Dr . Mahalingam College of Engineering and Technology
(An Autonomous Institution)
Pollachi - 642 003

Curriculum and Syllabus for

B.E. MECHANICAL ENGINEERING

SEMESTER I to VIII

2016 – REGULATION

(FROM 2017 BATCH ONWARDS)

DR MAHALINGAM
MCET
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds

DEPARTMENT OF MECHANICAL ENGINEERING (From 2017 Batch Onwards)

2016 REGULATION

Curriculum for B.E Mechanical Engineering from Semester I to VIII

SEMESTER I

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16ENT11	Communication Skills - I	2	0	2	3	100
16MAT11	Engineering Mathematics – I	3	2	0	4	100
16PHT11	Applied Physics	3	0	0	3	100
16CYT11	Applied Chemistry	3	0	0	3	100
16GET11R	Introduction to Engineering	2	0	2	3	100
PRACTICAL						
16EGL11R	Engineering Graphics	1	0	4	3	100
16PCL11	Physics and Chemistry Laboratory	0	0	4	2	100
PROFESSIONAL SKILLLS						
16PSL11	Promotion of Students' Wellness	0	0	2	1	100
TOTAL		**14**	**2**	**14**	**22**	

SEMESTER II

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16ENT21	Communication Skills - II	2	0	2	3	100
16MAT21	Engineering Mathematics – II	3	2	0	4	100
16PHT21R	Material Science	3	0	2	4	100
16GET21	Engineering Mechanics	4	0	0	4	100
16GET22	Engineering Metrology and Measurements	2	0	2	3	100
PRACTICAL						
16EPL21	Engineering Practices Laboratory	0	0	4	2	100
16CDL21	Computer Aided Drafting and Modeling Laboratory	1	0	4	3	100
PROFESSIONAL SKILLLS						
16PSL21	Sports For Wellness	0	0	2	1	100
TOTAL		**15**	**2**	**16**	**24**	

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Dr.Rama Thirumurugan

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SEMESTER III

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MAT31	Transforms and Partial Differential Equations	3	2	0	4	100
16AUT31	Engineering Thermodynamics	2	2	0	3	100
16AUT32	Fluid Mechanics and Machinery	2	2	0	3	100
16MET31R	Engineering Metallurgy	2	0	2	3	100
16MET32	Metal Forming , Joining and Casting Processes	3	0	0	3	100
16MET33	Theory of Machines – I	3	0	2	4	100
PRACTICAL						
16AUL31	Fluid Mechanics and Machinery Laboratory	0	0	4	2	100
16MEL31	Metal Forming , Joining and Casting Processes Laboratory	0	0	4	2	100
PROFESSIONAL SKILLLS						
16PSL31	Personal Effectiveness	0	0	2	1	100
OCC	One Credit Course	0	0	2	1	100
TOTAL		**16**	**6**	**14**	**26**	

SEMESTER IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MAT41	Numerical Methods	3	2	0	4	100
16MET41	Strength of Materials	3	0	2	4	100
16MET42	Metal Cutting Processes	3	0	0	3	100
16MET43	Theory of Machines – II	3	0	2	4	100
16CST46	C Programming	2	0	2	3	100
16EET45	Electrical Drives and Controls	3	0	0	3	100
PRACTICAL						
16MEL41	Metal Cutting Processes Laboratory	0	0	4	2	100
16EEL43	Electrical Drives and Controls Laboratory	0	0	4	2	100
PROFESSIONAL SKILLLS						
16PSL41	Ethical and Moral Responsibility	0	0	2	1	100
OCC	One Credit Course	0	0	2	1	100
TOTAL		**17**	**2**	**18**	**27**	

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SEMESTER V

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MET51	Design of Machine Elements	4	0	0	4	100
16MET52	Thermal Engineering	4	0	0	4	100
16MET53	Fluid Power Systems	3	0	2	4	100
16MET54	Automobile Engineering	3	0	0	3	100
16ECT56	Microcontroller and Applications	3	0	2	4	100
XXXXXX	Elective- I	3	0	0	3	100
PRACTICAL						
16MEL51	Thermal Engineering Laboratory	0	0	4	2	100
16MEL52	Computer Aided Machine Drawing Laboratory	0	0	4	2	100
PROFESSIONAL SKILLLS						
16PSL51	Teamness and Inter-Personal Skills	0	0	2	1	100
OCC	One Credit Course	0	0	2	1	100
TOTAL		**20**	**0**	**16**	**28**	

SEMESTER VI

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MET61	Finite Element Analysis	4	0	0	4	100
16MET62	Design of Transmission Systems	4	0	0	4	100
16MET63	Heat and Mass Transfer	4	0	0	4	100
16MET64	Power Plant Engineering	3	0	0	3	100
XXXXXXX	Elective – II	3	0	0	3	100
PRACTICAL						
16MEL61	Simulation and Analysis Laboratory	0	0	4	2	100
16MEL62	Heat Transfer Laboratory	0	0	4	2	100
PROFESSIONAL SKILLLS						
16PSL61	Campus to Corporate	0	0	2	1	100
OCC	One Credit Course	0	0	2	1	100
TOTAL		**18**	**0**	**12**	**24**	

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SEMESTER VII

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MET71	Mechatronics	4	0	0	4	100
16CET73	Environmental Studies	3	0	0	3	100
XXXXXXX	Elective-III	3	0	0	3	100
XXXXXXX	Elective-IV (Open)	3	0	0	3	100
PRACTICAL						
16MEL71	Mechatronics Laboratory	0	0	4	2	100
16MEL72	Product Design Laboratory	0	0	4	2	100
16MEL73	Innovative and Creative Project	0	0	8	4	100
TOTAL		**13**	**0**	**16**	**21**	

SEMESTER VIII

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
XXXXXXX	Elective-V	3	0	0	3	100
XXXXXXX	Elective-VI	3	0	0	3	100
XXXXXXX	Elective-VII	3	0	0	3	100
PRACTICAL						
16MEL81	Project	0	0	20	10	200
TOTAL		**9**	**0**	**20**	**19**	

SUMMARY	
Core Curriculum Credits	182
Professional Skills Credits	6
One Credit Courses Credits	4
Total No. of Credits	**192**
Core Curriculum Courses	56
Professional Skills Courses	6
One Credit Courses	4
Total No. of Courses	**66**

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ELECTIVES

Course Code	Course Title	Hours / Week			Credits	Marks
		L	T	P		
DESIGN STREAM						
16MEE01	Design for Manufacture, Assembly and Environment	3	0	0	3	100
16MEE02	Mechanical System Design	3	0	0	3	100
16MEE03	Composite Materials	3	0	0	3	100
16MEE04	Computational Fluid Dynamics	3	0	0	3	100
16MEE05	Vibration and Noise Engineering	3	0	0	3	100
16MEE06	Automotive Engine and Its Systems	3	0	0	3	100
16MEE07	Vehicle Design Engineering	3	0	0	3	100
16MEE08	Vehicle Dynamics	3	0	0	3	100
16MEE09	Design for Welding	3	0	0	3	100
16MEE10	Motor Cycle Dynamics	3	0	0	3	100
16MEE11	Design for Sheet Metal	3	0	0	3	100
16MEE12	Systems Engineering	3	0	0	3	100
16MEE13	Product Engineering I	3	0	0	3	100
16MEE14	Mechanics of Machines	3	0	0	3	100
16MEE15	Product Engineering II	3	0	0	3	100
16MEE16	Design Optimization	3	0	0	3	100
16MEE17	Computer Aided Engineering	3	0	0	3	100
16MEE53	Deign of Spark Ignition Engines	3	0	0	3	100
MANUFACTURING STREAM						
16MEE18	Process Planning and Cost Estimation	3	0	0	3	100
16MEE19	Unconventional Machining Processes	3	0	0	3	100
16MEE20	Flexible Manufacturing Systems	3	0	0	3	100
16MEE21	Non Destructive Testing Methods	3	0	0	3	100
16MEE22	Supply Chain Management	3	0	0	3	100
16MEE23	Analytical Techniques for Nano Material Characterization	3	0	0	3	100
16MEE24	Nanomaterials Synthesis and Applications	3	0	0	3	100
16MEE25	Manufacture and Inspection of Gears	3	0	0	3	100
16MEE26	Micro and Nano Manufacturing	3	0	0	3	100
16MEE27	Lean Manufacturing	3	0	0	3	100

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ELECTIVES

Course Code	Course Title	Hours /Week			Credits	Marks
		L	T	P		
16MEE28	Computer Integrated Manufacturing	3	0	0	3	100
16MEE29	Industrial Robotics and Automation	3	0	0	3	100
16MEE30	Additive Manufacturing	3	0	0	3	100
16MEE31	Systems Approach for Engineers	3	0	0	3	100
16MEE32	Automotive Fundamentals and Manufacturing	3	0	0	3	100
16MEE33	Logistics Engineering	3	0	0	3	100
16MEE34	Manufacturing Systems Engineering	3	0	0	3	100
16MEE35	Reliability Engineering	3	0	0	3	100
16MEE36	Industrial Engineering	3	0	0	3	100
16MEE37	Advanced Manufacturing Processes	3	0	0	3	100
16MEE38	Tool Engineering	3	0	0	3	100
16MEE52	Metal Cutting Process Engineering	3	0	0	3	100
16MEE55	Assembly Engineering	3	0	0	3	100
QUALITY, TESTING AND MAINTENANCE STREAM						
16MEE39	Refrigeration and Air-Conditioning	3	0	0	3	100
16MEE40	Principles of Management	3	0	0	3	100
16MEE41	Total Productive Maintenance	3	0	0	3	100
16MEE42	Industrial Safety Management	3	0	0	3	100
16MEE43	Solar and Wind Energy	3	0	0	3	100
16MEE44	Quality Engineering	3	0	0	3	100
16MEE45	Robust Design	3	0	0	3	100
16MEE46	Advanced Measurement & QC	3	0	0	3	100
16MEE47	Entrepreneurship Development	3	0	0	3	100
16MEE48	Operations Research	3	0	0	3	100
16MEE49	Engineering Economics and Cost Analysis	3	0	0	3	100
16MEE50	Probability and Statistics	3	0	0	3	100
16MEE51	Project Management	3	0	0	3	100
16MEE54	Spark Ignition Engines	3	0	0	3	100
16MEE56	Battery System for Electric Vehicles	3	0	0	3	100
OPEN ELECTIVES						
16OEXXX	Total Quality Management	3	0	0	3	100
16OEXXX	Industrial Robotics	3	0	0	3	100
16OEXXX	Automation Systems	3	0	0	3	100

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SEMESTER I

Course Code: 16ENT11	**Course Title:** COMMUNICATION SKILLS I (Common to all B.E/B.Tech Programmes)	
Core/Elective: Core	**L: T : P : C**	3: 0 : 2 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

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

Course Objectives

The course is intended to:

1. Listen to conversations, comprehend and answer questions.
2. Answer questions about one self and business-related themes.
3. Read passages, infer and respond to the questions.
4. Write appropriate business e mail, note, memo and letter.
5. Write simple and grammatically correct sentences

UNIT I **LISTENING** **6+6**

Short conversations/monologues - numbers and spelling (dates, prices, percentages, figures, etc.) - and locate specific information - longer monologue and guided note taking - gap filling - Understanding the gist and extracting the main idea.

UNIT II **SPEAKING** **6+6**

Answering questions about oneself, agreeing and disagreeing, expressing preferences - mini-presentation on a business theme (Oral) - Giving information and expressing opinions - discussion on business related topics – initiate a conversation and respond appropriately - business vocabulary - collocation.

UNIT III **READING** **6+6**

Read short texts and understand the main message (signs, messages, postcards, notes, emails, labels) - Read and find specific information - Interpreting visual information - Comprehend detailed factual information - gather gist – cloze test

UNIT IV **WRITING** **6+6**

Internal written communication - short messages to colleagues - note, message, memo, email- External communication - letter, email, notice - set phrases for letters and e-mails- Discourse markers, sign post words.

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UNIT V **GRAMMAR** **6+6**

Types of sentences – Declarative, interrogative, imperative and exclamatory – Usage of tenses (Simple and continuous forms) - Voices – Concord (Subject and verb) - Auxiliary - Infinitive and Gerunds – Article - Preposition - Comparative and superlative adjectives.

Course Outcomes

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

CO1: Listen to conversations, comprehend and answer questions equivalent to BEC preliminary listening exercises.
CO2: Answer questions about oneself and business-related themes on par with BEC preliminary speaking tests.
CO3: Read passages, infer and respond to the questions from BEC preliminary reading exercises .
CO4: Write appropriate business e mail, note, memo and letter on par with BEC preliminary writing tests.
CO5: Write simple and grammatically correct sentences.

Text Books

1. Whitby Norman, "Business Benchmark Pre-intermediate to Intermediate Students" Book CUP Publications, 2nd Edition, 2014.
2. Wood Ian, Williams Anne, Cowper Anna, "Pass Cambridge BEC Preliminary", Cengage Learning, 2nd edition, 2015.

References

1. "BEC Preliminary Cambridge Handbook for Language Teacher", 2nd Edition, CUP 2000.
2. Hewings Martin "Advanced Grammar in use - Upper-intermediate Proficiency", CUP, Third Edition, 2013.

Web references

- www.cambridgeenglish.org/exams/business.../business-preliminary/
- http://www.pearsonlongman.com/intelligent_business/bec_tests/preliminary.html

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Course Code: 16MAT11	**Course Title:** ENGINEERING MATHEMATICS - I (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3 : 2 :0 : 4
Type: Theory	**Total Contact Hours:**	75 Hours

Course Objectives

The course is intended to:

1. Determine the canonical form of a quadratic form.
2. Determine the curvature and equation of evolutes of a curve.
3. Identify the extreme values for two variable functions.
4. Determine the area of bounded curves and volume of solids.
5. Solve the various types of first order ordinary differential equations

UNIT I EIGENVALUES AND EIGENVECTORS 9+6

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and eigenvectors – Cayley-Hamilton Theorem – Diagonalization of matrices by orthogonal transformation–Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT II DIFFERENTIAL CALCULUS 9+6

Curvature – Cartesian and polar coordinates – Radius and Centre of curvature - Circle of curvature – Involutes and Evolutes – Envelopes.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+6

Partial derivatives – Homogeneous functions and Euler's theorem –Total derivative – Change of variables – Jacobians –Partial differentiation of implicit functions – Taylor's series for functions of two variables –Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV MULTIPLE INTEGRALS 9+6

Double integration-Cartesian and polar coordinates-Change of order of integration-Transformation from Cartesian to polar, spherical and cylindrical coordinates-Triple integration in Cartesian Coordinates-Applications: Evaluating area and volume using multiple integrals.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER 9+6

Formation of ordinary differential equation-Solution of differential equations of first order and first degree: homogeneous form, linear form and exact differential equations - Applications to engineering problems related to resisted motion.

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Course Outcomes

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

CO1: Determine the canonical form of a quadratic form using orthogonal transformation.

CO2: Determine the curvature and equation of evolutes of a curve using differential calculus.

CO3: Identify the extreme values for two variable functions using partial derivatives.

CO4: Determine the area of bounded curves and volume of solids using multiple integrals.

CO5: Solve the various types of first order ordinary differential equations.

Text Books

1. Srimanta Pal & Subodh C. Bhunia. "Engineering Mathematics", First edition, 2015, Oxford University Press.
2. Ervin Kreyszig. "Advanced Engineering Mathematics", 10th edition, 2015, Wiley India.

References

1. Peter V. O'Neil. "Advanced Engineering Mathematics", 7thEdition, 2012, Thomson Nelson, Toronto.
2. K.A. Stroud & Dexter J. Booth. "Advanced Engineering Mathematics", 5thEdition,2011, Palgrave Macmillan.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 40th Edition, 2007.

Web Reference

- http://nptel.ac.in/video.php?subjectId=122107036

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Course Code: 16PHT11	**Course Title:** APPLIED PHYSICS (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3 : 0 :0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Course Objectives

The course is intended to:

1. Calculate the equilibrium condition of particles and rigid bodies.
2. Apply the knowledge of conduction and radiation in materials.
3. Impart the knowledge of Ultrasonics to inspect the quality of materials.
4. Know the process of vacuum creation and its measurement.
5. Apply lasers for various industrial applications.

UNIT I BASICS OF MECHANICS **10**

Review of fundamental laws of mechanics – scalars, vectors - Newton's law of mechanics, Gravitational law. Particles and rigid body, Concept of force and its effect on rigid body system of forces-Free body diagram-principle of transmissibility-equilibrium conditions-equilibrium of particles subjected to coplanar and non-coplanar force system - Triangle law, Parallelogram law and Lami's theorem.

UNIT II TRANSMISSION OF HEAT **8**

Conduction – Co-efficient of the thermal conductivity – Cylindrical flow of heat – determination of thermal conductivity of bad conductor – Lee's disc method - Experimental determination of Specific heat of liquid, variation of specific heat and atomic heat with temperature. Radiation– Black body – Wein's Law - Rayleigh Jeans Law – Stefan's law – Experimental Determination of Stefan's constant.

UNIT III ULTRASONICS AND NDT **10**

Properties of Ultrasonic waves, Production of ultrasonics by magnetostriction and piezoelectric methods –Detection of ultrasonics: acoustic grating –Cavitation -. Industrial applications: ultrasonic cleaning, welding and cutting. Non Destructive Testing: Principle of Ultrasonic testing – ultrasonic transducer – Couplant – Inspection techniques: Liquid Penetrant Method, Radiographic testing, Ultrasonic flaw detector: Pulse echo system, transmission, A, B & C scan displays. Inspection standards.

UNIT IV VACUUM SCIENCE AND TECHNOLOGY **9**

Introduction concepts of vacuum – throughput, pumping speed, effective pumping speed and conductance. Types of pumps – working principle and construction of rotary pump, diffusion pump, turbo molecular pump. Operation of pressure gauges – pressure range,

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measurement of vacuum using Pirani and Penning gauges, merits and limitations - Working of a vacuum system.

UNIT V LASER PHYSICS AND APPLICATIONS 8

Laser principles: Stimulated and spontaneous emissions of radiations - Population inversion and pumping methods – Properties of lasers - Nd: YAG laser and CO_2 molecular laser – Applications of Lasers: welding, brazing, drilling, cutting and heat treatment of materials.

Course Outcomes

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

CO1: Use the laws of mechanics to determine the equilibrium condition of particles and rigid bodies.
CO2: Compute the amount of heat transfer by conduction and radiation in materials.
CO3: Apply the knowledge of Ultrasonics to inspect the quality of materials through NDT.
CO4: Use the different types of pumps and gauges.
CO5: Apply lasers in various industrial applications.

Text Books

1. R. C. Hibbeller, "Engineering Mechanics: Combined static and dynamics", Prentice Hall, 2009
2. Rajendran, "Engineering Physics", Tata McGraw Hill Publishing Company limited. New Delhi, 2009.

References

1. BrijLal and Dr. N. Subrahmanyam, "Heat and Thermodynamics", S. Chand & Company Ltd., New Delhi, 1997.
2. 'David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics Extended", Ninth Edition, Wiley India.
3. Jayakumar S, "Engineering Physics", R K Publishers, Coimbatore, 2007

Web References

- http://nptel.ac.in/courses/115106061/
- www.apsu.edu
- www.physicsclassroom.com
- www.study.com
- www.physics.org

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Course Code: 16CYT11	**Course Title** : APPLIED CHEMISTRY (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3 : 0 :0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Course Objectives

The course is intended to:

1. Explain the chemistry of the water treatment processes.
2. Select batteries based on the life cycle,
3. Determine the rate of corrosion of a given metal
4. Select a polymeric material for a engineering application
5. Describe the efficiency of fuels in different state
6. Identify appropriate lubricant for engineering applications

UNIT – I WATER TECHNOLOGY 9

Water Quality Parameters – Hardness – Types and expression - Determination of hardness by EDTA method. Boiler feed water. Boiler troubles – Sludge and Scale formation, Caustic embrittlement and Boiler corrosion. Methods of Boiler Water Treatment: Internal (Carbonate, Phosphate & Calgon) and External conditioning – Demineralization, Reverse Osmosis. Domestic Water Treatment.

UNIT – II ELECTROCHEMISTRY AND BATTERIES 9

Electrochemical Cells – Reversible and Irreversible cells, Galvanic Cells, Concentration Cells, Batteries: Characteristics, types - Dry Cell (Alkaline Battery), Lead-Acid, Lithium Ion (Li / TiS_2 and Li / S) – Construction, Working and Application. Batteries for automobiles. Fuel Cells - Construction and Working of Hydrogen - Oxygen fuel cell.

UNIT – III CORROSION AND CONTROL 9

Chemical Corrosion –Electrochemical corrosion – different types – galvanic corrosion, differential aeration corrosion, factors influencing corrosion. Corrosion control – sacrificial anode and impressed current cathodic methods – Corrosion inhibitors- Inorganic coating- Metallic coating – Galvanizing –Tinning- Organic coating. Electroplating of silver and electroless (Ni) - plating.

UNIT – IV POLYMER CHEMISTRY 9

Classification of Polymers – Thermoplastic and Thermosetting. Polymerisation: types – Addition, condensation and copolymerization, Properties of polymers: Tg, Tacticity, Molecular Weight (Weight average, Number average), polydispersity index. Compounding

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of plastics, Moulding techniques - blow and extrusion. Commodity plastics – Preparation, properties and uses of PE, and PET. Engineering plastics – Preparation, properties and uses of PC, Teflon, Foams - Preparation, properties and uses of PU and poly olefins.

UNIT – V FUELS AND LUBRICANTS 9

Calorific value (GCV and NCV) – metallurgical coke – manufacture by Otto-Hoffmann method – knocking – octane number and cetane number. Gaseous fuels- CNG and LPG - composition, properties and uses. Lubricants – types– properties of liquid lubricants and its significance. Greases – preparation, types and uses.

Course Outcomes

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

CO1: Explain the chemistry of water and specify the water treatment processes.
CO2: Explain batteries based on the life cycle, working principle and their applications.
CO3: Determine the rate of corrosion of a given metal in a given environment and identify appropriate control techniques to avoid corrosion.
CO4: Identify a polymeric material for a specific engineering application.
CO5: Describe the fuel characteristics based on composition and calorific value.
CO6: Identify appropriate lubricant for different engineering applications

Text Books

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 16th Ed., Dhanpat Rai Pub, Co., New Delhi (2006).
2. "Engineering Chemistry", Second Edition, Wiley India Pvt. Ltd. New Delhi (2011).

References

1. L. Brown and T. Holme, "Chemistry for Engineering Students", 3rd Edition, Cengage Learning (2010).
2. P.W. Atkins and de Paula Julio, "Physical Chemistry", Oxford University Press, 9th Ed. (Indian Student Edition) (2011).
3. S.Chawla, "A Text Book of Engineering Chemistry", Dhanpat Rai Publishing Company, New Delhi (2013).

Web References

- http://nptel.ac.in/courses/122101001/downloads/lec-23.pdf
- http://nptel.ac.in/courses/122101001/downloads/lec-25.pdf
- http://nptel.ac.in/courses/104105039/

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Course Code: 16GET11R	**Course Title** : INTRODUCTION TO ENGINEERING	
Core/Elective: Core	**L : T : P : C**	2 : 0 :2 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Course Objectives

The course is intended to:

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

UNIT I CAREERS OPPORTUNITIES IN ENGINEERING **15**

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 **15**

OBE Model, PEOs and POs, technical POs, professional POs, mapping with Graduate attributes, Classification of courses, resources available in the campus and e-resources, resources and facilities available to acquire specific competencies, on-campus and off-campus activities, the methods by which students can systematically involve in activities, significance of professional skill courses, plan for utilizing the resources and facilities to develop specific competencies.

UNIT III STAYING RELEVANT THROUGH CONTINUOUS IMPROVEMENT /ENVIRONMENTAL VERSATILITY **7**

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

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UNIT IV OBSERVE EVERY PRODUCT AND PROCESSES WITH AN ENGINEERING PERSPECTIVE AND INQUISITIVENESS **9**

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

UNIT V LEARNING AND DEVELOPMENT LEVERAGING THE RESOURCES AND INFRASTRUCTURE **7**

Process of Learning, Situated Learning with Examples, Own Learning (Not Copying), Differences between Real Life and Simulated Environment, the Sprit Of Experimentation, Various Learning Enablers, Measure The Performance Against The Plan.

UNIT VI UNSAFE CONDITIONS AND ACTS AND FOLLOWS ENVIRONMENT FRIENDLY PRACTICES **7**

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

Course Outcomes

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

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

BoS Chairman

References

1. L. A Bloomfield, "How things work: The physics of everyday life", WILYS 5th Edition, 2013.
2. C. Mason, "How things work," Usborne Publishing Ltd 2009.
3. D.K. Publishing, "How things work encyclopedia", 2009.
4. R. J. Segalat, "How things work", Edito-Service Vol.I-IV, 1990.
5. J. L. Adams, "Flying Buttresses, Entropy, and O-Rings: The World of an Engineer" Harvard University Press; Reprint edition.
6. J. E. Gordon, "The New Science of Strong Materials or Why You Don't Fall through the Floor" Princeton University Press; With a New introduction by Philip Ball edition.
7. R.P. Feynman," Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher", Basic Books; 4 edition 2011.

Web References

- https://en.wikibooks.org/wiki/General_Engineering_Introduction/Engineering_Science
- http://science.howstuffworks.com/engineering-channel.htm

Other References

1. Worksheets and Handouts prepared by MCET team.

BoS Chairman

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Course Code: 16EGL11R	**Course Title** : ENGINEERING GRAPHICS	
Core/Elective: Core	**L : T : P : C**	1: 0 :4 : 3
Type: Practical	**Total Contact Hours:**	75 Hours

Course Objectives

The course is intended to:

1. Communicate combination of basic shapes using engineering drawing

UNIT I INTRODUCTION TO ENGINEERING DRAWING 10

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

UNIT II FREEHAND SKETCHING 10

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

UNIT III AUTOCAD 15

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

UNIT IV ORTHOGRAPHIC PROJECTION 30

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

UNIT V DEVELOPMENT OF SURFACES 10

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

Course Outcomes

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

CO1: Communicate combination of basic shapes using engineering drawing in AutoCAD meeting all the required standards.

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Text Books

1. K. V. Natrajan, "A Text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai (2013).
2. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD" Tata McGraw Hill Publishing Company Limited (2008).

References

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing
   Company Limited, New Delhi, (2008).
2. Cencil Jensen, Jay D. Helsel and Dennis R. "Short Engineering Drawing and Design". Tata McGraw Hill Publishing Company Limited (2012).

PUBLICATIONS OF BUREAU OF INDIAN STANDARDS

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

Web References

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

BoS Chairman

Course Code: 16PCL11	**Course Title** :PHYSICS AND CHEMISTRY LABORATORY (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	0: 0 :4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Course Objectives

The course is intended to:

1. Use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

Physics Laboratory

1. Young's Modulus of the material – Cantilever bending method
2. Rigidity modulus of the metallic wire – Torsional Pendulum method
3. Thermal Conductivity of the insulator – Lee's Disc method
4. Comparison of Co-efficient of viscosity of the liquids
5. Wavelength of laser and determination of particle size using laser
6. Testing the optical planeness of the given glass plate
7. Thickness of the sample using Air Wedge
8. Efficiency of the solar cell

Chemistry Laboratory

I - Water Analysis

1. Determination of total hardness of water sample by EDTA method.

II - Viscometry

1. Determination of molecular weight of a polymer – Ostwald viscometric method.

III - Electrochemistry

1. To determine the strength of given acid – pH metrically
2. To determine the amount of ferrous ions by potentiometric titrations.

IV - Corrosion Testing

1. Determination of corrosion rate for mild steel specimen – weight loss method.
2. Determination of inhibitor efficiency of an organic inhibitor for mild steel specimen – weight loss method.

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Course Outcomes

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

CO1: Use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

References

1. "Engineering Physics Laboratory Manual" R. Jayaraman, V. Umadevi, S. Maruthamuthu and B. Saravanakumar.
2. "Engineering Chemistry Laboratory Manual" Faculty, Chemistry Department, MCET.

BoS Chairman

Course Code: 16PSL11	**Course Title** : PROMOTION OF STUDENTS WELLNESS (Common to Automobile, Mechanical, Mechatronics Production, Civil & EEE)	
Core/Elective: Core	**L : T : P : C**	0: 0 :2 : 1
Type: PS	**Total Contact Hours:**	30 Hours

Course Objectives

The course is intended to:

1. Maintain physical wellbeing.
2. Maintain mental wellbeing.
3. Maintain social wellbeing.

Course Content

UNIT I PHYSICAL HEALTH

Physical structure and functions of human body – simplified physical exercises (hand exercises, Leg exercises, breathing exercises, eye exercises – kapalapathi – Maharasanas 1-2 – Massages – Acupuncture – relaxation – importance and benefits. Suryanamaskar.

UNIT II MENTAL HEALTH

Maintenance of youthfulness and life force – kayakalpa yoga – anti ageing process – benefits. Mind and its functions – mind wave frequency – meditation process – Agna, shanthi, thuriam – benefits

UNIT III PERSONALITY DEVELOPMENT – I

Purpose of life and analysis of thought – philosophy of life – introspection – practice. Moralization of desires and neutralization of anger - practices

UNIT IV PERSONALITY DEVELOPMENT – II

Eradication of worries and benefits of blessings – wave theory –practices. Genetic centre – purification – cause and effect theory

UNIT V SOCIAL HEALTH

Greatness of guru – cultural education – love and compassion – fivefold culture. Greatness of friendship and social welfare – individual, family and world peace .

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Course Outcomes

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

CO1: Maintain physical wellbeing - grooming, BMI, flexibility, muscle strength, body compositions (vatha, pitha, kapa)

CO2: Maintain mental wellbeing - perceptions, attention/concentration, memory, gunas

CO3: Maintain social wellbeing - etiquettes, emotional and psychological aspects, stress management, morality and values

Text Books

1. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar ,"Value education for harmonious life (Manavalakalai Yoga)", Vethathiri Publications, Erode, I Ed. (2010)

References

1. Dr.R.Nagarathna, Dr.H.R.Nagendra, "Integrated approach of yoga therapy for positive health", Swami Vivekananda Yoga Prakashana, Bangalore, 2008 Ed.
2. Dr.R.Nagarathna, Dr.H.R.Nagendra , "New perspectives in stress management", Swami Vivekananda Yoga Prakashana, Bangalore, I Ed June 1986

OPERATIONAL MODALITIES

Orientation programme

Theory and practice demonstration

3 days - 7 hours /day for syllabus coverage

Follow-Up Practice

12 weeks x 2 hours/week: 24 hours

Evaluation:

Continuous evaluation:

Physical Exercises, Kaya kalpa practice, meditation	= 40 marks
Introspection (assessment of students workbook)	= 20 marks
Total	= 60 marks

Semester end examination:

Written test (MCQ and short answers)	= 30 marks
Physical exercises, meditation	= 50 marks
Viva-voce	= 20 marks
Total	= 100 marks

End semester mark out of 100 is reduced to 40 marks

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

DIMENSIONS AND TOOLS IN MEASUREMENT

Dimension	Sub dimension	Measurement tools
Physical	BMI	Electronic Weighing Machine, Height Measurement
	Flexibility	Sit & Reach
	Muscle Strength	Handgrip Dynamometer
	Prakruti	Dr Ramakrishna's Prakruti Questionnaire
Mental	Perception	Critical Flicker Fusion
	Attention	Digit Letter substitution Test
		Six Letter Cancellation Test
		Stroop Test
	Memory	Digit backward & Forward
Social	Interpersonal Effectiveness & Self Concept	FIRO B
	Psychological Well Being	Short wellbeing scale
		Short Happiness scale
		Barrat Impulsive Scale

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END OF SEMESTER- I

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SEMESTER II

Course Code: 16ENT21	**Course Title** : COMMUNICATION SKILLS II (Common to all B.E/B.Tech Programmes)	
Core/Elective: Core	**L : T : P : C**	2: 0 :2 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have:

- Communication Skills I

Course Objectives

The course is intended to:

1. Listen to monologues or dialogues, comprehend and answer questions.
2. Answer questions about oneself and business-related themes.
3. Read business correspondence, infer and respond to the questions.
4. Write appropriate business e-mail, memo, proposal, report and letter.
5. Write complex sentences.

