types of Maintenance – Maintenance systems – (Planned, Unplanned / Breakdown, Corrective, Opportunistic, Routine, Preventive, Predictive, Condition based maintenance systems),Maintenance planning and scheduling, Maintenance Logistics, Human factors in Maintenance and Staffing methods, Maintenance manuals, Maintenance costs

**UNIT II    ANALYTICAL TOOLS IN MAINTENANCE MANAGEMENT            9**

Failure Data Analysis, MTBF,MTTF, Useful life-Survival curves, Repair time, Breakdown time distributions- Poisson's, Normal, Exponential, Availability, Reliability, Maintainability, Maintainability prediction – System effectiveness- Overhaul / Repair / Replace maintenance policy, Queuing applications, simulation, spare parts

management, Replacement Decisions: Optimal interval between preventive replacements, Overall Equipment Effectiveness

### **UNIT III RELIABILITY CENTERED MAINTENANCE**

**9**

Reliability Centered Maintenance (RCM), Objectives and function, Steps in RCM implementation, steps in RCM analysis, System selection, Tero technology – RCM effectiveness indicators, RCM tasks Proactive Maintenance, Reliability models - System reliability- Series, Parallel and mixed configuration, System reliability determination; Reliability improvement, Scheduled restoration and scheduled discard, The P-F interval and P-F curves, linear as non linear PF curves , Default actions, RCM Decision diagrams.

### **UNIT IV TPM AND GLOBAL TRENDS**

**9**

Concept of TPM, Characteristics of TPM, Zero breakdown concepts, Zero Defects and TPM, FMECA – Maintainability prediction- Design for maintainability, Maximizing equipment effectiveness, Autonomous maintenance program, Five pillars of TPM, TPM Small group activities. Implementing TPM.Philosophy / Indications of TPM. TPM Development - Preparation phase, Master Plan, Initiatives, Promotion, Planning, Organization, Awareness, Training, Establishment of basic policies and goals, TPM organization, Implementation phase; Consolidation phase. Measuring TPM effectiveness: Measuring TPM effectiveness Indicators, Plant effectiveness and Measuring; TPM Benefits and Global trend

### **UNIT V CONDITION MONITORING IN MAINTENANCE**

**9**

Condition Based Maintenance: Machine signatures, Signature Analysis-MMIS Expert systems, Temperature noise, vibration and wear particle analysis, on line and off line techniques. Online Monitoring Condition Monitoring Techniques, Vibration Monitoring and Signature Analysis. Wear Debris Monitoring, Maintenance Management Information System, Expert systems, Corrosion Monitoring and Control, Case Studies in Maintenance, Measurement and benchmarking of performance, MIS for maintenance.



Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Describe modern maintenance concepts and practices	Understand
CO2: Apply analytical tools in maintenance management	Apply
CO3: Apply Reliability Centered Maintenance for industrial systems	Apply
CO4: Illustrate TPM and global trends in maintenance management	Apply
CO5: Demonstrate use of simple instruments used for condition monitoring in maintenance	Apply

#### **Text Book(s):**

T1.Seiichi Nakajima, "Introduction to TPM", Productivity Press, Chennai, 2010.

T2.Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts Management", Prentice - Hall of India Pvt. Ltd., 2013.

#### **Reference(s):**

R1. Goto, F., "Equipment planning for TPM Maintenance Prevention Design", Productivity Press, 1992.

R2. David J. Sumanth, "Total Productivity Management : A Systematic and Quantitative Approach to Compete in Quality, Price and Time", Productivity Press, 1997.

#### **Web References:**

1. [http://www.plant-maintenance.com/articles/tpm\\_intro.pdf](http://www.plant-maintenance.com/articles/tpm_intro.pdf)
2. <http://www.ame.org/sites/default/files/TPM-introduction-AME.pdf>

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1017</b>		<b>Course Title: INDUSTRIAL SAFETY MANAGEMENT</b> (Common to AU, MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Manufacturing Technology

### **Course Objectives**

The course is intended to:

1. Explain the importance of safety management.
2. Explain the measurement and monitoring techniques.
3. Explain the roles and responsibilities of Safety department.
4. Describe the importance of Industrial safety acts.
5. Explain the classes of fires and controlling techniques.

## **UNIT I INTRODUCTION TO SAFETY MANAGEMENT 9**

Principles of Safety Management ,Need of safety in organisation, Occupational Health & hygiene, modern safety concept-Safe operating procedure (SOP's), Safety permits, Social and physiological effects, Behavioural based safety- aim, benefits, law and rules, Accident - Near Miss, injury, Cost of accident, Unsafe act , Unsafe condition, Environmental safety - air pollution, water pollution ,industrial noise & vibration control ,physical hazards - chemical hazards , biological hazards, electrical hazards.

## **UNIT II SAFETY PERFORMANCE MONITORING 9**

Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Components of safety audit, types of audit, audit methodology, permanent total disabilities, permanent partial disabilities, temporary total disabilities - Concept of an accident, reportable and non-reportable accidents, unsafe act and condition – principles of accident prevention incident rate, accident rate, safety score, safety activity rate Records of accidents, accident reports.

