Dr.Mahalingam College of Engineering and Technology

(An Autonomous Institution)

Pollachi – 642003

Curriculum and Syllabus

B.E. AUTOMOBILE ENGINEERING

SEMESTER I to VIII

REGULATIONS 2016

DR MAHALINGAM MCET

COLLEGE OF ENGINEERING AND TECHNOLOGY

Enlightening Technical Minds

DEPARTMENT OF AUTOMOBILE ENGINEERING

2016 REGULATION (CBCS)

Curriculum for B.E Automobile 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
16GET11	INTRODUCTION TO ENGINEERING	2	0	2	3	100
PRACTICAL						
16EGL11	ENGINEERING GRAPHICS	2	0	4	4	100
16PCL11	PHYSICS AND CHEMISTRY LABORATORY	0	0	4	2	100
PROFESSIONAL SKILL COURSE						
16PSL11	PROMOTION OF STUDENTS' WELLNESS	0	0	2	1	100
TOTAL		**15**	**2**	**14**	**23**	**800**

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
16PHT21	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 SKILL COURSE						
16PSL21	SPORTS FOR WELLNESS	0	0	2	1	100
TOTAL		**15**	**2**	**16**	**24**	**800**

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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
16MET31	ENGINEERING METALLURGY	2	0	2	3	100
16MET34	METAL CUTTING PROCESSES	3	0	0	3	100
16CST34	C PROGRAMMING	2	0	2	3	100
PRACTICAL						
16AUL31	FLUID MECHANICS AND MACHINERY LABORATORY	0	0	4	2	100
16MEL32	METAL CUTTING PROCESSES LABORATORY	0	0	4	2	100
PROFESSIONAL SKILL COURSE						
16PSL31	PERSONAL EFFECTIVENESS	0	0	2	1	100
ONE CREDIT COURSE						
XXXX	ONE CREDIT COURSE	0	0	2	1	100
TOTAL		**14**	**6**	**16**	**25**	**1000**

SEMESTER IV

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MET44	METAL FORMING, JOINING AND CASTING PROCESSES	3	0	0	3	100
16MET41	STRENGTH OF MATERIALS	3	0	2	4	100
16AUT41	IC ENGINES	3	0	0	3	100
16AUT42	KINEMATICS OF MACHINES	4	0	0	4	100
16AUT43	AUTOMOTIVE FUELS AND LUBRICANTS	2	0	2	3	100
16AUT44	AUTOMOTIVE ELECTRICALS	3	0	0	3	100
PRACTICAL						
16MEL42	METAL FORMING, JOINING AND CASTING PROCESSES LABORATORY	0	0	4	2	100
16AUL41	ENGINE PERFORMANCE AND EMISSION TESTING LABORATORY	0	0	4	2	100
PROFESSIONAL SKILL COURSE						
16PSL41	ETHICAL AND MORAL RESPONSIBILITY	0	0	2	1	100
ONE CREDIT COURSE						
XXXX	One Credit Course	0	0	2	1	100
TOTAL		**18**	**0**	**16**	**26**	**1000**

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SEMESTER V

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16AUT51	AUTOMOTIVE CHASSIS	2	0	2	3	100
16MET51	DESIGN OF MACHINE ELEMENTS	4	0	0	4	100
16AUT52	AUTOMOTIVE ELECTRONICS	3	0	0	3	100
16AUT53	AUTOMOTIVE TRANSMISSION	3	0	0	3	100
16AUT54	MECHANICS OF ROAD VEHICLES	3	0	2	4	100
XXXX	ELECTIVE- I	3	0	0	3	100
PRACTICAL						
16MEL52	COMPUTER AIDED MACHINE DRAWING LABORATORY	0	0	4	2	100
16AUL51	AUTOMOTIVE ELECTRICAL AND ELECTRONICSLABORATORY	0	0	4	2	100
PROFESSIONAL SKILL COURSE						
16PSL51	TEAMNESS AND INTERPERSONAL SKILLS	0	0	2	1	100
ONE CREDIT COURSE						
XXXX	ONE CREDIT COURSE	0	0	2	1	100
	TOTAL	**18**	**0**	**16**	**26**	**1000**

SEMESTER VI

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16MET61	FINITE ELEMENT ANALYSIS	4	0	0	4	100
16AUT61	DESIGN OF IC ENGINE COMPONENTS	2	2	0	3	100
16AUT62	VEHICLE DYNAMICS	2	2	0	3	100
16AUT63	AUTOMOTIVE EMBEDDED SYSTEM	3	0	0	3	100
16CET65	ENVIRONMENTAL STUDIES	3	0	0	3	100
XXXX	ELECTIVE – II*	2	2	0	3	100
PRACTICAL						
16MEL61	SIMULATION AND ANALYSIS LABORATORY	0	0	4	2	100
16AUL61	AUTOMOTIVE EMBEDDED SYSTEMS LABORATORY	0	0	4	2	100
PROFESSIONAL SKILL COURSE						
16PSL61	CAMPUS TO CORPORATE	0	0	2	1	100
ONE CREDIT COURSE						
XXXX	ONE CREDIT COURSE	0	0	2	1	100
	TOTAL	**16**	**6**	**12**	**25**	**1000**

* 16MAE01- NUMERICAL METHODS

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SEMESTER VII

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
16AUT71	DESIGN OF AUTOMOTIVE CHASSIS COMPONENTS	2	2	0	3	100
16AUT72	AUTOMOTIVE POLLUTION CONTROL	3	0	0	3	100
XXXX	ELECTIVE – III	3	0	0	3	100
XXXX	ELECTIVE – IV (OPEN ELECTIVE)	3	0	0	3	100
PRACTICAL						
16AUL71	VEHICLE MAINTENANCE LABORATORY	0	0	4	2	100
16AUL72	MODELLING AND ANALYSIS OF AUTOMOTIVE SUBSYSTEMS LABORATORY	0	0	4	2	100
16AUL73	INNOVATIVE AND CREATIVE PROJECT	0	0	8	4	100
	TOTAL	**11**	**2**	**16**	**20**	**700**

SEMESTER VIII

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
THEORY						
XXXX	ELECTIVE – V	3	0	0	3	100
XXXX	ELECTIVE – VI	3	0	0	3	100
XXXX	ELECTIVE – VII	3	0	0	3	100
PRACTICAL						
16AUL81	PROJECT	0	0	20	10	200
	TOTAL	**9**	**0**	**20**	**19**	**500**

SUMMARY

Core Curriculum Credits	178
Professional Skills Credits	6
One credit courses credits	4
Total No. of Credits	**188**
Core Curriculum Courses	57
Professional Skills Courses	6
One Credit Courses	4
Total No. of Courses	**67**

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B.E. Automobile Engineering - List of Electives
(Applicable for the students admitted from 2016 onwards)

COURSE CODE	COURSE TITLE	HOURS/ WEEK			CREDITS	MARKS
		L	T	P		
DESIGN STREAM						
16AUE01	ADVANCED THEORY OF IC ENGINES	3	0	0	3	100
16AUE02	ELECTRIC, HYBRID AND FUEL CELL VEHICLES	3	0	0	3	100
16AUE03	VEHICLE SAFETY AND COMFORT SYSTEMS	3	0	0	3	100
16AUE04	HYDRAULIC AND PNEUMATIC SYSTEMS	3	0	0	3	100
16AUE08	AUTOMOTIVE AERODYNAMICS	3	0	0	3	100
16AUE09	NOISE, VIBRATION AND HARSHNESS	3	0	0	3	100
16AUE10	SUPERCHARGING AND SCAVENGING	3	0	0	3	100
16AUE11	ADVANCED VEHICLE SYSTEMS	3	0	0	3	100
16AUE12	OFF ROAD VEHICLES	3	0	0	3	100
16AUE13	VEHICLE CONTROL SYSTEMS	3	0	0	3	100
16AUE14	PRODUCT DESIGN AND DEVELOPMENT	3	0	0	3	100
16AUE15	FAILURE ANALYSIS AND DESIGN	3	0	0	3	100
16AUE18	PRODUCT INNOVATION THROUGH TRIZ	3	0	0	3	100
16AUE19	OPTIMIZATION TECHNIQUES	3	0	0	3	100
16AUE20	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3	100
16MAE01	NUMERICAL METHODS	2	2	0	3	100
16MEE01	DESIGN FOR MANUFACTURE, ASSEMBLYAND 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
16MEE09	DESIGN FOR WELDING	3	0	0	3	100
16MEE11	DESIGN FOR SHEET METAL	3	0	0	3	100
MANUFACTURING STREAM						
16AUE21	RAPID PROTOTYPING AND TOOLING	3	0	0	3	100
16AUE22	PLANT LAYOUT AND MATERIAL HANDLING	3	0	0	3	100
16AUE23	MICRO MANUFACTURING	3	0	0	3	100
16AUE24	PRODUCTION PLANNING AND CONTROL	3	0	0	3	100
16MEE18	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	100
16MEE19	UNCONVENTIONAL MACHINING PROCESSES	3	0	0	3	100