UNIT I LISTENING **6+6**

Listening to monologues or dialogues and noting specific information - Listening to identify topic, context, and function - Listening for details and main ideas - Gap filling and matching job descriptions and titles.

UNIT II SPEAKING **6+6**

Giving personal information -Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - mini-presentation on a business theme - Giving information and expressing and justifying opinions - discussion on a business-related topic - Expressing and justifying opinions, speculating, comparing and contrasting, agreeing and disagreeing, etc. – negotiating and persuading.

UNIT III READING **6+6**

Reading - skimming for gist and scanning for specific information (Newspaper and magazine articles, reports, advertisements, letters, messages, brochures, guides, manuals) - Reading and understanding text structure – Comprehension – Reading for vocabulary and structure - understanding sentence structure and finding errors.

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UNIT IV WRITING **6+6**

Internal written communication - Writing a message, memo or an email: giving instructions, explaining development, asking for comments, requesting information, agreeing to requests - External Communication (e.g. explaining, apologizing, reassuring, complaining), reports (e.g. describing, summarizing) or proposals (e.g. describing, summarizing, recommending, persuading and negotiating).

UNIT V GRAMMAR **6+6**

Conditional sentences – Modals and their usage- common errors - Linkers and discourse markers – concord (pronoun and antecedent)

Course Outcomes

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

CO1: Listen to monologues or dialogues, comprehend and answer questions equivalent to BEC vantage listening exam.

CO2: Answer questions about oneself and business-related themes on par with BEC vantage speaking exam.

CO3: Read business correspondence, infer and respond to the questions similar to BEC vantage reading exam.

CO4: Write appropriate business e mail, memo, proposal, report and letter on par with BEC vantage writing exam.

CO5: Write complex sentences using appropriate discourse markers.

Text Books

1. Whitby Norman, "Business Benchmark Upper Intermediate Students" Book CUP Publications, 2nd Edition, 2014.

References

1. Cambridge "BEC Vantage - Practice Tests", Self-study Edition, Cambridge University Press, 2002.
2. Hewings Martin, "Advanced Grammar in use - Upper-intermediate Proficiency", Cambridge University Press, Third Edition, 2013.

Web References

- www.cambridgeenglish.org/exams/business.../business-preliminary/
- http://www.examenglish.com/BEC/BEC_Vantage.html
- www.splendid-speaking.com/exams/**bec**_speaking.htmlhtml

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Course Code: 16MAT21	**Course Title** : ENGINEERING MATHEMATICS-II (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3: 0 :2 : 4
Type: Theory	**Total Contact Hours:**	75 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics I

Course Objectives

The course is intended to:

1. Determine the solution of second and higher order ordinary differential equations
2. Solve directional derivative, integral theorems.
3. Determine the analytic function and behaviour of conformal mappings
4. Apply the concept of singularities to evaluate integrals.
5. Apply the Laplace transform techniques to solve differential equations

Course Content

UNIT I DIFFERENTIAL EQUATIONS OF SECOND AND HIGHER ORDER 9+6

Second and higher order linear differential equations with constant coefficients.Solution by variation of parameters, first order simultaneous differential equations. Applications to Simple Harmonic motion.

UNIT II VECTOR CALCULUS 9+6

Gradient, divergence and curl, irrotational and solenoidal vector fields- Directional derivatives-Green's theorem in a plane (without proof)-Gauss divergence theorem (without proof) - Stoke's theorem (without proof)-evaluation of integrals using Green's, Gauss's and Stoke's theorem.

UNIT III COMPLEX DIFFERENTIATION 9+6

Function of a complex variable-Analytic function -Singular points –Cauchy Riemann equations (without proof) – Properties-Construction of analytic functions. Conformal mapping: w = z+ a, az, 1/z – Bilinear Transformation.

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UNIT IV COMPLEX INTEGRATION **9+6**

Cauchy's fundamental theorem (without proof) – Cauchy's Integral formula- Taylor and Laurent expansions- Types of singularity - Residues-Cauchy Residue theorem.

UNIT V LAPLACE TRANSFORM **9+6**

Laplace transform-Conditions for existence-Transform of elementary functions- Properties-Transform of derivatives– Transformation of periodic functions-Inverse Laplace transform-Convolution theorem- Solution of linear ODE of second order with constant coefficients using Laplace transform.

Course Outcomes

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

CO1: Determine the solution of second and higher order ordinary differential equations using standard techniques
CO2: Solve directional derivative, integral theorems using vector differentiation and integration.
CO3: Determine the analytic function and behaviour of conformal mappings for a complex function
CO4: Apply the concept of singularities to evaluate integrals.
CO5: Apply the Laplace transform techniques to solve differential equations

Text Books

1. Srimanta Pal & Subodh C. Bhunia. "Engineering Mathematics", First edition, 2015, Oxford University Press.
2. Ervin Kreyszig. "Advanced Engineering Mathematics", 10th edition, 2015, Wiley India.

References

1. Peter V. O'Neil. "Advanced Engineering Mathematics", 7th Edition, 2012, Thomson Nelson, Toronto.
2. K.A. Stroud & Dexter J. Booth. "Advanced Engineering Mathematics", 5th Edition, 2011, Palgrave Macmillan.
3. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 40th Edition, 2007.

Web Reference

- http://nptel.ac.in/video.php?subjectId=122107036

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Course Code: 16PHT21R	Course Title : MATERIALS SCIENCE	
Core/Elective: Core	L : T : P : C	3: 0 :2 : 4
Type: Theory & Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course(s):

- Applied Physics

Course Objectives

The course is intended to:

1. Calculate the crystal parameters.
2. Explain the mechanical properties
3. Analyze the phase diagram
4. Choose an appropriate heat treatment process
5. Choose an appropriate ferrous and non ferrous alloy

UNIT I CRYSTAL PHYSICS 9

Introduction: Crystalline and Non crystalline materials. Single crystal , Polycrystalline materials Anisotrophic 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 allotrophy. Crystal imperfections: Point , line , surface and volume , grain boundary and its role in mechanical properties.

UNIT II MECHANICAL PROPERTIES AND TESTING OF MATERIALS 9

Elasticity and plasticity of bulk materials, Ductility , malleability ,and brittleness. Stress and strain behavoiur. Hookes law, Yield strength, Impact strength, Tensile strength , Resilience , Hardness - Rockwell hardness, Brinell hardness, Micro hardness- Vickers Hardness. Failure of metals: Fracture behavior, Ductile and Brittle fracture.

UNIT III CONSTITUTION OF ALLOYS AND PHASE DIAGRAM 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_3C diagram.

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UNIT IV HEAT TREATMENT 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. Introduction to surface treatment.

UNIT V FERROUS AND NON FERROUS ALLOYS 9

Ferrous alloy: Effect of alloying elements on properties of steel (Ms, Si, Cr, Mn, Va 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 alloy , Nickel and its alloys– Composition, Properties, Applications.

Course Outcomes

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

CO1: Calculate the crystal parameters and analyze different crystal structure
CO2: Explain the mechanical properties of bulk materials
CO3: Analyze the phase diagram of an alloy by Gibbs phase rule and infer its property for a given composition
CO4: Select an appropriate heat treatment process for the given ferrous alloy such as steel, cast iron for a suitable application and determine its harden ability
CO5: Choose an appropriate Ferrous and Non ferrous nonferrous alloy for a suitable application.

Text Books

1. William D Callister "Material Science and Engineering", John Wiley and Sons, 2014.
2. AnupGoel, SS Sabharwal, "Engineering Materials and Metallurgy", Technical Publication, 2014.

References

1. Raghavan.V "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd., 2015.
2. Dieter G. E., "Mechanical Metallurgy", McGraw Hill Book Company, 2013
3. Sydney H. Avner "Introduction to Physical Metallurgy" McGraw Hill Book Company, 2008.

Web References

- http://nptel.ac.in/courses/113106032/
- http://www.nptel.ac.in/courses/112108150/
- https://en.wikipedia.org/wiki/Materials_science

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Materials Science Lab

List of Experiments: **15 hrs**

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.

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Course Code: 16GET21	**Course Title** : ENGINEERING MECHANICS {Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	4: 0 :0 : 4
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Graphics
- Engineering Mathematics - I

Course Objectives

The course is intended to:

1. Construct free body diagram and calculate the unknown force
2. Calculate the magnitude of force acting in each member of frame and machine
3. Calculate the geometric properties of given sections.
4. Analyze the effect of dry friction in contact surfaces
5. Calculate and plot the motion of a particle

UNIT I EQUILIBRIUM OF RIGID BODIES **12**

Moment and couple. Free body diagram. Equilibrium conditions applicable to rigid bodies. Varignon's theorem. Moment about point and axis. Problems in equilibrium of rigid body. Beams-types of supports and their reactions-types of forces-method of finding reactions in statically determinate beams.

Introduction to Supports and connections for 3D machine members and their reactions. Problems related to reactions in machine members supported with ball and socket joints only.

UNIT II ANALYSIS OF FRAMES AND MACHINES **9**

Introduction - Frames - Machines, Structures containing multi-force members, Analysis of a frame, Analysis of machines.

UNIT III PROPERTIES OF SURFACES AND SOLIDS **15**

Properties of surface-centroid, Centroid of simple regular sections using integration (Rectangle, circle and triangle). Method of calculating centroid of composite sections. Problems involving centroid for composite planes such as **L, I, T.**

Moment of inertia for simple sections using integration such as Rectangle, circle and triangle. Parallel and perpendicular axis theorem- concept of polar moment of inertia. Problems involving moment of inertia for composite sections such as T,I,L. Principal MI and principal axis for composite section such as T,I,L.

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Properties of solid geometry - centroid and centre of gravity. Centre of gravity of simple solids. Mass moment of inertia for simple solids. Pappus Guldinus theorem. Relation to area moment of inertia. Problems involving mass moment of inertia for composite solids consist of block, cylinder, cone, and sphere.

UNIT IV FRICTION 12

Characteristics of dry friction, law of dry friction, theory of friction- free body diagram for equilibrium and impending motion conditions. Equilibrium conditions involving dry friction, problems involving wedge, screw, ladder and flat belt drive. Problems in impending motion condition involving dry friction at some points.

UNIT V DYNAMICS OF PARTICLES 12

Kinematic parameters - displacement, velocity, acceleration and time. Types of motion-uniform, non-uniform motion, motion of particles in plane - Rectilinear and curvilinear motion of particles-normal and tangential component-motion of projectile- Relative motion-Dependent motion.Kinetics of particles-D'Alemberts principle-works energy and impulse momentum method.

Course Outcomes

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

CO1: Construct free-body diagrams and calculate the unknown forces necessary to ensure static equilibrium condition.

CO2: Calculate the magnitude of force acting in each member of frame and machine under static equilibrium condition.

CO3: Calculate geometric properties such as centroids and moment of inertia

CO4: Analyze the effect of dry friction in contact surfaces (ladder ,wedge, screw and belt)

CO5: Calculate and plot the motion of a particle

Textbooks

1. R.C. Hibbeller, "Engineering Mechanics: Combined Statics & Dynamics", Prentice Hall, 2009
2. F.P. Beer, and Jr. E.R Johnston, "Vector Mechanics for Engineers – Statics and Dynamics", Tata McGraw-Hill Publishing Company, New Delhi, 2012

References

1. James L. Meriam and L.Glenn Kraige, "Engineering Mechanics (Statics and Dynamics)", John Wiley & Sons, 2008.
2. Shames.I.H, and Krishna Mohana Rao.G, "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. Pearson Education, 2006.
3. S. Rajasekaran and G. Sankarasubramanian, "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., New Delhi, 2005.

Web References

- http://nptel.ac.in/courses/112103109/
- https://en.wikipedia.org/wiki/Mechanics

BoS Chairman

Course Code: 16GET22	**Course Title:** ENGINEERING METROLOGY AND MEASUREMENTS {Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	2: 0 :2 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Applied Physics

Course Objectives

The course is intended to:

1. Explain Metrology and Various Measuring Instruments and methods
2. Explain Geometric Dimensioning and Tolerancing (GD&T).
3. Evaluate dimensional accuracy of components.
4. Demonstrate form measurement methods.
5. Describe advanced methods and automation in measurements

UNIT I INTRODUCTION TO ENGINEERING METROLOGY 6

General Concepts of metrology-Importance of metrology-Types of metrology-Dynamic, legal, deterministic-Measurement systems-units, standards, accuracy, precision-dimensional accuracy and precision-Methods of measurement-Sensitivity-Errors in measurements-Method of measurement-various measuring instruments.

UNIT II FORM AND SIZE TOLERANCE 6

Fundamental drawing rules-Tolerance grade and fundamental deviations- Fits, Limits and Tolerances and its needs on CAD/CAM –Datums- Application of datums- Datum feature identification - Cylindrical and Inclined- Form- Flatness, straightness, cylindricity and circularity-Orientation -Angularity, perpendicularity and parallelism –Position- Types of position - Clearance hole, Threaded hole and coaxiality-Concentricity and symmetry – Examples of concentricity and symmetry- Concept of Control Charts, Types of Control Charts, Control Charts for Attributes, p Chart, np Chart, c Chart, u Chart, Control Charts for Variables x Chart, R Chart.

UNIT III LINEAR AND ANGULAR MEASUREMENTS 6

Introduction to linear measurement-Linear measuring instruments-Scale, Vernier, micrometer-types-Gauges-slip gauges, plug gauge, ring gauge, snap gauge-comparators-mechanical, electrical, pneumatic-Introduction to Angular measurement-angular measuring instruments-Sine bar, bevel protractor, autocollimator, angle dekkor.

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UNIT IV FORM MEASUREMENTS 6

Screw thread terminology - Errors in threads - Internal and external screw thread measurements - Screw thread measuring elements - Major diameter, Minor diameter, Pitch diameter & Thread form - Gear terminology - Types of gears - Gear errors - Gear measurement techniques -parkinson gear tester, Autocollimator ,Profile projector - Surface texture -Elements of surface texture - Surface finish methods- Average roughness, Peak to vally, Form factor - Surface finish measuring instruments – Surface Measurement - Roundness Measurements- Temperature: bimetallic strip, thermocouples, electrical resistance thermometer.

UNIT V LASER METROLOGY AND CMM 6

Laser metrology- Laser interferometer - Michelson, Dual frequency, Twyman green, Laser viewers - Types of CMM - Bridge, Cantilever, Horizontal boring mill type, Vertical mill type - Errors in CMM - Application, advantages & disadvantages of CMM - Coordinate Measuring Machine

Course Outcomes

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

CO1: Explain Metrology and Various Measuring Instruments and methods
CO2: Explain the Geometric Dimensioning and Tolerancing (GD&T) Principles and Symbol
CO3: Evaluate dimensional accuracy of components using linear and angular measuring instruments
CO4: Demonstrate form measurement methods.
CO5: Describe advanced methods and automation in measurements

Textbooks

1. 1 Gopalakrishna, K. R., "Machine Drawing", 20th Edition, Subhas publishing House, 2007.
2. Jain R.K., "Engineering Metrology", Khanna Publishers, 2005.

References

1. Cencel .H.Jensen and J.D.Helsel, "Engineering Drawing and Design" McGraw Hill Science, 7th Edition, 2007.
2. Gupta S.C, "Engineering Metrology", Dhanpat rai Publications, 2005.
3. Jayal A.K, "Instrumentation and Mechanical Measurements", Galgotia Publications, 2000.

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List of Experiments

30 Hrs

1. Measure the dimensions of the given component using vernier caliper.
2. Determine the diameter of a cylindrical component to accuracy of 0.01mm using micrometer and to check the result with digital micrometer.
3. Measure the height of the machined component using vernier height gauge.
4. Determine the thickness of the ground MS plate using slip gauges.
5. Measure the thickness of gear tooth by using gear tooth vernier and profile projector.

Web References

- http://nptel.ac.in/courses/112106138/
- https://en.wikipedia.org/wiki/Metrology

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Course Code: 16EPL21	**Course Title** ENGINEERING PRACTICES LABORATORY {Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	0: 0 :4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Course Objectives

The course is intended to:

1. Demonstrate the basic carpentry, fitting and plumbing operations.
2. Demonstrate the operations of different power tools.
3. Exhibit the proper connection in electrical wiring.
4. Interpret various characteristics of basic electronic components.
5. Demonstrate the installation, formatting and partitioning of computer system.

List of Experiments

1. Make a wooden window frame to the required dimensions with 'T' joint and Dove Tail joint.
2. Make a steel table using fitting process to the required dimensions.
3. Assemble a pipe line from overhead tank to kitchen sink and dining wash basin.
4. Demonstrate the operations of different power tools.
5. a) Make a Domestic wiring circuit to connect a lamp, a fan with regulator and a socket.
   b) Make the internal wiring of a tube light and check the connection.
6. Make a Stair case wiring for controlling a lamp from two different locations.
7. Do the continuity check in the given PCB and rectify the faults.
8. Make an electronic circuit for bi-cycle horn.
9. Install the given OS in the computer system.
10. Do formatting and partitioning of Hard Disk Drive

Course Outcomes

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

CO1: Demonstrate the basic carpentry, fitting and plumbing operations.
CO2: Demonstrate the operations of different power tools.
CO3: Exhibit the proper connection in electrical wiring.
CO4: Interpret various characteristics of basic electronic components.
CO5: Demonstrate the installation, formatting and partitioning of computer system.

References

1. Jeyachandran.K, Natarajan.S & Balasubramanian.S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, TamilNadu (India), 2007.
2. Rajendra Prasad.A & Sarma.P.M.M.S, "Work shop Practice", Sree Sai Publication, 2002.

BoS Chairman

BoS Chairman

Course Code: 16CDL21	**Course Title** :COMPUTER AIDED DRAFTING AND MODELING LABORATORY {Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	1: 0 :4 :3
Type: Practical	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Graphics

Course Objectives

The course is intended to:

1. Develop part and assembly models
2. Prepare production drawing for manufacturing process

UNIT I STANDARDS, SYMBOLS& CONVENTIONS 3

Conventional representation of machine components and materials, Designation of Standard parts - keys, pin joints, fasteners, hexagonal and square head bolts and nuts, conventional representation of threads. BIS codes for practice of Machine Drawing - Dimensioning, abbreviations and conventions, welding symbols, surface finish symbols, screws, bolts, nuts and rivets.

UNIT II CAD SOFTWARE FEATURES 3

Capabilities of CAD software - Parametric modeling-Concepts, 3D software packages features-reference planes – 2D sketching tools - relationships and constraints –part modelling tools – extrusion, revolve, sweep – modifying tools

UNIT III DEVELOPMENT OF PART AND ASSEMBLY MODELS 3

Drawing front view, top view and side view of objects from the given pictorial views. Preparation of 2-D drawings of standard machine elements.-Assembly tools features of modelling software. Creation of assembly models with functional features.

UNIT IV PART DRAWING OF MACHINE COMPONENTS 3

Create part drawing using CAD software with manufacturing considerations. Exercise on bolt & nut (square and hexagon), studs and washers. Exercise on different types of keys, screws, spring etc.

UNIT V PRODUCTION DRAWING 3

Preparation of Production drawing - Multiple views of part modelsand machine components –Bill of materials - Drawing Layout.

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List of Experiments

45 Hrs

1. Preparation of isometric view for the orthographic views of simple parts
2. Exercise on square, hexagonal bolt and nuts
3. Exercise on different types of keys
4. Exercise on screws , rivets and springs
5. Preparation of part drawing - aluminum wheel.
6. Preparation of part drawing - support bracket
7. Preparation of part drawing -sheet metal guard
8. Preparation of Assembly drawing - castor wheel
9. Preparation of production drawing -aluminum wheel assembly

Course Outcomes

At the end of the course the student will be able to

CO1: Develop part and assembly models using CAD Software.

CO2: Prepare production drawing for manufacturing process using CAD software

References

1. Gopalakrishna, K. R., "Machine Drawing", 20th Edition Subhas publishing House,2007.
2. Cecil Jensen, Jay D. Helsel, Dennis R. Short , "Engineering Drawing & Design", 7th edition McGraw-Hill Higher Education. 2007

BoS Chairman

Course Code: 16PSL21	**Course Title** : SPORTS FOR WELLNESS (Common to Automobile, Mechanical, Mechatronics Production, Civil & EEE)	
Core/Elective: Core	**L : T : P : C**	0: 0 :2 :1
Type: PS	**Total Contact Hours:**	30 Hours

Prerequisites:

The student should have undergone the course(s):

- Promotion of Students Wellness

Course Objectives

The course is intended to:

1. Explain the significance of physical fitness.
2. Maintain physical fitness.
3. Exhibit mental agility.

UNIT I HEALTH

Meaning of health - Components of health - physical, mental, social, emotional, spiritual - importance of health - Personal hygiene - Heredity and environment –Adopting healthy habits

UNIT II FITNESS & WELLNESS

Fitness and wellness – what is physical fitness - categories - components of health related physical fitness- components of skill related physical fitness-values of physical fitness – Physical fitness development.

What is wellness - importance of wellness for engineers –factors promoting wellness – Physiology and health : cardio-respiratory, muscular and nervous systems – ageing

UNIT III FOOD & HEALTH

Energy balance and body composition – nutrients- problems of surplus and deficiency- balanced diet - good food habits for better health – hazards of junk food - food and the gunas.

UNIT IV FITNESS & DEVELOPMENT I

Exercises related ailment and injuries - safety and precautions - first aid.

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

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UNIT V FITNESS & DEVELOPMENT II

Speed, agility, balance and coordination – exercises: sprint, cone drill, ladder drill, hurdle drill, ball throw - mental agility tests.
Dexterity - 12 minutes cooper test – long run – adventure games
Team games.

Course Outcomes

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

CO1: Explain the significance of physical fitness for healthy living
CO2: Maintain physical fitness through exercises
CO3: Exhibit mental agility

References

1. Tony Buzan, Harper Collins, "The Power of Physical Intelligence", Thorsons Publications 2003.
2. Student reading material and workbook prepared by PS team of the college.

OPERATIONAL MODALITIES:

Orientation programme

Special lectures by invited resource persons at semester beginning
3 lectures x 4 hours = 12 hours

Follow-up practice

12 weeks x 2 hours/week = 24 hours

Evaluation

Continuous evaluation:

Physical Exercises	= 40 marks
Assessment of students workbook	= 20 marks
Total	= 60 marks

Semester end examination:

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

MEASUREMENTS:

At the Beginning + At Semester End

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SCHEDULE OF EXERCISES FOR STUDENTS WITH DIFFERENT PHYSICAL CONDITIONS

Underweight	Normal	obese
Flexibility exercis - stretching	Flexibility exercis - stretching	- Brisk walking
Minor games -forward running relay -backward running relay - over&under relay -circle games, etc.	-Walking - Walking-cum-jogging	- Minor games
Strength Training - Calisthenics	Cardio/Functional Fitness - Skipping - Stair climbing - jogging - bicycling - long distance running	flexibility exercises - stretching - Cycling (static)
Cardio/Functional Fitness - Skipping - Stair climbing - jogging - bicycling	Agility - ladder drills - hurdle drill - cone drill	Cardio/Functional Fitness Skipping Jogging bicycling
Agility exercises - ladder drills - hurdle drill - cone drill	Strength Training -Calisthenics -gym workout for maj muscles	Strength Training - Calisthenics - gym workouts
Diet Considerations	Diet considerations	Diet considerations
Measurements		
BMI Hand grip strength test 12 m Cooper run Sit & reach	BMI 12 m Cooper run Sit & reach test Illinois agility test	BMI Body fat percentage Waist-to-hip ratio Sit&reach

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END OF SEMESTER- II

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SEMESTER III

Course Code: 16MAT31	**Course Title:** TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS {Common to Automobile, Civil, Mechanical, Mechatronics & Production)	
Core/Elective: General	**L : T : P : C**	3: 2 : 0 : 4
Type: Theory & Tutorial	**Total Contact Hours:**	75 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Mathematics I
- Engineering Mathematics II

Course Objectives

The course is intended to:

1. Determine the solution of partial differential equations.
2. Solve the Fourier series expansion.
3. Solve one dimensional wave equation.
4. Solve heat flow equation.
5. Calculate the Fourier transformation for a periodic function.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS **9+6**

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations – Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES **9+6**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity –Complex form of Fourier series- Harmonic analysis.

UNIT III SOLUTION OF ONE DIMENSIONAL WAVE EQUATION **9+6**

Method of separation of variables - Classification of second order linear partial differential equations, Solutions of one dimensional wave equation by Fourier series method.

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UNIT IV SOLUTION OF ONE AND TWO DIMENSIONAL HEAT FLOW EQUATION **9+6**

One dimensional equation of heat conduction - Steady state solution of two-dimensional equation of heat conduction (Insulated edges excluded), Solution by Fourier series method.

UNIT V FOURIER TRANSFORM **9+6**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

Course Outcomes

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

CO1: Determine the solution of first and second order partial differential equations for homogeneous and non-homogeneous types.

CO2: Solve the Fourier series expansion for given periodic function using Euler's formula.

CO3: Solve one dimensional wave equation to represent the vibrating string using Fourier series method.

CO4: Solve one dimensional and two dimensional heat flow equation using Fourier series method.

CO5: Calculate the Fourier transformation for aperiodic function using Fourier Integral theorem.

Text Books

1. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, First Edition, Oxford University Press, New Delhi, 2015
2. Veerarajan T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley Publications, 2015.

References

1. Grewal B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012
2. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 8th Edition, Laxmi Publications Pvt Ltd, 2011.
3. Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

Web References

- http://nptel.ac.in/courses/122107037/19
- http://nptel.ac.in/video.php?subjectId=108106075

BoS Chairman

Course Code : 16AUT31	**Course Title:** ENGINEERING THERMODYNAMICS (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Core	**L : T : P : C**	2 : 2 : 0 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Mathematics I
- Applied Physics

Course Objectives

The course is intended to:

1. Apply the first law of thermodynamics to closed and open systems
2. Apply second law of thermodynamics and the concept of entropy for evaluating the performance of heat engine, refrigerator and heat pump
3. Evaluate the performance of Rankine, Reheat and Regenerative vapor power cycles
4. Evaluate the properties of ideal, real gas and gas mixtures
5. Estimate the heating and cooling loads for automotive, domestic and industrial air conditioning systems.

UNIT I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 6+6

Basic concepts - continuum, Microscopic and Macroscopic approaches. Path and point functions. Intensive and extensive properties, total and specific quantities. System, surrounding, boundary and their types. Thermodynamic Equilibrium. State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer - definition and comparison, sign convention. Zeroth law – concept of temperature and thermal equilibrium. First law – application to closed and open systems – PMM-I – steady and unsteady flow processes.

UNIT II SECOND LAW OF THERMODYNAMICS 6+6

Need for second law of thermodynamics, Kelvin - Plank and Clausius statements, PMM-II. Carnot cycle, Carnot theorem and irreversibility, Clausius inequality, concept of entropy, entropy analysis for open and closed systems, availability. Heat engine, refrigerator and heat pump -performance. Third law of thermodynamics.

UNIT III PROPERTIES OF PURE SUBSTANCE AND VAPOR POWER CYCLES 6+6

Phase rule, properties of pure substance (water) in three phases - P-V diagram, T-S diagram, H-S diagram, P-V-T surface. thermodynamic properties of steam. Vapor power cycles- steam rate, heat rate, efficiency calculation of Rankine, Reheat cycles - Regenerative cycle (qualitative treatment only).

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UNIT IV PROPERTIES OF GASES AND GAS MIXTURES **6+6**

Properties of Ideal and real gases - Gas laws, Ideal and real gas properties, Equations of state - Van der walls equation, Virial expansion, Law of Corresponding states – generalized compressibility chart- Properties of gas mixtures- Internal energy, enthalpy, entropy and specific heats of gas mixtures— problems.

UNIT V PSYCHROMETRY **6+6**

Psychrometry- properties, chart, properties of air vapour mixture, property calculations, psychrometric processes - sensible heating and sensible cooling processes, humidification and dehumidification. Heating and cooling loads for Automotive, Domestic and Industrial air conditioning systems.

(Use of Steam table, Mollier diagram and Psychometric chart are permitted in the End Semester examination)

Course Outcomes

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

CO1: Apply the first law of thermodynamics to closed and open systems and calculate the work and heat interactions in these systems using various thermodynamic properties

CO2: Apply second law of thermodynamics and the concept of entropy for evaluating the performance of heat engine, refrigerator and heat pump by the comparison of efficiency and coefficient of performance through the Carnot Principles.

CO3: Evaluate the performance of Rankine, Reheat and Regenerative vapor power cycles by calculating the thermal efficiencies of these cycles influenced by modifications to the ideal cycle.

CO4: Evaluate the properties of ideal, real gas and gas mixtures using the gas laws, volumetric and gravimetric analysis.

CO5: Estimate the heating and cooling loads for automotive, domestic and industrial air conditioning systems applying the basic principles of psychrometry using analytical methods and charts.

Text Books

1. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill,New Delhi,2013.
2. Cengel, "Thermodynamics – An Engineering Approach" 3rdEdition ,Tata McGraw Hill, New Delhi, 2015.

References

1. Holman.J.P., "Thermodynamics", 3rd Edition McGraw-Hill, 1995.
2. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1994
3. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.

Web References

- http://nptel.ac.in/courses/112105123/1
- https://en.wikipedia.org/wiki/Thermodynamics

BoS Chairman

Course Code: 16AUT32	**Course Title:** FLUID MECHANICS AND MACHINERY (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Core	**L : T : P : C**	2 :2 : 0 : 3
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics – I
- Applied Physics

Course Objectives

The course is intended to

1. Calculate the properties of fluids.
2. Determine the flow properties of ideal fluid.
3. Determine flow rates, head loss in viscous and turbulent flow.
4. Calculate the performance of various types of turbines.
5. Calculate the performance of various types of Pumps.

UNIT I FLUID PROPERTIES AND STATICS 6+6

Fundamental Units and Dimensions, Properties-mass density, specific weight, specific gravity, specific volume, surface tension, capillarity and compressibility- Problems, Viscosity- Newton's law of viscosity and dynamic viscosity, kinematic viscosity - Problems, types of Fluids, concept of Continuum, Statics - Pressure, Pressure head, Pascal's law- Problems, Simple and differential manometers- Problems.

UNIT II PRINCIPLES OF KINEMATICS AND DYNAMICS IN FLUID FLOW 6+6

Types of Fluid flow-Steady, unsteady, uniform, non-uniform, Laminar, turbulent, rotational, ir-rotational, compressible, incompressible, 1D, 2D and 3D flows, application of control volume to continuity equation, Kinematics-Lagrangian and Eularian approach – Stream lines, path lines and streak lines, Dynamics-Euler's equation (Bernoulli's equation)-applications-Venturimeter Orifice meter and Pitot tube - Problems, Velocity and Acceleration of fluid flow, Newton's second law of motion - momentum equation for a fluid- Problems.

UNIT III FLOW THROUGH PIPES AND DIMENSIONAL ANALYSIS 6+6

Major Head losses in pipes - Darcy Weisbach's equation - Problems, Minor losses in Pipe bend, entry, exit, sudden enlargement, sudden contraction – Problems, Flow through Pipes - series pipe, Equivalent pipe, Parallel pipe, Dimensional Homogeneity and Buckingham's π Theorem– Problems, Dimensionless numbers, Model analysis, Similarities - Concept only.

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UNIT IV HYDRAULIC TURBINES **6+6**

Impact of jets - Stationary vertical plates, Stationary curved plates - Concept only. Turbines - Reaction and Impulse, working principles, classification, Draft tube, heads and efficiency, specific speed, unit quantities, Velocity triangle- impulse and reaction turbines, Work done and Power delivered by the Pelton turbine – Problems - Performance of turbines.