### UNIT III SAFETY ORGANISATION

9

Role and responsibilities of management and line staffs Supervisors and Employees, Safety committee, Motivation, budgeting for safety, safety policy, Safety Education and Training, Importance of training-identification of training needs- Training methods – programme, seminars, conferences, role of government agencies and private consulting agencies in safety training - creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training, Personal Protective Equipment (PPE) - Requirements of PPE, Selection and Usage of PPE, Importance of IS Standard, Types of PPE

### UNIT IV INDUSTRIAL ACTS

9

Indian Factories act 1948, Tamilnadu Factories rule 1950 – Environmental protection act 1986- Indian electricity act 1910, Indian electricity rule 1956 - Indian boiler act 1923 - Workmen's compensation act 1923 - Explosive act 1983 - Noise pollution rules 2000

### UNIT V DISASTER MANAGEMENT AND EMERGENCY PREPAREDNESS 9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of Combustion - sources of ignition - fire triangle - principles of fire extinguishing - active and passive fire protection systems – various classes of fires – a, b, c, d, e – fire extinguishing agents - fire stoppers, Emergency preparedness and responsibilities, On site and off site emergency plan, Mock drill Bhopal Gas tragedy - faulty handling of equipment's, failure of hoist, crane.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the importance of safety management to control the accidents, pollution and hazards.	Understand
CO2: Explain the measurement and monitoring techniques to report the safety performance.	Understand
CO3: Explain the roles and responsibilities of Safety department in an organization to eliminate the unsafe act and conditions.	Understand
CO4: Describe the importance of Industrial safety acts related to safety environment pollution in India.	Understand
CO5: Explain the classes of fires and controlling techniques and plan for an onsite and offsite emergency.	Understand

**Text Book(s):**

- T1. Deshmukh .L.M "Industrial Safety Management" McGraw-Hill, 2006.
- T2. C.RayAsfahl "Industrial Safety and Health management" Pearson Prentice Hall, 2010.

**Reference(s):**

- R1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
- R2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980
- R3. Subramanian.V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras Book Agency, 21st ed., Chennai, 2000.

**Web References:**

1. <http://www.icebookshop.com>
2. <http://nptel.ac.in/courses/112107143/40>

**Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C01	2	1	-	-	1	-	-	1	-	1	-	1	-	-
C02	2	1	-	-	1	-	-	1	-	1	-	1	-	-
C03	2	1	-	-	1	-	-	1	-	1	-	1	-	-
C04	2	1	-	-	1	-	-	1	-	1	-	1	-	-
C05	2	1	-	-	1	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



**UNIT III DIESEL AND GAS TURBINE POWER PLANT****9**

Layout of Diesel Power Plant -Types and Components - Engine Selection based on Application-Recent developments.

Gas Turbine Power Plant – Layout – Fuels - Gas Turbine Material - Types of Combustion Chambers - Performance Improvement Methods - Reheating, Regeneration, Inter cooling, Combined Cycle Power Plant- Recent developments.

**UNIT IV NON-CONVENTIONAL POWER PLANTS****8**

Solar Power Plants-Low, Medium and High Temperature Systems -Wind Energy Conversion System-Horizontal and Vertical Wind Turbines -Geo-Thermal Power Plant - Bio Gas Power Plant - MHD - OTEC Systems - Tidal Power Plants.

**UNIT V POWER PLANT ECONOMICS****7**

Load duration curves - Cost of Electric Energy, Types of Tariffs- Economics of Load Sharing - Comparison of Economics of Various Power Plants. Energy Conservation and Energy Audit in steam power plant - Renovation and Modernization of aged power plants.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1:Describe the construction and working principle of various subsystem and pollution control methods in a steam power plant	Understand
CO2:Explain the working principle of various components of hydroelectric and various types of nuclear reactor used in nuclear power plant.	Understand
CO3:Describe the various components, working principle and performance improvement methods in diesel and gas turbine power plant	Understand
CO4:Explain the working principle of various types of non conventional power plants viz Solar, Wind, Geothermal, Bio Gas, MHD, OTEC, Tidal	Understand
CO5: Calculate the cost of power generation for various power plant using different types of tariff systems.	Apply



**Text Book(s):**

T1.S. C. Arora and S. Domkundwar, "A course in Power Plant Engineering",  
Dhanpat Rai & Sons, New Delhi, 2008.

T2.P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Company Pvt Ltd., New  
Delhi, 2007.

**Reference(s):**

R1. M. M. El-Wakil, "Power Plant Technology", Tata McGraw Hill Publishing  
Company Pvt Ltd., New Delhi, 1985.

R2. G.R. Nagpal, "Power Plant Engineering", Khanna Publishers, New Delhi, 2002.

R3. G.D. Rai, "Introduction to Power Plant Technology", Khanna Publishers, New  
Delhi, 1995.

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1018</b>		<b>Course Title: AUTOMOBILE ENGINEERING</b> (Common to MC & ME)	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

- Applied Thermodynamics

**Course Objectives:**

The course is intended to:

1. Explain the vehicle structure and components.
2. Explain the IC Engines and lubricating systems.
3. Explain the construction and working principle of Transmission system.
4. Explain the construction and working principle of steering, braking and suspension system.
5. Explain electrical system, accessories and emission norms.