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16MEE21	NON-DESTRUCTIVE TESTING METHODS	3	0	0	3	100
16MEE27	LEAN MANUFACTURING	3	0	0	3	100
16MEE28	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	100
16MEE29	INDUSTRIAL ROBOTICS AND AUTOMATION	3	0	0	3	100
16MEE31	SYSTEMS APPROACH FOR ENGINEERS	3	0	0	3	100
16MEE33	LOGISTICS ENGINEERING	3	0	0	3	100
16MEE34	MANUFACTURING SYSTEMS ENGINEERING	3	0	0	3	100
THERMAL, QUALITY AND MAINTENANCE STREAM						
16AUE05	ALTERNATIVE FUELS FOR IC ENGINES	3	0	0	3	100
16AUE06	RELIABILITY AND MAINTENANCE ENGINEERING	3	0	0	3	100
16AUE07	VEHICLE BODY ENGINEERING	3	0	0	3	100
16AUE15	AUTOMOTIVE INSTRUMENTATION AND CONTROL	3	0	0	3	100
16AUE16	VEHICLE MAINTENANCE	3	0	0	3	100
16AUE17	TRANSPORT MANAGEMENT	3	0	0	3	100
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
16MEE44	QUALITY ENGINEERING	3	0	0	3	100
16MEE49	ENGINEERING ECONOMICS AND COST ANALYSIS	3	0	0	3	100
OPEN ELECTIVES						
16OE01	AUTOMOTIVE INFOTRONICS	3	0	0	3	100
16OE02	AUTOMOTIVE SENSORS	3	0	0	3	100
16OE03	ELECTRONICS IN AUTOMOBILES	3	0	0	3	100
16OE04	MANUFACTURING OF AUTOMOTIVE ELECTRICAL AND ELECTRONICS PARTS	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**	2: 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

Course Content **Hours**

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, Production and Mechatronics)	
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

Course Content **Hours**

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.

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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.

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, Production and Mechatronics)	
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.

Course Content **Hours**

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

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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, Production and Mechatronics)	
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 an engineering application
5. Describe the efficiency of fuels in different state
6. Identify appropriate lubricant for engineering applications

Course Content **Hours**

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 of plastics, Moulding techniques - blow and extrusion. Commodity

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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 : 16GET11	Course Title : INTRODUCTION TO ENGINEERING (Common to Automobile, Production and Mechatronics)	
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 outcome based curriculum, structure of the courses, learning and assessment methodologies
2. Explain how the products that are used in day-to-day life
3. Explain the different scientific principles
4. Explain the different engineering disciplines
5. Observe every product with an engineering perspective
6. Explain the lab facilities and learning resources available in the institution

Course Content **Hours**

UNIT I ENGINEERING EDUCATION **12**

Expectations and Aspirations of engineering students, Graduate Engineering Attributes, Outcome based Engineering Curriculum, Engineering Skills – Technical and Professional. Courses, course map, Concepts and Theories of Learning – Higher Order Thinking Skills, Multiple Intelligences, learning styles inventory, teaching/learning process and methodologies (Theorys, tutorials, activities, lab/workshop exercises, factory visits, internships, projects, alignment to co-curricular activities and hobby projects) Rubrics, Assessment.

UNIT II SCIENCE AND ENGINEERING IN PRODUCTS **12**

Products used in day-to-day life, functions, science and engineering principles applied in the products disciplines, Working of the product, individual parts of the product, Scientific / Engineering principle. + Demonstration with Refrigerator, Wet Grinder, Pump, Windmill, Washing machine, Water purifier Motorbike, Microwave oven. Activity to explore working of products used in day to day life.

UNIT III MULTI-DISCIPLINARY ENGINEERING **12**

Mechanical Engineering: Introduction to manufacturing methods, materials, relative motion between parts (Linear and Circular) Fastening methods

Electrical and Electronics Engineering: Electricity system used for domestic and industrial purpose (AC vs DC, AC signal, Single-phase, Three-phase, prime movers (motors) in products used in day to day life, DC, Electrical components: resistor, capacitor, and inductor, Electronic components: diode, transistor, SCR, DIAC and TRIAC. IC and PCB.

Computer science Engineering: Processor board, Computer peripherals, Operating system.

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UNIT IV PRODUCT APPRECIATION 12

Essential needs in day-to-day life, Connections between the needs and the products, Product appreciation with engineering perspective

UNIT V LEARNING RESOURCE MANAGEMENT 12

Awareness and effective use of resources for learning: - library resources, professional societies, centers of excellences, and value-added divisions. Code of conduct for resource utilization.

Note: CO6 will be assessed only in formative assessment mode.

Course Outcomes

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

CO1: Explain the outcome based curriculum, structure of the courses, learning and assessment methodologies
CO2: Explain how the products that are used in day-to-day life of students and family work/function
CO3: Explain the different scientific principles used in this product
CO4: Explain the different engineering disciplines used in this product
CO5: Observe every product with an engineering perspective
CO6: Explain the lab facilities and learning resources available in the institution and how they can utilize them effectively

References

1. Louis A. Bloomfield, "How things work - Physics of everyday life", Wiley publication 2013
2. C. David, "How it works: Printing and Processes", Ladybird book's publication
3. S. Peter, "How it works: Rockets and Space craft", Ladybird book's publication
4. Granada, " How things work", Granada, 1978
5. J. L. Adams, "Flying Buttresses, Entropy, and O-Rings: The World of an Engineer".
6. J. E. Gordon, "The New Science of Strong Materials or Why You Don't Fall through the Floor".
7. R.P. Feynman," Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher", 2011

Web References

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

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Course Code : 16EGL11	**Course Title :** ENGINEERING GRAPHICS (Common to Automobile, Mechanical, Production and Mechatronics)	
Core / Elective: Core	**L: T : P: C**	2 : 0 :4 : 4
Type : Practical	Total Contact hours:	**60 Hours**

Course Objectives

The course is intended to:

1. Sketch different engineering curves
2. Prepare orthographic and isometric drawings
3. Prepare development of lateral surfaces.
4. Prepare perspective drawings

Course Content **Hours**

UNIT I CURVES USED IN ENGINEERING PRACTICES **12**

Importance of graphics in engineering applications –BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning- Methods of Dimensioning. Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method –Construction of cycloid and involutes of square and circle – Drawing of tangents and normal to the above curves. Mathematical representation of these curves and their applications

UNIT II ORTHOGRAPHIC AND ISOMETRIC PROJECTION **12**

Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout of views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects. Orthographic projection of solids – Practices on three view projection of solids. Isometric Projection of solids – practices on simple solids

UNIT III PROJECTION OF LINES AND PLANE SURFACES **12**

Projection of straight lines located in the first quadrant and inclined to both the planes – Concept of true lengths and true inclinations – Projection of polygonal surface and circular lamina inclined to both reference planes. Detailed factual information - gather gist – cloze test

UNIT IV PROJECTION OF SOLIDS AND ITS SECTION **12**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane. Need for sectioning of solids – Sectioning of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by cutting planes inclined to one reference plane and perpendicular to the other – Orthographic views of sections of simple solids.

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UNIT V DEVELOPMENT OF SURFACES AND PERSPECTIVE PROJECTIONS 12

Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones. Concepts of Perspective projection of prisms, pyramids and cylinders by visual ray method.

Course Outcomes

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

CO1: Sketch different engineering curves and explain its application.
CO2: Prepare orthographic and isometric drawings of simple solids
CO3: Prepare development of lateral surfaces of simple objects.
CO4: Prepare perspective drawings of regular solids

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).
3. John.K.C and Verghese.P.I "Machine Drawing", Jovast Publishers, Trissur, 2007.

Publications of Bureau of Indian Standards

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

Web References

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

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Course Code : 16PCL11	**Course Title :** PHYSICS AND CHEMISTRY LABORATORY (Common to Automobile, Mechanical, Production and Mechatronics)	
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.

Course Outcomes

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

1. 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.

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Course Code : 16PSL11	**Course Title :** PROMOTION OF STUDENTS WELLNESS (Common to Automobile, Mechanical, Production, Mechatronics, Civil and 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

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

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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 undergone the course(s):

- 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.

Course Content **Hours**

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, Production and Mechatronics)	
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 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 **Hours**

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 : 16PHT21	**Course Title :** MATERIAL SCIENCE (Common to Automobile, Mechanical, Production and Mechatronics)	
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):

- Applied Physics

Course Objectives

The course is intended to:

1. Calculate crystal parameters and analyze different crystal structures.
2. Explain the mechanical, thermal and magnetic properties of bulk materials.
3. Demonstrate the Mechanical and Thermal behaviors of bulk materials.
4. Choose a suitable material for specific application.