UNIT V HYDRAULIC PUMPS **6+6**

Centrifugal pumps - working principle and types, specific speed, unit quantities, heads and efficiency, Priming, Cavitation, Performance curves, Net Positive Suction Head, Reciprocating pump and rotary pump – working, types, Performance of positive displacement pumps

Course Outcomes

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

CO1: Calculate the properties of real fluids such as water, oils and mercury
CO2: Determine the flow properties of ideal fluid by applying the kinematic and dynamic principles
CO3: Determine flow rates and head losses in real fluids in viscous and turbulent flows.
CO4: Calculate the performance of impulse and reaction turbines for various loading and head conditions.
CO5: Calculate the performance of rotary and reciprocating pumps for various head conditions.

Text Books

1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi, Ninth Edition, 2017.
2. YunusCengel, John Cimbalal , "Fluid Mechanics- Fundamentals and Applications", Tata McGraw-Hill Education, 2014.

Reference Books

1. Rajput, R.K., "A Text Book of Fluid Mechanics", Chand S and Co. New Delhi, 2015.
2. Som S. K, Biswas G " Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2011.
3. Ramamritham. S, "Fluid Mechanics, Hydraulics and Fluid Machines", DhanpatRai& Sons, Delhi, 2015.

Web References

- http://nptel.ac.in/courses/112105171/1

BoS Chairman

Course Code : 16MET31R	Course Title: ENGINEERING METALLURGY	
Core/Elective: Core	L : T : P : C	2: 0 : 2 : 3
Type: Theory & Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Material Science

Course Objectives

The course is intended to:

1. Select an appropriate surface treatment process
2. Select an appropriate powder metallurgy technique
3. Choose an appropriate mechanical processing technique
4. Choose an appropriate material characterizing method
5. Choose a suitable polymers and Ceramic materials

UNIT I SURFACE HEAT TREATEMENT PROCESS 9

Surface treatment process – Purpose of surface treatment . Case hardening-Carburizing- types –Pack carburizing Liquid carburizing, Gas carburizing, Nitriding, Cyaniding, Flame and Induction hardening-working principle, merits, demerits and applications

UNIT III POWDER METALLURGY 9

Steps in Powder Metallurgy, scope, advantages, limitations and applications of P/M with specific examples Powder Production Techniques- introduction to PIM & SHS, powder characterization-particle size analysis.

Powder Consolidation: Cold Isostatic Pressing, Hot pressing and Hot Isostatic Pressing. (HIP)

Sintering: Theory of solid state and liquid phase sintering. Stages in sintering, structure and property changes Finishing Operations and Secondary Operations: Machining, plating, heat treatment and infiltration, sizing and coining, P/M products.

UNIT III PHYSICAL METALLURGY 9

Cold Working and Hot working: Structure and properties of cold worked metals-Annealing-recovery, recrystallization and grain growth, comparison of cold working and hot working.

Strengthening Mechanisms: Cold working, Grain size control, precipitation hardening, dispersion hardening, particulate and fiber strengthening, texture strengthening.

/UNIT IV CHARACTERIZATION OF MATERIALS 9

Optical Metallography- Micro and Macro Examination. Advanced Microscopic Techniques: Scanning probe microscopy, atomic force microscopy, field ion microscopy - principle, instrumentation and applications.

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X-ray diffraction: X-ray powder diffraction-single crystal diffraction techniques-Structure analysis- Particle size analysis using Scherer formula. Determination of crystal structure, lattice parameter, Residual stress measurements.
SEM: Basic design of the SEM-Modes of operation-Backscattered electrons-Secondary electrons-X-rays-Application of SEM-Bragg's law-D spacing-Transmission Electron Microscope (TEM): Basic design of the TEM-Modes of operation

UNIT V POLYMERS AND CERAMIC MATERIALS 9

Polymers: Introduction: Hydrocarbon molecules, Polymer molecules, Molecular weight and molecular shape, Molecular structure. **Classification of polymers:** Thermoplastics, Thermosets & Elastomers – Common polymeric materials and Industrial application of polymers (Quantitative).
Ceramics – Constituents, properties and applications of Diamond, silicon carbide (SiC), zirconia (ZrO_2), Alumina (Al_2O_3), boron carbide (B_4C), and titanium diboride (TiB_2).

Course Outcomes

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

CO1: Select an appropriate surface treatment process for ferrous and non-ferrous alloys to improve its surface hardness
CO2: Select an appropriate powder metallurgy technique, based on its functionality.
CO3: Choose an appropriate mechanical processing technique of material and its strengthening mechanism to attain the desired property of materials.
CO4: Choose an appropriate material characterizing method to get required results and to study its inference
CO5: Choose a suitable polymers and Ceramic materials based on a specific application to meet its functionality.

Text Books

1. William D Callister "Material Science and Engineering", John Wiley and Sons, 2014.
2. Donald R Askeland "The Science and Engineering of Materials", CL Engineering 6 th edition, 2010.

References

1. Angelo, P.C., Subramanian, R. "Powder Metallurgy - Science, Technology and Applications"- PHI Learning Private Limited, 2009.
2. Dieter G. E., "Mechanical Metallurgy", McGraw Hill Book Company, 2013.
3. Sydney H. Avner "Introduction to Physical Metallurgy" McGraw Hill Book Company, 2008.

BoS Chairman

Web References

- http://nptel.ac.in/courses/113106032/
- http://www.nptel.ac.in/courses/112108150/
- https://en.wikipedia.org/wiki/Materials_science

Course Outcomes

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

CO1: Evaluate atomic crystalline structure of a material by X-Ray Diffraction analysis using Braggs law and its relation to crystal structure.

CO2: Analyze the X Ray Diffraction data of the Powder Compacted Stainless Steel and determine the various metallurgical characteristics of the given sample

List of Experiments **15 Hrs**

1. Determine the grain size of the given sample microstructure manually and by using metallurgical microscope.
2. Analyze the phases present in the given microstructure by using metallurgical microscope.
3. Determine the determine the *d-spacing*, *crystallite size*, *unit cell dimension*, and *degree of crystallinity* of well-known material from the X Ray diffraction analysis data provided.
4. Determine the mechanical properties of the powder compacted specimen using the XRD data provided.
5. Indexing the powder pattern for NaCl.

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Course Code: 16MET32	Course Title: METAL FORMING JOINING AND CASTING PROCESSES (Common to Automobile & Mechanical)	
Core/Elective: Core	L : T : P : C	3 : 0: 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Material Science
- Engineering Metrology and Measurements

Course Objectives

The course is intended to:

1. Explain operational and procedural steps required in casting process.
2. Explain operational and procedural steps required in sheet metal process.
3. Choose appropriate welding process.
4. Describe the procedure of forging process
5. Select appropriate processes to manufacture a part involving casting, welding, forging and sheet metal processes.

UNIT I CASTING 9

Sand casting process, Pattern - Types, materials and allowances. Moulding sand – Types and properties. Mould preparation- Tools and equipments, Core making process. Centrifugal casting processes (True, Semi, Centrifuging), Continuous casting. Casting metals, properties. Working principle of Cupola furnace, Crucible furnace, Electric arc furnace, Induction furnace.

UNIT II METAL FORMING 9

Hot working and Cold working of metals. Rolling: Rolling mills, Roll passes and sequences, Rolling defects; Forging: Types (Smith, Drop, Press & Machine), Forging operations (Drawing down / Swaging, Upsetting, Punching, Bending, Coining); Forging defects; Extrusion: Types (Direct, Indirect, Impact, Tube). Drawing: Tube drawing, Wire drawing.

UNIT III SHEET METAL PROCESSES 9

Sheet metal characteristics, Shearing processes (Punching, Piercing, Perforation, Blanking, Trimming, Notching, Nibbling and Shaving processes) Progressive, Compound and Combination dies. Bending - Spring back, allowance, operations (Angle bending, Roll bending, Roll forming, Seaming). Drawing processes (Shallow drawing, Deep drawing, Reverse drawing and redrawing), Rigid die forming processes (Embossing, Coining and Stamping), Stretch forming, Defects in sheet metal operations.

UNIT IV METAL JOINING 9

Fusion welding processes: Arc welding processes - Manual metal arc welding, TIG & MIG welding, Submerged arc welding, Electro slag welding, Types of electrodes.

BoS Chairman

Gas welding process (Oxy-acetylene), Types of flames, Working principle, Equipments, Gas cutting. Non- fusion welding processes: Electrical resistance welding (ERW), Types (Spot, seam, percussion, projection, flash butt). Soldering, Brazing (Silver brazing, torch brazing, furnace brazing), Weld material preparation, Importance of Orientation, Direction, Welding speed, Welding symbol.

UNIT V ADVANCED PROCESSES IN CASTING, SHEET METAL AND WELDING 9

Casting:

Lost wax process, Shell mould casting, Die casting (Cold chamber / Hot chamber), Casting defects, Inspection and testing of cast components

Sheet Metal forming:

Flexible die forming processes (Rubber pad, Hydro forming), High energy rate forming (Explosive, electromagnetic), Metal spinning, Super plastic forming, Inspection and testing of Sheet metal components.

Joining:

Thermit welding, Electron beam welding, Laser beam welding, welding defects. Testing methods of welds (Destructive, Non-destructive)

Course Outcomes

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

CO1: Explain operational and procedural steps required in casting process for manufacturing a cast part.

CO2: Explain operational and procedural steps required in sheet metal process for manufacturing a sheet metal part.

CO3: Choose appropriate welding process for the required weld joint.

CO4: Describe the procedure for manufacturing a forged part.

CO5: Select appropriate processes and its sequence required to manufacture a given design requirement which involves casting, welding, forging and sheet metal processes.

Text Books

1. Serope Kalpakjian, Steven R Schmid, "Manufacturing Process for Engineering Materials" –Pearson Education, 4th Edition, 2009. .
2. Rao P.N. "Manufacturing Technology – Vol.1", Tata McGraw Hill Publishing Company Limited, New Delhi, 2013

References

1. HMT Bangalore, "Production Technology", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. A. K. Hajra Choudhury,Nirjhar Roy,S. K. Hajra Choudhury, "Elements of Production Technology –Vol.II", Asia Publishing House, 2008..
3. Jain. R.K., "Production Technology", Khanna Publishers, New Delhi, 2012.

Web References

- http://nptel.ac.in/courses/112107144/
- http://nptel.ac.in/courses/112107145/

BoS Chairman

Course Code: 16MET33	Course Title: THEORY OF MACHINES I	
Core/Elective: Core	L : T : P : C	3 : 0 : 2 : 4
Type: Theory& Practical	Total Contact Hours:	75 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Mathematics I
- Engineering Mechanics

Course Objectives

The course is intended to:

1. Calculate the DOF of simple mechanisms.
2. Calculate the kinematic parameters of simple mechanisms.
3. Calculate the static and dynamic forces for equilibrium of mechanisms
4. Develop cam profile
5. Calculate the kinematic parameters of gears and gear trains

UNIT I BASICS OF MECHANISMS 9

Mechanism, Machine, Structure. Kinematic link, Kinematic pair and their types.Working of four bar mechanism, slider crank mechanism and their respective inversions. Gruebler's criteria and Grashof's law. Degrees of Freedom (DoF), Transmission angle, Mechanical advantage. Working of Pantograph, Straight line generator (Peaucellier mechanism), Ackerman Steering, Geneva indexing mechanisms.

UNIT II KINEMATIC ANALYSIS 9

Linear, angular, absolute and relative velocities. Rubbing velocity. Tangential and radial components of acceleration. Instantaneous centre (IC) of rotation- properties of IC, Kennedy's theorem of three centres, procedure for locating ICs for four bar and slider crank mechanisms. Finding velocity and acceleration of four bar and slider crank mechanisms using: relative velocity method, instantaneous centre method - analytical expressions for the position, velocity and acceleration of slider crank mechanism.

UNIT III STATIC AND DYNAMIC FORCE IN MECHANISMS 9

Applied and constrained forces, D'Alembert's principle, Static equilibrium conditions of Two and three force members, Problems in static force analysis, Inertia force and Inertia torque,

Dynamic analysis in reciprocating engine- Gas forces, Bearing loads, Crank shaft torque,Turning moment diagrams, Flywheels, Coefficient of fluctuation of Energy and speed, mass of flywheel required.

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UNIT IV KINEMATICS OF CAM 9

Types of cams - Types of followers - Radial cam -Terminology of radial cam - Types of follower motions- uniform motion, simple harmonic motion, constant acceleration/deceleration motion, cycloidal motion. cam profile for knife edge, roller, flat faced follower.

UNIT V KINEMATICS OF GEARS AND GEAR TRAINS 9

Types of gears, the spur gear terminologies, law of gearing, Conjugate action and conjugate curves, merits and demerits of involute and cycloidal profiles, The path of approach, Recess, length of path of contact - The arc of approach, Recess, length of arc of contact. - contact ratio, interference and undercutting - Derivation for the Minimum numbers of teeth on the pinion to avoid Interference - Classification of gear trains, calculation of velocities of Simple, Compound, Epicyclic & Reverted gear trains (tabulation method only).

Course Outcomes

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

CO1: Calculate the DOF, given the kinematic diagram or the real world picture of planar mechanisms.
CO2: Calculate the position, velocity and acceleration parameters of the given simple mechanism using graphical method.
CO3: Calculate the static and dynamic forces for equilibrium of the given a slider crank or a four bar mechanism
CO4: Develop the radial cam profile for the given type of follower and motion function.
CO5: Calculate the kinematic parameters of spur gear and velocity ratio of simple, compound and epicyclic gear trains.

Text Books

1. Ambekar A. G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 2007.
2. Rattan S S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2014.

References

1. UickerJ.J.Pennock G.R., Shigley J.E., "Theory of Machines and Mechanisms"(Indian Edition), Oxford University Press, 2010.
2. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 2005.
3. Sadhu Singh, "Theory of Machines", Pearson Publishers, 2012.

BoS Chairman

Laboratory

List of Experiments **30 Hrs**

1. Draw models and simulate the following mechanisms:
    a. Four bar mechanisms
    b. Double rocker mechanism
    c. Crank rocker mechanism
    d. Double crank mechanism
    e. Slider crank mechanism
2. Perform an experiment on the Cam follower setup and plot the follower displacement against the crank rotation.
3. Do a study of differential gear train setup, identify the different gears and draw a neat sketch of the gear train
4. Perform an experiment on the compound gear train setup and calculate the velocity ratios based on i) revolutions and ii) number of teeth of the gears

Web References

- http://nptel.ac.in/courses/112104121/1

BoS Chairman

BoS Chairman

Course Code: 16AUL31	Course Title: FLUID MECHANICS AND MACHINERY LABORATORY (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Core	L : T : P : C	0: 0 : 4 : 2
Type: Practical	Total Contact Hours:	60 Hours

Course Objectives

1. Determine the actual and theoretical discharge of fluid flow.
2. Determine friction factor and Reynolds Number for a fluid flow.
3. Conduct performance tests on hydraulic machineries.

List of Experiments

1. Determination of the Coefficient of discharge of given Orificemeter.
2. Determination of the Coefficient of discharge of given Venturimeter
3. Determination of the velocity of flow using Pitot Tube
4. Determination of the rate of flow using Rota meter.
5. Determination of friction factor of given set of pipes.
6. Draw the characteristic curves of Centrifugal pump
7. Draw the characteristic curves of Reciprocating pump.
8. Draw the characteristic curves of Gear pump.
9. Draw the characteristic curves of Pelton wheel.
10. Draw the characteristics curves of Francis turbine.
11. Draw the characteristic curves of Kaplan turbine.
12. Measurement of Reynolds Number

Course Outcomes

At the end of the course the student will be able to

CO1: Determine the actual and theoretical discharge of fluid flow using various flow measuring devices.

CO2: Determine friction factor and Reynolds Number for a fluid flow through pipe.

CO3: Conduct performance tests and draw the characteristics curves of pumps and turbines

BoS Chairman

BoS Chairman

Course Code: 16MEL31	Course Title: METAL FORMING , JOINING AND CASTING PROCESSES LABORATORY (Common to Automobile & Mechanical)	
Core/Elective: Core	L : T : P : C	0 : 0 : 4 : 2
Type: Practical	Total Contact Hours:	60 Hours

Course Objectives

1. Make a cast component
2. Make a welded component
3. Make a forged component
4. Make a sheet metal component

List of Experiments

1. Preparation of sand mould for single piece pattern
2. Preparation of sand mould for split pattern
3. Casting of Aluminum wheel
4. Manual Metal Arc welding of Butt joint
5. Manual Metal Arc welding of T- Joint
6. Welding of support bracket
7. Forging of round rod to square rod
8. Forging of wheel shaft -Upsetting of pin head
9. Fabrication of sheet metal tray
10. Fabrication of sheet metal guard for the wheel
11. Assembly of castor wheel and validating for functional requirement

Course Outcomes

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

CO1: Make a cast component using sand /die casting process for the given design requirement

CO2: Make a welded component using arc welding for the given design requirement

CO3: Make a forged component by hand forging process for the given design requirement

CO4: Make a sheet metal component by forming process for the given design requirement

BoS Chairman

BoS Chairman

Course Code: 16PSL31	**Course Title:** PERSONAL EFFECTIVENESS (Common to all B.E/B.Tech Programmes)	
Core/Elective: General	**L : T : P : C**	0 : 0: 2 : 1
Type: PS	**Total Contact Hours:**	30 Hours

Course Objectives

1. Identify the strengths, weaknesses and opportunities
2. Set goals for academics, career, and personal aspirations
3. Establish the road map for goals
4. Apply time management techniques
5. Create time and pursue activities of self-interest

Course Content

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

BoS Chairman

UNIT V PUTTING INTO PRACTICE

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

Course Outcomes

At the end of the course the student will be able to:

CO1: Identify one's 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

Course handouts (compiled by PS team, MCET)

1. Learner's workbook
2. Personal efficiency Journal
3. Reading material for Personal Effectiveness

Further Reading

1. Stephen R Covey, "First things first", Simon & Schuster Uk, Aug 1997.
2. Sean Covey, "Seven habits of highly effective teenagers", Simon & Schuster Uk, 2004.

END OF SEMESTER- III

BoS Chairman

SEMESTER IV

Course Code: 16MAT41	**Course Title:** NUMERICAL METHODS (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3 : 2 : 0 : 4
Type: Theory	**Total Contact Hours:**	75 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Mathematics I
- Engineering Mathematics II
- Engineering Mathematics III

Course Objective

The course is intended to:

1. Determine the dominant Eigen value of linear equation.
2. Determine the solution of non-linear equations and fit a curve.
3. Determine the unknown values, derivatives and integrals from the given data
4. Solve first order ordinary differential equations.
5. Solve partial differential equations.

UNIT I SOLUTION OF SYSTEM OF LINEAR EQUATIONS 9+6

Solution of system of linear equations-Direct method: Gaussian elimination method, Choleski method, Iterative methods: Gauss-Seidel - sufficient conditions for convergence. Power method to find the dominant Eigen value and the corresponding Eigen vector.

UNIT II SOLUTION OF NON-LINEAR EQUATION & CURVE FITTING 9+6

Solution of non-linear equation: Method of false position - Newton- Raphson method -Order of convergence of these methods. Curve fitting - Method of least squares.

UNIT III INTERPOLATION, NUMERICAL DIFFERENTIATION & INTEGRATION 9+6

Newton's forward, backward interpolation – Lagrange's interpolation. Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 rule – Gaussian two point and three point quadrature formula –Double integration using Trapezoidal rule.

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UNIT IV SOLUTION OF FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS

9+6

Numerical solution of first order ordinary differential equation-Single step method: Taylor's series- Euler's method - Runge-Kutta method of fourth order – Multi step method: Adams' method.

UNIT V SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 9+6

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method.

Course Outcomes

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

CO1: Determine the dominant Eigen value based on the solutions of linear equations obtained using standard techniques.

CO2: Determine the solution of non-linear equations and fit a curve for the given data.

CO3: Determine the unknown values, derivatives and integrals from the given data using numerical techniques.

CO4: Solve first order ordinary differential equations using numerical techniques.

CO5: Solve partial differential equations using numerical techniques.

Text Books

1. Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", First Edition, Oxford University Press, New Delhi, 2015.
2. Grewal, B.S. and Grewal, J. S., "Numerical Methods in Engineering and Science", Sixth Edition, Khanna Publishers, New Delhi, 2004.

References

1. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2006.
2. Jain M. K., Iyengar, S. R. and Jain, R. K, "Numerical Methods for Scientific and Engineering Computation", New Age Publishers, 2012.
3. Sastry.S.S "Introductory Methods of Numerical Analysis", 3rd Edition, PHI, 2003.

Web References

- http://nptel.ac.in/courses/122102009/

BoS Chairman

Course Code: 16MET41	Course Title: STRENGTH OF MATERIALS (Common to Automobile & Mechanical)	
Core/Elective: Core	L : T : P : C	3 : 0 : 2 : 4
Type: Theory	Total Contact Hours:	75 Hours

Prerequisites

The student should have undergone the course:

- Engineering Mechanics

Course Objectives:

The course is intended to:

1. Calculate the normal stresses, strains and elastic constants
2. Determine two dimensional stresses
3. Determine stresses in beam
4. Analyse deflections of beams and stability of columns.
5. Calculate problems on circular shafts and close coil helical springs.

UNIT I STRESS AND STRAIN OF SOLIDS 9

Rigid body and deformable body, Stiffness - types of stresses and strains-stresses in simple and compound bars under axial load- factor of safety- Poisson's ratio- elastic constants - Modulus of Elasticity- bulk Modulus- modulus of rigidity-Relationship between elastic constants- temperature stress and strain- Strain energy(concept only).

UNIT II STRESSES IN TWO DIMENSIONS 9

Stresses on inclined planes-principal planes and stresses-Mohr's circle for biaxial stresses (Concepts only).Thin wall pressure vessel and it types- The Longitudinal Stress - Hoop stress - application - Stresses and Strain in cylindrical thin shells.

UNIT III BEAMS - LOADS AND STRESSES 9

Beam- Types of beams- transverse loads and its types- Shear force and bending moment - cantilever simply supported beams and overhanging beams (simple problems only).

Theory of simple bending - bending equation – bending stress -Neutral axis – transverse shear stress - shear stress for I section and T section of beams.

UNIT IV DEFLECTION OF BEAM AND COLUMN 9

Deflection beams- Moment Area method, Double integration method. Failure of a column-Euler's Column Theory - Limitation of Euler's formula- End conditions for long columns- Effective length-Slenderness Ratio- Rankine's formula.

BoS Chairman

UNIT V TORSION OF SHAFTS AND SPRINGS 9

Torsion- assumptions in the theory of pure torsion- torsional rigidity – torque transmitted by a solid and hollow bar of circular cross section- torque transmitted by a stepped shaft - torque transmitted by a compound shafts. Springs and its types- closed coil Helical springs subjected to compressive loads

Course Outcomes

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

CO1: Calculate the normal stresses, strains and elastic constants of structural member subjected to external loading such as axial loads and thermal loads in one dimensional member such as bar.

CO2: Determine two dimensional stresses such as normal, shear, hoops and longitudinal on the bar element and thin cylindrical pressure vessel.

CO3: Determine stresses in beam structures subjected to transverse loading by constructing shear force and bending moment diagrams of cantilever, simply supported beams & overhanging beams.

CO4: Analyse deflections of cantilever & simply supported beams and stability of short & long columns using Euler's formula and Rankine's Formula.

CO5: Calculate shear stress, torsional rigidity, diameter required and deflection on circular shafts subjected to torsion and close coil helical springs subjected to compressive load.

Text Books

1. Hibbeller RC, "Mechanics of Materials", Prentice-Hall of India, New Delhi, 2013.
2. James M Gere, " Mechanics of Materials", Cengage Learning, India, 2012.

References

1. Rattan SS "Strength of Materials" Tata McGraw-Hill Education Pvt Ltd., New Delhi, 2011.
2. Beer F. P. and Johnston R," Mechanics of Materials", McGraw-Hill Book Co, Seventh Edition, 2017.
3. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 1995.

Web References

- http://nptel.ac.in/courses/112107147/

BoS Chairman

Laboratory

Course Objectives

The course is intended to:

1. Conduct experiments and calculate the different mechanical properties

List of Experiments

30 Hrs

1. Conduct tension test on the given mild steel rod using universal testing machine for determining the yield stress, ultimate stress, breaking stress, percentage of reduction in area and percentage of elongation over a gauge length and Young's modulus.
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.
6. Determine the flexural rigidity of given rectangular beam.
7. Estimate the stiffness and modulus of rigidity of the helical spring by Compression test.

Course Outcomes

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

CO1: Conduct experiments and calculate the different mechanical properties of the given specimen.

BoS Chairman

BoS Chairman

Course Code: 16MET42	Course Title: METAL CUTTING PROCESSES (Common to Automobile, Mechanical & Production)	
Core/Elective: Core	L : T : P : C	3 :0: 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Metal Forming , Joining and Casting Processes
- Material Science

Course Objectives

The course is intended to:

1. Explain the basic principles involved in metal cutting process.
2. Select appropriate metal cutting processes to manufacture a cylindrical part.
3. Select appropriate metal cutting operations to manufacture a prismatic a part.
4. Select appropriate metal finishing processes for the given design requirement
5. Develop part programme using Computer Numerical Control machines.

UNIT I THEORY OF METAL CUTTING 9

Metal removal processes, Orthogonal cutting, Oblique cutting, Cutting tools, Tool geometry of single point cutting tool, Types of chips, Cutting tool – Characteristics, materials, Mechanics of orthogonal cutting, Machinability, Tool life using Taylors equation, Types of tool wear, Cutting fluids – Functions, types

UNIT II MACHINING CYLIDRICAL FEATURES 9

LATHE

Centre lathe - Constructional Features, Parts, Operations performed, Attachments/Accessories, Process parameters, Capstan lathe and Turret lathe, Types of automatic lathes, Turret indexing mechanism, Bar feeding mechanism, semi-automatic and automatic lathes, Tooling layout.

DRILLING

Constructional features of drilling machine, upright drilling machine, radial drilling machine, Operations, Process parameters.

UNIT III MACHINING PRISMATIC COMPONENTS WITH MILLING MACHINES 9

Milling machines - Types, Constructional features. Milling cutter - Types, nomenclature. Up milling & Down milling, Operations performed in milling machine, Process parameters.

BoS Chairman

UNIT IV METAL FINISHING PROCESSES 9

Grinding: Types of grinding machines, Types of grinding wheels, Grinding wheel designation, Classification of grinding machines and grinding wheels, Constructional features of cylindrical grinding machines, Surface grinding machines, Process parameters.

Honing, Types of honing, Lapping, Types of lapping (Equalising, form), Types of lapping machines, Burnishing, Polishing and Buffing. – Process and Application

UNIT V CNC MACHINING 9

CNC Machines- Fundamentals, Constructional features. Machining centre, Part programming fundamentals – manual part programming.

Course Outcomes

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

CO1. Explain the basic principles involved in manufacturing a part by metal cutting process.

CO2. Select appropriate metal cutting processes to manufacture a cylindrical part which involve Lathe, Automat and Drilling machines.

CO3. Select appropriate metal cutting operations to manufacture a prismatic a part which involve Milling machines.

CO4. Select appropriate metal finishing processes which involve grinding, honing, burnishing and lapping for the given design requirement

CO5. Develop part programme for producing a part using Computer Numerical Control machines.

Text Books

1. Rao P N, "Manufacturing Technology, Vol 2, Metal Cutting and Machine Tools", 2nd Edition, Tata McGraw Hill, New Delhi, 13th reprint 2012
2. Serope Kalpakjian, Steven Schmid, "Manufacturing Engineering and Technology", Addison Wesley Publishing Company, 7th edition, 2014.

References

1. Rajput R K, "A Text Book of Manufacturing Technology", Laxmi Publications (P) Ltd., New Delhi, Reprint 2016.
2. Sharma P C, "A Text book of Production Engineering", S Chand & Co Ltd., Reprint, 2008.
3. Jain R K, "Production Technology", Khanna Publishers, New Delhi, 17th edition, 2012.

Web References

- http://nptel.ac.in/courses/112105126/
- http://nptel.ac.in/courses/112105127/

BoS Chairman

Course Code: 16MET43	Course Title: THEORY OF MACHINES – II	
Core/Elective: Core	L : T : P : C	3: 0 : 2 : 4
Type: Theory & Practical	Total Contact Hours:	75 Hours

Prerequisites

The student should have undergone the course:

- Theory of Machines – I

Course Objective

The course is intended to:

1. Calculate the characteristics of control mechanism
2. Analyze the rotating unbalances masses & reciprocating unbalances masses
3. Calculate the damped & undamped vibration parameters
4. Calculate the natural frequency and mode shapes of transverse vibration
5. Calculate the natural frequency and mode shapes of torsional vibration

UNIT I GOVERNORS AND GYROSCOPES 9

Governors - types - centrifugal governors – watt governor, gravity controlled-Porter and Proell governor and spring controlled- Hartnell governor. Centrifugal governors characteristics – stability- sensitiveness-hunting, isochronisms-effect of friction - controlling force.

Gyroscopes - gyroscopic forces and torques - gyroscopic stabilization - gyroscopic effects in automobiles, ships and airplanes

UNIT II BALANCING 9

Static and dynamic balancing - balancing of rotating masses - balancing of single rotating mass by a single mass in the same plane. Balancing of single rotating mass by two masses in different plane and balancing of several rotating masses in the same plane, balancing of several masses in different planes - balancing of reciprocating masses-balancing of primary and secondary unbalanced forces of reciprocating masses. Partial balancing in locomotive engines – balancing of coupled locomotives.

UNIT III LONGITUDINAL VIBRATION 9

Undamped free vibration of single degree of freedom system- simple and compound pendulum.springs in series, springs in parallel and combinations. Natural frequency, Damped free vibration of single degree of freedom system, types of damping-viscous damping- critically damped- under damped system, Logarithmic decrement. Forced vibration of single degree of freedom system, constant harmonic excitation, steady state vibration, magnification factor. Vibration isolation and transmissibility.

BoS Chairman

UNIT IV TRANSVERSE VIBRATION 9

Natural frequency of free transverse vibrations, Natural frequency of transverse vibration due to point load, uniformly distributed load over a cantilever beam-simply supported shaft-shaft fixed at both the ends, shaft subjected to number of point loads- Dunkerly's method, Critical speed –whirling of shafts.

UNIT V TORSIONAL VIBRATION 9

Torsional systems- natural frequency, natural frequency of single, two and three rotor systems, equivalent shafts, free torsional vibration of geared systems, Holzer's method, Signature Analysis.

Course Outcomes

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

CO1: Calculate the characteristics of control mechanism such as governors and gyroscope.

CO2: Analyze the rotating unbalances masses in single & different planes and the reciprocating unbalances in locomotives.

CO3: Calculate the vibration parameters of damped & undamped free and forced longitudinal SDOF system.

CO4: Calculate the natural frequency and mode shapes of transverse vibration of beams and shafts.

CO5: Calculate the natural frequency and mode shapes of torsional vibration of two and three rotor system.

Text Books

1. Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Ltd., New Delhi, 2014.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms" ,3rd Edition, Oxford University Press, 2009.

References

1. Rao J.S and Dukkipati R.V, "Mechanism and Machine Theory", New Age International, New Delhi, 2006.
2. R.S.Khurmi and J.K Gupta., "Theory of Machines",14th revised edition, S Chand Publications,2005.
3. Ballaney.P.L "Theory of Machines", Khanna Publishers, 2003..

BoS Chairman

Laboratory

List of Experiments **30 Hrs**

1. Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Spring
   controlled Governors
2. Motorized Gyroscope-Verification of laws -Determination of gyroscopic couple.
3. Balancing of reciprocating masses and rotating masses.
4. Vibrating system – spring mass system –Determination of damping co-efficient of single degree of freedom system.
5. Determination of transmissibility ratio - vibrating table.
6. Whirling of shaft-Determination of critical speed of shaft.
7. Demonstration on Fast Fourier Transform (FFT) analyzer.