**UNIT I      VEHICLE STRUCTURE AND ENGINES**

**9**

Types of automobiles , vehicle construction and different layouts chassis, frame and body, resistances to vehicle motion and need for a gearbox, Introduction to IC Engines-types, working principles, components of engines-their forms functions and materials. Air bags- Air pollution control- Catalytic converter working principle-Emission norms- Bharat and Euro emission Standards

**UNIT II      FUELS AND LUBRICATION SYSTEM**

**9**

Petrol fuel feed system: Feed pump – mechanical, electrical type – Carburetors – fixed venturi type (carter), variable venturi type (SU), multiple barrel type (Solex, Mikuni), carburetors for two wheelers -Petrol injection - Multi Point Fuel Injection (MPFI), VVT (petrol engines), Turbo chargers, Diesel fuel system: Jerk type fuel injection pump-Methods of fuel injection-common rail, distributor types-Nozzles-Cold starting aids, Cooling system: Direct and indirect cooling, Lubricating system: Mist, wet and dry sump. Ignition system- coil ignition and magneto ignition system - Spark plug

**UNIT III TRANSMISSION SYSTEMS****9**

Clutch-types and construction , gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel -torque converter, propeller shaft, slip joints, universal joints ,Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive

**UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS****9**

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control. Battery -Construction and maintenance, Starter motor – types, alternator, distributor, generator, cut out relay, panel board instruments

**UNIT V ELECTRIC VEHICLE****9**

EV Historical background, Benefits of using EVs, comparison with IC engine drive vehicles, Types of EVs, Motor drive technology, Energy sourcing, and charging technology, EV charging standards-V2G, G2V, V2B, and V2H, EV subsystem and configuration, Introduction to Hybrid electric vehicle,

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the vehicle structure chassis layouts and different types of IC Engines	Understand
CO2: Describe the fuels and lubrication system used in SI & IC engines. viz carburetors, APFI, VVT, Turbo charger, CRDI, Lubrication system viz mist, wet and dry sump system	Understand
CO3: Explain the construction and working principle of various components of a Transmission system viz gear box,, clutch, torque converter, fluid flywheel, differential etc.	Understand
CO4: Describe the construction and working principle of steering and suspension system of a Automotive vehicle	Understand
CO5: Explain the electrical vehicle and its sub systems.	Understand

**Text Book(s):**

T1.Kirpal Singh, "Automobile Engineering Vol. 1 & Vol 2", Standard Publishers, 7<sup>th</sup> Edition, 2012.

T2.Sethi H.M, "Automobile Technology", Tata McGraw-Hill, 2003.

**Reference(s):**

R1. Jain, K.K., and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.

R2. Srinivasan.S, "Automotive Mechanics" 2<sup>nd</sup> edition, Tata McGraw-Hill, 2003.

R3. Joseph Heitner, "Automotive Mechanics", 2<sup>nd</sup> edition, East-West Press, 1999.

**Web References:**

1. [https://en.wikipedia.org/wiki/Automotive\\_engineering](https://en.wikipedia.org/wiki/Automotive_engineering)
2. <http://auto.howstuffworks.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	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



**UNIT III AIR CONDITIONING SYSTEM AND ITS COMPONENTS****9**

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams. Different types of Air Conditioner- Room/Window, Central Air Conditioner.

**UNIT IV AIR CONDITIONING LOAD ESTIMATION AND ITS APPLICATION 10**

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Food Preservation, Food Storage & Distribution, LNG – Ice Manufacturing Plant – Solar Air Conditioning, – Automobile air conditioning, Refrigerated trucks.

**UNIT V INSTALLATION AND SERVICING****8**

Air distribution systems - Study of different types of duct systems - Charging of refrigerant - Servicing of air-conditioning, – Safety procedures, Leak detection procedures- Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors - Automatic Dew point recorder, Actuators & Safety controls.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Calculate the performance of vapor compression refrigeration cycles.	Apply
CO2: Explain the various components of vapor compression refrigeration system viz. evaporator, compressor, condenser and expansion valve.	Understand
CO3: Explain the various air conditioning system using psychrometric concepts.	Understand
CO4: Explain various air conditioning system load calculation and the applications of refrigeration and air conditioning systems viz. food preservation, automobile air conditioning, solar air conditioning.	Understand
CO5: Explain the refrigerant charging procedure, leakage detection and various control methods.	Understand

**Text Book(s):**

T1.Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 2015.

T2.Arora. C.P., "Refrigeration and Air conditioning", 3<sup>rd</sup> edition. Tata McGraw-Hill, 2017.

**Reference(s):**

R1. Dossat, R.J. "Principles of Refrigeration", Prentice-Hall, 2013.

R2. R.S.Khurmi, J.K.Gupta. "Textbook of Refrigeration and Air-conditioning" S.Chand, 2<sup>nd</sup> Edition, 2006.

R3. ASHRAE 2017 Hand book (Fundamentals & Equipments).