Course Content **Hours**

UNIT I CRYSTAL STRUCTURE OF MATERIAL PROPERTIES 9

Introduction: Crystalline and Non crystalline Materials: Single crystals, polycrystalline materials, Anisotropy Crystal Parameters: Atomic radius, Number of atoms per unit cell, Co-ordination number, Atomic Packing factor for SC, BCC, FCC and HCP – Crystal Planes: Miller indices, Bragg's law, Debye Scherrer method, Interplanar distance –Polymorphism and allotropy. 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 material, Ductility, malleability and brittleness, Stress and strain behavior, Hooke's law, Yield strength, Impact strength, Tensile strength, Resilience, Hardness, Rockwell hardness, Brinell hardness, Vicker's hardness, Micro indentation hardness. Failure of Metals: Fracture behavior, Ductile and Brittle fracture, Toughness, Fatigue- Fatigue fracture-Fatigue test, Endurance limit, SN curve. Creep-Creep fracture- Stages of creep, Creep testing.

UNIT III THERMAL & MAGNETIC PROPERTIES OF MATERIALS 9

Thermal Properties of materials: Introduction to concept of Heat - Thermal Expansion, Thermal conductivity, Thermal diffusivity, Thermal stress, Thermal shock resistance, Thermal stability and Heat resistance - Magnetic Properties of materials: Basic concepts, Diamagnetism, Para magnetism, Ferromagnetism, Domains and hysteresis, Soft and Hard magnetic materials, applications: motors, generators, and transformers. Antiferromagnetism, Ferrimagnetism, Influence of temperature on magnetic behavior.

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UNIT IV CERAMIC MATERIALS 9

Modern ceramic materials, Cermet as Cutting tools, Glass ceramics and Fibres - 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).

UNIT V COMPOSITES 9

Introduction, properties, functions of matrix and reinforcement in composites – Law of mixtures. Classification of composites: Particle-reinforced, Fiber-reinforced and Structural compositesTypes of composite materials: Polymer-matrix composites, Metal-matrix composites, Ceramic-matrix composites, Carbon-carbon composites and Hybrid composite – Aerospace, machinery and sports applications.

Materials Science Lab

Any Four Experiments: **15 hrs.**

1. Determination of Coercivity, Retentivity, Saturated magnetism and Permeability from Hysteresis loop
2. Determination of Conductivity and Resistivity of samples using Four Probe method
3. Measurement of Melting point of wax with Thermocouple
4. Measurement of mechanical properties of materials using Hardness, Impact and I guard test
5. Determination of Stress strain behavior using Universal Testing Machine.
6. Determination of lattice constants – Debye Scherrer photograph.

Course Outcomes

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

CO1: Calculate crystal parameters and analyze different crystal structures
CO2: Explain the mechanical, thermal and magnetic properties of bulk materials
CO3: Demonstrate the Mechanical and Thermal behaviors of bulk materials
CO4: Choose a suitable material for specific application

Text Books

1. William D. Callister Jr, "Materials Science and Engineering – An Introduction", John Wiley and Sons Inc., Sixth Edition, New York, 2007.
2. Khanna. O.P "A Text book of Materials Science and Metallurgy", Khanna Publishers, 2003.

References

1. Raghavan.V "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd., 2007.
2. Vijaya. M.S. and G. Rangarajan, "Material Science", Tata McGraw-Hill, 2007.
3. P.K. Palanisamy, "Material Science for Mechanical Engineers", Scitech Publication (India) Pvt Ltd, 2005.

Web References

- www.nptel.ac.in
- www.ocw.mit.edu

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Course Code : 16GET21	**Course Title :** ENGINEERING MECHANICS (Common to Automobile, Mechanical, Production and 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 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

Course Content **Hours**

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

Text Books

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

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Course Code : 16GET22	**Course Title :** ENGINEERING METROLOGY AND MEASUREMENTS (Common to Automobile, Mechanical, Production and Mechatronics)	
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

Course Content **Hours**

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 valley, 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

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.

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.

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, Production and Mechatronics)	
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.

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Course Code : 16CDL21	**Course Title :** COMPUTER AIDED DRAFTING AND MODELING LABORATORY (Common to Automobile, Mechanical, Production and Mechatronics)	
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

Course Content **Hours**

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 models and 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

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Course Code : 16PSL21	**Course Title :** SPORTS FOR WELLNESS (Common to Automobile, Mechanical, Production, Mechatronics, Civil and 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.

Course Content

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, Mechanical, Production, Mechatronics and Civil)	
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 course(s):

- Engineering Mathematics- I
- Engineering Mathematics- II

Course Objectives

The course is intended to:

1. Determine the solution of first and second order partial differential equations.
2. Compute the Fourier series expansion for given periodic function.
3. Compute the solution of one dimensional wave equation.
4. Compute the solution of one dimensional and two dimensional heat flow equation.
5. Calculate the Fourier transformation for a periodic function.

Course Content **Hours**

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 15

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 15

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 15

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

UNIT IV SOLUTION OF ONE AND TWO DIMENSIONAL HEAT FLOW EQUATION 15

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

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UNIT V FOURIER TRANSFORMS 15

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

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

CO4: Compute the solution of one dimensional and two dimensional heat flow equation using Fourier series method.

CO5: Calculate the Fourier transformation for a periodic 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.

Reference Books:

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:

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

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Course Code : 16AUT31	Course Title: ENGINEERING THERMODYNAMICS (Common to Automobile, Mechanical and 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):

- Applied Physics
- Applied Chemistry

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

Course Content **Hours**

UNIT I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 12

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 12

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

UNIT III PROPERTIES OF PURE SUBSTANCE AND VAPOR POWER CYCLES 12

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 12

Properties of Ideal and real gases - Gas laws, Ideal and real gas properties, Equations of state - Vander 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 12

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.

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" 3rd Edition ,Tata McGraw Hill, New Delhi, 2015.

Reference Books:

1. Holman.J.P, "Thermodynamics", 3rd Ed. 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:

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

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Course Code : 16AUT32	Course Title : FLUID MECHANICS AND MACHINERY (Common to Automobile, Mechanical and 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. Apply the principles of kinematics and dynamics for fluid flow.
3. Determine flow rates, head loss in viscous and turbulent flow.
4. Evaluate the performance of various types of turbines.
5. Evaluate the performance of various types of Pumps

Course Content **Hours**

UNIT I FLUID PROPERTIES AND STATICS 12

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 12

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 Orificemeter 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 12

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 12

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 12

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 under viscous and turbulent flows.
CO4. Evaluate the performance of impulse and reaction turbines under various loading and head conditions
CO5. Evaluate the performance of rotary and reciprocating pumps under various head conditions

Text Books:

1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi, Ninth Edition, 2017.
2. Yunus Cengel, 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", Dhanpat Rai& Sons, Delhi, 2015.

Web References:

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

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Course Code : 16MET31	Course Title: ENGINEERING METALLURGY (Common to Automobile, Mechanical and 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):

- Material Science

Course Objectives

The course is intended to:

1. Analyze a phase diagram.
2. Select an appropriate heat treatment process
3. Select an appropriate surface treatment process
4. Choose an appropriate alloying element to impart a desired property for ferrous alloys
5. Choose an appropriate alloying element to impart a desired property for non-ferrous alloys

Course Content **Hours**

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 6

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 (Austenite, Ferrite, Cementite, Pearlite, Martensite, Bainite), Pearlite transformation.

UNIT II HEAT TREATMENT 6

Heat treatment process-purpose heat treatment. Types of heat treatment: Full Annealing, Process annealing, Stress relief annealing, Speroidising, Isothermal annealing, Normalizing , Hardening, Tempering of steel-Low tempering, medium tempering, high tempering. Austempering and Martempering. Quenching and quenching media. Isothermal transformation Diagram (TTT Diagram). Cooling curves superimposed on TTT diagram. CCR. Harden ability- Definition. Method to determine Harden ability- Jominy end quench test. Ideal Critical diameter.

UNIT III SURFACE HEAT TREATEMENT PROCESS 6

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 IV FERROUS ALLOYS 6

Ferrous metals - Definition. Steel - Types (Low carbon, medium carbon and High carbon steels). Effect of alloying elements on properties of steel (Ms, Si, Cr, Mn, Va and W). Properties and applications of Stainless Steel and Tool steel. HSLA steels- Maraging steels. TRIP steels. Cast Iron-Types - White, Malleable, Grey and Spheroidal – Microstructure, properties and applications.

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UNIT V NON-FERROUS ALLOYS 6

Non-ferrous metals – Types – Aluminium and its alloys -Designation system, Copper and its alloys, Nickel and its alloys Magnesium and its alloys, Titanium and its alloy – Composition, Properties, Applications

List of Experiments: **30 Hrs.**

1. Prepare a specimen using mounting press for metallographic examination.
2. Draw the microstructure of cast iron, copper and aluminium using Metallurgical microscope
3. Compare the hardness number and impact strength for unhardened, hardened and tempered mild steel specimens
4. Determine the hardenability of steel by Jominy End Quench test

Course Outcomes

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

CO1: Analyze the phase diagram of an alloy by Gibbs phase rule and infer its property for a given composition.