Web References

- http://nptel.ac.in/courses/112104114/
- https://en.wikipedia.org/wiki/Dynamics_(mechanics)

BoS Chairman

BoS Chairman

Course Code: 16CST46	Course Title: C PROGRAMMING (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Core	L : T : P : C	2: 0 : 2 : 3
Type: Theory & Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Nil

Course Objective

The course is intended to:

1. Write a simple program for given problems.
2. Write a program using control statements and arrays.
3. Write modular programs using functions and files.
4. Write a program using pointers.
5. Write a program using structures and unions.

UNIT I INTRODUCTION 6

Basics of computers- Algorithm – Flow Chart-Introduction of C program-Identifier-Keywords -Data Types-Variables and Constants-Operators and Expressions – Managing Input and Output operations.

UNIT II CONTROL STATEMENTS AND ARRAYS 6

Decision Making and Branching-Looping statements-Nested looping- Arrays-Declaration-Initialization – One dimensional and two dimensional arrays-Advantages and Limitations of Arrays.

UNIT III STRINGS AND FUNCTIONS 6

String-Character Arrays-String operations--Arrays of Strings.Function –Built in function-User defined function-– Declaration of function – Definition of function-Pass by value – Pass by reference– Recursion.

UNIT IV POINTERS AND FILES 6

Pointers - Operations on Pointers– Arithmetic & Relational operations on pointers-Void Pointer- Null Pointer – Relationship between Pointers and Arrays - Array of Pointers- Applications of Pointers- Files-File Operations.

UNIT V STRUCTURES AND UNIONS 6

Structure definition – Structure declaration – Operations on Structures–Pointer to Structures- Array of structures– Nested Structures-functions and structures-Union - Practical applications of Unions and structures.

BoS Chairman

Course Outcomes

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

CO1: Write a simple program for given problems using appropriate programming paradigms.

CO2: Write a program using control statements and arrays for the given problem.

CO3: Write a modular programs using functions and files for the given scenario.

CO4: Write a program using pointers for effective memory usability.

CO5: Write a program for the given application using structures and unions.

Text Books

1. Anita Goel, Ajay Mittal, "Computer Fundamentals and programming in C" , First Edition, Pearson Education, 2013.
2. PradipDey, ManasGhosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2013

References

1. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2016.
2. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
3. R.G. Dromey, "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007.

List of Experiments **30 Hrs**

1. Program to evaluate an Expression using various types of operators
2. Program using Decision making and Branching statements
3. Program using Loops
4. Program using Arrays
5. Program using Strings
6. Program using Functions
7. Program using Pointers
8. Program using structures
9. Program using union
10. Program Using Files

Reference

1. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.

BoS Chairman

Course Code: 16EET45	**Course Title:** ELECTRICAL DRIVES AND CONTROLS (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course:

- NIl

Course Objective

The course is intended to:

1. Explain an electrical drives and its control
2. Explain the characteristics of DC drives with different control techniques
3. Explain the characteristics of AC drives with different stator side control.
4. Explain the operating principle of special electrical drives
5. Choose an electrical drive for residential or industrial purpose.

UNIT I INTRODUCTION **9**

Fundamentals of electric drives - characteristics of loads – different types of mechanical loads – four quadrant operation of electric drive- control circuit components: Fuses, circuit breakers, contactors, relays

UNIT II SPEED CONTROL OF DC MACHINES **9**

Constructional features and working principle of a DC machine - Speed Torque characteristics of DC shunt & series motor – Methods of Speed control - Solid state DC drives: bridge rectifier fed DC drives, Chopper fed DC drives, Static Ward Leonard method.

UNIT III SPEED CONTROL OF AC MACHINES **9**

Constructional details of induction motors – Types of rotors – Principle of operation – Slip - Speed torque Characteristics of Induction motors – speed control using: pole changing, stator frequency variation, stator voltage variation - basic inverter fed induction motor drive - variable voltage variable frequency drive.

BoS Chairman

UNIT IV SPECIAL ELECTRICAL DRIVES & CONTROLS 9

Stepper motor: Constructional and working – applications -BLDC motor : Constructional and working – applications – encoders - AC and DC Servo Motor : Constructional and working – applications.

UNIT V CONTROL AND SELECTION OF ELECTRIC DRIVES 9

Microcontroller, PLC & PC based control - Selection of an electric drive –IP classes - insulation testing and classes of electric motors - SF motors - continuous, intermittent and short time duty – Selection of drive for home appliances, machine tools, automobile applications, locomotives and steel rolling mills.

Course Outcomes

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

CO1: Explain an electrical drives and its control to operate in different modes.
CO2: Explain the characteristics of DC drives with different control techniques such as field and armature control.
CO3: Explain the characteristics of AC drives with different stator side control.
CO4: Explain the operating principle of special electrical drives such as stepper, BLDC and servo drive.
CO5: Choose an electrical drive for residential or industrial purpose.

Text Books

1. N.K De and P.K Sen "Electric Drives" Prentice Hall of India Private Ltd.,2012.
2. VedamSubramaniam "Electric Drives" Tata McGraw Hill, New Delhi, 2010.

References

1. Bhattacharya Brinjinder Singh S.K, "Control of Electrical Machines" New Age International Publishers, 2006.
2. Dubey.G.K., "Fundamental of Electrical Drives", Narosa publishing House, New Delhi 2013.
3. Krishnan R, "Electric motor drives Modeling, analysis and control", Pearson Education, New Delhi, 2003.

Web References

- http://nptel.ac.in/courses/108108077/
- https://en.wikipedia.org/wiki/Solid-state_drive
- nptel.ac.in/syllabus/108104011/

BoS Chairman

Course Code: 16MEL41	**Course Title:** METAL CUTTING PROCESSES LABORATORY (Common to Automobile, Mechanical & Production)	
Core/Elective: Core	**L : T : P : C**	0 : 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Course Objective

The course is intended to:

1. Develop process sequence for manufacturing a machined part
2. Use Lathe, Automat, Drilling, Milling, Slotting and grinding machines

List of Experiments

1. Exercise on turning of shaft.
2. Exercise on Cylindrical Grinding.
3. Exercise on Key-way Milling.
4. Exercise on Spur Gear Cutting.
5. Exercise on Surface Grinding.
6. Exercise on Machining of bolt in capstan lathe.
7. Exercise on Shaping- Male dove tail part.
8. Exercise on Drilling, Reaming and Tapping.
9. Exercise on Key-way Machining in Slotting machine.
10. Exercise on Assembly of machined components (includes welding of gear housing)

Exercise on Assembly of machined components (includes welding of gear housing)

Course Outcomes

At the end of the course the student will be able to

CO1: Develop process sequence for manufacturing the given machined part using the available machine tools.

CO2: Use Lathe, Automat, Drilling, Milling, Slotting and grinding machines to manufacture a given machined part.

BoS Chairman

BoS Chairman

Course Code: 16EEL43	**Course Title:** ELECTRICAL DRIVES AND CONTROLS LABORATORY (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	0 : 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Course Objective

The course is intended to:

1. Analyze the DC motor to verify its mechanical characteristics.
2. Demonstrate the DC motor and induction motor
3. Demonstrate the stepper motor drives
4. Demonstrate the megger, multimeter and control circuit components

List of Experiments

1. Draw the load characteristics of DC shunt motor.
2. Draw the load characteristics of DC series motor.
3. Draw the load characteristics of 3 Phase Induction Motor.
4. Draw the speed control curves of DC shunt motor.
5. Draw the speed control curves of 3 Phase Induction Motor using VFD.
6. Draw the speed control curves of DC Shunt Motor using Bridge Rectifier.
7. Draw the speed control curve of DC Shunt Motor using chopper.
8. Demonstrate the Position Control of Stepper Motor.
9. Demonstrate insulation testing of motors using Megger.
10. Demonstrate the Star-delta starter and Three-point starter.

Course Outcomes

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

CO1: Analyze the DC motor to verify its mechanical characteristics.
CO2: Demonstrate the DC motor and induction motor to operate in different speeds.
CO3: Demonstrate the stepper motor drives to operate in various speeds
CO4: Demonstrate the megger, multimeter and control circuit components to measure and control various electric parameters.

BoS Chairman

BoS Chairman

Course Code: 16PSL41	Course Title: ETHICAL AND MORAL RESPONSIBILITY (Common to all B.E/B.Tech Programmes)	
Core/Elective: General	L : T : P : C	0: 0 : 2 : 1
Type: PS	Total Contact Hours:	30 Hours

Course Objective

The course is intended to:

1. Articulate the importance of ethical and moral responsibilities
2. Explain the fundamental aspects of ethics and morality
3. Validate one's appropriate and inappropriate behaviors.
4. Elaborate code of conduct
5. Explain the importance of professional practices.

UNIT I ETHICAL PRACTICES - IMPORTANCE 8*

Why ethical practices; The current day scenario of ethical practices – parents, society, politics & business; Awareness of skewedness of information – news, advertisements and other media; The need for ethical and moral responsibility on a personal level; Handling oneself amidst peer pressure and societal pressure;

UNIT II ETHICAL PRACTICES - FUNDAMENTALS 6*

Morality & Ethics; Moral issues, inquiry, moral dilemmas; Moral autonomy – Kohlberg's theory and Gilligan's refinement; Theories on "right action" – virtue ethics, utilitarianism, duty ethics, rights ethics – resolving moral dilemmas; justifying moral obligations;

UNIT III CODES OF CONDUCT 8*

Importance of code of conduct and its role;Evolving draft Code of conduct for different roles – son/daughter, student, future employee & citizen; Reflectionon real time incidences at the college

Engineers as responsible experimenters; Faith of the Engineer (ABET); Pledge and Code of ethics as per National Society of Professional Engineers (NSPE); Code of Ethics of Institution of Engineers (India); Case studies and discussions in professional context

UNIT IV PROFESSIONAL PRACTICES AT WORK 8*

Transition from a student to a professional; Importance of professional practices at work; Integrity as the topmost virtue of a professional; Self-awareness: Where competence ends and professionalism takes over; Professional qualities;

Need to align oneself to culture & values of organizations; Need to embrace diversity in organizations.

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At least one lecture by senior people from Industries/Government organizations/reputed institutions to be conducted.

Course Outcomes

At the end of the course the student will be able to:

- CO1 Articulate the importance of ethical and moral responsibilities
- CO2 Explain the fundamental aspects of ethical practices
- CO3 Validate one's appropriate and inappropriate behaviors in various roles
- CO4 Elaborate code of conduct of professional bodies
- CO5 Explain the importance of professional practices as a future employee/entrepreneur

Course handouts (compiled by Professional Skills team, MCET)

1. Learner's workbook (for the student)
2. Learner's logbook (Journal)
3. Reading Material

References

1. Mike W Martin & Roland Schinzenger, Ethics in Engineering, Tata McGraw-Hill Education Pvt. Ltd, Third Edition.
2. Code of conduct document, MCET student handbook
3. Gail D Baura, "Engineering Ethics - an industrial perspective", Academic Press, Elsevier, 2006.
4. Subrato Bagchi, The professional - Defining the new standard of Excellence at work, Penguin India, 2011.

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END OF SEMESTER- IV

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SEMESTER V

Course Code: 16MET51	**Course Title:** DESIGN OF MACHINE ELEMENTS (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	4 : 0 : 0 : 4
Type: Theory	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Theory of Machines-II
- Strength of Materials

Course Objective

The course is intended to

1. Design the machine elements subjected to static loads.
2. Design the machine elements against fluctuating and impact loads
3. Calculate the design parameters for power transmitting element .
4. Determine the design parameters of helical and leaf spring.
5. Design/Select a suitable bearing.

UNIT I DESIGN FOR STATIC LOAD OR STEADY STRESSES 12

Design Processes and its types. Static stress- yield stress and ultimate stress, direct, bending bearing and shear stresses - factor of safety, selection. Selection of materials and its properties - eccentric loading-stress due to eccentric loading, problems. Theories of failure, simple problems.

UNIT II DESIGN FOR FLUCTUATING AND IMPACT LOADS 12

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.

UNIT III DESIGN OF SHAFTS, KEYS, AND COUPLINGS 12

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 shunk key and spline.

BoS Chairman

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 **12**

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 **12**

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. Mckees equation, Somer field equations -Bearing characteristic number problems.

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

Course Outcomes

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

CO1: Design the machine elements subjected to simple and combined static loads.
CO2: Design the machine elements against fluctuating loads and impact loads
CO3: Calculate the design parameters for power transmitting element such as shaft, key, and coupling.
CO4: Determine the design parameters of helical and leaf spring for given application.
CO5: Design/Select a suitable bearing for the given application.

Text Books

1. V.B. Bhandari. "Design of Machine Elements" Tata McGraw Hills Education, 3rd edition2014.
2. P. C Sharma and A. K Agarwal. "Machine Design" (SI units). S.K. Kataria& Sons. Reprint 2013.

BoS Chairman

References

1. Shigley J.E and Mischke C.R., "Mechanical Engineering Design", Sixth Edition, Tata McGraw Hill, 2012.
2. Ugural A.C, "Mechanical Design – An Integral Approach", McGraw-Hill Book Co., 2010.
3. Spotts M.F., Shoup T.E "Design and Machine Elements" Pearson Education, 2012.

Web References

- http://nptel.ac.in/courses/112105124/
- http://www.nptel.ac.in/downloads/112105125/
- http://nptel.ac.in/courses/112106137/
- http://www.skf.com/in/index.html

BoS Chairman

BoS Chairman

Course Code: 16MET52	Course Title: THERMAL ENGINEERING	
Core/Elective: Core	L : T : P : C	4: 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Engineering Thermodynamics

Course Objective

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 CYCLESAND PERFORMANCE OF IC ENGINES 12

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 12

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 12

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 12

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.

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UNIT V REFRIGERATION AND AIR CONDITIONING 12

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.

NOTE: (Use of Steam table, Mollier diagram, Psychometric chart and Refrigeration property table are permitted in the end semester examination)

Course Outcomes

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

CO1: Evaluate the thermodynamic characteristics of IC engines using air-standard cycles.

CO2: Calculate the performance characteristics of steam boiler and condenser.

CO3: Analyze the performance characteristics of steam nozzles and impulse, reaction steam turbines using velocity diagrams.

CO4: Evaluate the performance characteristics of reciprocating and rotary air compressors

CO5: Calculate the performance of refrigeration and air-conditioning systems using psychrometric chart.

Text Books

1. Kothandaraman C.P, Domkundwar and A.V. Domkundwar, "A Course in Thermal Engineering", Dhanpat Rai& Sons, Fifth Edition, 2002.
2. Rajput R.K. "Thermal Engineering", Laxmi Publications (P) Ltd., New Delhi, 6th edition, 2005.

References

1. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill,3rd edition,2013.
2. Arora C.P., "Refrigeration and Air conditioning", Tata McGraw-Hill, New Delhi, 2005.
3. Sarkar B.K., "Thermal Engineering", Tata McGraw-Hill, New Delhi New Delhi, 2001.

Web References

- http://www.nptel.ac.in/courses/112104039/
- http://www.ignou.ac.in/

BoS Chairman

Course Code: 16MET53	Course Title: FLUID POWER SYSTEMS	
Core/Elective: Core	L : T : P : C	3: 0 : 2 : 4
Type: Theory & Practical	Total Contact Hours:	75 Hours

Prerequisites

The student should have undergone the course(s):

- Fluid Mechanics and Machinery

Course Objective

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 6

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.

UNITII HYDRAULIC SYSTEM AND COMPONENTS 12

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

BoS Chairman

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

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

CO1: Explain the fluid power systems with fluid properties and applications.
CO2: Explain the construction and working of hydraulic system components.
CO3: Develop a hydraulic circuit for milling, grinding and automobile braking application.
CO4: Explain the construction and working of pneumatic system components.
CO5: Develop a pneumatic circuit for material handling and machining application.

List of Experiments **30 Hrs**

1. Design a hydraulic circuit for the actuation of hydraulic cylinder using Mechanical actuation.
   a) Using 4/2 DCV.
   b) Using 4/3 DCV.
2. Design a hydraulic circuit for the actuation of hydraulic cylinder using Electrical actuation.
   a) Using 4/2 DCV.
   b) Using 4/3 DCV.
3. Design a hydraulic circuit for Speed regulation of a double-acting cylinder (Meter in & Meter out).
4. Design a hydraulic circuit for Clamping and Drilling function (Pressure reducing valve).
5. Design a Pneumatic circuit for the actuation of single and double acting cylinder using Mechanical actuation.
6. Design a Pneumatic circuit for the actuation of single and double acting cylinder using Electrical actuation.
7. Develop a CASCADE circuit for given sequence operation (two and three cylinders).
8. Develop a Pneumatic circuit for Material handling application.

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Text Books

1. Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2008.
2. Majumdar, S.R., "Oil Hydraulic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2006.

References

1. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, 2006.
2. Andrew Parr, "Hydraulics and Pneumatics, A technician's and engineer's guide", Third Edition, Butterworth-Heinemann, 2011.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2006

Web References

- http://www.nptel.ac.in/courses/112106175/
- http://nptel.ac.in/courses/112105046/

BoS Chairman

BoS Chairman

Course Code: 16MET54	Course Title: AUTOMOBILE ENGINEERING	
Core/Elective: Core	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Electrical Drives and Controls
- Design of Machine Elements
- Thermal Engineering

Course Objective

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.

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.

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.

BoS Chairman

UNIT V ELECTRICAL SYSTEMS, ACCESSORIES AND EMISSION NORMS 9

Ignition system- coil ignition and magneto ignition system – Spark plug, Battery – Construction and maintenance, Starter motor – types, alternator, distributor, generator, cut out relay, panel board instruments and: Power operated windows-Vehicle Air conditioning-Air bags- Air pollution control- Catalytic converter working principle-Emission norms-Bharat and Euro emission Standards

Course Outcomes

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

CO1: Explain the vehicle structure chassis layouts and different types of IC Engines

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

CO3: Explain the construction and working principle of various components of a Transmission system viz gear box,, clutch, torque converter, fluid flywheel, differential etc.

CO4: Describe the construction and working principle of steering and suspension system of a Automotive vehicle

CO5: Explain the electrical system and its accessories viz battery, starter motor, panel board, power operated windows, air bags and the emission norms.

Text Books

1. Kirpal Singh, "Automobile Engineering Vol. 1 &Vol 2", Standard Publishers, 7th Edition, 2012.
2. Sethi H.M, "Automobile Technology", Tata McGraw-Hill, 2003.

References

1. Jain, K.K., and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
2. Srinivasan.S, "Automotive Mechanics" 2nd edition, Tata McGraw-Hill, 2003.
3. Joseph Heitner, "Automotive Mechanics", 2nd edition, East-West Press, 1999.

Web References

- https://en.wikipedia.org/wiki/Automotive_engineering
- http://auto.howstuffworks.com/

BoS Chairman

Course Code: 16ECT56	Course Title: MICROCONTROLLER AND APPLICATIONS	
Core/Elective: Core	L : T : P : C	3 : 0 : 2 : 4
Type: Theory& Practical	Total Contact Hours:	75 Hours

Prerequisites

The student should have undergone the course:

- NIl

Course Objective

The course is intended to

1. Explain the basic concepts of Microprocessor and Microcontroller.
2. Develop simple assembly language programs.
3. Explain the procedure for interfacing various Peripherals.
4. Write Embedded 'C' programs for interfacing various Peripherals.
5. Design various applications for Industry automation.

UNIT I INTRODUCTION TO DIGITAL SYSTEM **6**

Introduction to number system, Logic gates , Registers and Flip flops , Encoder , Decoder — Introduction to Microprocessor & Microcontroller .

UNIT II 8-BIT MICROCONTROLLER **10**

Architecture of 8051 – Pin configuration – Memory Organization – SFRs – Interrupts – Addressing modes – Instruction set – Assembly Language Programming – Timer – Counter .

UNIT III MICROCONTROLLER INTERFACING **12**

Interfacing concepts – Input /Output port configuration – Interfacing of LED, Switch, Matrix keyboard, Display Interfacing – 7 segment, LCD. DC Motor Interfacing – ADC /DAC interface, simple sensor interfacing.

UNIT IV MICROCONTROLLER WITH EMBEDDED ' C ' PROGRAMS **9**

Introduction to Embedded 'C' –IDE – Simple Assembly Language Programming using IDE. Embedded C Programming using IDE: Interfacing of LED, Switch, 7 segment, LCD, DC Motor, ADC Sensor and Serial port.

UNIT V APPLICATIONS OF MICROCONTROLLER **8**

Case study of Wind Screen Wiper Motion, a Pick and Place Robot, Car Engine Management, Controlling of AC & DC Appliances, Measurement of Frequency. Simple applications for Industry Automation.

BoS Chairman

Course Outcomes

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

CO1: Explain the basic concepts of Microprocessor and Microcontroller using the principles of digital system.

CO2: Develop simple assembly language programs using 8 bit microcontroller instructions.

CO3: Explain the procedure for interfacing various Peripherals with 8-bit microcontroller.

CO4: Write Embedded 'C' programs for interfacing various Peripherals with 8-bit microcontroller.

CO5: Design various applications for Industry automation using the concept of 8-bit microcontroller.

Text Books

1. M.A. Mazidi and J.G. Mazidi, "The 8051 Microcontroller and Embedded Systems", PHI/ Pearson Education, 2006.
2. M.MorrisMano,"Digital Design",3rdEdition,Pearson Education Pvt. Ltd., New Delhi, 2008.

References

1. Kenneth J. Ayala,"The 8051 Microcontroller, Architecture, Programming and Applications", Thomson Delmar Learning, Indian Edition, 2007.
2. Krishna Kant, "Microprocessor and Microcontroller", Prentice Hall of India, 2007.
3. William Botton, "Mechatronics – A Multidisciplinary Approach", Pearson Education Pvt. Ltd., New Delhi, 4th Edition, 2010.

List of Experiments **30 Hrs**

1. Arithmetic operation using Microcontroller (ADD, SUB, MUL, DIV)
2. ALP based Compare instructions (GR, LR)
3. Study of Integration Development Environment
4. Simple Arithmetic operation using IDE
5. Write an Embedded C programming using IDE to interface the following
   - I. LED
   - II. Switch
   - III. Display (7- segment LED&LCD)
   - IV. DC Motor
   - V. Temperature sensor using ADC
   - VI. Serial port programming
6. Read and display the temperature sensor value using microcontroller to control the DC motor.

Web References

- http://www.daenotes.com/electronics/digital-electronics/
- http://www.engineersgarage.com/microcontroller
- www.intorobotics.com

BoS Chairman

Course Code: 16MEL51	Course Title: THERMAL ENGINEERING LABORATORY	
Core/Elective: Core	L : T : P : C	0: 0 : 4 : 2
Type: Practical	Total Contact Hours:	60 Hours

Course Objective

The course is intended to

1. Construct the valve and port timing diagrams
2. Evaluate the performance of IC engines
3. Determine the fuel properties
4. Study the performance of steam boilers and turbines

I.C Engine Lab and Fuels Lab

1. Valve timing and port timing diagrams.
2. Performance test on single cylinder, 4-stroke high speed diesel engine.
3. Performance test on single cylinder, 4-stroke computerized VCR petrol/diesel engine.
4. Heat balance test on twin cylinder, 4-stroke diesel engine.
5. Morse test on multi-cylinder petrol engine.
6. Retardation test to find frictional power of single cylinder, slow speed diesel engine.
7. Performance test on centrifugal air blower.
8. Wind tunnel- lift drag measurements.
9. a). Determination of viscosity using Redwood viscometer.
   b). Determination of flash point and fire point using Pensky-Martens closed cup apparatus.

Steam Lab

1. Study of steam generators and turbines.

Course Outcomes

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

CO1: Construct the valve and port timing diagrams of 2stroke and 4 stroke IC engines.

CO2: Evaluate the thermal performance of single cylinder and multi-cylinder petrol and diesel engines.

CO3: Determine the fuel properties viz. viscosity, flash point and fire point of lubricating and fuel oils using Redwood viscometer and Pensky-Martens closed cup apparatus.

CO4: Study the thermal performance and energy utilization of steam boilers and turbines.

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Course Code: 16MEL52	**Course Title:** COMPUTER AIDED MACHINE DRAWING LABORATORY (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Core	**L : T : P : C**	0: 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Graphics
- Metrology & Measurements
- Computer Aided Drafting and Modeling Laboratory

Course Objective

The course is intended to

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

List of Experiments

1. Exercise on Knuckle joint
2. Exercise on Flange coupling
3. Exercise on Plummer Block
4. Exercise on Screw Jack
5. Exercise on Piston and Connecting rod
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

Course Outcomes

At the end of the course the student will be able to

CO1: Develop part models of machine components as per the design specification to prepare the assembly.

CO2: Prepare assembly drawings of machine components to disseminate how the parts fit together.

References

1. Gopalakrishna, K. R., "Machine Drawing", SubhasPublishing House, 20th Edition, 2007.
2. Cecil Jensen, Jay D. Helsel, Dennis R. Short , "Engineering Drawing & Design", McGraw-Hill Higher Education, 7th edition, 2007.

BoS Chairman

BoS Chairman

Course Code: 16PSL51	Course Title: TEAMNESS AND INTER-PERSONAL SKILLS(TIPS) (Common to All BE/B.Tech Programmes)	
Core/Elective: Core	L : T : P : C	0 : 0 : 2 : 1
Type: PS	Total Contact Hours:	30 Hours

Course Objective

The course is intended to

1. Be aware of attitudinal, behavioral and emotional aspects of self
2. Learn continuously and be in harmony with self
3. Understand others' preferences, values, roles & contexts
4. Identify barriers to harmonious relationships
5. Work collaboratively as a team

UNIT I HARMONY WITH SELF

Importance of learning about self continuously; Approaches to learn about self: introspection, being open to feedback, critical incidences as opportunities; Understanding life stages and challenges associated with them; Healthy ways of handling self in response to life's challenges;
Instruments/inventories to understand self and others: A) Know your temperament, B) Mayer Briggs Type Indicator, C) Interpersonal Needs Inventory (tentative).

UNIT II HARMONY WITH OTHERS

Importance of living in harmony with others; What it takes to live in harmony with others; Understanding preferences, values, roles and contexts of others; Approaches to navigating through differences between self and others;
Barriers to harmonious relationships - Perceptions, Judgments, and Emotional instability; Ways to handle each of the barriers; Importance of reaching-out to others

UNIT III GROUP DYNAMICS AND CONFLICTS RESOLUTION

Group dynamics: overt and covert processes at micro and macro levels; Understanding the basis of conflicts; Understanding one's own conflict handling style; Methods to handling conflicts effectively.

UNIT IV WORKING IN TEAMS

Effectiveness in communication; Forming – storming – norming and performing model; Competition vs collaboration – impact of both on team tasks; TEAM Questionnaire – components of a healthy team and approaches to improving them.

Course Outcomes

BoS Chairman

At the end of the course, students will

CO1: Be aware of attitudinal, behavioral and emotional aspects of self
CO2: Prefer to learn continuously about self and be in harmony with self
CO3: Understand others' preferences, values, roles & contexts and be in harmony with others
CO4: Identify barriers to harmonious relationships and derive ways to handle them
CO5: Work collaboratively as a team to deliver expected outcomes

Mode of delivery:

1. A 2-day learning workshop

1. Activities (experiential learning)
2. Audio visuals (affective learning)
3. Case discussions (cognitive learning)
4. Instruments/questionnaires (reflective learning) Guided by Learner's workbook.

2. Continuous learning guided by learning journal, and reviews by faculty
3. Half-day reinforcement session towards the end of the semester

Assessments and Evaluation:

Assessment	Details	Weightage	Administration	By Whom	When
Continuous Assessment					
Initial Knowledge Test	Multiple choice questions (20)	10%	Pen and paper	Internal team	Immediately after the initial workshop.
Review of student journal	Student held journal book.	50%	Student journals to be reviewed	Trained Internal faculty	Once in a week.
Semester End Examination:					
Final comprehensive Knowledge test	Multiple choice questions (40)	10%	Pen and paper	Internal team	End of semester after the reinforcement program.
Viva-Voce	Scenario based questions	30%		Internal team	

Continuous Assessment = 60%
Semester end examination = 40%
An overall mark of 50 is to be scored for a pass in the course

END OF SEMESTER V

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SEMESTER VI

Course Code: 16MET61	Course Title: FINITE ELEMENT ANALYSIS (Common to Automobile and Mechanical)	
Core/Elective: Core	L : T : P : C	4 : 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics - I
- Numerical Methods
- Strength of Materials
- Heat and Mass Transfer

Course Objective

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 12

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, solution of numerical problems.

UNIT II ONE DIMENSIONAL VECTOR VARIABLE PROBLEMS 12

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.

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UNIT III TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS USING CONSTANT STRAIN TRIANGLES 12

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 12

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

UNIT V TWO DIMENSIONAL VECTOR VARIABLE PROBLEM USING QUADRILATERAL ELEMENTS 12

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.

Course Outcomes

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

CO1: Convert physical problems into mathematical model using finite element procedure and solve simple problem using spring element

CO2: Solve the one dimensional structural problems such as bar, truss and beam using natural co ordinate system.

CO3: Solve the 2D vector variable problems by applying plane stress, strain and axi-symmetric conditions using CST element.

CO4: Solve the 1D and 2D scalar variable problems such as conduction and convection.

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.

Text Books

1. Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", Prentice-Hall of India, 3rd Edition, Eastern Economy Editions, 2011.
2. Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002

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References

1. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition, 2005.
2. J.N.Reddy, "An Introduction to the Finite Element Method", McGraw-Hill International Editions (Engineering Mechanics Series), 2005.
3. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Web References

- http://nptel.ac.in/courses/112104115/4
- http://textofvideo.nptel.iitm.ac.in/105106051/lec1.pdf
- http://nptel.ac.in/courses/112104116/

BoS Chairman

BoS Chairman

Course Code: 16MET62	Course Title: DESIGN OF TRANSMISSION SYSTEMS	
Core/Elective: Core	L : T : P : C -	4 : 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course(s):

- Theory of Machines – I & II
- Design of Machine Elements

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 12

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 12

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 12

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 12

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

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UNIT V DESIGN OF CLUTCHES AND BRAKES 12

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)

Course Outcomes

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

CO1: Design a suitable flexible element drives such as flat belt, V-belt and chain drives for power transmitting applications.

CO2: Design a spur gear and helical gear drives considering the tooth bending and surface strength for given application.

CO3: Design and analyze a bevel and worm gear drives for strength and surface durability.

CO4: Design a single/multi stage sliding mesh gear box having maximum of 12 speeds and calculate the output speeds for machine tool applications.

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.

Text Books

1. Shigley J.E and Mischke C.R, "Mechanical Engineering Design" 9th Edition, Tata McGraw-Hill,2011.
2. Bhandari V.B, "Design of Machine Elements" 3rdEdition,Tata McGraw-Hill, 2010.

References

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

Web References

- http://nptel.ac.in/courses/112106137/
- http://nptel.ac.in/courses/112102014/38
- http://dunloptransmissions.com/
- http://www.renold.in/Products/TransmissionChainSprockets/TransmissionChainIndexPage.asp
- http://khkgears.net/gear-knowledge/

BoS Chairman

Course Code: 16MET63	Course Title: HEAT AND MASS TRANSFER	
Core/Elective: Core	L : T : P : C	4 : 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics
- Fluid Mechanics & Machinery
- Engineering 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 12

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 12

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 12

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.

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UNIT IV RADIATION **12**

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 **12**

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)

Course Outcomes

At the end of the 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.

CO2: Solve forced and natural convection heat transfer problems for external and internal fluid flows in simple geometries.

CO3: Design a heat exchanger using LMTD and NTU methods with and without phase change.

CO4: Calculate radiation heat transfer between different geometries using shape factor concept.

CO5: Solve diffusion mass transfer through plane membrane.

CO6: Describe the different applications of heat transfer.

Text Books

1. Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi, 2012.
2. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International, 2010.

References

1. Yadav R "Heat and Mass Transfer" Central Publishing House, 1995.
2. Nag P.K, " Heat Transfer", Tata McGraw-Hill, New Delhi, 2011
3. Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co., 1994.