**Web References:**

1. <http://nptel.ac.in/courses/112105128/>

2. <https://www.ashrae.org/>

**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	-	-
CO2	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO3	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEN1015</b>		<b>Course Title: SOLAR AND WIND ENERGY ENGINEERING</b>	
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours: 45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

- Applied Thermodynamics

### **Course Objectives**

The course is intended to:

1. Identify the availability of solar radiation.
2. Describe main features and operation of solar thermal systems.
3. Explain the working principle of solar-photovoltaic systems.
4. Acquire the knowledge of wind turbine aerodynamics.
5. Describe main features and operation of various wind turbines and their energy conversions.

## **UNIT I SOLAR ENERGY RADIATION AND SOLAR THERMAL COLLECTORS 9**

Solar radiation availability - radiation measurement – transmittance - absorptance – Basic earth sun angles - estimation of average solar radiation, radiation on tilted surface - Flat plate collectors - heat transfer correlations - collector efficiency - heat balance - absorber plate – types - selective surfaces. Solar water heaters - types- their performance. Solar driers - types - heat transfer - performance of solar dryers - agro industrial applications.

## **UNIT II SOLAR CONCENTRATING COLLECTORS**

**9**

Concentrating collectors - types - reflectors - solar thermal power stations - principle and applications - Solar energy storage systems - thermal - sensible and latent heat, chemical, electrical, electro-magnetic energy storage - selection of materials for energy storage - Solar distillation - application - Solar stills - types - Solar pond - performance - characteristics - applications – Solar refrigeration.



**UNIT III SOLAR PV TECHNOLOGY****9**

Solar photovoltaic technology -introduction - solar cell basics - Types of solar cells and modules - encapsulation - Design of solar PV system - load estimation - batteries - invertors - operation - system controls. Standalone and grid connected systems - PV powered water pumping - Hybrid system - Solar technologies in green buildings.

**UNIT IV WIND ENERGY****9**

Nature of the wind – power in the wind – factors influencing wind – wind energy potential and installation in India- wind speed monitoring - wind resource assessment - wind power laws - velocity and power duration curves - Betz limit - site selection.

**UNIT V WIND MILL TYPES AND APPLICATIONS****9**

Wind energy conversion devices - classification, characteristics, applications - Design of horizontal axis wind mill rotor diameter - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures. Water pumping - Hybrid systems – Wind mill safety and environmental aspects.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Identify the availability of solar radiation in different places and operation of solar thermal systems.	Understand
CO2: Describe main features and application of solar collectors.	Understand
CO3: Explain the working principle of solar-photovoltaic systems.	Understand
CO4: Acquire the knowledge of wind energy and its assessment.	Understand
CO5: Describe main features and operation of various wind turbines and their energy conversions.	Understand

**Text Book(s):**

- T1. Rai., G.D. "Solar Energy Utilization" Khanna publishers, New Delhi, 2012.
- T2. Solanki, C.S. "Renewable Energy Technologies: A Practical guide for beginners". PHI learning Pvt. Ltd, New Delhi. 2008.

**Reference(s):**

- R1. Wind Energy Engineering, Pramod Jain, McGraw Hill Education, New York, 2<sup>nd</sup> Edition, 2010.
- R2. Rajput. R.K. "Non- Conventional Energy Sources and Utilization", S. Chand & Company Pvt. Ltd, New Delhi, 2013.
- R3. Rao.S and B.B. Parulekar. "Energy Technology - Non conventional, Renewable and Conventional". Khanna Publishers, Delhi, 2000.

**Web References:**

1. <http://www.icebookshop.com>
2. <http://nptel.ac.in/courses/112107143/40>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Tutorial	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



#### **UNIT IV INTEGRATION ASPECTS IN AN ELECTRIC VEHICLE (2 & 4 WHEELER) 10**

Expectations from an electric vehicle - Vehicle design, body styles - Vehicle layout - Vehicle's subsystems - Vehicle concepts - Longitudinal dynamics of an electric vehicle, torque demand - Crash requirements and vehicle's safety requirements.

#### **UNIT V TRENDS AND OUTLOOK**

**10**

Study of battery systems in electric passenger vehicles (Bus, Car and Two Wheeler) - Production and cost analysis - Mass production demands - Cell manufacturing - Demands on cooling systems - Fast charging and charging stations - Second life use for battery packs - Solid state batteries - Ecosystem for electric vehicles.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Select suitable Li-Ion battery cells for use in electric vehicles based on the calculation of various cell parameters	Apply
CO2: Prepare mechanical assembly drawings of battery systems for electric vehicles using available CAD software	Apply
CO3: Design battery management system for various battery systems to obtain peak performance by monitoring and charge equalization.	Apply
CO4: Prepare vehicle layout for sub-systems in TWO and FOUR wheelers using available CAD software	Apply
CO5: Perform cost benefit analysis of battery sub systems based on market conditions and manufacturability	Apply

#### **Text Book(s):**

T1.Reiner Korthauer, "Lithium-Ion Batteries: Basics and Applications", Springer, August 2018. ISBN 978-3-662-53069-6

#### **Reference(s):**

R1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles", Wiley, 2015.