CO2: Select an appropriate heat treatment process to impart a desired property for a given ferrous alloy such as steel, cast iron and determine its hardenability

CO3: Select an appropriate surface treatment process for ferrous and non-ferrous alloys to improve its surface hardness.

CO4: Choose an appropriate alloying element to impart a desired property for a given ferrous alloy such as steel and cast iron.

CO5: Choose an appropriate alloying element to impart a desired property for a given nonferrous alloy such as Aluminium , Copper , Nickel, Magnesium and Titanium.

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.

Reference Books:

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:

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

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Course Code : 16MET34	Course Title : METAL CUTTING PROCESSES (Common to Automobile and 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(s):

- Materials science
- Engineering Metrology and Measurements

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.

Course Content **Hours**

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 CYLINDRICAL 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.

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

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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 C, "Manufacturing Technology, Vol 2, Metal Cutting and Machine Tools", 2nd Edition, Tata McGraw Hill, New Delhi, 13th reprint 2012
2. Kalpakjian, "Manufacturing Engineering and Technology", Addison Wesley Publishing company, 3rd edition, 1995.

Reference Books:

1. HMT Bangalore, "Production Technology", McGraw Hill Education Pvt. Ltd., New Delhi, Reprint 2011.
2. Rajput R K, "A Text Book of Manufacturing Technology", Laxmi Publications (P) Ltd., New Delhi, Reprint 2010
3. Sharma P C, "A Text book of Production Engineering", S Chand & Co Ltd., Reprint 2003
4. Jain R K, "Production Technology", Khanna Publishers, New Delhi, 4th edition, 1999
5. Roy A Lindberg, "Processes and Materials of Manufacture", PHI, 4th edition, 8th reprint, 1999

Web References:

1. http://nptel.ac.in/courses/112107144/

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Course Code : 16CST34	**Course Title :** C PROGRAMMING (Common to Automobile, Mechanical and Mechatronics)	
Core / Elective: Core	**L: T : P: C**	2: 0 : 2 : 3
Type : Theory & Practical	Total Contact hours:	**60 Hours**

Course Objectives

The course is intended to:

1. Implement modular programs using functions and files.
2. Apply pointers for effective memory usability.
3. Articulate the necessity of structures and unions.

Course Content **Hours**

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.

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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.Implement modular programs using functions and files for the given scenario.

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

CO5. Implement 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, 2009

Reference Books:

1. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
2. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006
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.

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Course Code : 16AUL31	**Course Title :** FLUID MECHANICS AND MACHINERY LABORATORY (Common to Automobile, Mechanical and Mechatronics)	
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. 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 students 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

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Course Code : 16MEL32	**Course Title :** METAL CUTTING PROCESSES LABORATORY (Common to Automobile and Mechanical)	
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 Metrology and Measurements

Course Objectives

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

Course Outcomes

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

1. Develop process sequence for manufacturing the given machined part using the available machine tools.
2. Use Lathe, Automat, Drilling, Milling, Slotting and grinding machines to manufacture a given machined part.

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

Course Objective

The course is intended to:

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 **Hours**

UNIT I THE IMPORTANCE OF ENVISIONING

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

UNIT II FUNDAMENTAL PRINCIPLES OF GOAL SETTING AND WORKING TO TIME

Clarifying personal values, interests and orientations – Awareness of opportunities ahead – Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, what you see depends on the role you assume

UNIT III GOAL SETTING AND ACTION ORIENTATION

Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment – Importance of action orientation - Converting goals to actionable tasks – Establishing road map – Using Gantt chart for planning and progress

UNIT IV TIME MANAGEMENT - TOOLS AND TECHNIQUES

Pareto 80-20 principle of prioritization – Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying 'NO' – Managing procrastination

UNIT V PUTTING INTO PRACTICE

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

Course Outcomes

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

CO1. Identify the strengths, weaknesses and opportunities
CO2. Set well-articulated goals for academics, career, and personal aspirations
CO3. Establish the road map to realize the goals
CO4. Apply time management techniques to complete planned tasks on time
CO5. Create time and pursue activities of self-interest that add value

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Course hand outs (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.
3. College student's guide to time management (e-book)
4. Michael S Dobson, Susan B Wilson, "Goal setting" (e-book)

Operational modality:

Enablement through learning workshops	Conducted by external experts and trained internal faculty	2 days7 hours each	14 hours
Progress monitoring (face to face interaction with student and checking workbook/Journal	Internal faculty	1 hour per week for a minimum of 10 weeks	10 hours
Mid semester reinforcement-workshop	External expert	1 day	6 hours
Total			30 hours
No: of credits			1

Assessments:

Assessment	Details	Weight -age	Administration	By Whom	When
Knowledge Test*	Multiple choice questions (20)	20%	Pen and paper	Internal team	Immediately after the initial workshop
Final comprehensive Knowledge test*	Multiple choice questions (40)	30%		Internal team	End of semester
Scenario based knowledge test*	Multiple choice scenario responses(15)	30%	Pen and paper	Internal team	Immediately after mid-semester reinforcement
Review of student journal	Student held journal with enough pages for the whole semester	10%	Student journals to be reviewed	Trained Internal faculty	Once in a week.
Review of student journal by external expert		10%	Student journal comprehensive review	External expert and Internal reviewer	End of semester

*Prepared by external expert team.

END OF SEMESTER- III

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SEMESTER-IV

Course Code : 16MET44	**Course Title :** METAL FORMING, JOINING AND CASTING PROCESSES (Common to Automobile and 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. Describe the procedure of forging process
3. Explain operational and procedural steps required in sheet metal process.
4. Choose appropriate welding process.
5. Select appropriate processes for manufacture a part involving casting, welding, forging and sheet metal processes.

Course Content **Hours**

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.

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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. 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: Describe the procedure for manufacturing a forged part.
CO3: Explain operational and procedural steps required in sheet metal process for manufacturing a sheet metal part
CO4: Choose appropriate welding process for the required weld joint
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/

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Course Code : 16MET41	**Course Title :** STRENGTH OF MATERIALS (Common to Automobile, Mechanical and Production)	
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:

- Engineering Mechanics

Course Objectives:

The course is intended to:

1. Calculate the stresses, strains and elastic constants
2. Solve problems on two dimensional stresses
3. Sketch shear force and bending moment diagrams and calculate stresses in beams.
4. Compare deflections of beams and stability of columns.
5. Solve problems on circular shafts and close coil helical springs.

Course Content **Hours**

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.

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

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Laboratory

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: 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: Solve two dimensional stresses such as normal, shear, hoops and longitudinal on the bar element and thin cylindrical pressure vessel.
CO3: Articulate shear force and bending moment diagrams for cantilever simply supported beams and overhanging beams and stresses in beam structures subjected to transverse loading.
CO4: Analyse deflections of cantilever and simply supported beams and stability of short and 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, Third Edition, 2002.
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/

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Course Code : 16AUT41	Course Title : IC ENGINES	
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):

- Applied Physics
- Engineering Thermodynamics
- Fluid Mechanics and Machinery

Course Objectives:
The course is intended to:

1. Calculate the thermodynamic parameters of engine operating cycles
2. Explain the working principle of induction and ignition systems
3. Describe the influences of combustion chamber geometry on combustion
4. Explain the working principle of cooling and exhaust systems
5. Illustrate the recent IC engine techniques such as HCCI, CRDI, GDI, etc.

Course Content **Hours**

UNIT I CONSTRUCTION AND WORKING 9

Heat engine – Types. IC engine – classification – reciprocating engine – terminologies. SI engine and CI engine – construction – working principle. 2s and 4s engine – construction – working principle – port timing diagram – valve timing diagram. Engine operating cycle – air standard cycle – Otto cycle – Diesel cycle – dual cycle – analysis – simple problems.

UNIT II INDUCTION AND IGNITION SYSTEM 9

Carburetion – air- fuel ratio – importance – requirements – simple carburettor – working – petrol injection types. Fuel injection system – functional requirements – inline, rotary and common rail injection systems – working – feed pump – atomizer – injection pump – injector and nozzles. Ignition system – requirements – ignition timing – spark advance mechanism – centrifugal and vacuum advance mechanism – battery coil, magneto, CDI and distributor-less ignition – spark plug.

UNIT III COMBUSTION AND COMBUSTION CHAMBERS 10

Richard's combustion theory – SI engine – combustion stages – knocking. SI Engine combustion chamber – Types. CI Engine – combustion stages – abnormal combustion. CI engine combustion chambers – classification – factors controlling combustion chamber design. Air motion – swirl, squish and turbulence. Introduction to thermodynamic analysis of combustion process.

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UNIT IV COOLING AND EXHAUST SYSTEMS 8

Cooling System: Engine heat transfer – importance of heat transfer – importance of cooling–cooling system classification – air cooling system – liquid cooling system – coolant properties – thermostat – thermosyphon – forced circulation cooling – evaporative cooling.
Supercharger – turbocharger – working – turbocharger matching. Exhaust system – exhaust manifold – exhaust down pipe – resonator – muffler – tailpipe – catalytic converter.