Web References

- http://nptel.ac.in/courses/112101097/
- http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Heat%20and%20Mass%20Transfer/New_index1.html

BoS Chairman

Course Code: 16MET64	Course Title: POWER PLANT ENGINEERING
Core/Elective: Core	L : T : P : C : M – 3 : 0 : 0 : 3 : 100
Type : Theory	Total Contact Hours: 45 Hours

Prerequisites

The student should have undergone the course(s):

- Thermal Engineering
- Engineering Economics and Cost Analysis

Course Objective

The course is intended to

1. Explain the construction and working principle of steam power plant
2. Explain the working principle of hydroelectric and nuclear power plants
3. Explain the operation and maintenance of diesel and gas turbine power plant
4. Explain the working principle of non conventional power plants
5. Calculate the cost of power generation for various power plants

UNIT I STEAM POWER PLANT 12

Layout of Steam power plant- Fuel and Ash handling systems - Combustion equipment for burning coal- Mechanical Stokers – Pulveriser – Gas cleaning systems- Electrostatic Precipitator and Mechanical dust collector. Draught – Different types- Surface Condenser and Cooling Towers. Steam Boilers– High Pressure, Super Critical Boilers and Ultra supercritical boilers– Fluidised Bed Boilers, Pollution Control methods.

UNIT II HYDROELECTRIC AND NUCLEAR POWER PLANT 9

Layout of Hydroelectric Power Plant – Essential Elements –Types – Standalone and Pumped storage- Site selection - Indian Scenario.

Nuclear Energy – Fission, Fusion Reaction- Layout of Nuclear power plant-Types of Reactors- Pressurized water , Boiling water , Gas cooled , Fast breeder Reactor- Waste Disposal and safety - site selection- Indian scenario – Recent Developments.

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.

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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, RENOVATION AND MODERNIZATION 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.

Course Outcomes

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

CO1: Describe the construction and working principle of various subsystem and pollution control methods in a steam power plant

CO2: Explain the working principle of various components of hydroelectric and various types of nuclear reactor used in nuclear power plant.

CO3: Describe the various components, working principle and performance improvement methods in diesel and gas turbine power plant

CO4: Explain the working principle of various types of non conventional power plants viz Solar, Wind, Geothermal, Bio Gas, MHD, OTEC, Tidal

CO5: Calculate the cost of power generation for various power plant using different types of tariff systems.

Text Books

1. S. C. Arora and S. Domkundwar, "A course in Power Plant Engineering", Dhanpat Rai& Sons, New Delhi, 2008.
2. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Company Pvt Ltd., New Delhi,2007.

References

1. M. M. El-Wakil, "Power Plant Technology", Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,1985.
2. G.R. Nagpal, "Power Plant Engineering", Khanna Publishers, New Delhi,2002.
3. G.D. Rai, "Introduction to Power Plant Technology", Khanna Publishers, New Delhi, 1995.

Web References

- http://nptel.ac.in/courses/108105058/8
- http://www.ignou.ac.in/

BoS Chairman

Course Code: 16MEL61	Course Title: SIMULATION AND ANALYSIS LABORATORY (Common to Automobile, Mechanical & Production)	
Core/Elective: Core	L : T : P : C	0 : 0 : 4 : 2
Type: Practical	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the course(s):

- Numerical Methods
- Thermal Engineering
- Strength of Materials
- Theory of Machines -I&II
- Design of Hydraulics & Pneumatics System

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 C /MAT Lab.
2. Simulation of free vibration characteristics of spring, mass and damper system.
3. Simulation of Hydraulic / Pneumatic cylinder using C / MAT Lab.
4. Simulation of cam and follower mechanism using C / MAT Lab.

Analysis (Simple Treatment Only)

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

Course Outcomes

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

CO:1 Apply finite element simulation software to solve simple problems such as structural, thermal and vibration problems in Mechanical Engineering.

CO:2 Write programs in a mathematical simulation software to solve mathematical model of mechanical engineering applications

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Course Code: 16MEL62	**Course Title:** HEAT TRANSFER LABORATORY	
Core/Elective: Core	**L : T : P : C**	0: 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics
- Fluid Mechanics & Machinery
- Thermal Engineering

Course Objective

The course is intended to

1. Determine the thermal conductivity of insulating materials.
2. Calculate the heat transfer coefficient and fin efficiency.
3. Calculate the Stefan boltzman constant and emissivity of grey surfaces.
4. Evaluate the performance of heat exchangers
5. Evaluate the performance of reciprocating air compressor, refrigeration and air-conditioning systems.

Heat Transfer

1. Thermal conductivity measurement using guarded plate method.
2. Thermal conductivity measurement of pipe insulation using lagged pipe approach.
3. Heat transfer through composite wall
4. Thermal conductivity of insulating powder in a concentric sphere
5. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
6. Determination of heat transfer coefficient under forced convection inside tube.
7. Heat transfer from pin-fin (Natural and Forced convection mode)
8. Determination of Stefan Boltzman constant.
9. Determination of emissivity of grey surface.
10. Effectiveness of parallel/counter flow heat exchanger.
11. Performance test on Cooling tower.
12. Performance test on Computerized shell and tube heat exchanger

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Refrigeration & Air-Conditioning

1. Study of Refrigeration & Air-conditioning systems
2. Determination of COP of Refrigeration system.
3. Determination of COP of Air-conditioning system.
4. Performance test on two stage reciprocating air compressor

Course Outcomes

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

CO1: Determine the thermal conductivity of insulating materials viz. wood, asbestos powder and glass wool using conduction mode of heat transfer.

CO2: Calculate the heat transfer coefficient and fin efficiency under natural and forced convection modes of heat transfer.

CO3: Calculate the Stefan Boltzmann constant and emissivity of grey surfaces using radiation heat transfer.

CO4: Evaluate the performance of heat exchanger and to calculate its effectiveness under parallel and counter flow modes.

CO5: Evaluate the performance of reciprocating air compressor, refrigerating and air- conditioning systems to calculate its volumetric efficiency, isothermal efficiency and Coefficient of Performance (COP).

BoS Chairman

Course Code: 16PSL61	**Course Title:** CAMPUS TO CORPORATE (Common to All BE/B.Tech Programmes))	
Core/Elective: Core	**L : T : P : C**	0 : 0 :2 : 1
Type: PS	**Total Contact Hours:**	30 Hours

Course Objective

The course is intended to

1. Display gratitude and social responsibility
2. Understand various business environments
3. Explain the transition from a campus mindset to corporate mindset
4. Be prepared to the work culture
5. Choose to be presentable and agile

UNIT I GRATITUDE AND SOCIAL RESPONSIBILITY

Importance of gratitude; Finding opportunities to give back to society; Responsible behavior in public places; Volunteerism during calamities;Social relevancy during engineering design and manufacturing – how social issues could be tackled by engineering solutions;

UNIT II THE WORLD OF BUSINESS (get to the specifics of behavioral responses to certain specific contexts)

World of business - Perceptions vs reality; Various business types - B2B, B2C, & other business models; Various industry verticals – fundamentals, dynamics & nuances; Nature of work as per various functions – Sales & Marketing, Service, Research & Development, Production etc; Self-reflective questionnaire to identify the fitment to a particular field/function;

UNIT III TRANSITION FROM A CAMPUS MINDSET TO CORPORATE MINDSET

ROCK as an acronym (Responsibility, Ownership, Contribution, Knowledgeable (continuous learning)); Responsibility – ways in which responsibility should be demonstrated; Ownership – owning one's career, owning mistakes, desisting from complaining; Contribution – focus on creating value, giving more than receiving (salary & perks); Knowledgeable(continuous learning) – learning just begins after campus, aspects of learning mindset, various opportunities to learn and how they can be utilised at work;

UNIT IV PREPAREDNESS TO ADAPT TO WORK CULTURE

Skills to get through selection process – Interview conversations, resume writing, group discussion & presentation;

Handling Cultural differences; Handling Gender dynamics; Alignment to Ethics and values; Alignment to work processes & code of conduct; Handling multiple (often conflicting) demands; Handling peer influence; Conducting sensitively with subordinates, peers &boss; Managing personal finance; Maintaining work-life balance – work & social life, hobbies etc;

UNIT V PRESENTABLE AND AGILE

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Dressing & grooming – Reasons for good dressing & grooming; Professional etiquette – what is etiquette, professional etiquette vs social etiquette, Aspects of professional etiquette; Wellness – Healthy eating habits, Importance of sleep, Importance of fitness; Importance of cleanliness of surroundings – desk, work area, place of stay (5S);

Course Outcomes

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

CO1: Display gratitude and social responsibility
CO2: Understand various business environments – industry & function wise
CO3: Explain the transition from a campus mindset to corporate mindset
CO4: Be prepared to adapt to the future work culture
CO5: Choose to be presentable and agile

MODE OF DELIVERY:

1. A 2-day learning workshop guided by Learner's workbook.
2. Continuous learning guided by learning journal, and reviews by faculty

ASSESSMENTS AND EVALUATION:

Assessment	Details	Weigh tage	Administrati on	By Whom	When
Workbook record assessment	Assess the necessary elements to be entered in the workbook	20%	Individual workbooks reviewed by the faculty		Immediately after the learning workshop
Initial Knowledge Test and Scenario based knowledge test	Multiple choice questions (20)	25%	Pen and paper,	Internal team	Immediately after the learning workshop
Review of student journal	Student held journal for the whole semester	30%	Individual journals reviewed by the faculty	Trained faculty members	Once in a week.
Final Knowledge test and Scenario based knowledge test	Multiple choice questions (40)	10%		Internal team	End of semester
Review of student journal by external expert		15%	Student journal comprehensiv e review	Trained faculty members	End of semester

END OF SEMESTER VI

BoS Chairman

SEMESTER VII

Course Code: 16MET71	Course Title: MECHATRONICS	
Core/Elective: Core	L : T : P : C	4 : 0 : 0 : 4
Type: Theory	Total Contact Hours:	60 Hours

Prerequisites

The student should have undergone the courses:

- Design of Hydraulic and Pneumatic systems
- Microprocessor and its application

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 user interface
5. Design automation systems

Course Content

UNIT I INTRODUCTION 12

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 12

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 12

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 12

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

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UNIT V DESIGN OF MECHATRONICS SYSTEMS 12

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

Course Outcomes

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

CO1: Explain the fundamentals of mechatronics systems such as the components and control schemes with block diagrams

CO2: Select sensors for various measurements including pressure, temperature, flow, level and light used in different systems

CO3: Write logic programs for real time applications such as home automation, machine tool control, process control using PLC

CO4: Design user interface for arithmetic, logical, sequencing data acquisition operations in analog and digital modes using virtual instrumentation.

CO5: Design automation systems such as pick and place , autonomous mobile robots, wireless surveillance balloons, engine management system, car park barrier using sensors , actuators and control systems

Text Book

1. Bolton,W, "Mechatronics" , Pearson education, fourth edition, 2011.
2. Jovitha Jerome, 'Virtual Instrumentation using LabVIEW' PHI Learning Private Limited, New Delhi, Second Printing, 2011.

References

1. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
2. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company 2007.
3. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications" Tata McGraw-Hill Publishing company Limited, 2003.

Web References

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

BoS Chairman

Course Code: 16CET73	Course Title: ENVIRONMENTAL STUDIES (Common to All BE/B.Tech Programmes)	
Core/Elective: Core	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Nil

Course Objective

The course is intended to

1. Describe the multidisciplinary nature of environmental studies
2. Explain the importance of ecosystem and biodiversity
3. Identify the causes and propose suitable methods of control for various types of environmental pollution
4. Brief the importance of environmental protection in social and global context
5. Explain the relationship between environment and human beings

Course Content

UNIT I MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES 9

Definition, scope and importance; Need for public awareness; Natural resources and associated problems - Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources; Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT II ECOSYSTEMS AND BIODIVERSITY 9

Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of the following ecosystem - Forest, Grassland, Desert, Aquatic; Biodiversity and its conservation: Introduction; Biogeographically classification of India; Value of biodiversity; Biodiversity at global, national and local levels; India as a mega diversity nation; Threats to biodiversity; Endangered and endemic species of India; Conservation of biodiversity : In-situ and Ex-situ conservation.

UNIT III ENVIRONMENTAL POLLUTION 9

Definition; Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution; Solid waste Management: Causes, effects and control measures of urban and industrial wastes;

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

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9

From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Environmental ethics: issues and possible solutions; Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation ; Consumerism and waste products; Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9

Population growth, variation among nations; Population explosion - Family Welfare Programme; Environment and human health; Human Rights; Value Education; HIV/AIDS; Women and Child Welfare; Role of information Technology in Environment and human health; Case studies; Field work – Visit to a local area to document environmental assets –river/forest/grassland/hill/mountain; Visit to a local polluted site Urban /Rural /Industrial /Agriculture; Study of simple ecosystems – pond, river, hill, slopes, etc. Pollution norms

Course Outcomes

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

CO1: Describe the multidisciplinary nature of environmental studies
CO2: Explain the importance of ecosystem and biodiversity
CO3: Identify the causes and propose suitable methods of control for various types of environmental pollution
CO4: Brief the importance of environmental protection in social and global context
CO5: Explain the relationship between environment and human beings

Text Book

1. Benny Joseph, "Environmental Studies", Tata McGraw Hill, New Delhi, 2006.
2. Mackenzie Davis and Susan Masten, "Principles of environmental engineering and science", Mc-Graw Hill, 3rd edition, 2014.

References

1. Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media 2004.
2. Cunningham, W.P.Cooper., T.H. Gorhani, "Environmental Encyclopedia", Jaico Publishing House, Mumbai, 2001.
3. Rajagopalan. R, "Environmental Studies - From Crisis to Cure", Oxford University Press, 2005

BoS Chairman

Course Code: 16MEL71	**Course Title:** MECHATRONICS LABORATORY (Common to Mechanical & Production)	
Core/Elective: Core	**L : T : P : C**	0 : 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the courses:

- Design of Hydraulic and Pneumatic systems
- Microcontroller and its application

Course Objective

The course is intended to

1. Calculate process control parameters in closed loop system
2. Develop logic Program for real time interfacing
3. Develop a user interface for measurements

List of Experiments

1. Closed loop response of Pressure process
2. Closed loop response of Temperature process
3. Closed loop response of flow process
4. Closed loop response of fluid level process
5. Basics logic using PLC Programming - AND, OR, Latch, Interlock
6. Control of multiple actuators in Hydraulic and pneumatic System by using PLC
7. Control of Bottle filling system using PLC
8. Creating simple VIs, Editing and Debugging
9. Creating Sub VI
10. Temperature signal interface using Lab VIEW
11. Vibration Measurement using Lab VIEW

Course Outcomes

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

CO1: Construct process control parameters in control loop system in temperature, pressure, floe and liquid level.

CO2: Develop a logic Programme for real time interfacing using plc for fluid power system, logic function and bottle filling.

CO3: Develop a user interface for temperature and vibration measurement using virtual instrumentation. .

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Course Code: 16MEL72	**Course Title:** PRODUCT DESIGN LABORATORY (Common to Mechanical & Production)	
Core/Elective: Core	**L : T : P : C**	0 : 0 : 4 : 2
Type: Practical	**Total Contact Hours:**	60 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Practices Laboratory
- Metal Forming, Joining and Casting Processes
- Metal Cutting Processes
- Simulation and Analysis Laboratory
- Computer Aided Machine Drawing Laboratory
- Design of Machine Elements

Course Objective

The course is intended to

1. Realise and formulate the Mechanical Engineering products from the customer.
2. Create 3D solid model parts of mechanical components and assemble the parts using CAD software.
3. Work collaboratively on a team to successfully complete a design project

List of Experiments:

Part 1

The students in a group (maximum of three) have to realise a mechanical engineering product and submit a report based on their realisation. The mark will be awarded based on the report and oral examination on the same by internal examiners.

Part 2

The students in a group (maximum of three) have to develop digital and physical prototype models using 3D Printing machine / clay models of a new product/ existing product with enhanced feature involving the following areas:

- Automotive components
- Tool and die components
- Press tool components

The fabricated models may be in the form of Rapid prototype models, clay models, sheet metal models or cardboard models etc... The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the report, demonstration of the new product developed and oral examination on the same by internal examiners.

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Course Outcomes

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

CO1: Realise and formulate the Mechanical Engineering products from the customer.

CO2: Create 3D solid models of mechanical components and assemble the parts using CAD software

CO3: Work collaboratively on a team to successfully complete a design project.

Text Book

1. Gopalakrishna,K.R, "Machine Drawing", 16th Edition Subhas publishing House, Bangalore, 2017 .
2. Maitra Prasad, "Hand Book of Mechanical Design", Second edition, Tata McGraw Hill, Noida 2011.

References

1. Cencil Jensen, Jay D. Helsel and Dennis R. Short Engineering Drawing and Design. Tata McGraw Hill Publishing Company Limited 2012.
2. Sidheswar.N, Kannaiah.P, Sastri.V.V.S "Machine Drawing", Reprint, TMH, New Delhi 2006.
3. Faculty of Mechanical Engineering,"PSG Design Data Book", DPV Printers, Coimbatore 2006

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Course Code: 16MEL73	**Course Title:** INNOVATIVE AND CREATIVE PROJECT	
Core/Elective: Core	**L : T : P : C**	0 : 0 : 8 : 4
Type: Practical	**Total Contact Hours:**	120 Hours

Course Objective

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 goal of this course is to help students to identify innovative projects that promote creativity to explore the variables that affect creativity and innovation. By the end of the semester, the students should be familiar with current thinking in their field, and able to apply the concepts to relevant research problems or practical applications. The goal of this course is to drive them to learn concepts, models, frameworks, and tools that engineering graduates' need in a world where creativity and innovation is fast becoming a precondition for competitive advantage. Each student will choose a frequently/commonly encountered workplace problem or socially relevant problems that have been difficult for them to "solve." At the end of the semester, each or group of students have to submit a report for evaluation.

Course Outcomes

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

CO1: Take up any challenging practical problems and find solution by formulating proper methodology.
CO2: Work collaboratively on a team to successfully complete a design project
CO3: Effectively communicate the results of projects in a written and oral format

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SEMESTER VIII

Course Code: 16MEL81	Course Title: PROJECT	
Core/Elective: Core	L : T : P : C	0 : 0 : 20 : 10
Type: Practical	Total Contact Hours:	300 Hours

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 students in a group of 2 to 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report.

Course Outcomes

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

CO1: Take up any challenging practical problems and find solution by formulating proper methodology.
CO2: Work collaboratively on a team to successfully complete a design project
CO3: Effectively communicate the results of projects in a written and oral format

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ELECTIVES

Course Code: 16MEE01	**Course Title:** DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.
- Design of Machine Elements

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 FACTORS INFLUENCING FORM DESIGN 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.

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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 Design for energy efficiency – Design to regulations and standards. AT&T life cycle assessment methods.

Course Outcomes

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

CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.
CO2: Describe the factors influencing form design of castings, forgings and welding.
CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.
CO4: Optimize the given casting part by applying design principles.
CO5: Explain the environmental consideration in design while using DFMA tools.

Text Books

1. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , "Product Design for Manufacture and Assembly", Third Edition, CRC Press, 2010
2. Boothroyd, G, "Design for Assembly, Automation and Product Design"., Marcel Dekker, New York 2005

References

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

Web References

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

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Course Code: 16MEE02	**Course Title:** MECHANICAL SYSTEM DESIGN (Common to Automobile and Mechanical)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics -I
- Numerical Methods

Course Objectives

The course is intended to:

1. Explain the engineering process and system approach
2. Explain the system theories and system modeling concepts
3. Apply the mathematical formulation in system design and optimization concepts
4. Apply the decision analysis principles and system simulation concepts
5. Apply the financial analysis to evaluate the system performance

UNIT I SYSTEM APPROACH AND PROBLEM FORMULATION 9

Engineering processes- Role of an Engineer in Mechanical system Design, Engineering Problem solving. System approach-Application of system concepts, Characteristics of systems, elements of systems, Types of systems. Problem formulation-Problems and forming models, nature of engineering problems, problem characteristics, problem environment, problem statement and techniques involved in defining a problem, a case study.

UNIT II SYSTEM THEORIES AND SYSTEM MODELING 9

System Theories-Black box approach, state theory approach, component integrated approach, decision theory approach. System Modeling-Need of modeling, modeling process, principles, modeling types-static physical model, dynamic physical model, static mathematical model, dynamic mathematical model, a case study on system modeling.

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.

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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.

Course Outcomes

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

CO1: Explain the engineering process and system approach to formulate a problem.
CO2: Explain the system theories and system modeling concepts to study the system behavior.
CO3: Apply the mathematical formulation in system design and optimization concepts to optimize the system.
CO4: Apply the decision analysis principles and system simulation concepts optimize the system.
CO5: Apply the financial analysis to evaluate the system performance.

Text Books

1. R.C Mishra and Simant, "Mechanical System Design-PHI" learning New Delhi, 2017.
2. K.U. Siddiqui and Manojkumarsingh, "Mechanical system Design"-New Age international Publishers, 2016.

References

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

Web References

- http://content.asce.org/files/pdf/team20102Mechanical_systems_designpresentation.pdf
- http://www.engr.mun.ca/~yuri/Courses/MechanicalSystems/Design.pdf
- http://www.coursera.org

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Course Code: 16MEE03	**Course Title:** COMPOSITE MATERIALS (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Materials Science
- Strength of Materials
- Metallurgical Engineering.

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 –Classifications of composite materials, Matrix materials, Functions of a Matrix, desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and selection of reinforcement materials, Types of fibres, 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, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

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, Inter laminar stresses.

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.

Course Outcomes

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

CO1: Explain the properties of matrices and reinforcements
CO2: Explain the various types of composite materials
CO3: Explain the fabrication and testing of composites.
CO4: Explain the mechanics and lamination theory of fiber reinforced composites.
CO5: Explain the load bearing behavior of composite and composite Structures

Text Books

1. Krishnan K.Chawla, "Composite Materials Science and Engineering", Springer 2006.
2. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design",Manee Dekker Inc, 2007.

References

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites",John Wiley and Sons, New York, 2012.
2. Gibson, R.F., "Principles of Composite Material Mechanics", McGraw-Hill, 2011.
3. Srinivasan K , "Composite Material" NarosaPublication , 2009.

Web References

- http://nptel.ac.in/courses/101104010/
- http://nptel.ac.in/courses/Webcourse-contents/IISc BANG/Composite%20Materials/New_index1.html

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Course Code: 16MEE04	**Course Title:** COMPUTATIONAL FLUID DYNAMICS (Common to Automobile & Mechanical)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Fluid Mechanics & Machinery
- 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**

Taylors 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.

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UNIT V TURBULENCE AND ITS MODELLING 9

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

Course Outcomes

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

CO1: Explain the governing equations, classification of partial differential equation, initial and boundary conditions.
CO2: Discretize governing equations using finite difference method.
CO3: Discretize governing equations using finite volume method.
CO4: Solve incompressible viscous flow problems using MAC and SIMPLE algorithms.
CO5: Discuss basics of turbulence, its modeling and boundary conditions in real life problems.

Text Books

1. Anderson D.A., Tannehil J.C, Pletcher R.H, "Computational Fluid Mechanics & Heat Transfer", Hemisphere Publishing Corporation, New York, 2004.
2. Versteeg H.K, Malalasekara W, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Second Edition, Pearson Publishers, 2007.

References

1. Klaus A. Hofmann, Steve T. Chiang, "Computational Fluid Dynamics", Fourth Edition, Engineering Education System, 2000.
2. John D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", First Edition, McGraw-Hill Education, 2012
3. Murlidhar.K.,Sunderrajan.T, "Computational Fluid Mechanics and Heat Transfer", Narosa Publishing House, 2008.

Web References

- http://nptel.ac.in/courses/112105045/
- http://www.cfd-online.com/

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Course Code: 16MEE05	Course Title: VIBRATION AND NOISE ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Theory of Machines-II

Course Objectives

The course is intended to:

1. Calculate the natural frequency of the given systems.
2. Calculate natural frequency of continuous system using approximate methods.
3. Identify the required vibration measuring instruments.
4. Calculate the basic noise parameters from the given condition.
5. Analyze the industrial noise and apply the control techniques.

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, linear and non-linear vibration, response of damped and undamped systems under harmonic force, Free and forced vibration of multi-degree of freedom systems.

UNIT II VIBRATION OF CONTINUOUS SYSTEMS 9

Vibration of continuous systems: exact methods, boundary value problem, Eigen value problem, axial vibration of rods, transverse vibration of beams, response of system by modal analysis, General elastic waves, approximate methods to analyse system, different methods like Rayleigh's energy method, Rayleigh-Ritz method, Dunkerley's method.

UNIT III VIBRATION ANALYSIS AND CONTROL TECHNIQUES 9

Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. –Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments.

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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.

Course Outcomes

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

CO1: Calculate the natural frequency of the given systems.
CO2: Calculate natural frequency of continuous system using approximate methods like Rayleigh's energy method, Rayleigh-Ritz method and Dunkerleys method.
CO3: Identify the required measuring instruments for vibration analysis in engine system.
CO4: Calculate the basic noise parameters from the given condition.
CO5: Analyze the industrial noise and apply the control techniques in automobile.

Text Books

1. Ambekar A.G. "Mechanical Vibrations and Noise Engineering" Prentice Hall of India Pvt. Ltd, 2008
2. SingiresuS.Rao - "Mechanical Vibrations" - Pearson Education, ISBM –81-297-0179-0 -2010.

References

1. Rao V. Dukkipati&Srinivas J. "Mechanical Vibrations" - Prentice Hall of India Pvt. Ltd, 2008
2. KewalPujara "Vibrations and Noise for Engineers, DhanpatRai& Sons, 1992.
3. W. T. Thomson, "Theory of Vibrations with applications",CBS Publishers,2002
4. Rao, J.S., & Gupta, K. "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1999.
5. Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.

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Web References

- http://nptel.ac.in/courses/112107088/
- http://nptel.ac.in/courses/112104040/
- http://www.journals.elsevier.com/journal-of-sound-and-vibration/most-downloaded-articles/
- http://www.kineticsnoise.com/industrial/
- http://www.nerc.ac.uk/about/policy/safety/procedures/procedure-vibration/
  https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/290397/sp4-079-tr-1-e-e.pdf

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Course Code: 16MEE06	Course Title: AUTOMOTIVE ENGINE AND ITS SYSTEMS (Common to Mechanical & Mechatronics)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Thermal Engineering
- Automobile 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 –

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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

At the end of the course the student will be able to:

CO:1 Explain the construction details of the power train such as Valve & crank train layout used in four stroke IC engines.

CO:2 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.

CO:3 Describe the functions of various engine subsystems such as cooling system, induction system and exhaust system of an automobiles.

CO:4 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.

CO:5 Examine various advanced engines like Wankel, lean burn, GDI, HCCI and alternate fuels like alcohol, vegetable oils, LPG, CNG used in automobiles.

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Text Books:

1. Edward F. Obert, "Internal Combustion Engines and Air Pollution" First Edition, Addison-Wesley Educational Publishers, Incorporated, reprint, 2012.
2. V. Ganesan, "Internal Combustion Engines" McGraw-Hill, reprint 2012.

Reference Books:

1. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill, reprint 2012.
2. Richard Stone, "Introduction to Internal Combustion Engines", Third edition, Society of Automotive Engineers, Incorporated 1999.

Web References:

- https://en.wikibooks.org/wiki/Automotive_Systems
- https://bajatutor.net/online-baja-crash-course-for-atv-enthusiasts/

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Course Code: 16MEE07	Course Title: VEHICLE DESIGN ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mechanics

Course Objectives

The course is intended to:

1. Convert customers' voice into vehicle specifications.
2. Explain the function of structural parts & dynamic sub systems.
3. Design the part of a sub-system or the entire sub-systems.
4. Explain the various material/design standards.
5. Recommend a suitable test for testing of parts/subsystem of the vehicle.

UNIT I QUALITY FUNCTION DEPLOYMENT **9**

Translation of customer's voice into engineering requirements – HOQ for converting customer voice into technical specifications & enlisting design parameters against each voice -Mapping customers voice & technical specification of different manufacturers -Interactions between technical requirement &specifications – Identification &contribution of stake holders in product life cycle.

UNIT II SUB –SYSTEMS – SPECIFICATIONS **6**

Functions of structural parts and sub systems - frame, body and cover parts, footrest, handle bar, parking systems & other peripheral system - Key specification of sub systems to deliver the required functions and the impact of their non-conformance.

UNIT III STATIC SUB - SYSTEMS **10**

Various forms and geometries adopted for delivering the functions of various static sub-systems - Basic design calculations of various forms and geometries of chassis frame- calculation of Section modulus, Moment of Inertia and dimensions of various cross sections. Selection of material manufacturing process and costing for the part / sub-system - Optimization of design specification of the parts including special requirements to achieve target cost.

UNIT IV DYNAMIC SUB - SYSTEMS **10**

Functions–Influence of Vehicle layout - Suspension, Brakes and Wheels -Various forms and geometries adopted for delivering the functions of various dynamic sub-

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systems. Basic design calculations of various dynamic sub-systems -Selection of material& manufacturing process and costing for the part / sub-system –Optimization of design specification of the parts including special requirements to achieve target cost.

UNIT V TESTING AND STANDARDS **10**

Global material/design/regulatory & automotive standards for automobile industry - Introduction of standards like IS, ARAI, ECE, AIS and other test standards.Design of tests & test conditions to verify part against all failure modes - Design of test fixtures, loads – case studies -Failure analysis &counter-measures, Formulation of design verification plan - Working environment of part / sub system / vehicle in usage &handling by various stake holders –Identification of various applicable tests - Stake holders requirements including handling, touch & feel areas and visual appeal, emission norms.

Course Outcomes

At the end of the course the student will be able to:

CO1: Convert customers' voice into appropriate vehicle specifications using HoQ.

CO2: Explain the function of structural parts & dynamic sub systems and identify the key specifications.

CO3: Design the part of a sub-system or the entire sub-system like Structural parts, suspension, brakes and wheels.

CO4: Explain the various material/design standards applicable globally for automobile industry.

CO5: Recommend a suitable test for testing of parts/subsystem of the vehicle as per the requirements of stake holders/regulation standards.

Text Books:

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

Reference Books:

1. Jason C. Brown, A. John Robertson, Stan T. Serpento, "Motor vehicles structures: Concepts and Fundamentals - Automotive Engineering Series", Butterworth-Heinemann Limited, 2002.
2. Tom Birch, Thomas Wesley Birch, "Automotive Chassis Systems", Delmar, Thomson Learning, 1999.

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Course Code: 16MEE08	Course Title: VEHICLE DYNMAICS	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Automobile Engineering
- Automotive Fundamentals and Manufacturing
- Theory of Machines I & II

Course Objectives

The course is intended to:

1. Determine the suitable geometrical parameters of a motor cycle layout
2. Design a Spring and Damper system for a motor cycle suspension.
3. Determine the dimensions of various structural members of motor cycle.
4. Design the plastic parts used in the motor cycle.
5. Explain the use of systems approach in the part and sub system design.

UNIT I DESIGN OF VEHICLE LAYOUT 9

Various methods of capturing customer requirements - Translation of customer's requirements into engineering requirements – Design Philosophy – Engineering requirements –Introduction to vehicle layout and packaging – Vehicle layout parameters and definitions – Design calculations for vehicle layout.

UNIT II DESIGN OF SUSPENSION SYSTEM 9

Suspension characteristics – Types of suspension – Design calculation on various aspects – Design of Spring and Damper.

UNIT III DESIGN OF STRUCTURAL PARTS 9

Various factors affecting structure - Loads and boundary conditions – Simple problems – Design calculation for various structures.

UNIT IV DESIGN OF PLASTIC PARTS 9

Introduction to plastic parts – Fit and finish of plastic parts – Design of plastic parts.