ISBN 978-1-118-41478-1

R2. Seth Leitman and Bob Brant, "Build Your Own Electric Vehicle", McGraw Hill, 2013. ISBN 978-0-07-177056-9

R3. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2018. ISBN 978-81-265-5670-8

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1019</b>	<b>Course Title: INDUSTRIAL IOT</b> (Common to AU, MC & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives:**

The course is intended to:

1. Explain the basic concepts of IIoT.
2. Explain the various Architectures of IIoT.
3. Explain the sensors available in IIoT based on application requirement.
4. Explain the basics of Big Data and IoT Analytics.
5. Explain the various applications of IoT .

**UNIT I INTRODUCTION**

**9**

Introduction to IoT, IoT Vs. IIoT, History of IIoT, Components of IIoT -Sensors, Interface, Networks, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Role of IIoT in Manufacturing Processes, Sustainability through Business excellence tools Challenges & Benefits in implementing IIoT.

**UNIT II ARCHITECTURES**

**9**

Overview of IOT components, various architectures of IOT and IIOT, Advantages & Disadvantages, IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT, IIoT Business Model and Reference Architectures, Industrial IoT-Sensing,IIoT-Processing and Communication, IIoT Networking.

**UNIT III      SENSOR AND INTERFACING****9**

Introduction to sensors, Transducers, Classification, Roles of sensors in IIOT, Various types of sensors, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet and BACNet.

**UNIT IV      BIG DATA AND IOT ANALYTICS****9**

Big Data, Characteristics of Big Data, Types of Big Data, Analysing of Data, Applications, Big Data tools, Introduction to Machine Learning and Data Science ,R and Julia Programming, IOT Analytics, Role of Analytics in IOT, Data visualization Techniques.

**UNIT V      IoT APPLICATIONS****9**

Internet of Things Applications : City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIoT in Manufacturing Sector, Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the basic concepts of IIoT.	Understand
CO2: Explain the various Architectures of IIoT.	Understand
CO3: Explain the sensors available in IIoT based on application requirement.	Understand
CO4: Explain the basics of Big Data and IoT Analytics.	Understand
CO5: Explain the various applications of IoT.	Understand

**Text Book(s):**

- T1.Sudip Misra, Chandana Roy, Anandarup Mukherjee – Introduction to Industrial Internet of Things and Industry 4.0|| CRC Press,1st edition 2020.
- T2.Adrian McEwen, Hakim Cassimally –Designing the Internet of Things||, John Wiley & Sons, 1st edition, 2013.
- T3.Perry Lea, –Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security||, Packt Publishing Ltd., 2018.
- T4.Vijay Madisetti and Arshdeep Bahga, –Internet of Things (A Hands-on Approach)||, Orient Blackswan Private Limited - New Delhi, 1<sup>st</sup> edition 2015.

**Reference(s):**

- R1. Qusay F. Hassan, –Internet of Things A to Z: Technologies and Applications||, John Wiley & Sons,2018.
- R2. Joe Biron and Jonathan Follett –Foundational Elements of an IoT Solution: The Edge, The Cloud, and Application Development||, Cisco Press, First Edition, 2017.
- R3. Alasdair Gilchrist, –Industry 4.0: The Industrial Internet of Things||, Apress; 1st edition 2017.

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1



**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:</b> 19AUEC1002	<b>Course Title: FLEET MANAGEMENT</b> (Common to AU & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives**

The course is intended to:

1. Develop knowledge on Fleet Management.
2. Develop knowledge on the Fleet Analysis.
3. Develop knowledge on the Fleet Policy Management.
4. Develop knowledge on the Fleet Life Cycle & Optimization.
5. Develop knowledge on the Current Technologies & Systems used in Fleet.

**UNIT I INTRODUCTION TO FLEET MANAGEMENT 9**

Overview of Fleet Management - Origins of Fleet Management -Main functions of Fleet Management - Fleet Manager- Roles and Responsibilities

**UNIT II FLEET ANALYSIS 9**

Fleet Analysis and Operations Survey - Fleet Audits - Conditions and Location of the Fleet Vehicle- Fleet Scheduling- Driver Management

**UNIT III FLEET POLICY MANAGEMENT 9**

Formulate a Fleet Policy - critical policy issues - critical expenses- Discover risk issues facing your fleet operation- perform critical expense control calculations for fuel, maintenance, depreciation, tyres

**UNIT IV FLEET LIFE CYCLE & OPTIMIZATION****9**

Route optimization- ergonomic user interfaces- Intelligent maps- Dispatch Management and GPS Tracking- Open and robust IT architecture- Fleet life cycle- Discover different methods of financing fleet - calculate total fleet costing, insurance premium calculations and optimization – Fleet Life Cycle & Optimization Case Studies

**UNIT V INTELLIGENT TRANSPORT SYSTEMS****9**

Developer Platforms : Google and Apple Technologies - Vehicle Hacking using Arduino and CAN Bus shield -Design Wireless Smart City ecosystem , Design Vehicle Tracking Systems - Advanced fleet management software solutions- Case Studies.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Explain the fundamental concepts of Fleet management	Understand
CO2: Explain the various fleet management and analysis technique	Understand
CO3: Describe the components Fleet Policy Management	Understand
CO4: Explain the concept on Fleet Life Cycle & Optimization	Understand
CO5: Explain the concept of Intelligent Transport Systems	Understand

**Text Book(s):**

- T1.Asvin Goel, "Fleet Telematics: Real-time Management and Planning of Commercial Vehicle Operations", Springer, 2017.
- T2.John Dolce, "Analytical Fleet Maintenance Management", 3rd Edition, SAE International , 2009.