UNIT V RECENT TRENDS 9

HCCI – Lean burn engine – stratified charge engine – four valve and overhead cam engines, VVT – variable geometry turbochargers (VGT) – electronic engine management – CRDI – GDI – DAQ System – combustion and heat release analysis in engines.

Course Outcomes

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

CO1. Calculate the thermodynamic parameters of engine operating cycles for SI and CI engines
CO2. Explain the working principle of induction and ignition systems of IC engines
CO3. Describe the influences of combustion chamber geometry on combustion characteristics
CO4. Explain the working principle of cooling and exhaust systems of IC engines
CO5. Illustrate the recent IC engine techniques such as HCCI, CRDI, GDI, etc.

Text Books

1. Ramalingam K.K., "Internal Combustion Engines", Sci-Tech Publications, 2005.Richard stone, "Introduction to Internal Combustion Engines",4th edition, SAE International and Macmillan Press, 2012.
2. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2007.
3. Mathur P.L and Sharma, "Internal Combustion Engines", Dhanpat Rai and Sons, 2002.

References

1. John B. Heywood, "Internal Combustion Engines Fundamentals", McGraw Hill, New York, 2011.
2. Willard W. Pulkrabek, "Engineering Fundamentals of the Internal Combustion Engine", Pearson Prentice Hall, 2004.
3. Martyr A.J, Plint M.A, "Engine Testing: Theory and Practice", Butterworth-Heinemann publications, 2007.

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Course Code : 16AUT42	Course Title : KINEMATICS OF MACHINES	
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 Mechanics

Course Objectives

The course is intended to:

1. Calculate the degrees of freedom of simple mechanisms.
2. Calculate the kinematic parameters of simple mechanisms.
3. Develop cam profile for different follower motions
4. Calculate the kinematic parameters of gears
5. Calculate the kinematic parameters of gear trains

Course Content **Hours**

UNIT I INTRODUCTION TO MECHANISMS 12

Mechanism, machine and structure, constrained motion and its types, working of simple mechanisms such as Four bar mechanism, single slider crank mechanism and their inversions, Kutzbach criterion, Grubler's criterion, Grashof's law, Degree of freedom of simple mechanisms.

UNIT II VELOCITY AND ACCELERATION IN SIMPLE MECHANISMS 12

Linear and angular velocities, absolute and relative velocities, rubbing velocity, Tangential, radial and Coriolis components of acceleration, Relative velocity method for determination of velocity and acceleration of the links in four bar mechanism and single slider crank mechanism. Expressions for the position, velocity and acceleration of the links in a Slider crank mechanism.

UNIT III DESIGN OF CAM PROFILE 12

Types of cams, types of followers, radial cam, terminology of radial cam, types of follower motions: uniform velocity motion, simple harmonic motion, constant acceleration/deceleration motion, cycloidal motion, cam profile for knife edge, roller and flat faced follower – Graphical method

UNIT IV KINEMATICS OF GEARS 12

Types of gears, spur, Helical, Bevel and worm gear terminologies, law of gearing, Conjugate action and conjugate curves, merits and demerits of involute and cycloidal profiles, length of path of contact, length of arc of contact, contact ratio, interference and undercutting, Minimum number of teeth on the pinion to avoid Interference

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UNIT V KINEMATICS OF GEAR TRAINS 12

Classification of gear trains, calculation of Gear ratio, number of teeth for the gears in the gear trains, velocities of the gears in gear trains such as Simple, Compound, Reverted & Epicyclic (using tabulation method) gear trains, Differential gear train.

Course outcomes

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

CO1. Calculate the degrees of freedom of simple mechanisms
CO2. Calculate the velocity and acceleration of various links of simple mechanisms using graphical method
CO3. Develop the radial cam profile for the given type of follower and motion function
CO4. Calculate the kinematic parameters of spur gears
CO5. Calculate the kinematic parameters of gear trains such as simple, compound and epicyclic gear trains

Text Books

1. Rattan SS, "Theory of machines" – Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2009.
2. Ambekar A.G., "Mechanism and machine Theory", Prentice Hall of India New Delhi, 2007.

References

1. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2009.
3. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd., New Delhi, 1988.

Web References

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

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Course Code : 16AUT43	Course Title : AUTOMOTIVE FUELS AND LUBRICANTS	
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(s):

- Applied Chemistry

Course Objectives

The course is intended to:

1. Describe the petroleum oil refining process and manufacturing process of lubricants.
2. Demonstrate the testing of fuel properties.
3. Demonstrate the testing procedures of lubricants.
4. Illustrate the working principle of engine lubrication system
5. Explain the properties of additives and alternate fuels

Course Content **Hours**

UNIT I INTRODUCTION **9**

Requirements of automotive fuels – manufacturing of fuels and lubricants – crude petroleum – structure – constituents – refining process – thermal cracking, catalytic cracking, polymerisation, alkylation, isomerisation, reforming, blending – products of refining process.

Lubricant – base stocks – classification – grades of base stocks – viscosity – properties of base stock –base oil processes – manufacturing process of lubricants.

UNIT II PROPERTIES AND TESTING OF FUELS **15**

Fuel standard – ASTM testing – octane number – self ignition temperature – cetane number – distillation temperature measurement – viscosity measurement – flash point & fire point measurement – calorific value measurement – aniline point measurement – effects of fuel properties on engine performance.

UNIT III PROPERTIES AND TESTING OF LUBRICANTS **15**

Lubricants – Classification – components of lubricants – functions – selection of lubricating oils –properties – nomenclature and specifications – SAE Rating – synthetic lubricants – grease – properties– NLGI Numbers – ASTM testing – viscosity measurement – flash point & fire point measurement –pour point & cloud point measurement – effects of lubricant properties on engine performance.

UNIT IV LUBRICATION **9**

Engine friction fundamentals – influence of engine variable on friction – hydrodynamic and elasto-hydrodynamic lubrication – boundary lubrication – bearing lubrication – functions of the lubricationsystem – mist lubrication – dry sump lubrication – wet sump lubrication – working. Introduction to automotive tribology – crankshaftbearing lubrication.

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UNIT V ADDITIVES AND ALTERNATIVE FUELS 12

Need of additives – gasoline additives –diesel additives –lubricant additives – properties.
Alternative Fuels – need – classification – alcohols – gaseous fuels – biofuels – properties.

LIST OF EXPERIMENTS:

1. ASTM distillation test of liquid fuels
2. Aniline point test of diesel
3. Calorific value of liquid fuel.
4. Flash and fire points of petrol and diesel.
5. Cloud and pour point Test.
6. Temperature dependence of viscosity of lubricants by Redwood viscometer.
7. Viscosity index of lubricants by Saybolt viscometer
8. Study of ASTM standard test method for dropping point of lubricating grease

Course Outcomes

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

CO1. Describe the petroleum oil refining process and the manufacturing process of lubricants.
CO2. Demonstrate the testing procedures of fuels as per ASTM standard.
CO3. Demonstrate the testing of procedures of lubricants as per ASTM standard.
CO4. Explain the fundamentals of lubrication and the automotive lubrication system.
CO5. Explain the properties of additives and alternative fuels

Text Books

1. V. Ganesan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 2007.
2. P.L.Mathur and Sharma, "Internal Combustion Engines", Dhanpat Rai and Sons, 2010.

References

1. John B. Heywood, "Internal Combustion Engines Fundamentals", McGraw Hill, New York, 2011
2. George E. Totten, "Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing", ASTM International, 2003
3. Surinder Parkash, "Petroleum Fuels Manufacturing Handbook", McGraw-Hill, New York, 2010

WEB REFERENCES

- http://nptel.ac.in/courses/103105110/

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Course Code : 16AUT44	Course Title : AUTOMOTIVE ELECTRICALS	
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):

- Applied Physics

Course Objectives

The course is intended to:

1. Calculate the torque of electrical motors that drive automotive systems
2. Calculate the electrical parameters in a given circuit
3. Explain the characteristics and working of battery charging system
4. Choose the Electrical wires; fuses and lighting systems in an automobile
5. Explain the procedure for fault diagnosis in automotive electrical systems

Course Content **Hours**

UNIT I INTRODUCTION TO ELECTRICAL ENGINEERING 9

DC Generator and motor -working principle-Armature torque- shunt and series motor characteristics -Brushless DC Motor - Brushless DC (BLDC) Driver circuit - BLDC motor characteristics - Different DC motors torque equations - torque Calculations- 3phase and single phase AC motor construction and characteristics -introduction to stepper motor.