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UNIT V CONCEPT OF PART, SUB SYSTEM AND SYSTEM 9

Importance of the system design approach and part design – Study of part design in different systems and its applications

Course Outcomes

At the end of the course the student will be able to:

CO1: Determine the suitable geometrical parameters of a vehicle layout to achieve the desired performance of a motor cycle.
CO2: Design a Spring and Damper system for a vehicle suspension used in motor cycle.
CO3: Determine the dimensions of various structural members of motor cycle based on the given boundary conditions.
CO4: Design the plastic parts used in the vehicles considering its impact on motor cycle performance.
CO5: Explain the use of systems approach in the part and sub system design of a motor cycle.

Text Books:

1. Tony Foale, "Motorcycle Handling and chassis design" Tony Foale designs, 2006.
2. V Cossalter, "Motorcycle Dynamics" Published by Race dynamics, 8421 Midland Dr., Greendale, 2002.
3. Thomas D.Gillespie, "Fundamentals of vehicle dynamics" Published by Society of Automotive Engineers, Inc, 1992.

Reference Books:

1. Jason C. Brown, A. John Robertson, Stan T. Serpento,"Motor vehicles structures: Concepts and Fundamentals - Automotive Engineering Series", Butterworth-Heinemann Limited, 2002.
2. Tom Birch, Thomas Wesley Birch, "Automotive Chassis Systems", Delmar, Thomson Learning, 1999.

Web References:

- http://www.derby.ac.uk/courses/motorcycle-engineering-beng-hons/-Website of Derby University

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Course Code: 16MEE09	Course Title: DESIGN FOR WELDING (Common to Automobile & Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Engineering Metrology and Measurements
- Metal Forming, Joining and Casting Processes.
- Engineering Metallurgy

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

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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.

Course Outcomes

At the end of the course the student will be able to:

CO1:Choose suitable welding processes.
CO2:Identify the potential failure modes of a weld joint.
CO3:Explain the types of Fixtures used in welding process.
CO4:Design the welding fixtures for the given weld parts.
CO5:Explain the inspection, maintenance and calibration procedure of welding fixtures.

Text Books:

1. O.P Khanna "A Textbook of Welding Technology", Dhanpat Rai & Sons, Twentieth Reprint, 2011.
2. Omer. W.Blodgett, James F. Lincoln, "Design of Welded Structures,rc Welding Foundation", 1st Edition 1996.
3. Prakash Hiralal Joshi, "Welding and Assembly Fixtures", McGraw-Hill Professional, 2010.

Reference Books:

1. S.J Maddox, "Fatigue Strength of Welded Structures", Woodhead Publishing, 1991.
3. 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:

- https://ocw.mit.edu/courses/materials-science-and-engineering/3-37-welding-and-joining-processes-fall-2002/lecture-notes/
- http://www.esabna.com/euweb/awtc/lesson1_1.htm

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Course Code: 16MEE10	**Course Title:** MOTOR CYCLE DYNAMICS	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the courses:

- Theory of Machines I & II
- Automobile Engineering

Course Objectives

The course is intended to:

1. Determine the magnitude of design parameters in a braking system of motorcycle
2. Determine the magnitude of design parameters in a suspension system
3. Determine the magnitude of design parameters for stability and maneuverability
4. Choose a suitable tyre for a given condition based on the characteristics of tyres
5. Explain the impact of aerodynamic parameters on the vehicle performance

UNIT I BASICS OF MOTORCYCLE DYNAMICS AND BRAKES 9

Introduction to Motorcycle dynamics – Basics of motorcycle dynamics – Coordinate system and important definitions Frictional force, deceleration & Simple brake calculations – Dynamics during braking – Introduction to CBS, ABS.

UNIT II DYNAMICS OF SUSPENSION 9

Sprung mass, Un-sprung mass and vibration modes Quarter car and half car models – Suspension elements and design parameters.

UNIT III STABILITY AND MANEUVERABILITY 9

Introduction – Definitions – Vibration modes – Study of dynamics in steady turn – SHM, Transient maneuvers, input & output parameters – Design parameters for stability and maneuverability, geometrical, mass and structural stiffness.

UNIT IV TYRE DYNAMICS 9

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

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UNIT V ERGONOMICS AND AERODYNAMICS 9

Introduction and importance – Elements of ergonomics – Riding posture design, 'H' point, seat design. Aerodynamics - Introduction – Definitions – Aerodynamics parameters – Effect on vehicle performance

Course Outcomes

At the end of the course the student will be able to

CO1: Determine the magnitude of design parameters in a braking system of motorcycle such as friction force and stopping distance.

CO2: Determine the magnitude of design parameters in a suspension system such as type of springs, spring stiffness and pitch.

CO3: Determine the magnitude of design parameters for stability and maneuverability such as geometrical, mass and structural stiffness.

CO4: Choose a suitable tyre for a given condition based on the characteristics of tyres such as vertical, cornering, camber stiffness, rolling resistance.

CO5: Explain the impact of aerodynamic parameters on the motorcycle performance

Text Books:

1. Tony Foale, "Motorcycle Handling and chassis design" Tony Foale designs, 2006.
2. V Cossalter, "Motorcycle Dynamics", Published by Race dynamics, 8421 Midland Dr., Greendale, 2002.

Reference Books:

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

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Course Code: 16MEE11	Course Title: DESIGN FOR SHEET METAL (Common to Automobile & Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Metal Forming, Joining and Casting Processes.
- Strength of materials

Course Objectives

The course is intended to:

1. Calculate the forces involved in bending and drawing operations
2. Select appropriate press tools
3. Select appropriate press machines
4. Suggest a suitable bending process
5. Estimate the cost required for forming and tube bending
6. Choose a suitable sequence and tool for forming and tube bending processes

UNIT I SHEET METAL & FORMING PROCESS 9

Basics of forming, bending & drawing process, Advantages and its Applications in Automotive Parts. Terminology of forming & bending- Bending force & Blank holding force Calculations, Spring Back, Bending defects and remedies. terminology of drawing -Working principle of drawing operations and reverse drawing, Calculation of Draw force, Calculation of cutting force, Blanking & Piercing, Blank holding force (Die cushion), Blank development - No of Draws - Selection of Press tonnage, defects, causes and remedies in drawing operation.

UNIT II PRESS TOOLS 8

Types of forming and press tools, Basis of selection of forming and press tool, Tool steel and merits, demerits and its applications, Tool Design, Tool Maintenance, Punches Types of Punches and Punch tool requirements.

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.

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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

At the end of the course the student will be able to:

CO1: Calculate the forces involved in bending and drawing operations such as bending force, drawing force and blank holding forces.
CO2: Select appropriate press tools for forming processes based on the geometry and material of the given part.
CO3: Select appropriate press machines for forming processes based on the geometry and material of the given part.
CO4: Suggest a suitable bending process based given part geometry and material.
CO5: Estimate the cost required for forming and bending for the given part.
CO6: Choose a suitable sequence and tool for forming and bending processes for the given part

Text Books:

1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Addition Wesley Longman Pvt. Ltd., First Indian reprint, 2000.
2. S.K. HajraChoudhury and A.K. HajraChoudhury, "Elements of Work shop Technology", Vol – I Manufacturing Processes, Media Promoters and Publishers Pvt. Ltd, 2018.

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Reference Books:

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

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Course Code: 16MEE14	Course Title: MECHANICS OF MACHINES	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mechanics
- Theory of Machines I & II

Course Objectives

The course is intended to:

1. Construct graphically linkage synthesis solutions involving four bar and slider crank mechanisms.
2. Solve for position, velocity and acceleration of compound mechanisms using graphical method and four bar and slider crank linkages
3. Apply analytical methods for static and dynamic force analysis to solve dynamics problems of four bar, slider crank and cam mechanisms
4. Solve for natural frequencies and modes of two degree of freedom vibrating system.
5. Apply coordinate transformation concepts to robot manipulator and obtain position solutions

UNIT I MECHANICS BASICS & SYNTHESIS OF LINKAGES 9

Mass, force, weight, momentum and impulse – linear and angular momentum - conservation of angular momentum, angular impulse – equivalent mass of rotating body. Degree of Freedom of mechanisms.

Synthesis of linkages: type, number and dimensional synthesis – function generation, path generation and body guidance – two-position synthesis – three position synthesis - precision positions: Chebychev spacing – Cognate linkages: Robert-Chebychev theorem. (adopt graphical method)

UNIT II KINEMATIC ANALYSIS OF MECHANISMS 9

Velocity and acceleration analysis of compound mechanisms (graphical methods) – coriollis acceleration – vector loop representation of linkages - algebraic position solution of four bar linkages – Freudenstein's equation – position solutions for slider crank linkage – transmission angles – analytical solutions for velocity and acceleration analysis of four bar, slider crank.

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UNIT III FORCE ANALYSIS IN MECHANISMS 9

Analytical static force analysis in four bar and slider crank linkages – dynamic analysis of four bar linkage, slider crank linkage – shaking force and shaking moment – linkage force analysis by energy methods – dynamically equivalent system – inertia of connecting rod – dynamic force analysis of force-closed cam-follower – undamped and damped responses.

UNIT IV VIBRATION ANALYSIS OF TWO DEGREE OF FREEDOM SYSTEMS 9

Systems with 2-DOF - Equations of Motion for Forced Vibration - Free-Vibration Analysis of an undamped System: natural frequencies and modes – 2-DOF torsional systems – coordinate coupling – forced vibration analysis – semi definite systems – self excitation and stability analysis.

UNIT V ROBOT MANIPULATOR KINEMATICS 9

Spatial description: position, orientation and frames – mapping description from frame to frame – homogeneous transformations - operators: translations, rotations, and transformations – compound transformations – transform equations – manipulator forward kinematics – Denavit Hartenberg parameters – inverse kinematics.

Course Outcomes

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

CO 1 : Construct graphically linkage synthesis solutions involving four bar and slider crank mechanisms.
CO 2 : Solve for position, velocity and acceleration of compound mechanisms using graphical method and four bar and slider crank linkages using analytical method.
CO 3 : Apply analytical methods for static and dynamic force analysis to solve dynamics problems of four bar, slider crank and cam mechanisms
CO 4 : Solve for natural frequencies and modes of two degree of freedom vibrating system for free and forced vibrations
CO 5 : Apply coordinate transformation concepts to robot manipulator and obtain position solutions using forward kinematics and inverse kinematics given the Denavit-Hartenberg parameters.

Text Books

1. Norton, Robert L. Kinematics and dynamics of machinery. McGraw-Hill Higher Education, 2011.
2. Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley. Theory of machines and mechanisms. Vol. 1. New York, NY: Oxford University Press, 2011.

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References

1. Rattan, S. S. Theory of machines. Tata McGraw-Hill Education, 2014.
2. Rao, Singiresu S., and Fook Fah Yap. Mechanical vibrations. Vol. 4. Upper Saddle River: Prentice Hall, 2011.
3. Craig, John J. Introduction to robotics: mechanics and control. Pearson Education India, 2008
4. Hannah, John, and Richmond Courtney Stephens. Mechanics of machines, advanced theory and examples. Viva low priced student Edition, 1999.

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Course Code: 16MEE16	Course Title: DESIGN OPTIMIZATION	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering mechanics
- Theory of machines I & II

Course Objectives

The course is intended to:

1. Solve engineering problems through un constrained optimization techniques
2. solve engineering problems through constrained optimization techniques
3. Choose and apply suitable advanced optimization techniques engineering problems
4. Design optimized shafts, springs for static systems
5. Design optimized shafts, springs for static systems

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 9

Introduction to optimum design - General principles of optimization – Problem formulation and their classifications Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 9

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 9

Multi stage optimization – dynamic programming; stochastic programming; Multi-objective optimization, Genetic algorithms, Simulated Annealing algorithm and particle swarm optimization algorithm; Neural network principles in optimization

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UNIT IV STATIC APPLICATIONS 9

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs

UNIT V DYNAMIC APPLICATIONS 9

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

Course Outcomes

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

CO1: Solve engineering problems through unconstrained optimization techniques
CO2: Solve engineering problems through constrained optimization techniques
CO3: Choose and apply suitable advanced optimization techniques for solving combinatorial engineering problems
CO4: Design optimized shafts, springs for static systems
CO5: Design optimized shafts, springs for dynamic systems

Text Books

1. Singiresu S.Rao., "Engineering Optimization Theory and Practice", Wiley; 4 edition 20, 2009.
2. Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2006.

References

1. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 2012
2. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 2002

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Course Code: 16MEE17	Course Title: COMPUTER AIDED ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering mechanics
- Theory of machines I & II

Course Objectives

The course is intended to:

1. Explain the basics of new product development
2. Explain solid modeling features for sheet metal and plastic parts
3. Convert physical problems into mathematical model using finite element
4. Solve the 2D vector variable problems
5. Solve ISO parametric problems

UNIT I INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN 9

Concept design – parametric sketching – constraints – computer graphics principles-2D transformation, scaling, rotation – windowing, view ports – clipping – data exchange formats.

UNIT II COMPUTERS IN DESIGN 9

Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations

UNIT III INTRODUCTION & ONE-DIMENSIONAL PROBLEMS 9

Relevance of finite element analysis in design - Variational principles and methods – Weighted-Integral statements – Weak formulations – Ritz method – Method of weighted residuals – Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One dimensional finite element models in Solid mechanics and Heat transfer – Finite element model for beams

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UNIT IV TWO-DIMENSIONAL PROBLEMS 9

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement

UNIT V DYNAMIC APPLICATIONS 9

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications

Course Outcomes

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

CO1: Explain the basics of new product development in the areas of CAD/CAM
CO2: Explain solid modeling features for sheet metal and plastic parts.
CO3: Convert physical problems into mathematical model using finite element procedure and solve simple problem using spring element
CO4: Solve the 2D vector variable problems by applying plane stress, strain and axi- symmetric conditions using CST element
CO5: Solve ISO parametric problems using Gauss quadrature Numerical integration methods

Text Books

1. Ibrahim Zeid "CAD/CAM – Theory and Practice" – McGraw Hill, International Edition 2010.
2. Reddy J.N.,"An Introduction to the Finite Element Method",McGraw Hill, International Edition,2005

References

1. Rao. P .N. "CAD/CAM :Principles and Applications" Tata McGraw Hill , Second Edition. 2010
2. Logan D.L, "A First Course in the Finite Element Method", Third Edition, Thomson Learning, 2011.

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Course Code: 16MEE18	**Course Title:** PROCESS PLANNING AND COST ESTIMATION (Common to Automobile, Mechanical & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

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 tress 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 –

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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.

Course Outcomes

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

CO1: Understand the basic concepts of process planning.
CO2: Evaluate the various approaches of manual and computer aided process planning and costing.
CO3: Understand the different components involved in direct and indirect costs.
CO4: Analyze the cost calculation methods of different manufacturing process.
CO5: Understand the concept of Break Even Analysis & Cost Management.

Text Books

1. Kannappan D, "Mechanical Estimating and Costing", Tata McGraw Hill, New Delhi, 2003.
2. Banga T R and Sharma S C, "Mechanical Estimating and Costing", Khanna Publishers, New Delhi, 2010.

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References

1. Russell R.S and Tailor B.W, "Operations Management", PHI, 4th Edition, 2003.
2. Chitale A.V and Gupta R.C, "Product Design and Manufacturing", PHI, 2nd Edition, 2002.
3. Kesavan R "Process Planning and Cost Estimation", New Age International Pvt. Ltd., Chennai, 2005.

Web References

- https://en.wikipedia.org/wiki/Planning
- http://nptel.ac.in/courses/Webcourse-contents/IIT Delhi/Computer%20Aided%20Design%20&%20ManufacturingII/Module%20G /Module%20G(5)/p3.htm
- https://en.wikipedia.org/wiki/Cost_estimate

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Course Code: 16MEE19	Course Title: UNCONVENTIONAL MACHINING PROCESSES (Common to Automobile, Mechanical & Mechatronics)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

Course Objective

The course is intended to:

1. Explain the Classification of UCM
2. Describe the mechanical energy based UCM
3. Explain electrical energy based unconventional machining processes
4. Explain Chemical & Electro chemical energy based UCM
5. Describe Thermal energy based unconventional UCM

UNIT I INTRODUCTION 9

Need for unconventional machining process-Advantages of UCM - Disadvantages of UCM - Comparison of conventional and unconventional machining processes - Process parameters - Processes based on type of energy required to shape the material- Processes based on mechanism of material removal- Processes based on transfer media- Processes based on source of energy

UNIT II MECHANICAL ENERGY BASED UCM PROCESSES 9

Principle of Mechanical energy based UCM Processes - Mechanical energy based unconventional machining processes: Ultrasonic machining process, Abrasive Jet machining process, Water Jet Machining process - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Mechanical energy based unconventional machining processes

UNIT III ELECTRICAL ENERGY BASED UCM PROCESSES 9

Principle of Electrical energy based UCM Processes - Electrical energy based unconventional machining processes: Electric Discharge machining - Principle, Layout of EDM process, Functions and types of dielectric fluid, Properties of different tool materials, Working of R-C (Relaxation) circuit, R-C-L circuit, rotary pulse generator circuit, controlled pulse generator circuit, Process parameters in EDM Process, Mechanism of metal removal, Applications, Advantages and

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Disadvantages. Wire cut EDM (WCEDM) process: Layout, Construction and working of various elements, Applications, Advantages and Disadvantages.Drilling and Die sinking by EDM process. Comparison of Electrical energy based unconventional machining processes

UNIT IV CHEMICAL & ELECTRO CHEMICAL ENERGY BASED UCM PROCESSES **9**

Principle of Chemical & Electro chemical energy based UCM Processes - Chemical & Electro chemical energy based unconventional machining processes: Chemical machining, Electro chemical machining, Electro chemical grinding, Electro chemical honing processes - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Chemical & Electro chemical energy based unconventional machining processes

UNIT V THERMAL ENERGY BASED UCM PROCESSES **9**

Principle of Thermal energy based UCM Processes - Thermal energy based unconventional machining processes: Electron Beam machining (EBM), Laser Beam machining (LBM), Plasma Arc machining (PAM) processes - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Thermal energy based unconventional machining processes.

Course Outcomes

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

CO1: Explain the various methods of Unconventional Machining Processes based on type of energy required, mechanism of material removal, transfer media and source of energy.

CO2: Select mechanical energy based unconventional machining processes such as Ultrasonic machining process, Abrasive Jet machining process and water jet machining process based on machining requirements for a product.

CO3: Choose Electrical energy based unconventional machining processes such as EDM based on machining requirements for a product.

CO4: Select Chemical & Electro chemical energy based unconventional machining processes such as Chemical machining, Electro chemical machining and Electro chemical grinding based on machining requirements for a product..

CO5: Choose Thermal energy based unconventional machining processes such as Electron Beam machining (EBM), Laser Beam machining (LBM), Plasma Arc machining (PAM) processes for special applications.

BoS Chairman

Text Books

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007
2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2007.

References

1. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in manufacturing" Prentice Hall of India Pvt. Ltd., New Delhi ,8th Edition, 2001.
2. Ghosh and Malik, "Manufacturing Science", 1st ed., EWP Private Ltd., 2008.

Web References

- https://en.wikipedia.org/wiki/Machining
- https://en.wikipedia.org/wiki/Laser_beam_machining
- https://en.wikipedia.org/wiki/Electrical_discharge_machining
- http://mechteacher.com/manufacturing-technology/
- http://www.engineershandbook.com/MfgMethods/nontraditionalmachining

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Course Code : 16MEE20	Course Title: FLEXIBLE MANUFACTURING SYSTEMS (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

Course Objectives

The course is intended to:

1. Classify and distinguish FMS and other manufacturing systems
2. Explain processing stations and material handling systems used in FMS environments.
3. Understand tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.
4. Understand the concepts of group technology in FMS.
5. Design and analyze FMS using simulation and analytical techniques

UNIT I UNDERSTANDING AND CLASSIFICATION OF FMS 9

Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type Classification of FMS Layout - Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc

UNIT II PROCESSING STATIONS AND MATERIAL HANDLING SYSTEM 9

Processing stations: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station.
Material Handling System: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS)

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

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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

Course Outcomes

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

CO1: Classify and distinguish FMS and other manufacturing systems
CO2: Explain processing stations and material handling systems used in FMS environments
CO3: Understand tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS
CO4: Understand the concepts of group technology in FMS
CO5: Design and analyze FMS using simulation and analytical techniques

Text Books

1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 1991
2. Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt.Ltd. New Delhi 2009

References

1. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991.
2. John E Lenz "Flexible Manufacturing" Marcel Dekker Inc New York, 1989.

Web References

- https://nptel.ac.in/courses/112107143/36
- https://nptel.ac.in/courses/112104228/31

BoS Chairman

Course Code: 16MEE21	**Course Title:** NON-DESTRUCTIVE TESTING METHODS (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering 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 Hollography- 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, emlusifiers 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-Penetrameter-Radiographic Inspection Techniques-single wall single image technique, wall penetration technique, Latitude technique-Applications and Limitations of Radiographic Inspection Techniques.

Course Outcomes

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

CO1: Explain the testing procedure for Visual Inspection and Eddy Current Testing Method in Quality Assurance.

CO2: Explain testing procedure for Magnetic Particle Testing Method for Quality Assurance.

CO3: Explain testing procedure for Liquid Reentrant Testing Method for Quality Assurance.

CO4: Plan inspection sequence for Ultrasonic Testing Method for Quality Assurance.

CO5: Plan inspection sequence for Radiographic Testing Method for Quality Assurance.

Text Books

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu,"Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. J Prasad, C G K Nair, "Non-Destructive Testing and Evaluation of Materials", Tata McGraw-HillEducation Private Limited, 2003.

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References

1. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
2. American Metals Society, "Non-Destructive Examination and Quality Control", Metals Hand Book, Vol.17, 9th Edition, Metals Park, 1989.
3. Paul Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition,New Jersey,2005.

Web References

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- http:// http://117.55.241.6/library/E-Books/NDT%20Notes.pdf
- http:// www.slideshare.net/ndtindia123/introduction-uses-of-non-destructive-testing-24377016
- http:// www.eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf
- http://www.hse.gov.uk/comah/sragtech/ndt2.pdf

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Course Code : 16MEE22	Course Title: SUPPLY CHAIN MANAGEMENT (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3:0:0:3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

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

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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.

Course Outcomes

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

CO1: Identify the potential failure modes in material storage and handling between POM/POS to POC.
CO2: Use REBA/RULA tools and techniques to study ergonomics in storage and material handling design.
CO3: Verify produced part quality is delivered to the point of consumption.
CO4: Design material storage and handling system to prevent potential failure modes.
CO5: Develop standardized storage and handling work procedures.

Text Books

1. Mikel P.Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", PHI Publishers, 3rd Edition 2016.
2. Blanchard and Benjamin S, "Logistics Engineering and Management", 6th International Edition, Prentice Hall Inc, 2015

References

1. Christopher M, "Logistics and Supply Chain Management - Creating Value Adding Networks", Prentice Hall, 2010.
2. James M. Apple, "Plant Layout and Material Handling" John Wiley, 7th Edition, 2000.
3. Prauss L,"The Green Multiplier - a Study of Environmental Protection and Supply Chain", Antonn Rauss Limited, Palgrave Macmillan, 2005.

BoS Chairman

Course Code : 16MEE23	Course Title: ANALYTICAL TECHNIQUES FOR NANO MATERIAL CHARACTERIZATION	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Material science

Course Objectives

The course is intended to:

1. Analyze the crystal parameters using X-Ray diffraction.
2. Analyze the thermal properties of nano materials.
3. Describe the SEM and TEM process and its inferences.
4. Describe the AFM process and its inferences.
5. Explain the corrosion behaviour of nano materials.

UNIT I X- RAY DIFFRACTION 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

UNIT II THERMAL ANALYSIS METHODS 9

Principle and Instrumentation of Thermogravimetry, Differential Thermal Analysis and Differential Scanning Calorimetry- Importance of Thermal Analysis For Nanostructures.

UNIT III 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 IV ATOMIC FORCE MICROSCOPY 9

Basic concepts- Interaction force- AFM and the optica 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.

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UNIT V ELECTROCHEMICAL TECHNIQUES 9

Cyclic voltammetry, Galvanostatic charge discharge measurements- Impedance measurements- Tafel and bode plot for corrosion measurements.

Course Outcomes

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

CO1: Analyze the crystal parameters and determine the particle size of nanomaterials by X-ray diffraction techniques.

CO2: Analyze the thermal stability of nanomaterials based on thermo gravimetric analysis.

CO3: Analyze the morphological behaviour of nanomaterials based on SEM and TEM.

CO4: Calculate the roughness of the materials based on atomic force microscopy results.

CO5: Analyze the electrochemical behavior of nanomaterials.

Text Books

1. T.Pradeep, Nano "The essentials understanding nanoscience and nanotechnology" , McGraw Hill, 2009.
2. Keith Oldham, Jan Myland, Alan Bond, " Electrochemical Science and Technology: Fundamentals and Applications", Wiley Publications, 2011.

References

1. B.D Cullity " Elements of X-ray Diffraction" , 4 th Edition, Addison Wiley, 2001.
2. J. Goldstein, D.E. Newbury, D.C. Joy "Scanning Electron Microscopy and X-ray Microanalysis", 2003.

BoS Chairman

Course Code : 16MEE24	Course Title: NANOMATERIALS SYNTHESIS AND APPLICATIONS (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Material science

Course Objectives

The course is intended to:

1. Explain the basic of nano technology.
2. Describe various dimensional structures of nano materials.
3. Explain the chemical synthesis of nanostructures.
4. Explain physical synthesis of nanostructures
5. Explain about energy applications of nanomaterials

UNIT I INTRODUCTION TO NANO TECHNOLOGY 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.

UNIT II NANOSTRUCTURES AND ITS CLASSIFICATION 9

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 III 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 IV 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.

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UNIT V ENERGY APPLICATIONS OF NANOMATERIALS 9

Challenges in energy- conventional and unconventional fissile fuels- nanotechnology in fuel production- Renewable energy sources- photovoltacies hydrogen production- fuel cells- thermoelectricity- Implementation of renewable energy technologies.

Course Outcomes

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

CO1: Explain the properties of nanomaterials based on size reduction.
CO2: Identify the structure of nanomaterials and examine its kinetics.
CO3: Compare the different chemical synthesis techniques of nanostructure formation in materials.
CO4: Describe the various physical methods of nanostructure formation.
CO5: Explain the basic concepts involved in energy systems and to explore applications of nano technology.

Text Books

1. T. Pradeep, Nano "The essentials understanding nanoscience and nanotechnology", McGraw Hill, 2009.
2. Javier Garcia- Martinez, "Nanotechnology for the energy challenge", Wiley- VCH verlag GmbH & Co, 2010.

References

1. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.
2. A.S. Edelstein and R C. Cammarata, Nanomaterials: "Synthesis, Properties & Applications" , Institute of Physics Pub., 1998.

BoS Chairman

Course Code : 16MEE25	Course Title: MANUFACTURE AND INSPECTION OF GEARS (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3: 0: 0: 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Theory of Machines-I
- Metal Forming, Joining and casting Processes
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Specify the gear and gear material for given application
2. Explain the gear tooth generation processes such as hobbing, planning, shaping and milling
3. Explain the gear finishing processes and heat treatment processes
4. Explain the various sources of errors in gear tooth and drive and chose the instruments for measuring the errors.
5. Explain the gear tooth forming methods such as, stamping, moulding, casting powder metal, rolling and broaching.

UNIT I INTRODUCTION TO GEARS AND GEAR MATERIALS 9

Types of gears, classification, gear drawings, gearboxes, application of gears, gear production methods- an overview, involumetry.

Non-metallic, ferrous and non-ferrous gears. Properties of gear materials, selection of material for typical gears and applications – blank preparation methods for different gears, size, type and material.

UNIT II MANUFACTURE OF GEARS 9

Preforming Gear Blanks, Forming- Hobbing, Shaping, Planning, milling, Production of straight bevel gears and spiral gears, milling, and generation by straight bevel gear generator. Spiral bevel gear generator

UNIT III GEAR FINISHING AND HEAT TREATMENT OF GEARS 9

Gear finishing advantages, finishing of gears by grinding, shaving, lapping, honing methods and cold rolling of gears. Description of machines, process and process parameters

Through hardening, case hardening, flames hardening, induction hardening of gears, Nitriding of gears. Tuft riding of gears.

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UNIT IV **METROLOGY OF GEARS** **9**

Metrology of Gears: Gear tooth terminology, Sources of errors in manufacturing of gears, Measurement of tooth thickness: Gear tooth vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile: Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash checking. Measurement of concentricity, Alignment of gears. Inspection of gears for hardening defects.

UNIT V **MODERN GEAR PRODUCTION METHODS** **9**

Gear production by stamping, die casting, power metal process, injection and compression Moulding in plastics. Die casting, cold and hot rolling, mass production methods, shear speed shaping. Gear broaching – Gleason. G-Trac Gear generation method, Quality of the gears.

Course Outcomes

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

CO1: Specify the gear and gear material for given application
CO2: Explain the gear tooth generation processes such as hobbing, Planning, shaping and Milling
CO3: Explain the gear finishing processes and heat treatment processes
CO4: Explain the various sources of errors in gear tooth and drive and chose the instruments for measuring the errors
CO5: Explain the gear tooth forming methods such as, stamping, moulding, casting powder metal, rolling and broaching

Text Books

1. David A. Stephenson, John S. Agapiou "Metal Cutting Theory and Practice",CRC Press, 2016
2. Stephen P.Radzevich, "Dudley's Handbook of Practical Gear Design and Manufacture", CRC Press, 2012

References

1. J.R.Davis. "Gear Materials, Properties, and Manufacture" ASM International, 2005
2. HMT, "Production Technology "TMH, INDIA 2008
3. Gitin M Maitra, Handbook of Gear Design, TMH,2020.
4. Society of Manufacturing engineers, Gear Processing and Manufacturing", 2nd Edition, 1984
5. Prem H.Daryani, "The Art of Gear Fabrication", Industrial Press Inc, 2001.

Web References

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- https://onlinecourses.nptel.ac.in/noc17_mm15/preview
- https://nptel.ac.in/courses/112105126/33.
- https://nptel.ac.in/courses/112106137/pdf/2_5.pdf.
- https://nptel.ac.in/courses/112105127/pdf/LM-32.pdf.
- https://khkgears.net/gear-manufacturing/

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Course Code : 16MEE26	Course Title: MICRO AND NANO MANUFACTURING (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type :Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course:

- Metal Forming, Joining and casting Processes
- Metal Cutting Processes
- Material Science

Course Objectives

The course is intended to:

1. Understand the properties, design and behaviour of various micro-materials.
2. Understand the concept of various micro fabrication processes.
3. Impart the principles of different micro machining process
4. Understand the principles and applications of Micro Electro Mechanical Fabrication Systems.
5. Understand the properties, structures and fabrication methods

UNIT I MICROMECHANICS 9

Introduction to Micro System design - Material properties - micro fabrication Technologies. Structural behavior - sensing methods - micro scale transport – feedback systems - Microstructure of materials - its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including marten site – ferroelectric and diffusional phase transformations - twinning and domain patterns - smart materials.

UNIT II MICRO-FABRICATION 8

Bulk processes – surface processes – sacrificial processes and Bonding processes – special machining: Laser beam micro machining-Electrical Discharge Machining – Ultrasonic Machining- Electro chemical Machining. Electron beam machining. Clean room-yield model – Wafer IC manufacturing – PSM – IC industry-New Materials-Bonding and layer transfer- devices.

UNIT III MECHANICAL MICRO-MACHINING 10

Theory of micromachining-Chip formation-size effect in micromachining-micro-turning, micro- milling, micro-drilling- Micromachining tool design-Precision Grinding-Partial ductile mode grinding-Ultra precision grinding- Binder less wheel – Free form optics

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UNIT IV MICRO ELECTRO MECHANICAL SYSTEM FABRICATION 9

Introduction – advance in Microelectronics – characteristics and Principles of MEMS – Design and application of MEMS: Automobile, defence, healthcare, Aerospace, industrial properties etc., - Materials for MEMS – MEMS fabrication- Bulk Micro Machining-LIGA – Microsystems packaging- Future of MEMS

UNIT V NANO TECHNOLOGY 9

Classification of nano structures – effect of the nanometre length scale effects of nano scale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Top down processes – bottom up process – nano positioning systems.