**Reference Book(s):**

- R1. Fleet Telematics: Real-time management and planning of commercial vehicle operations, Springer, 2007.

**Web Reference:**

1. <https://www.udemy.com/course/introduction-to-fleet-management/>
2. <https://blogsyear.com/learn-about-telematics-and-its-impact-on-fleet-management/>
3. <https://www.descartes.com/resources/knowledge-center/5-critical-features-fleet-solutions-route-optimization-dispatch>

### Course Articulation Matrix

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

High-3; Medium-2; Low-1

### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:</b> 19AUEC1003	<b>Course Title: IN-VEHICULAR NETWORKS</b> (Common to AU & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives**

The course is intended to:

1. Develop knowledge on The CAN protocol and its Working.
2. Develop knowledge on The LIN protocol and its Working.
3. Develop knowledge on of MOST , FlexRay protocol and its Working.
4. Develop knowledge on The PCI, I2C, RS232 and SPI protocol and its Working.
5. Develop knowledge on The GPS and GSM Systems Working and automobile application.

**UNIT I            ELECTRONIC SIGNAL ACQUISITION AND CONDITIONING            9**

Overview of vehicular Data communication and networking - Types of Bus- need of vehicle networking-CAN Protocol: frame formats, message transmission - bit encoding - bit timing and synchronization - types of errors – Error handling -data rate Vs bus length.

**UNIT II            LOCAL INTERCONNECTED NETWORK            9**

Introduction to LIN- standard overview - applications - LIN Communication real time data transmission - message frame formats, bit encoding- timing and synchronization - data rate and bus length- network topology- bus access - physical layer standards

**UNIT III            MOST AND FLEXRAY            9**

MOST and FlexRay: MOST review - data rates - data types – topology- application areas- FlexRay Introduction- network topology - ECUs and Bus interfaces - Controller host interface and protocol operation controls - media access control

and frame and symbol processing - coding/decoding unit - FlexRay scheduling - message processing - Wakeup/startup -applications.

#### **UNIT IV OTHER PHYSICAL LAYER COMMUNICATION PROTOCOLS 9**

Peripheral component interface (PCI)- Inter-Integrated Circuit(I<sup>2</sup>C)- RS232- Serial Peripheral Interface (SPI) -Ethernet

#### **UNIT V WAN , SATELLITE NETWORKS AND GSM 9**

Introduction to WAN Networks-GPS - setting receivers - Positioning - activating the navigation function -Concept of latitude and longitude grid system - Mapping and location technologies – application- GSM.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Demonstrate Working of The CAN protocol	Understand
CO2: Demonstrate Working of The LIN protocol	Understand
CO3: Explain the construction and working of MOST and FlexRay protocol	Understand
CO4: Explain the construction and working of PCI, I2C, RS232 and SPI	Understand
CO5: Demonstrate Working of The GPS and GSM systems	Understand

#### **Text Book(s):**

- T1.Bosch, "Robet. Bosch Automotive Networking: Expert Know-How on Automotive Technology", Germany, Bentley Publishers, 2007.
- T2.Kukushkin, Alexander, "Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G", Germany, Wiley, 2018.
- T3. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, "Global Navigation Satellite Systems, Inertial Navigation, and Integration", 3rd Edition. 2015.

**Reference Book(s):**

R1. Dressler,Falko,and Sommer, Christoph, – Vehicular Networking|| United Kingdom, Cambridge University Press, 2014.

R2. Elliott D. Kaplan, Christopher J. Hegarty (eds.), Understanding GPS/GNSS. Principles and Applications, Third Edition, Artech House.

**Web Reference:**

1. <https://nptel.ac.in/courses/117/102/117102062/>
2. <https://nptel.ac.in/courses/117/105/117105131/>
3. <https://nptel.ac.in/courses/108/102/108102045/>

**Course Articulation Matrix**

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

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code:19AUEC1004</b>	<b>Course Title: AUTOMOTIVE INFOTRONICS</b> (Common to AU & ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

**Pre-requisites:**

➤ Nil

**Course Objectives**

The course is intended to:

1. Develop knowledge on general construction and working of Driver information system.
2. Develop knowledge on Lateral/Side Sensing and Control Systems.
3. Develop knowledge on Longitudinal Sensing and Control Systems.
4. Develop knowledge on Integrated Lateral and Longitudinal Control and Sensing Systems.
5. Develop knowledge on Security systems and its Working used in automobile application.