UNIT II CIRCUIT ANALYSIS 9

Recap of basic circuit laws- AC/DC circuits- Circuit reduction: Series, parallel and combinational Resistance circuit-Star circuit to Delta circuit- delta circuit to star circuit-voltage and current divider rule-mesh, super mesh, node and super node analysis

UNIT III BATTERY CHARGING SYSTEMS 9

DC generator-Output emf –Characteristics -Alternator -Output emf -Characteristics- Working principle of silicon diode- Automobile regulator Functions-Basic charging system of automobile battery - Three phase bridge rectifier -Nine diode rectifier- Mechanical and IC Voltage Regulators-characteristics

UNIT IV ELECTRICAL DEVICES IN AUTOMOBILE 9

Power window-Starting system-torque to drive power window-torque to drive Engine - Car wiring layout- Cables and wiring basics- -voltage drop in a Cable- Wire selection- Wire rating -current flow through the circuit-fuse rating. Lamp: Tungsten halogen, Gas discharge and -Lamp glow Current – Parabolic, Bifocal, Homifocal reflector construction and function-Vertical and Horizontal deflector construction and function-plano convex, cylindrical lens and Poly-ellipsoid (PES) construction and function -lamp Location-switching types and switch rating.

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UNITV ELECTRICAL SYSTEM MAINTENANCE 9

Testing methods for checking electrical components, faults in the car electrical system, checking battery, starter motor, charging systems, Ignition system, lighting systems, Fault diagnosis and maintenance of modern electrical controls.

Course Outcomes

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

CO1. Calculate the torque of electrical motors that drive automotive systems
CO2. Calculate the electrical parameters in a given circuit
CO3. Explain the characteristics and working of battery charging system in automobile
CO4. Choose electrical wires, fuses and lighting systems for given load rating in an automobile
CO5. Explain the procedure for fault diagnosis in automotive electrical systems

Text Books

1. Kohli,P.L., "Automotive Electrical Equipment", Tata McGraw-Hill Co. Ltd., New Delhi,2014.
2. Tom Denton, "Automobile Electrical and Electronic systems", 3rd Edition, Elsevier publications, 2011.

References

1. Mckenzie Smith I, John Hiley and Keith Brown, "Hughes Electrical and electronics technology", Pearson,10th Edition, 2010.
2. Cathey J J, Nasar S A, "Basic electrical engineering" 2nd Edition, McGraw-Hill.
3. Jegathesan V, Vinoth kumar K and Saravana kumar R "Basic electrical and electronics engineering" Wiley India, 2011.

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Course Code : 16MEL42	**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

The course is intended to:

1. Produce a cast part.
2. Produce a welded part.
3. Produce a forged part.
4. Produce a sheet metal part.

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

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Course Code : 16AUL41	Course Title : ENGINE PERFORMANCE AND EMISSION TESTING LABORATORY	
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. Analyze the engine performance characteristics
2. Analyze the engine emission levels

LIST OF EXPERIMENTS

1. Performance and emission test on single cylinder CI engine with rope brake dynamometer
2. Performance and emission test on single cylinder SI engine
3. Performance and emission test for variable compression ratio engine
4. Performance and emission test on MPFI engine
5. Performance and emission test on CRDI engine
6. Examination of frictional and indicated power in MPFI engine using Morse test method
7. Heat balance analysis on single cylinder engine
8. Performance and emission test on turbocharged diesel engine
9. Comparison of performance among electronic fuel injection engines such as CRDI and MPFI, turbocharged engines and conventional engine
10. Compare of emission measurements from EFI and conventional type engines with BS IV emission standards

Course Outcomes

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

CO1. Analyze the performance characteristics of internal combustion engines
CO2. Analyze the emission levels of internal combustion engines

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Course Code : 16PSL41	**Course Title :** ETHICAL AND MORAL RESPONSIBILITY (Common to all B.E/B.Tech Programs)	
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. Articulate the importance of ethical and moral responsibilities.
2. Explain the fundamental aspects of ethical practices.
3. Validate one's appropriate and inappropriate behaviors in various roles.
4. Elaborate code of conduct of professional bodies.
5. Explain the importance of professional practices as a future employee / entrepreneur.

Course Content **Hours**

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.

*- Includes review sessions

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Course Outcomes

At the end of the course students 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.

Assessments:

Assessment	Details	Wt:	Administration	When
Class room participation	Group assignments presentation; Case discussions participation	70%	Continuous assessment in class	During class
Knowledge test	Multiple choice questions	10%	Pen and Paper	End of course
Scenario based assessments	Multiple choice questions	20%	Pen and Paper	End of course

No. of hours& credits:

Enablement through class room lecture, case discussions and group presentations	Conducted by trained internal faculty	30 hours – 1 credit
At least two guest lectures	Delivered by senior people from Industries/Government organizations	

COURSE HANDOUTS (compiled by Professional Skills team, MCET)

1. Instructor's Manual (for the faculty)
2. Learner's workbook (for the student)

REFERENCES

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

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END OF SEMESTER IV

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SEMESTER V

Course Code:16AUT51	Course Title : AUTOMOTIVE CHASSIS	
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(s):

- Engineering Mechanics

Course Objectives

The course is intended to:

1. Identify the different components used in the vehicles
2. Plot a steering system layout.
3. Select the type of axle, wheels and tyres required for the various vehicles
4. Compare the different types of suspension systems used in vehicles
5. Compare the construction and working principles of various braking system

Course Content **Hours**

UNIT I FRAMES **6**

Classification of vehicles, Types of chassis layout with reference to power plant locations. Vehicle frames, loads on frames, types of frames – Conventional, Integral frame, tubular frame - constructional details, defects in chassis frames.

UNIT II STEERING SYSTEM **6**

Steering system- purpose, requirements, working mechanism and steering parts, front wheel geometry: castor, camber, king pin inclination, toe-in. conditions for true rolling motion of wheels during steering, steering geometry, Ackermann and Davis steering system, constructional details of steering linkages, Construction and working of different types of steering gear boxes, steering linkages and layouts, turning radius, wheel wobble, power assisted steering-principle and types.

UNIT III AXLES, WHEELS AND TYRES **6**

Front axle – types, construction and working details. Drive Axles – construction. Types of loads acting on drive axles, Full – Floating, Three – Quarter Floating and Semi – Floating Axles, stub axle – types and constructional details, Axle Housings and Types, Types and Constructional Details of Different Types of Wheels and Rims, Tyre nomenclature, Different Types of tyres and their constructional details

UNIT IV SUSPENSION SYSTEM **6**

Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs, independent suspension, pneumatic suspension, MR fluids, semi and fully active suspension system, shock absorbers – types and constructional details.

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UNIT V BRAKING SYSTEM 6

Theory of braking – Purpose, requirements, stopping distance, braking torque, stopping time and braking efficiency, Effect of weight transfer during braking, classification of brakes, drum brakes and disc brakes, constructional details, concept of dual brake system, parking brake, mechanical braking system, hydraulic system, vacuum assisted system, air brake system, regenerative braking system, antilock braking, EBD, ESC

Course Outcomes

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

CO1. Identify the different chassis and Transmission components used in the on road and off road vehicles
CO2. Plot a steering system layout for dependent suspension and independent suspension based on the conditions for true rolling.
CO3. Select the type of front axle and rear axle, wheels and tires required for the various on road and off road vehicles
CO4. Compare the Passive suspension and active suspension systems based on the vehicle stability and comfort for on road vehicles.
CO5. Compare the construction and working principles of disc brake and drum brake based on the efficiency and stopping distance.

LABORATORY EXPERIMENTS: (30 Hours)

1. Measurement and study of the Light duty vehicle chassis frame
   a. Wheel Base
   b. Wheel Track
   c. Total Length of the vehicle
   d. Width of the Vehicle
   e. Distance between suspension
2. Dismantle, Study and assembly of Rear Axle.
3. Dismantle, Study and assembly of steering gear boxes (Rack and Pinion, Worm and Sector)
4. Dismantle, Study and assembly of suspension System
5. Dismantle, Study and assembly of braking system

TEXT BOOKS

1. Heinz heizler, "Advanced Vehicle Technology" – ButterworthHeinemann.2002
2. Newton, Steeds and Garrot- "Motor Vehicles"- Butterworths, London- 2000

REFERENCES

1. Heldt.P.M.- "Automotive Chassis"- Chilton Co., New York- 1990
2. Judge A.W- "Mechanism of the Car"- Chapman and Halls Ltd., London- 1986
3. Giles.J.G- "Steering, Suspension and Tyres"- Iiiffe Book Co., London- 1988.

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Course Code:16MET51	Course Title : DESIGN OF MACHINE ELEMENTS (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):

- Kinematics of Machines
- 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.

Course Content **Hours**

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.

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

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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 BEARINGS **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.

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

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Course Code :16AUT52	Course Title: AUTOMOTIVE ELECTRONICS	
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):

- Automotive Electricals

Course Objectives

The course is intended to:

1. Explain the basic Electronic devices used in Automobile
2. Construct digital circuit using logic gates
3. Select appropriate sensors for automobile systems
4. Select appropriate actuator for automobile systems
5. Choose the Electrical wires, fuses and lighting systems.