Course Outcomes

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

CO1: Understand the properties, design and behaviour of various micro-materials.
CO2: Understand the concept of various micro fabrication processes.
CO3: Impart the principles of different micro machining process
CO4: Understand the principles and applications of Micro Electro Mechanical Fabrication Systems.
CO5: Understand the properties, structures and fabrication methods

Text Books

1. Sámi Franssila, "Introduction to Micro Fabrication", John Wiley and sons Ltd., UK, 2004,
2. Jain V.K, "Micro manufacturing Processes", CRC Press, 2012

References

1. Madore J, "Fundamental of Micro fabrication", CRC Press, 2002.
2. Mark J. Jackson, "Micro fabrication and Nanomanufacturing", CRC Press, 2006.
3. Peter Van Zant, "Microchip fabrication", McGraw Hill, 2004.

Web References

- https://en.wikipedia.org/wiki/Microfabrication
- http://www.micromanufacturing.net/didactico/Desarollo/microforming/1-introduction

BoS Chairman

Course Code: 16MEE27	**Course Title:** LEAN MANUFACTURING (Common to Automobile, Mechanical & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting 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.

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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.

Course Outcomes

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

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

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 .

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.

CO4: Design manufacturing solutions for manufacturing and service industries based on Hosin Planning.

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.

Text Books

1. Don Tapping, Tom Luyster, and Tom Shuker, "Value stream Management Eight steps to planning", Mapping and sustaining Lean Improvements, Productivity Press,New York, ,2012.
2. N.Gopalakrishnan, "Simplified Lean Manufacture Elements, Rules", Tools and implementation, PHI Learning, New Delhi, 2010.

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References

1. James P. Womack, Daniel T Jones, Daniel Ross "The Machine That Change the world", Free Press trade paperback edition, U.S.A, 2007.
2. Ronald G. Askin& Jeffrey B.Goldberg, "Design and Analysis of Lean Production Systems",2003, John Wiley & Sons,2003.
3. 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

- https:// www.learning –to-see.co.uk.
- https://www.lean.org.
- https://www.leanproduction.com.

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Course Code: 16MEE28	Course Title: COMPUTER INTEGRATED MANUFACTURING (Common to Automobile & Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

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.

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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.

Course Outcomes

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

CO1: Write program for NC, DNC and CNC in Automated Manufacturing systems such as CIM.

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

CO3: Select appropriate Materials handling and storage systems such as AGVs, AS/RS and Robots for material handling and Storage System in CIM

CO4: Write codes using DCLASS, MICLASS and OPITZ for Group Technology in CIM

CO5: Design Automated Manufacturing based on Artificial Intelligent system, Expert system and FMS to gradually convert Traditional Manufacturing environment in CIM.

Text Books

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2015.
2. Mikell. P. Groover and Emory ZimmersJr.,"CAD/CAM", Prentice hall of India Pvt. Ltd., 2013.

References

1. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.
2. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005.
3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd., 2005.

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Web References

- https://en.wikipedia.org/wiki/Computer-integrated_manufacturing
- https://en.wikipedia.org/wiki/Computer-aided_manufacturing
- https://en.wikipedia.org/wiki/Integrated_Computer-Aided_Manufacturing

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Course Code: 16MEE29	Course Title: INDUSTRIAL ROBOTICS AND AUTOMATION (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes
- Theory of Machines – I
- Electrical Drives & Controls
- Metal cutting Process

Course Objectives

The course is intended to:

1. Explain the fundamentals of robot.
2. Choose robot drive systems and end effectors
3. Explain the working principle of various sensors.
4. Explain robot kinematics and programming.
5. Explain the implementation of robotics

UNIT I FUNDAMENTALS OF ROBOT 7

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 10

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

UNIT III SENSORS AND MACHINE VISION 10

Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors),

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Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors,Slip Sensors Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction: Edge detection Feature Extraction and Object Recognition - Algorithms. Applications – Inspection, Identification Visual Serving and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 10

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple Programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 8

Industrial applications like pick & place, welding, painting, inspection, etc. ; RGV, AGV; Implementation of Robots in Industries, Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method.

Course Outcomes

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

CO1: Explain the fundamentals of robot.
CO2: Describe the working of various robot drive systems and end effectors
CO3: Discuss the working principle of various sensors.
CO4: Explain the concepts of robot kinematics and robot programming.
CO5: Understand the implementation of robotics in industries.

Text Books

1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill, 2017.
2. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co., 1987

References

1. YoramKoren, "Robotics for Engineers", McGraw-Hill Book Co., 1992
2. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 1995
3. S.R.Deb and ShankaDeb "Robotics Technology and Flexible Automation", Tata McGraw Hill,2009.

Web References

- http://www.cdeep.iitb.ac.in/nptel/Mechanical/Robotics%20Course/TOC.htm
- http://nptel.ac.in/video.php?subjectId=112101099

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Course Code: 16MEE30	**Course Title:** ADDITIVE MANUFACTURING – (Common to Mechanical, Mechatronics & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal cutting Process

Course Objectives

The course is intended to:

1. Explain the importance of Rapid Prototyping Technology
2. Select liquid based and solid based rapid prototyping.
3. Design RPT solutions for data preparation
4. Select Three Dimensional Printing
5. Design RPT solutions based on tooling.

UNIT I INTRODUCTION **6**

Introduction: Need for time compression in product development, Product development – conceptual design – development – detail design – prototype – tooling.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS **10**

Classification of RP systems, Fusion Deposition Modeling – Principle – process parameters –Applications. Laminated Object Manufacturing – Principle – process parameters – Applications, Stereo lithography systems – Principle – process parameters –process details – Applications.- Selective laser sintering (SLS) - Direct Metal Laser Sintering (DMLS) system – Direct Metal Deposition- Principle – process parameters –Applications-Solid ground curing.

UNIT III DATA PREPARATION FOR RAPID PROTOTYPING TECHNOLOGIES **10**

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

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UNIT IV THREE DIMENSIONAL PRINTING 10

Three dimensional Printing (3DP):Principle, basic process, Physics of 3DP, types of printing process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies.

Shape Deposition Manufacturing (SDM): Introduction, basic process, shape decomposition, mold, SDM and applications. Selective Laser Melting, Electron Beam Melting – Rapid manufacturing

UNIT V RAPID TOOLING 9

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

Course Outcomes

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

CO1: Explain the importance of Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle and cost.

CO2: Select appropriate liquid based and solid based rapid prototyping systems such as Stereo lithography, Selective laser sintering, Direct Metal Laser Sintering and Direct Metal Deposition for modeling.

CO3: Design RPT solutions such as Model Slicing, direct slicing and adaptive slicing and Tool path generation for data preparation.

CO4: Select a suitable three Dimensional Printing from Selective Laser Melting and Electron Beam Melting for Shape Deposition Manufacturing for making prototype.

CO5: Design RPT solutions for automotive, aerospace and electrical industry.

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Second edition, World Scientific Publishers, 2010
2. Pham,D.T. &Dimov.S.S., "Rapid manufacturing", Springer-Verlag, 2001.

References

1. Andreas Gebhardt, Hanser "Rapid prototyping", Gardener Publications, 2003.
2. LiouW.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
3. Paul F Jacobs, "Rapid Prototyping and manufacturing – Fundamentals of Streolithography", Society of Manufacturing Engineering Dearborn, 1992.

Web References

- https://www.nde-ed.org/index_flash.htm

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Course Code: 16MEE31	Course Title: SYSTEMS APPROACH FOR ENGINEERS (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Nil

Course Objectives

The course is intended to:

1. Explain system thinking and system engineering approaches.
2. Explain the various elements of a system
3. Establish the systems output
4. Document the details of the problem
5. Establish the relationship between the technical output and systems output.

UNIT I SYSTEMS ENGINEERING AND SYSTEMS THINKING 9

Global economy and its impact on the workers – across the globe; & inside of India - Need of Engineers in Company - Introduction – System Definition by Experts – Principles of System – Systems with simple elements – Apparent and Subtle System - Systems Engineering - its Significance- Description of Industrial processes – Business Functions - Definition of Manufacturing System - Physical Processes Vs. Service Processes

UNIT II SYSTEM APPROACH FRAMEWORK 9

Solutions - New Solutions Vs. Replication Solutions - System approach Frame work for Industrial Processes and their solutions – Need of System approach. Engineer as a "System thinker" and "Solution provider" - Industrial Organization and the various jobs or departments where engineers are required. Defining the problem or assignment as an "Input/Transformations/Output" system. Typical Input and output variables in any Company, Industry and process.

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

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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

At the end of the course the student will be able to:

CO1: Explain system thinking and system engineering approaches used to define a problem on hand comprehensively.
CO2: Explain a system by grouping its elements as inputs, transformation and outputs
CO3: Establish the stake holders and outputs of value to them (systems output).
CO4: Document the details of the problem on hand and the solution required as input, transformation and output system.
CO5: Establish the relationship between the technical outputs of the process and systems output.

Text Books:

1. Dr. K. (Subbu) Subramanian, "Thriving in the 21st century economy – Transformational skills for Technical Professionals", ASME Press 2013.

Reference Books:

1. Donella H. Meadows, "Thinking in systems" published by Chelsea Green Publishing.2015.

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Course Code: 16MEE32	Course Title: AUTOMOTIVE FUNDAMENTALS AND MANUFACTURING (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Automobile Engineering
- Metal cutting Process

Course Objectives

The course is intended to:

1. Suggest a suitable vehicle configuration based on the required function and performance.
2. Explain various parameters of given sub-system in chassis system of automotive products.
3. Explain various parameters of given sub-system in power train of automotive products.
4. Explain various parameters of given sub-system in Electrical and Electronic System of automotive products.
5. Identify the manufacturing processes that are used for automotive products.

UNIT I INTRODUCTION TO AUTOMOTIVE PRODUCTS 9

Automotive Products -Two wheelers: mopeds, scoters, motorcycles, bebek, moto-scooters (skubek) Three wheelers: Auto-rickshaws, Pick-up/delivery vehicles Four wheelers: LCV (hatchback, Sedan/saloon, coupe, convertible, limousine, estate), MCV(cut away vehicle, van), HCV (bus, truck) – Functions - Configuration: specifications of automotive products (Engine type, displacement, transmission, power, torque, battery rating, battery capacity, ground clearance, tire width, wheel base, kerb weight, fuel tank capacity).

UNIT II CHASSIS SYSTEM 9

Functions and Types: Steering system, Steering geometry, Steering lock angle, Turning circle Radius, Self Aligning moment, Wobble and Weave, Rolling behaviour, Frames: Functions, Types, mountings and support, centre of gravity, Suspension system: Functions, Types: Rigid, Independent - Pitch, bounce, roll, Angle of suspension, sprung and un sprung mass, Pitch frequency, squat and dive, Braking system: Functions, Types: Mechanism - drum, disc braking effort - brake balance, Stopping distance, braking efficiency, Wheels and Tires: Functions, types, Aspect ratio, tyre material, inflation pressure, Rolling resistance, Tractive effort.

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UNIT III POWER TRAIN SYSTEM 9

Engine and EHV's prime mover (motor), Engine location, Brake power, torque, load conditions, resistance, Indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency, efficiency ratio, mean effective pressure, mean piston speed, specific power output, specific fuel consumption, Inlet valve Mach index, Air-fuel ratio, Calorific value. Power Train: Functions-Clutch, gear box, propeller shaft, final drive, axles, Types of gear box, speed, torque, Propeller shaft: centre-to-centre distance, gear ratio, speed ratio, torque ratio, noise.

UNIT IV ELECTRICAL AND ELECTRONIC SYSTEMS 9

Electrical and electronic systems in automobiles- Importance, List of electrical and electronic systems in vehicle, Functions of electrical and electronic systems in a vehicle, Function Block Diagram with Components, Functions of System and parts. Effect of Non Conformance of Quality Characteristics to the product.

UNIT V MANUFACTURING OF AUTOMOTIVE PRODUCTS 9

Casting: Cylinder heads, engine block – conventional and expandable pattern. Forging: crank shaft, connecting rod and gudgeon pins; Upset forging: Valves. Sheet metal work: wheel disc, body components, fuel tanks

Course Outcomes

At the end of the course the student will be able to:

CO1: Select a suitable vehicle configuration based on the required function and performance.

CO2: Explain the functions, design parameters and performance parameters of given sub-system in chassis system of automotive products.

CO3: Explain the functions, design parameters and performance parameters of given sub-system in power train of automotive products.

CO4: Explain the functions and quality parameters of given sub-systems in Electrical and Electronic System of automotive products.

CO5: Identify the manufacturing processes for the given automotive products and explain the manufacturing process for automotive products.

Text Books:

1. Tony Foale, "Motorcycle Handling and Chassis Design", 2nd Edition, Tony Foale, 2006.
2. Jack Erjavec, "Systems approach to Automotive Technology", Prentice Hall, 2008.

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Reference Books:

1. Philip F Ostwald and JairoMunuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, 2005.
3. Crouse and Anglin, "Automotive Mechanics", 10th Edition, Tata-McGraw Hill Publishers,2004.
4. Joseph Heitner, "Automotive Mechanics,",Second Edition ,East-West Press ,1999.
5. Ganesan V." Internal Combustion Engines" ,Third Edition, Tata Mcgraw-Hill 2007.

Web References:

- http://nptel.ac.in/courses/125106001/

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Course Code: 16MEE33	Course Title: LOGISTICS ENGINEERING (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal cutting Process

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,

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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.

Course Outcomes

At the end of the course the student will be able to:

CO1: Identify the potential failure modes in material storage and handling between POM/POS to POC.
CO2: Use REBA/RULA tools and techniques to study ergonomics in storage and material handling design.
CO3: Verify produced part quality is delivered to the point of consumption.
CO4: Design material storage and handling system to prevent potential failure modes.
CO5: Develop standardized storage and handling work procedures.

Text Books:

1. MikelP.Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", PHI Publishers, 3rd Edition 2016.

2. Blanchard and Benjamin S, "Logistics Engineering and Management", 6th International Edition, Prentice Hall Inc, 2015.

Reference Books:

1. Christopher M, "Logistics and Supply Chain Management - Creating Value Adding Networks", Prentice Hall, 2010.
2. James M. Apple, "Plant Layout and Material Handling" John Wiley, 3rd Edition, 1977.
3. PraussL,"The Green Multiplier - a Study of Environmental Protection and Supply Chain", AntonnRauss Limited, Palgrave Macmillan, 2005.
4. Taylor G.D, "Logistics Engineering handbook", CRC Press, 2008.

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Course Code: 16MEE34	Course Title: MANUFACTURING SYSTEMS ENGINEERING (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

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 constrains.

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-

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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.

Course Outcomes

At the end of the course the student will be able to

CO1: Explain the components and characteristics of manufacturing systems engineering.

CO2: Identify seven types of waste through value added and non value added analysis.

CO3: Describe flow production and level production using "JIT" tools (Kanban, flow, level, synchronization).

CO4: Differentiate appropriate performance metrics of different manufacturing systems.

CO5: Develop cell level standardized work procedures by applying concepts of JIT.

Text Books:

1. Chase, Jacobs, Aquilano, "Production and Operations Management" 8th Edition, Tata McGraw Hill CompaniesInc, 2008.
2. PaneerSelvam R "Production and Operations Management" Prentice Hall of India, 2010.
3. Hiroyuki Hirano, "JIT Implementation Manual", English Translation Copy Right Productivity Press, 2009.

Reference Books:

1. KotsundoHitomis's, "Manufacturing System Engineering", Second Edition, Taylor & Francis, 1996.
2. Adam Jr, Everette E. and Ebert, "Production and Operations Management- Concepts; Models and Behavior" 5th Edition, Prentice-Hall of India, 2012.
3. Chary "Theory and Problems in Production and Operations Management" Tata Mc-Hraw Hill, 2009.

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Course Code: 16MEE36	Course Title: INDUSTRIAL ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the courses:

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

Course Objectives

The course is intended to:

1. Explain the concept of industrial engineering
2. Explain appropriate work and method study
3. Identify the suitable forecasting techniques
4. Explain the concept of ergonomics
5. Explain the importance of property rights and Industrial legislation

UNIT I INTRODUCTION **10**

INDUSTRIAL ENGINEERING: Meaning, Definition, Objective, Need, Scope, Evolution and developments. Concept of quality and cost, Logistics, Production planning and inventory control, Operations research, Quality control PRODUCTIVITY: Definition of productivity, individual enterprises, task of management Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (simple numerical problems). PRODUCT DESIGN AND DEVELOPMENT: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering.

UNIT II WORK AND METHOD STUDY **10**

WORK STUDY: Definition, objective and scope of work study. Human factors in work study. Work study and management, work study and supervision, work study and worker. Taylor's scientific management, Gilbreths's contributions; productivity – concepts and measurements METHOD STUDY: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts. principles of motion economy; work measurement – stop watch time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration; business process reengineering.

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UNIT III PRODUCTION PLANNING AND INVENTORY CONTROL 9

Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems..

UNIT IV ERGONOMICS 9

Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man-machine system and their functions – work capabilities of industrial worker, study of development of stress in human body and their consequences. Computer based ergonomics. DESIGN OF MAN-MACHINE SYSTEM: Fatigue in industrial workers, Quantitative qualitative representation and alphanumeric displays, Controls and their design criteria, control types, relation between controls and displays, layouts of panels and machines. Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.

UNIT V PROPERTY RIGHTS AND INDUSTRIAL LEGISLATION 7

Definition of intellectual property, importance of IPR; TRIPS and its implications, patent, copyright, industrial design and trademark. Need for Industrial legislation, Factories act 1948, Industrial dispute act 1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952 – Group Discussion.

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain concept of industrial Engineering to take the right decisions to optimize resources utilization by improving productivity

CO2: Explain the work study to eliminate unproductive activities and method study to use the Charts to record the Activities of the people, materials and Equipment for minimizing the waste and implement the best method.

CO3: Identify the suitable forecasting techniques to improve the processes and find the Standard Time for given applications

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CO4: Explain the concept of ergonomics to design the Man – Machine System to improve Human Efficiency and reduce the effort of the workers for a given resources

CO5: Explain the importance of property rights and Industrial legislation for the betterment of employees

Text Books:

1. Khan, M.I, "Industrial Engineering", New Age International, 2nd Edition, 2009.
2. "Work study", ILO, Second Edition, Oxford and IBH Publishin, 2010
3. Kapoor N.D, "Handbook of Industrial Law", sultan Chand & sons, 14th revised edition 2013.

Reference Books:

1. "Human Factors in Engineering Design" - S Sanders and E J McCormick, 7th Edition,2016
2. Industrial Engineering and Production management", Martand Telsang, S. Chand Publisher, 2006
3. Paul Kales, " Reliability for Technology Engineering and Management", Prentice Hall, New Jersey, 1998

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Course Code: 16MEE38	**Course Title:** TOOL ENGINEERING	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the courses:

- Metal cutting Process
- Design of Jig, Fixtures and Press tools

Course Objectives

The course is intended to:

1. Design a cutting tool for machining
2. Design a limit gauge and tool holders
3. Design a press tools and dies
4. Design a tools for casting and moulding
5. Explain the concept of rapid tooling

UNIT I DESIGN OF CUTTING TOOLS **11**

Broad Classification of Tools-Cutting tools, Dies, Holding and Measuring tools, Tool materials and heat treatment- Ferrous, Non-ferrous and Non metallic materials, tool making practices. Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat and circular form tools, their design and applications.

UNIT II DESIGN OF LIMIT GAUGES AND TOOL DESIGN FOR CNC MACHINES **8**

Fixed gauges, gauge tolerances, indicating gauges, automatic gauges, selection of materials, tool design for CNC machines- fixture design, cutting tools, tool holding, tool pre-setter, automatic tool changers and positioners.

UNIT III DESIGN OF PRESS TOOLS **9**

Basic Bending, Blanking or piercing operation, Shearing Theory, Analysis of cutting force and stripping force, calculation of press tonnage, Designing of cutting clearance. Method of reducing the cutting force, Function of screw hole and dowel holes, Die and Punch life. Design of blanking, Piercing Dies, Bending dies. Definition of Progressive dies, introduction to the progressive dies, Types of Progressive Dies, Progressive strip layouts. Difference between drawing and other forming operation, Introduction to Draw Dies and materials, Draw force analysis, Wrinkling Erickson test, Defects in drawing, forming theory, design of draw dies and extrusion dies.

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UNIT IV DESIGN FOR CASTING AND MOULD DIE 9

Design of Dies used for Casting and Moulding, Powder Metallurgy die design. Basic terminology ,Bolsters and its types, guide pillars and guide bushes, Ejection, ejection techniques, ejection from fixed half. ejection grid design, ejector plate assembly, return system, Types of gates, position of gate, gate balancing, runner, runner cross sectional shape, efficiency of various runner profiles. Rising, Razor design and its placements, Splits, Side core, Side cavity and Internal undercut. Mould for Threaded Components- mould for internally threaded components, split core design fixed threaded core design. Mould types - day lights, single, double and triple daylight moulds. Design of undercut runner system.

UNIT V RAPID TOOLING 8

Indirect rapid tooling - silicone rubber tooling, aluminum filled epoxy tooling, spray metal tooling, cast Kirksite, 3D Keltool, etc., direct rapid tooling - direct AIM, quick cast process, copper polyamide, rapid tool, DMILS, prometal, sand casting tooling, laminate tooling, soft tooling Vs hard tooling.

Course Outcomes

At the end of the course the student will be able to:

CO1: Design the cutting tools required for machining metallic and non-metallic materials
CO2: Design the limit gauges and CNC tools holders for appropriate machining
CO3: Design various press tools like bending, blanking, piercing and progressive dies for simple components.
CO4: Design a casting and moulding dies for production of simple metal or plastic components
CO5: Explain the concept of various soft and hard tooling processes for a given complex design

Text Books:

1. B.L. Juneja, G. S. Sekhon, Nitin Seth" Fundamental of Metal Cutting and Machine Tools", New Age International 2nd edition ,2003.
2. K Venkataraman, "Design of Jigs, Fixtures and Press tools", Wiley publications, 2015.
3. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer , 2010.

Reference Books:

1. Donaldson, C., "Tool Design", Tata Mc-Graw Hill, 2006
2. Grant, H,E., "Jigs and Fixtures, Tata Mc-Graw Hill, 2006
3. Tom Page "Design for Additive Manufacturing" LAP Lambert Academic Publishing, 2012.

BoS Chairman

Course Code: 16MEE39	Course Title: REFRIGERATION AND AIR-CONDITIONING (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Thermodynamics
- Thermal Engineering

Course Objectives

The course is intended to:

1. Calculate the performance of vapor compression refrigeration cycles.
2. Explain the various components of vapor compression refrigeration system
3. Explain the various air conditioning systems.
4. Explain the applications of refrigeration and air conditioning systems
5. Explain the refrigerant charging procedure, leakage detection and various control methods.

UNIT I REFRIGERATION 9

Thermodynamic principles of refrigeration – Types of Refrigeration Systems – **Vapour compression refrigeration System**, Ts and P-H diagrams, Performance calculation –

Vapor Absorption System: Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration

Refrigerants: Primary & secondary refrigerants, Nomenclature of Refrigerants, Properties and selection – Environment friendly alternatives.

UNIT II COMPONENTS OF REFRIGERATION SYSTEM 9

Refrigerant compressors - reciprocating, rotary and centrifugal compressors, evaporators - flooded, dry expansion, shell and tube and double pipe evaporators, condensers - air cooled, water cooled and evaporative condensers, expansion devices - automatic, capillary tube and thermostatic expansion valve.

UNIT III AIR CONDITIONING SYSTEM AND ITS COMPONENTS 9

Characteristics of Human comfort condition, Different types of Air Conditioner-Room/Window, Central Air Conditioner , Air conditioning Equipments- air filters , humidifiers & dehumidifiers, fans & blowers, Types of load - Cooling Load Calculations, Air Distribution Patterns.

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UNIT IV APPLICATION OF REFRIGERATION AND AIR CONDITIONING SYSTEMS 9

General layout, Working Principle, Advantages & Disadvantages - Food Preservation, Food Storage & Distribution - Beverage Coolers, LNG – Ice Manufacturing Plant – Solar Air Conditioning, – Automobile air conditioning, Refrigerated trucks, Aircraft air conditioning, Railway Refrigerator Cars.

UNIT V INSTALLATION AND SERVICING 9

Air distribution systems - study of different types of duct systems Duct installation - Charging of refrigerant - Servicing of air-conditioning, – Safety procedures, Leak detection procedures- Basic Elements of Control systems - temperature control, Bimetal thermostat, Electric resistance thermostat, Electronic thermostat- Humidity control elements- Automatic Dew point recorder.

Course Outcomes

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

CO1: Calculate the performance of vapor compression refrigeration cycles.
CO2: Explain the various components of vapor compression refrigeration system viz. evaporator, compressor, condenser and expansion valve.
CO3: Explain the various air conditioning system using psychrometric concepts.
CO4: Explain the applications of refrigeration and air conditioning systems viz. food preservation, automobile air conditioning, aircraft air conditioning and marine air conditioning.
CO5: Explain the refrigerant charging procedure, leakage detection and various control methods.

Text Book

1. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 2015
2. Arora. C.P., "Refrigeration and Air conditioning", 3rd edition. Tata McGraw-Hill, 2017.

References

1. Dossat, R.J. "Principles of Refrigeration", Prentice-Hall, 2013.
2. R.S.Khurmi, J.K.Gupta. "Textbook of Refrigeration and Air-conditioning" S.Chand, 2nd Edition, 2006.
3. ASHRAE 2017 Hand book (Fundamentals &Equipments)

Web References

- http://nptel.ac.in/courses/112105128/
- https://www.ashrae.org/

BoS Chairman

Course Code: 16MEE40	**Course Title:** PRINCIPLES OF MANAGEMENT (Common to All BE/B.Tech Programmes)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

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.

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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.

Course Outcomes

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

CO1: Describe the role of managers with reference to an organization context and business.
CO2: Explain the significance of planning, decision making and strategies for international business to accomplish the organizational goal.
CO3: Explain the significance of organizing the tasks to accomplish the organizational goal.
CO4: Explain the motivational theories to increase the productivity and retention rate of employees.
CO5: Explain the control techniques such as budgetary, maintenance, quality to accomplish the organizational goal.

Text Books

1. Stephen P. Robbins and Mary Coulter, "Management", Prentice Hall of India, 8th edition, 2009.
2. Charles W.L Hill, Steven L McShane, "Principles of Management", Mcgraw Hill Education, 2007.

References

1. Hellriegel, Slocum & Jackson, "Management – A Competency Based Approach", Thomson South Western, 10th edition, 2007.
2. Harold Koontz, Heinz Weihrich and mark V Cannice, "Management – A global & Entrepreneurial Perspective", Tata McGraw Hill, 12th edition, 2007.
3. Andrew J. Dubrin, "Essentials of Management", Thomson Southwestern, 7th edition, 2007.

Web References

- http://www.managementstudyguide.com/all-subjects.htm

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Course Code: 16MEE41	Course Title: TOTAL PRODUCTIVE MAINTENANCE (Common to Automobile, Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Describe modern maintenance concepts and practices
2. Apply analytical tools in maintenance management
3. Apply Reliability Centered Maintenance for industrial systems
4. Illustrate 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.

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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

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

CO1: Describe modern maintenance concepts and practices
CO2: Apply analytical tools in maintenance management
CO3: Apply Reliability Centered Maintenance for industrial systems
CO4: Illustrate TPM and global trends in maintenance management
CO5: Demonstrate use of simple instruments used for condition monitoring in maintenance

Text Books

1. Seiichi Nakajima, "Introduction to TPM", Productivity Press, Chennai, 1998.
2. Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts Management", Prentice – Hall of India Pvt. Ltd., 2013.

References

1. Goto, F., "Equipment planning for TPM Maintenance Prevention Design", Productivity Press, 1992.
2. David J. Sumanth, "Total Productivity Management : A Systematic and Quantitative Approach to Compete in Quality, Price and Time", Productivity Press, 1997

Web References

- http://www.plant-maintenance.com/articles/tpm_intro.pdf
- http:// www.ame.org/sites/default/files/TPM-introduction-AME.pdf

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Course Code: 16MEE42	**Course Title:** INDUSTRIAL SAFETY MANAGEMENT (Common to Automobile, Mechanical, Mechatronics & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

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 "t" 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,

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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 act1983 - 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

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

CO1: Explain the importance of safety management to control the accidents, pollution and hazards.
CO2: Explain the measurement and monitoring techniques to report the safety performance.
CO3: Explain the roles and responsibilities of Safety department in an organization to eliminate the unsafe act and conditions.
CO4: Describe the importance of Industrial safety acts related to safety environment pollution in India.
CO5: Explain the classes of fires and controlling techniques and plan for an onsite and offsite emergency.

Text Books

1. Deshmukh .L.M "Industrial Safety Management" McGraw-Hill 2006.
2. C.RayAsfahl "Industrial Safety and Health management" Pearson Prentice Hall,2003

References

1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980
3. Subramanian.V., "The Factories Act 1948 with Tamilnadu factories rules 1950", Madras Book Agency, 21st ed., Chennai, 2000.

Web References

- http://www.icebookshop.com
- http://nptel.ac.in/courses/112107143/40

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Course Code: 16MEE43	Course Title: SOLAR AND WIND ENERGY	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Physics
- Thermal Engineering
- Power plant engineering

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 RADIATION 9

Availability – Measurement and Estimation – Introduction to solar collectors – flat plate collectors and Concentrating collectors – Types, working principle and Performance – Solar Thermal storage – Sensible and latent heat storage systems.

UNIT II SOLAR THERMAL SYSTEMS 9

Solar water heating systems – Active and passive – Air heaters - Passive heating and cooling of buildings – Solar distillation – Solar Drying - Solar Pond – Solar Refrigeration

UNIT III SOLAR PHOTOVOLTAIC SYSTEMS 9

Types of solar cells – applications – Experimental techniques to determine the characteristics of solar cells. Photovoltaic hybrid systems Photovoltaic thermal systems – Storage Battery – Solar Array characteristics evaluation.

UNIT IV WIND TURBINES 9

Structure - Statistics – Measurement and Data Presentation – Wind Turbine Aerodynamics – Basics of Aerodynamics – Airfoil characteristics – Blade Element Theory – Aerodynamic Loads in Steady Operation in HAWT & VAWT – Wind Turbulence – Yaw system – Towers – Generators.

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UNIT V WIND ENERGY CONVERSION SYSTEMS (WECS) 9

Horizontal and Vertical axis Wind Turbines – Working principle - Rotor selection – Rotor Design Considerations – Number of Blades – Blade Profile – Energy Output - Testing of WECS – Control systems - Environmental Impact of WECS.

Course Outcomes

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

CO1: Identify the availability of solar radiation in different places.
CO2: Describe main features and operation of solar thermal systems.
CO3: Explain the working principle of solar-photovoltaic systems.
CO4: Acquire the knowledge of wind turbine aerodynamics.
CO5: Describe main features and operation of various wind turbines and their energy conversions.

Text Books

1. Solar Energy, S.P.Sukhatme and J.K.Nayak, McGraw Hill, Fourth Edition, 2017.
2. Solar Photovoltaics – Fundamentals, Technologies and Applications, Solanki C.S. PHI Publications, 2015.
3. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, 2004.

References

1. Wind Energy Engineering, Pramod Jain, McGraw Hill Education, New York, 2nd Edition, 2010Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980
2. Wind Energy Explained-Theory, Design and Application, James F.Manwell, Jon G.Mc Gowan, Anthony L.Rogers, 2nd Edition, 2010.
3. Solar Energy Utilization, G.D.Rai, Khanna Publishers, 2004.

Web References

- http://www.icebookshop.com
- http://nptel.ac.in/courses/112107143/40

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Course Code:16MEE44	Course Title: QUALITY ENGINEERING (Common to Automobile, Mechanical, Mechatronics &Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Metrology and Measurements.
- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes.