**UNIT I INTRODUCTION**

**8**

Driver information system: Architecture of Driver information system, Vehicular Sensors Datas, data types, Bus types and Gateway, interfacing devices, indication systems, data storage, Display devices

**UNIT II LATERAL/SIDE SENSING AND CONTROL SYSTEMS**

**10**

Lane Departure Warning System, Road Departure Warning Systems, Lane Keeping Assist Systems, Parallel Parking Assist, Side Sensing: Blind Spot Monitoring and Lane Change Assistance, Comprehensive Lateral Control Assistance, Rollover Collision Avoidance (RCA) for Heavy Trucks



**UNIT III LONGITUDINAL SENSING AND CONTROL SYSTEMS****9**

Rear Sensing for Parking-Night Vision-Adaptive Front Lighting-Adaptive Cruise Control-Safe Gap Advisory-Forward Collision Warning-Rear Impact Countermeasures-Forward Crash Mitigation (FCM) and Avoidance-Active Braking-Pedestrian Detection and Avoidance-Next Generation Sensors.

**UNIT IV INTEGRATED LATERAL AND LONGITUDINAL CONTROL AND SENSING SYSTEMS****9**

Sensor Fusion: CARSENSE for Urban Environments, INVENT Data Fusion Approach - Autonomous Intersection Collision Avoidance, Bus Transit Integrated Collision Warning System, Integrated Vehicle-Based Safety System (IVBSS) Program, PReVENT Integrated Systems.

**UNIT V SECURITY SYSTEMS****9**

Anti-theft technologies - mechanical, electromechanical and electronic immobilizers, alarm system, stolen vehicle tracking system, remote keyless entry, number plate coding and recognition system , Automotive cyber security - Car Hacking.

Course Outcomes	Cognitive Level
<b>At the end of this course, students will be able to:</b>	
CO1: Describe general construction and working of Driver information system	Understand
CO2: Explain the working of Lateral/Side Sensing and Control Systems	Understand
CO3: Explain the working of Longitudinal Sensing and Control Systems	Understand
CO4: Explain the working of Integrated Lateral and Longitudinal Control and Sensing Systems	Understand
CO5: Explain about security systems usage in vehicle automobile	Understand

**Text Book(s):**

T1.Bosch, "Robet. Bosch Automotive Networking: Expert Know-How on Automotive Technology", Germany, Bentley Publishers, 2007.

T2.Kukushkin, Alexander, "Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G", Germany, Wiley, 2018.

T3. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, "Global Navigation Satellite Systems, Inertial Navigation, and Integration", 3rd Edition. 2015.

#### Reference Book(s):

R1. Dressler, Falko, and Sommer, Christoph, "Vehicular Networking", United Kingdom, Cambridge University Press, 2014.

R2. Elliott D. Kaplan, Christopher J. Hegarty (eds.), Understanding GPS/GNSS. Principles and Applications, Third Edition, Artech House.

#### Web Reference:

1. <https://nptel.ac.in/courses/117/102/117102062/>
2. <https://nptel.ac.in/courses/117/105/117105131/>

#### Course Articulation Matrix

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

High-3; Medium-2; Low-1

#### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



SI Engine management system, CI Engine management system including emission control, Transmission management system.

**UNIT V CHASSIS ELECTRONICS****9**

Vehicle pitch, roll, yaw - Vehicle Gyro sensor and interfacing- Tyre Slip- ABS- TCS- ESP- EBD. Body electronics system wiper.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Execute simple program using microcontroller for controlling simple applications	Apply
CO2: Interface the required peripherals with microcontroller for given application	Apply
CO3: write program to Interface sensors and actuator using microcontroller	Apply
CO4: Explain the working principle of power train management system of an automobile	Understand
CO5: Explain the working principle of chassis electronics systems of an automobile	Understand

**Text book(s):**

- T1. Frank Vahid and Tony Givargis, "Embedded system design A unified Hardware/software Introduction", Wiley India pvt. Ltd., 2012
- T2. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.Mckinlay, "The 8051 Microcontroller and Embedded system using Assembly and C" 2nd Edition, Pearson education, 2009.

**References book(s):**

- R1. David E.Simon, "An Embedded software premier", Pearson education, 2010.
- R2. Automotive Handbook" 7th edition, Bosch, 2011.

R3. Halfacree, Gareth, and Upton, Eben. Raspberry Pi User Guide. Germany, Wiley, 2012.

R4. Hughes, J. M.. Arduino: A Technical Reference: A Handbook for Technicians, Engineers, and Makers. United States, O'Reilly Media, 2016.

**Website references:**

1. <https://nptel.ac.in/courses/108/102/108102045/>
2. <https://www.arduino.cc/en/Tutorial/HomePage>

**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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	2	1	-	-	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

<b>Course Code: 19MEEEC1021</b>	<b>Course Title : JAVA PROGRAMMING FOR MECHANICAL SCIENCES</b> (Common to AU, ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0:</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

➤ Nil

### **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**

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**

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**

String Handling -String Buffer class and functions - Library Functions - Math - Process - Clone - System Functions.