Course Content **Hours**

UNIT I ELECTRONIC DEVICES **9**

BJT, FET, DIAC, TRIAC and IGPT Construction and characteristics, Driver circuits, Electronic Devices Automobile Applications

UNIT II INTRODUCTION TO DIGITAL ELECTRONICS **9**

Logic gates: AND, OR, NOT, NAND, NOR, Convert circuit using NAND and NOR, Half Adder and Full Adder-Decoder-Encoder-MUX-Demuxflip-flops-4bit counter

UNIT III SENSORS **9**

HALL Inductive, Resistance temperature detector (RTDS): Negative Temperature coefficient (NTC), Positive Temperature co efficient (PTC) sensors, Seebeck and Peltier effect Applications, Manifold Absolute pressure sensor, Knock sensor, Mass air flow sensor, oxygen sensor

UNIT IV ACTUATORS **9**

Solenoid working principle, latching relay, bipolar and unipolar latching relay, linear unipolar relay, linear bipolar relay, piezoelectric injector, solenoid injector. introduction to Magneto Rheological fluids

UNIT V WIRING HARNESS AND INDICATORS **9**

Introduction to wiring harness, EMC, odometer, Speedometer, Fuel level indicator, Engine speed indicator, Coolant temperature indicator, Tire pressure indicator, Turn signal indicator, electrical Horn.

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Course Outcomes

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

CO1. Explain the construction and characteristics basic Electronic devices used in Automobile

CO2. Construct digital circuit using logic gates for the given logical operation

CO3. Select appropriate sensors to acquire the required parameter from automobile systems

CO4. Select appropriate actuator to control required function in the automobile systems

CO5. Choose the Electrical wires, fuses and lighting systems for given load rating in an automotive vehicle

Text Books

1. Tom Denton, "Automobile electrical and electronic systems", Fifth edition, Routledge, 2017.
2. Boylestad RL, Nashelsky L. "Electronic Devices and Circuit theory", Prentice Hall, 2012.

References

1. Salivahanan S. "Electronic devices and circuits", Tata McGraw-Hill Education, 2011.
2. Robert Bosch GmbH., Reif K, Dietsche KH, "Automotive handbook", Robert Bosch GmbH; 2014.

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Course Code:16AUT53	Course Title : AUTOMOTIVE TRANSMISSION	
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):

- Engineering Mechanics

Course Objectives

The course is intended to:

1. Compare the construction and working principle of friction clutches
2. Classify the types of gearboxes used in vehicles
3. Illustrate the drive line components used in vehicles
4. Compare the Hydrodynamic transmission system and Continuously Variable Transmission
5. Explain the working of Hydro static and Electric Transmission systems

Course Content **Hours**

UNIT I CLUTCH **9**

Role of Clutch-positive and gradually engaged types - types of clutches- single plate clutch- coil spring type and diaphragm spring type -multiple plate clutch-centrifugal clutch. Clutch operating mechanisms- Hydraulic - vacuum - Electromagnetic clutch.

UNIT II GEAR BOX **9**

Need and Objectives of Gear box - performance characteristics in different speeds, construction and operation of sliding mesh, constant mesh and synchromesh gearboxes. transfer case, overdrives. principle of planetary gear trains, simple Epicyclic gear box – Wilson Epicyclic gearbox

UNIT III DRIVE LINE **9**

Propeller shaft, Slip Joint, universal joints- trunnion type, ring type, flexible disc type. Effect of driving thrust and torque reactions - Hotchkiss drive, torque tube drive and radius rods.

Final Drive and Differential: Need of Final Drive- types of final drive- Single reduction and double reduction final drives. Need of Differential- Types of Differential, Differential Lock, Limited slip differential and Interaxle differential.

UNIT IV AUTOMATIC TRANSMISSION **9**

Automatic Transmission – Merits and demerits. Fluid coupling – principles - Performance characteristics – advantages – limitations. Torque converter - principles - Performance characteristics – advantages – limitations. Continuously Variable Transmission (CVT) – Types – Operations of a typical CVT

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UNIT V HYDROSTATIC AND ELECTRIC DRIVE 9

Hydrostatic drive -Various types of hydrostatic systems – Principles of Hydrostatic drive system, Advantages and limitations. Construction and working of typical Janny hydrostatic drive.

Electric drive-types- Principle of modified Ward Leonard Control system-Advantages & limitations.

Course Outcomes

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

CO1. Compare the construction and working principle of various types of friction clutches used in vehicles.
CO2. Classify the types of gearboxes used in manual and automatic gear boxes used in vehicles
CO3. Illustrate the construction and working principle of drive line components used in ON road vehicles and OFF road vehicles.
CO4. Compare the construction and working principle of Hydrodynamic transmission system and Continuously Variable Transmission used in vehicles
CO5. Explain the construction and working principle of Hydro static and Electric Transmission systems in vehicles.

Text Books

1. Heinz Heisler, "Advanced Vehicle Technology". Butterworth Heinemann Publishers,2002.
2. N K Giri " Automobile Mechanics" Khanna Publications,2015

References

1. Crouse W H, "Automotive Transmissions and Power Trains", McGraw Hill Book Co., 5th edition, 1976
2. Fenton J, "Hand book of Automotive Power Trains and Chassis Design",Progressive publisher, 1998
3. Garrett T K, Newton K. and Steeds W. "Motor Vehicle", Butter Worths & Co.Publishers Ltd., New Delhi, 2001.

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Course Code: 16AUT54	Course Title : MECHANICS OF ROAD VEHICLES	
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):

- Engineering Mechanics
- Kinematics of Machines
- IC Engines

Course Objectives

The course is intended to:

1. Determine the static and dynamic forces
2. Calculate the balancing forces of various masses
3. Analyze the effects of gyroscopic and fuel governing mechanisms
4. Calculate the tractive characteristics of vehicle
5. Analyze the stability characteristics of vehicle

Course Content **Hours**

UNIT I FORCE ANALYSIS **9**

Applied and Constraint Forces - Free body diagrams - Static Equilibrium conditions - two, three and four force members - Static force analysis in simple mechanisms – Dynamic force analysis – Inertia force and Inertia torque – D'Alemberts principle Dynamic Analysis in Reciprocating Engines Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque - Turning moment diagrams – Fly wheels - Engine shaking Forces

UNIT II BALANCING **9**

Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine Balancing Multi-cylinder Engines Balancing of reciprocating parts Concepts of direct and reverse crank mechanism

UNIT III GYROSCOPIC AND GOVERNING MECHANISM **9**

Gyroscopic principle - gyroscopic couple Effect of gyroscopic couple and centrifugal couple on four wheeled vehicle - Gyroscopic forces and Torques – Gyroscopic stabilization - Gyroscopic effects inships and airplanes. Governors - Types - Centrifugal governors- Classification of governors- sensitivity of various types of governor- controlling force of governor

UNIT IV VEHICLE PERFORMANCE **9**

Power requirement for propulsion, Air, Rolling and Gradient Resistances- Road performance curve for maximum acceleration – Determination of Centre of gravity – Drawbar pull, maximum speed and gradability, Maximum tractive effort calculation - handling and ride characteristics on different road surfaces

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UNIT V VEHICLE STABILITY 9

Calculation of equivalent weight- distribution of weight- stability of a vehicle on a slope - reactions for different drive - dynamics of a vehicle running on a banked track – stability of vehicle during cornering

Course Outcomes

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

CO1: Determine the static and dynamic forces acting in reciprocating engines
CO2: Calculate the balancing forces of rotating and reciprocating masses
CO3: Analyze the effects of gyroscopic and fuel governing mechanisms in automobile
CO4: Calculate the tractive characteristics of vehicle for different types of drive (front, rear and four wheel drives)
CO5: Analyze the stability characteristics of vehicle for various tracks (banked, curved and grade)

Text Books

1. Shigley J.E. and Uicker J J., "Theory of Machines and Mechanisms". McGraw Hill.Inc., 2002.
2. N.K. Giri "Automobile Mechanics" Khanna Publishers, 2015.

References

1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Rattan SS, "Theory of Machines", Tata McGraw Hill Publishing company Ltd. New Delhi, 1994
3. Hans B Packeja, "Tyre and Vehicle Dynamics", 2nd Edition, SAE International, 2005

LABORATORY EXPERIMENTS: (Hours: 30)

1. Balancing of rotating masses
2. Balancing of reciprocating masses
3. Gyroscope - Determination of gyroscopic couple
4. Governors - Determination of sensitivity
   a. Watt Governor
   b. Porter Governor
   c. Proell Governor
   d. Hartnell Governor

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Course Code:16MEL52	Course Title : COMPUTER AIDED MACHINE DRAWING LABORATORY (Common to Automobile and Mechanical)	
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
- Engineering Metrology & Measurements

Course Objectives

The course is intended to:

1. Develop part models
2. Prepare assembly drawings

Course Content

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", 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.