Course Objectives

The course is intended to:

1. Explain the need of quality and customer satisfaction.
2. Explain the basics of Quality cost with classification
3. Explain the concept of total quality management relevant to both manufacturing and service industry.
4. Explain the various tools used in Quality Engineering and Management.
5. Explain the steps used for Designing for Quality.

UNIT I INTRODUCTION 9

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.

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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

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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

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the need of quality and customer satisfaction.

CO2: Explain the basics of Quality cost with classification

CO3: Explain the concept of total quality management relevant to both manufacturing and service industry.

CO4: Explain the various tools used in Quality Engineering and Management.

CO5: Explain the steps used for Designing for Quality.

Text Books

1. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers.
2. Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Education .
3. Quality Management by Kanishka Bedi .
4. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
5. Total Quality Management by K C Arora, S K Kataria & Sons.
6. Statistical Quality Control by M. Mahajan, Dhanpat Rai & Co. (P) Ltd.

References

1. Quality planning and Analysis, Juran and Gryna, TMH, New Delhi
2. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India

Web References

- http://www.nptel.ac.in
- http://www.ocw.mit.edu

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Course Code: 16MEE47	Course Title: ENTREPRENEURSHIP DEVELOPMENT (Common to Mechanical & Production)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

Course Objectives

The course is intended to:

1. Describe the requirement of entrepreneurship.
2. Explain the different motivational theories and government policies.
3. Classify the types of enterprises
4. Explain the various processes in managing an enterprise
5. Explain the government norms and policies

UNIT I ENTREPRENEURSHIP 9

Definition, requirements to be an entrepreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship.

UNIT II ENTREPRENEURIAL MOTIVATION 9

Motivating factors, motivation theories-Maslow's Need Hierarchy Theory, McClelland's Acquired Need Theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes.

UNIT III TYPES OF ENTERPRISES AND OWNERSHIP STRUCTURE 9

Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.

UNIT IV MANAGEMENT OF ENTERPRISES 9

objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection, etc.; marketing and organizational dimension of enterprises; enterprise financing : raising and managing capital, shares, debentures and bonds, cost of capital; break- even analysis, balance sheet its analysis..

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UNIT V INSTITUTIONAL SUPPORT AND POLICIES 9

Institutional support towards the development of entrepreneurship in India, Technical consultancy organizations, government policies(MSME) for small scale enterprises.

Course Outcomes

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

CO1: Describe the requirements for entrepreneurship
CO2: Explain different motivational theories and policies for entrepreneur development
CO3: Explain the types of enterprises and ownership structure
CO4: Explain the various processes in managing an enterprise
CO5: Explain the government norms and policies that govern small scale enterprises

Text Books

1. Ram Chandran, "Entrepreneurial Development", Tata McGraw Hill, New Delhi, 2008.
2. Khanka, S S. "Entrepreneurial Development", S Chand & Company Ltd. New Delhi, 2007.

Reference Books

1. Saini, J. S., "Entrepreneurial Development Programmes and Practices", Deep & Deep Publications (P), Ltd, 2001.
2. Badhai, B "Entrepreneurship for Engineers", DhanpatRai& co. (p) Ltd,2013.
3. Desai, Vasant, "Project Management and Entrepreneurship", Himalayan Publishing House, Mumbai, 2013.

Web References

- http://www.ediindia.org/

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Course Code: 16MEE48	**Course Title:** OPERATIONS RESEARCH (Common to Mechanical & Production)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics I
- Engineering Mathematics II

Course Objectives

The course is intended to:

1. Solve linear programming problems
2. Select the optimal solution for transportation and assignment problems
3. Calculate EOQ and EBQ for manufacturing and purchase models
4. Select critical paths using CPM and PERT
5. Select the replacement policy and shortest queuing time

.UNIT I LINEAR PROGRAMMING **9**

Introduction - Formulation of linear programming models – Assumptions-Graphical solution procedure – solving LPP using simplex algorithm – Degeneracy, Revised Simplex Method Duality theory - Interpretation of dual variables- Primal Dual Relationships – Role of duality in sensitivity analysis - Dual simplex method.

UNIT II TRANSPORTATION & ASSIGNMENT MODELS **9**

Transportation problems, transportation simplex method– Assignment problems, Hungarian method- LP formulation of transportation and Assignment networks- Traveling sales man problem

UNIT III INVENTORY MODELS **9**

Purchase model with no shortages – manufacturing model with no shortage – Purchase model with shortage -- Manufacturing model with shortages –model with price breaks.

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.

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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.

Course Outcomes

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

CO1: Solve linear programming problems with simplex and graphical methods after formulation and assumption of required parameters.

CO2: Select the optimal solution for transportation and assignment problems, based on cost, using Northwest, Least Cost, Vogals Approximation and Hungarian methods.

CO3: Calculate EOQ and EBQ for manufacturing and purchase models operating with or without shortage.

CO4: Select critical paths using CPM and PERT in projects based on minimum duration of activities.

CO5: Select the replacement policy and shortest queuing time based on economic cost for various replacement and queuing models. them in domain specific situations

Text Books

1. Hillier and Lieberman "Introduction to Operations Research", TMH, 2015.
2. R.Panneerselvam, "Operations Research", PHI, 2006

References

1. Philips, Ravindran and Solberg, "Operations Research", John Wiley,2002
2. Hamdy A Taha, "Operations Research – An Introduction", Prentice Hall India,2003
3. Ronald L Rardin, "Optimization in Operations Research", Pearson, 2003

Web References

- http://nptel.ac.in/courses/112106134/1
- http://www.mit.edu/~orc/

BoS Chairman

Course Code:16MEE49	Course Title: ENGINEERING ECONOMICS AND COST ANALYSIS (Common to Automobile and Mechanical)	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics-I
- Metal Cutting Processes

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.

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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

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

CO1: Categorize different cost and calculate the breakeven point for a given business situation

CO2: Apply different interest formulae and their application in decision making process.

CO3: Evaluate present value, future value and annual worth analysis on one or more economic alternatives.

CO4: Determine the economic value of an asset and develop a better replacement policy for a given equipment.

CO5: Evaluate the depreciation of equipment per period.

Text Books

1. Panneerselvam R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2014
2. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2010.

References

1. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2010.
3. Grant.E.L., Ireson.W.G., and Leavenworth, R.S, "Principles of Engineering Economy", Ronald Press, New York,1990.

Web References

- https://en.wikipedia.org/wiki/Engineering_economics
- https://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis

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Course Code: 16MEE50	Course Title: PROBABILITY AND STATISTICS	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Engineering Mathematics I & II

Course Objectives

The course is intended to:

1. Calculate the moments of the discrete and continuous random variables.
2. Apply the discrete and continuous probability distributions to real life phenomena
3. Use sample mean and variance to test small and large samples
4. Test the samples based on the analysis of variance for design experiments.
5. Compute Correlation, Regression Co-efficient and Control Charts for the given data

UNIT I PROBABILITY AND RANDOM VARIABLES 9

Sample spaces – Events - Probability Axioms – Conditional Probability – Independent Events – Baye's Formula.
Random Variables : Distributions Functions – Marginal Distributions – Conditional Distributions – Expectation – Conditional Expectation and Conditional Variance – Moments - Moment Generating Functions.

UNIT II PROBABILITY DISTRIBUTION 9

Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Gamma, Weibull (Mean, Variance and Simple problems) and Chebyshev's inequality (Simple problems).

UNIT III TEST OF HYPOTHESIS 9

Tests for Means , Variances and proportions – Tests for Means , Variances and Attributes using t , F , Chi – Square distribution – Interval estimation for mean, Standard deviation – Proportion.

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UNIT IV ANALYSIS OF VARIANCE 9

One way classification, Two way classification and Latin square design (Only problems).

UNIT V INSTALLATION AND SERVICING 9

Statistical basis for control charts – Control limits – Control charts for variables : X , R Charts – Control chart for defective : p , np Chart - Control chart for defects : c charts. Correlation – Regression – Multiple and Partial Correlation – Partial Regression (Problems Only)

Course Outcomes

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

CO1: Calculate the moments of the discrete and continuous random variables.

CO2: Apply the discrete and continuous probability distributions to real life phenomena

CO3: Use sample mean and variance to test small and large samples

CO4: Test the samples based on the analysis of variance for design experiments.

CO5: Compute Correlation, Regression Co-efficient and Control Charts for the given data

Text Book

1. S.C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand& Sons, New Delhi – 1999.
2. S. P. Gupta, Statistical Methods , Sultan Chand & Sons , New Delhi, 1999.

References

1. K. S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, John Wiley and Sons, Second edition, New Delhi.2002.
2. T. Veerarajan,Probability , Statistics and Random Process , Tata McGraw Hill Publishing Company Ltd., New Delhi – 2003.
3. P. Kandasamy, ,K.Thilagavathy and K.Gunavathy, Probability and Random Process, S.Chand & Co. Ltd., New Delhi – 2007.

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Course Code: 16MEE51	Course Title: PROJECT MANAGEMENT	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal cutting Process

Course Objectives

The course is intended to

1. Use the concepts of project management
2. Develop project plans
3. Create project schedules
4. Estimate financial parameters of projects
5. Analyze the risks in projects

UNIT I INTRODUCTION 9

History of project management, product vs project management, stage gate process, project life cycles, systems thinking, types of organizational structures, skill requirements of project and programme managers, functional team, project organizational chart, project management bottlenecks, time management, conflict resolution, project management effectiveness, working with executives, PMP certification exam and case studies.

UNIT II PLANNING 9

General planning, life cycle phases, proposal preparation, kick off meetings, understanding participant roles, project planning, the statement of work, project specifications, milestone schedules, work breakdown structure, WBS decomposition problems, role of executives in project selection and planning, the planning cycle, work planning authorization, why do plans fail, stopping projects, handling project phase outs and transfers, schedules and charts, master production scheduling, project plan, total project planning, project charter, management control, project manager – line manager interface, fast tracking, configuration management, enterprise project management methodologies, project audits and problems.

UNIT III SCHEDULING 9

Network fundamentals, graphical evaluation and review technique (GERT), dependencies, slack time, network re-planning, estimating activity time, estimating total project time, total CPM/PERT planning, crash times, PERT/CPM problem

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areas, alternative- CPM/PERT models, precedence network, lag, scheduling problems, myths of schedule compression, understanding project management software, critical chain, customer reporting, bar (GANTT) chart, conventional presentation techniques, logic diagram and networks, case studies and problems.

UNIT IV PRICING AND ESTIMATING (PROJECT COSTING) 9

Global pricing strategies, types of estimates, pricing process, organizational input requirements, labour distributions, overhead rates, material/support costs, pricing out the work, smoothing out department man hours, pricing review procedure, systems pricing, developing the supporting/backup costs, the low bidder dilemma, estimating pitfalls, estimating high risk projects, project risks, life cycle costing (LCC), logistics support, capital budgeting, payback period, time value of money, net present value (NPV), internal rate of return (IRR), comparing NPT, IRR and payback, risk analysis, capital rationing, project financing, problems.

UNIT V CONTROLLING 9

Understanding control, the operating cycle, cost account codes, budgets, earned value measurement systems (EVMS), variance and earned value, the cost base line, justifying the costs, the cost overrun dilemma, recording material costs using EVMS, the material accounting criterion, material variances: price and usage, methodology for trade-off-analysis, tolerance for risk, risk management process, risk identification, risk analysis: qualitative and quantitative, probability distribution and Monte Carlo process, plan risk response, monitoring and control risks, case studies and problems.

Course Outcomes

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

CO1: Use the concepts of project management in effectively managing projects for the achievement of desired results
CO2: Develop project plans having various features essential the improve the project efficiency
CO3: Create project schedules adopting various networking techniques and project graphics
CO4: Estimate financial parameters of projects that enable decision making and predicting risks
CO5: Analyze the risks in projects using risk analysis tools/methods for controlling projects

Text Books

1. Harold Kerzner, "Project Management: A Systems Approach to Planning, Scheduling and Controlling", Wiley, 10th edition, 2012.
2. Erik Larson and Clifford Gray, "Project Management: The Managerial Process", McGraw Hill, 6th edition, 2017.

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References

1. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", McGraw Hill, 8th edition, 2017.
2. Project Management Institute, "A guide to the Project Management Body of Knowledge (PMBOK guide)", Project Management Institute, 2013.
3. Jack R. Meredith, Samuel J. Mantel Jr. and Scott M. Shafer, "Project Management: A Managerial Approach Paperback", Wiley, 2015.

Web References

1. https://onlinecourses.nptel.ac.in/noc18_mg28/preview (last visited on 26th October 2018)
2. https://ocw.mit.edu/courses/engineering-systems-division/esd-36-system-project-management-fall-2012/ (last visited on 26th October 2018)
3. https://www.pmi.org.in/pmboks.aspx?id=Practice-Standards-Framework (last visited on 26th October 2018)

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Course Code: 16MEE52	Course Title: METAL CUTTING PROCESSES ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Explain the types of geometric dimensioning and tolerancing of parts.
2. Explain the types of control elements used in automation of metal cutting processes.
3. Select appropriate machine, tools and machining process.
4. Select suitable machine elements
5. Write CNC programming for the machining processes.

UNIT I GEOMETRIC DIMENSIONING AND TOLERANCE 9

Fits: Introduction - Clearance fit, Transition fit, Interference fit, Hole basis system - Shaft basis system. Product - examples Introduction to GD & T - Geometric characteristic and symbols - straightness - flatness - parallelism - cylindricity - circularity - perpendicularity - angularity - position - symmetry - concentricity - run out Basics of work holding methods/devices - vice, collets, chucks, face plates, jigs and fixtures; types, Explain selection criteria - DOF, location, orientation & clamping. Construction/design parameters (brief of material, part description), selection criteria, GPMs & SPMS - brief description, features, supporting accessories, safety features

UNIT II INTRODUCTION TO AUTOMATION 9

Control systems – Basic elements used in control systems, Types, Advantages and Limitations. Raw materials for automotive components (cast iron, Aluminium, steel): composition, characteristics, Machinability of cast iron, Aluminium, steel (alloying element vs machinability), ISO/JIS standards of material specifications

UNIT III PROCESS SELECTION 9

Machining Economics: Cycle time and Cost calculation for processes of turning, milling, drilling, grinding and thread chasing. Process parameters - Definition of cutting speed, feed, Depth of cut, tool life vs process parameters. Selection of parameters based on work material, tool material and cost. Machining process selection: Selection ofwork holding, tool holding and inspection / gauging

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requirements for the component for different operations. Capabilities and limitations of metal cutting process: Selection of appropriate machine, tool and manufacturing process required to achieve the part quality

UNIT IV SELECTION OF MACHINE ELEMENTS 9

Machine elements - Guide ways, ball screw, lead screw and spindles. Criteria for linear motion guide ways or hard & ground guide ways. Machine specification - axis limits, over travel alarm, part-tool collision lay outs, referencing of axis, machine starting procedure, Machine operating modes-Jog,MDI,Single,Auto and edit. Sequence of machine operation - machine power on, axes referencing, movement of axes, tool indexing, tool clamping, reading of part programs, tool memory, reading of alarms, concept of origin and coordinate systems

UNIT V PROGRAMMING 9

Part programs- Methods of programming - absolute, incremental, basic G codes and M codes, structure of a CNC program - syntax requirements for turning centres and for machining centres (Exercises – drilling, reaming, boring, turning, milling and grinding). Dimensional control-Using tool off sets (wear off sets), Exercises. Practical trouble shootings: Ovality, chattering marks, run outs, flatness, surface roughness. Usage of surface roughness tester, gauges and Coordinate Measuring Machine.

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the types of geometric dimensioning and tolerancing of parts to achieve the desired function of the part.
CO2: Explain the types of control elements used in automation of metal cutting processes.
CO3: Select appropriate machine, tools and machining process to achieve the desired part quality.
CO4: Select suitable machine elements to support the machining process.
CO5: Write CNC programming for the machining processes such as turning, milling and grinding.

Text Books

1. Juneja, B L, Sekhon K L and Nitin Seth, "Fundamentals of Metal Cutting and Machine Tools", New Age International (P) Ltd., Publishers, 2003.
2. David A. Stephenson and John S Agapiou, "Metal Cutting Theory and Practice", CRC Press, 2005.

References

1. Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw-Hill Book Company, London, 1995.

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Course Code: 16MEE53	Course Title: DESIGN OF SPARK IGNITION ENGINES	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Thermal engineering
- Automobile engineering
- Design of Machine Elements

Course Objectives

The course is intended to:

1. Explain the different engine layouts
2. Select a suitable material for the engine parts.
3. Explain the various performance parameters of SI engines.
4. Design a Failure Mode Effects Analysis (FMEA)
5. Explain the various concepts of DFX

UNIT I ENGINE LAYOUT SCHEMES 9

Various types of engine layout – Advantages and challenges of a layout, Multicylinder, Single Cylinder, Aircooled, Liquid cooled engines –Layout

UNIT II MECHANICAL DESIGN 9

Mechanical construction details of Crank shaft assembly, piston assembly, Head assembly, Block, crank case, sealings and joints,Functional diagram – approach – Primary & Secondary functions – preparation of standard design input sheets-Selection and use of right material for engine: Introduction – case study - Basic functions of critical parts – Materials used in automotive engines, Types of loads on various engine parts – thermal load, mechanical load, life requirements

UNIT III DESIGN VERIFICATION 9

Introduction – case study – performance parameters, Types of wear – wear limit study – Durability – Emission norms – Customer requirements

UNIT IV FMEA 9

Various attributes contributing to engine behaviour – Design FMEA – function, cause, occurrence level, Detection of failure – judgment of severity – opportunities to detect severity

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UNIT V DESIGN OF ENGINES 9

Design for manufacturing – Design for assembly – Design for service – Design for economy - Design for performance, Case study – one each for each Design function.

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the different SI engine layouts.
CO2: Select a suitable material for the engine parts based on the function and loading conditions.
CO3: Explain the various performance parameters of SI engine to be managed for satisfying the statutory and customer requirements.
CO4: Design a FMEA to capture the severity of defects.
CO5: Explain the various concepts of DFX used in design of SI engines

Text Books

1. Charles Fayette Taylor, "The Internal Combustion Engine in Theory and Practice: Revised: Thermodynamics, Fluid flow, Performance", Vol.1-2nd edition, MIT Press, 1985.
2. Kevin L. Hoag, "Vehicular Engine Design", Springer Wein, New York and SAE Joint Publication 2005.

References

1. John Heywood, "Internal Combustion Engines Fundamentals", Tata McGraw Hill Publications, 2011

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Course Code: 16MEE54	Course Title: SPARK IGNITION ENGINES	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Thermal Engineering

Course Objectives

The course is intended to:

1. Explain the classifications of engines.
2. Explain the important engine characteristics and performance parameters.
3. Explain the balancing of SI engines and thermodynamic cycles used in SI engines.
4. Explain the combustion process in SI engines.
5. Explain the performance analysis used in SI engines

UNIT I INTRODUCTION 6

Engine classifications, Terminology and abbreviations, Engine components, SI Engine operation

UNIT II ENGINE PERFORMANCE PARAMETERS 9

Important engine characteristics, Geometrical properties, Brake torque, power and Indicated work per cycle, Mechanical Efficiency, Mean effective pressure, Fuel air ratio, Volumetric efficiency, Engine specific weight and specific volume

UNIT III ENGINE DYNAMICS AND THERMODYNAMIC CYCLES 10

Crank rod-slider/R ratio, Balancing, Firing order and interval-Thermodynamic cycles-Ideal cycle analysis, Fuel air cycle analysis, Comparison with real engine cycle

UNIT IV COMBUSTION 9

Fuel air mixtures-Characterization of flames, Combustion Stoichiometric, Air fuel mixture requirements, Carburetion, Fuel injection systems, Flow in intake manifolds-Gas exchange process- Inlet and exhaust processes in the four-stroke cycle, Volumetric efficiency, Flow through valves, Residual gas fraction, Exhaust gas flow rate and temperature variation, Scavenging in two stroke engines, Supercharging and Turbo charging

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UNIT V PERFORMANCE ANALYSIS 10

Thermodynamic analysis of SI engine combustion, Flame structure and speed, Cyclic variations in combustion, Spark ignition, Normal and Abnormal combustion, Fuel factors, Carbon monoxide, Unburned Hydrocarbon emissions, Oxides of Nitrogen, Exhaust gas treatment.

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the classifications of engines based on various factors such as construction, operation, type of fuel, etc.
CO2: Explain the important engine characteristics and performance parameters.
CO3: Explain the balancing of SI engines and thermodynamic cycles used in SI engines.
CO4: Explain the combustion process in SI engines.
CO5: Explain the performance analysis used in SI engines to measure the engine performance.

Text Books

1. Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engine", 2nd Edition, Prentice Hall, 2003.
2. V. Ganesan, "Internal Combustion Engines" McGraw-Hill, reprint 2012.
3. K.K.Ramalingam, "Internal Combustion Engines-Theory and Practice", Sci Tech Publications (India) Pvt Ltd, 2011.

References

1. John Heywood, "Internal Combustion Engines Fundamentals", Tata McGraw Hill Publications, 2011.
2. Charles Fayette Taylor, "The Internal Combustion Engine in Theory and Practice: Revised: Thermodynamics, Fluid flow, Performance", Vol.1-2nd edition, MIT Press, 1985.
3. Richard Stone, "Introduction to Internal Combustion Engines", Third edition, Society of Automotive Engineers, Incorporated 1999.

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Course Code: 16MEE55	Course Title: ASSEMBLY ENGINEERING	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Classify the process involved in assembly process
2. Explain the assembly process
3. Develop an assembly plan
4. Develop assembly inspection procedures
5. Develop quality assurance plan

UNIT I INTRODUCTION 6

Introduction Parts configuration and classification. Subassembly– Definition Subsystem and system.

UNIT II ASSEMBLY PROCESS 9

Assembly process - Definition - Primary assembly processes -Secondary assembly processes: Washing, Numbering, Pressing, Fastening, Leak testing and Oil filling. Joining process: Permanent joining - welding, pressing, riveting; Semi permanent joining - fastening; Types of fasteners and their applications - Bolt grade class. Product Flow: Single piece flow, Multi-model, Automatic assembly line – definition, Importance, merits and demerits.

UNIT III ASSEMBLY PLAN 11

Time and man power planning - Assembly Sequence with Mechanical Toy - Case studies.Facility planning - Conveyors - purpose, importance and working principle and types - Fastening tools – importance- Classification based on source of energy (pneumatic, hydro-pneumatic, electric), shape (straight, L- type), mechanism (impact, oil pulsed, clutch type, reversible mechanism, stall types), control (torque, angle, time), number of spindles (single & multi) tool RPM, power to weight ratio, air consumption -Types of sockets, pliers, bits, holding tools, folding tools and their function & importance – Types of torque wrenches, setting procedure - Calibration of tools & torque wrenches – Types of fixtures gauges and special tools with examples – orientation & location principles - Materials, life monitoring, fixture tool calibration techniques

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UNIT IV ASSEMBLY INSPECTION 10

Assembly Inspection Systems: Inspection and Assurance in assembly systems - Testing Machines: washing, numbering, riveting, pressing (bearing, oil seal, bush) - Fire testing machines and adhesive application machines, leak testing, chassis dynamometer, emission analyser, stacking - Performance testing: Engine testing, test parameter and capturing method of engine health -Vehicle testing, test parameter and capturing method of vehicle road test simulator - Types of automations - assembly, testing & inspection.

UNIT V QUALITY PLANNING 9

Defects in Assembly - Classification of defects based on type, assembly (Missing , Wrong part, Wrong orientation, reverse assembly, loose assembly), Types of controls (detection, prevention, poka-yoke,) - Effect of missing of parts in relation to product performance - Safety aspects in machines, aspect impact study, hazard risk areas and importance of PPE. Customer experience in mileage, ride comfort.

Course Outcomes

At the end of the course the student will be able to:

CO1: Classify the assembly process based on its systems and sub systems
CO2: Explain the assembly process based on the assembly sequence
CO3: Develop an assembly plan based on the given facilities.
CO4: Develop assembly inspection procedures based on tools available.
CO5: Develop quality assurance plan to ensure the quality of assembly.

Text Books

1. Daniel E Whitney, "Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development", Oxford University Press, 2004.
2. James A. Speck, "Mechanical Fastening, Joining, and Assembly", CRC Press, 2017.

References

1. Dean A.Shafer, PE, "Successful Assembly Automation: A Development and Implementation Guide", Society of Manufacturing Engineers, 1999.

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Course Code: 16MEE56	**Course Title:** BATTERY SYSTEM FOR ELECTRIC VEHICLES (Common to Mech and EEE)	
Core/Elective: Elective	**L : T : P : C**	3 : 0 : 0 : 3
Type: Theory	**Total Contact Hours:**	45 Hours

Prerequisites

The student should have undergone the course(s):

- Fundamentals of Li-Ion Battery Technology
- Computer Aided Drafting and Modeling

Course Objectives

The course is intended to:

1. Select suitable Li-Ion battery cells
2. Prepare mechanical assembly drawings of battery systems
3. Design battery management systems
4. Prepare vehicle layout for sub-systems
5. Perform cost benefit analysis of battery sub systems

UNIT I LI-ION BATTERY **7**

Significance of Li-ion batteries - Classification of Li-Ion batteries - Construction of Li-Ion batteries - Energy density - Charging and discharging profiles - influence of temperature - life and ageing issues - Safety aspects and thermal runaway.

UNIT II LI-ION BATTERY SYSTEMS **8**

Battery systems and subsystems - Battery modules - Cells in series and parallel configurations - Battery cooling systems - Battery management systems - Cell balancing - Battery housing - Assembly of battery systems - Production aspects - Regulations on battery systems

UNIT III BATTERY MANAGEMENT SYSTEM **10**

Battery management systems: functions and architecture, performance parameter measurement, equalization management circuit, data communication, logic and safety control, testing stability.

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

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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

Course Outcomes

At the end of the course the student will be able to:

CO1: Select suitable Li-Ion battery cells for use in electric vehicles based on the calculation of various cell parameters

CO2: Prepare mechanical assembly drawings of battery systems for electric vehicles using available CAD software

CO3: Design battery management system for various battery systems to obtain peak performance by monitoring and charge equalization.

CO4: Prepare vehicle layout for sub-systems in TWO and FOUR wheelers using available CAD software

CO5: Perform cost benefit analysis of battery sub systems based on market conditions and manufacturability

Text Books

1. Reiner Korthauer, "Lithium-Ion Batteries: Basics and Applications" , Springer, August 2018. ISBN 978-3-662-53069-6

References

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles" , Wiley, 2015 ISBN 978-1-118-41478-1
2. Seth Leitman and Bob Brant, "Build Your Own Electric Vehicle" , McGraw Hill, 2013. ISBN 978-0-07-177056-9
3. James Larminie and John Lowry, "Electric Vehicle Technology Explained" , Wiley, 2018. ISBN 978-81-265-5670-8

Web references

- http://batteryuniversity.com/
- https://nptel.ac.in/courses/108103009/

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Course Code: 16OEXXX	Course Title: TOTAL QUALIY MANAGMENT	
Core/Elective: Core	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Explain the views of different quality gurus
2. Explain the principles and concepts inherent in a Total Quality Management (TQM) approach
3. Evaluate an industrial process
4. Explain the various quality tools for identifying appropriate process improvements
5. Explain the quality management

UNIT I INTRODUCTION 9

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES 9

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure

UNIT III STATISTICAL PROCESS CONTROL (SPC) 9

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables

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and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TOOLS **9**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, overview of FMEA – Stages of FMEA

UNIT V QUALITY SYSTEMS **9**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2004 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits - AS9100 – introduction.

Course Outcomes

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

CO1: Explain the views of different quality gurus towards Total Quality Management.

CO2: Explain the principles and concepts inherent in a Total Quality Management (TQM) approach for managing a manufacturing or service organization

CO3: Evaluate an industrial process using control charts, process capability indices and six sigma.

CO4: Explain the various quality tools for identifying appropriate process improvements such as Bench marking, QFD,TPM and FMEA.

CO5: Explain the quality management with respect to the ISO 9000 & ISO 14000 quality management standards.

Text Books

1. Dale H. Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2014.
2. Subbarajramasamy, " Total Quality Management" McGraw-Hill, 2008.

References

1. James R.Evans& William M. Lidsay, "The Management and Control of Quality", 7th Ed., South-Western (Thomson Learning), 2009.
2. Oakland.J.S. "Total Quality Management", Butterworth Hcinemann Ltd., Oxford, 2014.

Web References

- https://en.wikipedia.org/wiki/Total_quality_management

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Course Code: 16OEXXX	Course Title: INDUSTRIAL ROBOTICS	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Course Objectives

The course is intended to:

1. Explain the basic concepts of Robots.
2. Describe different robotic components and its operations.
3. Explain various sensors and machine vision.
4. Apply different robot programming to actuate robots.
5. Explain the various industrial application of robots.

UNIT I INTRODUCTION 9

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drive- Basic robot motions - Point to point control - Continuous path control.

UNIT II COMPONENTS AND OPERATION 9

Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators – Forward and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.

UNIT III SENSING AND MACHINE VISION 9

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV ROBOT PROGRAMMING 9

Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation - Search techniques – AI and Robotics.

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UNIT V INDUSTRIAL APPLICATIONS 9

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the basic concepts of Robots used in various industries.
CO2: Describe different robotic components and its operations used in various industries.
CO3: Explain various sensors and machine vision used in various industrial robots.
CO4: Apply different robot programming to actuate robots for various industrial applications.
CO5: Explain the various industrial application of robots.

Text Books

1. Mikell P. Groover, mitchell Weiss, "Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 2017.

2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, " Robotic engineering - An Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

References

1. Er.R.K.Rajput, "Robotics and Industrial Automation" 3rd edition S Chand Publishers, 2008.

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Course Code: 16OEXXX	Course Title: AUTOMATION SYSTEMS	
Core/Elective: Elective	L : T : P : C	3 : 0 : 0 : 3
Type: Theory	Total Contact Hours:	45 Hours

Prerequisites

The student should have undergone the course(s):

- Metal Forming, Joining and Casting Processes.
- Metal Cutting Processes

Course Objectives

The course is intended to:

1. Describe the need of automation
2. Describe various pneumatic control elements
3. Describe the parts of PLC
4. Describe the PLC programming
5. Analyze different type of automation systems

UNIT I FUNDAMENTAL CONCEPTS OF AUTOMATION 9

History and developments in industrial automation, vertical integration of industrial automation, fundamental concepts in manufacturing and automation, reasons for automating. Types of production and types of automation, automation strategies, and levels of automation control elements in industrial automation

UNIT II PNEUMATIC SYSTEMS 10

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and integration - sequential circuits - cascade methods - step counter method. Electrical elements to control pneumatic equipments - selection of components - design calculations -application - fault finding – low cost automation - robotic circuits.

UNIT III BASICS OF PROGRAMMABLE LOGIC CONTROLLERS 9

Basics of PLC, advantages, capabilities of PLC, architecture of PLC, scan cycle, types of plc, types of i/o modules, configuring a plc, plc wiring,

UNIT IV PLC PROGRAMMING 10

Types of programming - simple process control programs using relay ladder logic - PLC arithmetic functions - timers and counters –data transfer-comparison and manipulation instructions

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UNIT V CASE STUDIES 7

Case studies of machine automation, process automation, and selection parameters for PLC and real time interfacing

Course Outcomes

At the end of the course the student will be able to:

CO1: Describe the need of automation for industrial applications
CO2: Describe various pneumatic control elements for low cost automation.
CO3: Describe the functional parts of PLC used for automation
CO4: Develop logic programmes for real time applications using PLC
CO5: Analyze different type of systems such as machine and process automation

Text Books

1. Esposito Anthony, "Fluid Power With Applications", Pearson education inc., New York, 2013.
2. Petruzella, Frank D,"Programmable logic controllers", The McGraw-Hill Companies, Inc 2018.

References

1. Devadas Shetty and Richard A.Kolk, "Mechatronics Systems Design", Cengage Learning Inc 2010.

Web references

- https://en.wikipedia.org/wiki/mechatronics
- http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html
- http://nptel.ac.in/courses/112103174/

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