**UNIT IV COLLECTIONS AND I/O STREAMS****9**

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**

Java Swing - Features -Components and Containers - Event handling - Exploring Swing - Menus - Java Database Connectivity.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
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, Ninth Edition, 2014
- T2. Mahmoud Parsian, "JDBC Metada, MySQL and Oracle Recipes: A Problem-Solution Approach", Apress Publications, 2016.

**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, Ninth Edition, 2014.
- R3. James M Slack, Programming and Problem solving with JAVA, Thomson Learning, 2002.

**Web Reference:**

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	-	-
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

**Assessment pattern**

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100



<b>Course Code:19MEEEC1022</b>	<b>Course Title : DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING WITH C++</b> (Common to AU, ME)		
<b>Course Category: Professional Elective</b>		<b>Course Level: Mastery</b>	
<b>L:T:P (Hours/Week) 3: 0: 0</b>	<b>Credits:3</b>	<b>Total Contact Hours:45</b>	<b>Max. Marks:100</b>

### **Prerequisites**

The student should have undergone the course(s):

➤ Nil

### **Course Objectives**

The course is intended to:

1. Write simple C++ programs.
2. Write advanced C++ programs.
3. Implement linear data structures and sorting & searching algorithms.
4. Implement non-linear data structures such as Trees and Graphs.
5. Explain Data mining in Knowledge discovery process.

## **UNIT I PRINCIPLES OF OBJECT ORIENTED PROGRAMMING**

**8**

Introduction-Tokens-Control Structures- Functions & Pointers -Concepts of OOP - Classes and Objects - Constructors and Destructors- Inheritance.

## **UNIT II ADVANCED OBJECT ORIENTED PROGRAMMING**

**9**

Polymorphism - Overloading: Function overloading & Operator overloading - Overriding- Virtual Functions -File Handling: Read & Write operations - Introduction to Exception Handling.

## **UNIT III LINEAR DATA STRUCTURES**

**11**

Algorithm Analysis-Abstract Data Types-List ADT-array and Linked List Implementation- Stack ADT - Queue ADT- Applications of Linear Data structure -Sorting Techniques: Bubble sort - Merge sort-Quick sort-Searching Techniques:Linear Search-Binary Search.

**UNIT IV TREES AND GRAPHS****9**

Trees: Binary Trees-Binary Search Tree ADT - Graph Algorithms: Topological Sort-Single Source Shortest Path Algorithm-All Pairs Shortest Path Algorithm - Minimum Spanning Tree - Prim's and Kruskal's Algorithm.

**UNIT V- INTRODUCTION TO DATA MINING****8**

Data Mining Overview - Knowledge Discovery in Databases process - Different Kinds of Data – Kinds of Patterns Mined – Technologies Used – Kinds of Applications – Issues in Data Mining - Data Warehouse Basic Concepts.

<b>Course Outcomes</b>	<b>Cognitive Level</b>
<b>At the end of this course, students will be able to:</b>	
CO1: Write C++ programs using classes, objects and Inheritance paradigms.	Apply
CO2: Write C++ programs using polymorphism, File and Exception handling operations.	Apply
CO3: Implement linear data structures and sorting& searching algorithms.	Apply
CO4: Implement non-linear data structures such as Trees and Graphs.	Apply
CO5: Explain Data mining in Knowledge discovery process and its applications.	Understand

**Text Book(s):**

- T1. Robert Lafore, "Object Oriented Programming in C++", Sams Publishing, Fourth edition, 2002.
- T2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education Asia, New Delhi, Third Edition, 2007.
- T3. Jiawei Han, Micheline Kamber, Jian Pei "Data Mining Concepts and Techniques", Elsevier, Third Edition, 2012.

**Reference Book(s):**

- R1. Balagurusamy E., "Object Oriented Programming with C++", Tata McGraw Hill, New Delhi, Fourth Edition, 2008.

R2. Alfred V.Aho, John E. Hopcroft and Jeffery D. Ullman, "Data Structures and Algorithms", Pearson Education, New Delhi, 2006.

R3. Ellis Horowitz, Sartaj Sahni, Dinesh Mehta "Fundamentals of Data Structures in C++", Galgotia Publication, New Delhi, Third Edition, 2009.

R4. Seymour Lipschutz, "Data Structures", McGraw-Hill, New Delhi, Third Edition, 2007.

R5. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.

#### Web Reference:

1. <https://nptel.ac.in/courses/117/103/117103063/>
2. <https://nptel.ac.in/courses/108/108/108108111/>
3. <https://nptel.ac.in/courses/108/104/108104091/>

#### 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	-	-
CO2	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO3	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO4	3	2	1	1	-	-	-	1	-	1	-	1	-	-
CO5	2	1	-	-	-	-	-	1	-	1	-	1	-	-

High-3; Medium-2; Low-1

#### Assessment pattern

	Assessment Component	CO .No.	Marks	Total
Continuous Comprehensive Evaluation	CCET 1	1,2	50	30
	CCET 2	3,4	50	
	Retest	1,2,3,4	50	
	CCET 3	5	50	
	Assignment	1,2,3,4,5	30	10
End Semester Examination	ESE	1,2,3,4,5	100	60
Total				100