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Course Code:16AUL51	Course Title : AUTOMOTIVE ELECTRICAL AND ELECTRONICS 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):

- Automotive Electricals

Course Objectives

The course is intended to:

1. Diagnose the fault in the car electrical system
2. Conduct experiments on given Alternator and starter motor used in Automobiles
3. Construct logic circuit
4. Construct simple power supply

LIST OF EXPERIMENTS

1. Diagnose the fault in the given battery
2. Diagnose the fault in the car electrical system
3. Diagnose the fault in the ignition system
4. Conduct no load test on given starter motor
5. Conduct load test on given alternator
6. Study of logic gates
7. Construct half adder and full adder circuit and test the output
8. Study of characteristics of PN Junction diode
9. Find the RMS value of half wave rectifier and full wave rectifier
10. Construct simple DC power supply and measure the output voltage

Course Outcomes

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

CO.1.Diagnose the fault in the car electrical system following the standard procedure
CO.2.Determine the status of given Alternator and starter motor used in Automobile by conducting suitable experiments
CO.3.Constuct logic circuit to carry out basic mathematical operations
CO.4.Constuct simple power supply unit for car electrical system

References

1. Automobile Electrical and Electronic Systems. 3rd edition. Tom Denton
2. Electronic devices and circuit theory. 10th edition, Robert Boylestad. Louis Nashelsky.

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Course Code:16PSL51	**Course Title :** TEAMNESS AND INTERPERSONAL SKILLS (Common to all B.E/B.Tech Programmes)	
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. Be aware of attitudinal, behavioral and emotional aspects of self
2. Prefer to learn continuously about self and be in harmony with self
3. Understand others' preferences, values, roles & contexts and be in harmony with others
4. Identify barriers to harmonious relationships and derive ways to handle them
5. Work collaboratively as a team to deliver expected outcomes

Course Content

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.

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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

Course Outcomes

At the end of the course, students will

CO1: Be aware of attitudinal, behavioural 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

***

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
- Strength of Materials

Course Objectives

The course is intended to:

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

Course Content **Hours**

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.

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.

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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", 3rd Edition, Prentice-Hall of India, Eastern Economy Editions 2011.
2. Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002

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/
-

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Course Code:16AUT61	Course Title : DESIGN OF IC ENGINE COMPONENTS	
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):

- IC Engines
- Engineering Thermodynamics
- Strength of Materials

Course Objectives:

The course is intended to:

1. Design the engine cylinder block and engine mountings
2. Design the piston components and valves
3. Compute the design parameters of connecting rod and crankshaft
4. Compute the design parameters of flywheel
5. Design the fuel system of petrol and diesel engine

Course Content **Hours**

UNIT I INTRODUCTION **12**

Principles of similitude – advantages – systems engineering – material properties – material selection – reliability engineering – robust engineering – cost engineering. Vehicle performance requirements – Design of cylinder wall-liner – cylinder head – engine mountings and types.

UNIT II DESIGN OF PISTON COMPONENTS AND VALVES **12**

Piston components– choice of material – gas force calculation – piston, piston pin, and piston rings design calculation – piston slap – piston failures. Valve train components – valve types – materials – design of valves.

UNIT III DESIGN OF CONNECTING ROD AND CRANKSHAFT **12**

Connecting rod – material – determining minimum length – small end design – shank design – design of big end cap bolts. Crankshaft – IC engines balancing – firing order – significance – material– design of crankshaft under bending and twisting.

UNIT IV DESIGN OF FLYWHEELS **12**

Mass of a flywheel – coefficient of speed fluctuation – engine flywheel – stresses on the rim – Design of hubs and arms of the flywheel – turning moment diagram.

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UNIT V DESIGN OF FUEL SYSTEM **12**

SI engine – carburettor – venture main jet – compensating jet – calculations. CI engine – fuel injection pump – theoretical fuel delivery – plunger diameter – complete plunger stroke – plunger active stroke – injector – fuel discharge time – mean velocity of fuel discharge – nozzle hole diameter.

Note: (Approved Design Data Book may be permitted in the examination)

Course Outcomes:

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

CO1: Calculate the dimensions of cylinder block and mountings based on vehicle performance requirement
CO2: Calculate the design parameters of piston components and valves for the in-cylinder combustion gas forces
CO3: Compute the design parameters of connecting rod and crankshaft considering the various loads acting on them
CO4: Compute the mass and dimensions of flywheel based on the cylinder to cylinder speed fluctuation
CO5: Compute the petrol and diesel engine fuel system design parameters based on engine performance requirement

Text Books

1. V. B. Bhandari," Design of Machine Elements", Tata McGraw-Hill Education, 2010.
2. Khurmi. R.S. & Gupta. J.K., "A textbook of Machine Design", Eurasia PublishingHouse (Pvt) Ltd, 2001.

References

1. Richard van Basshuysen, "Internal Combustion Engine Handbook", SAE International, 2004.
2. Kolchin and Demidov,"Design of automotive engines", Mir Publishers Moscow, 1984.

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Course Code:16AUT62	Course Title : VEHICLE DYNAMICS	
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):

- Automotive Chassis
- Mechanics of Road Vehicles
- Automotive Transmission

Course Objectives

The course is intended to:

1. Explain the basic concepts of vibration
2. Analyse the effect of vibrating elements
3. Infer the vehicle tyre characteristics
4. Analyze the vehicle handling characteristics
5. Judge the conflicting goals in the setup of vehicle suspension

Course Content **Hours**

UNIT I CONCEPTS OF VIBRATION **9**

Fundamentals of vibration-importance and sources- vibration terminologies- simple harmonic motion-vibration analysis procedure -parts of vibrating system – vehicle models- methods of vibration analysis- equilibrium method, energy method, Rayleigh method-types of vibration-free and forced vibration, linear and nonlinear vibration, damped and undamped vibration, deterministic and random vibration, torsional vibration.

UNIT II SINGLE AND MULTI DEGREE OF FREEDOM **15**

Free undamped vibration: differential equation- spring mass system-equivalent stiffness of spring combinations- frequency response of spring mass system. Free damped vibration: differential equation – under damping, critical damping and over damping-frequency response of spring, mass and damper system. Forced vibration: frequency response with external excitation – absolute motion-transmissibility-vibration isolation. Two degree of freedom-vibration response for undamped system-magnification factor- influence coefficient-orthogonality principle-matrix iteration method

UNIT III TYRE DYNAMICS **12**

Tyre terminology- tyre and vehicle axis system-rolling resistance of tyre- force generation mechanism- tractive properties-cornering properties- camber thrust-aligning moment- cornering behaviour characteristics-ride properties.

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UNIT IV VERTICAL DYNAMICS 12

Forces- side force, lift force, drag force- moments- yaw, roll, pitch and bounce – pitch and bounce frequencies of vehicle – anti squat and anti-dive geometry- roll center analysis- active suspension system – ride control, height control – body roll stability analysis- load transfer- lateral and longitudinal- "g" force for different riding conditions.

UNIT V LATERAL DYNAMICS 12

Steering geometry-steering handling characteristics- under steer, over steer, neutral steer- steady state response – yaw velocity response, lateral acceleration response, curvature response – testing of handling characterizes- constant radius test, constant speed test, constant steering angle test- direction stability- influences on cornering-suspension effects and tractive effects

Course Outcomes

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

CO1: Explain the fundamentals of vibration
CO2: Analyse the effect of vibrating elements (Spring, Mass & Damper) on vibrating systems
CO3: Infer the tyre characteristics on vehicle ride behavior
CO4: Analyze the vehicle handling characteristics based on lateral dynamics
CO5: Judge the conflicting goals in the setup of vehicle suspension on stability

Text Books

1. SingiresuS.Rao, Mechanical Vibrations (5th Edition), Prentice Hall, 2010
2. Thomas D.Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers Inc, 1992.
3. N.K.Giri "Automobile Mechanics" Khanna Publications 2015

References

1. G. NakhaieJazar, Vehicle Dynamics: Theory and Application, 1st Edition, Springer, 2008
2. Hans B Packeja, Tyre and Vehicle Dynamics, 2nd Edition, SAE International, 2005
3. J.Y. Wong, Theory of Ground Vehicle, 3rd Edition, Wiley-Interscience, 2001.

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Course Code:16AUT63	Course Title : AUTOMOTIVE EMBEDDED SYSTEM	
Core / Elective: Core	L: T : P: C	3 : 0 : 0 : 3
Type :Theory	Total Contact hours:	60 Hours

Prerequisites:

The student should have undergone the course(s):

- Automotive Electricals
- Automotive Electronics

Course Objectives

The course is intended to:

1. Write simple program using microcontroller
2. Write program to Interface peripherals with 8051 microcontroller
3. Choose an appropriate protocol for data communication
4. Explain the working principle of power train management system
5. Explain the working principle of chassis electronics systems

Course Content **Hours**

UNIT I INTRODUCTION **9**

Architecture of Microcontroller- Memory organization in microcontroller, Arithmetical and logical instruction- programs using arithmetical and logical instruction- simple programs using microcontroller- programs using branching instructions- addressing modes, branching instruction

UNIT II PERIPHERAL INTERFACING **9**

Analog to Digital converter (ADC) - Interface ADC - Digital to Analog converter (DAC)- Interface DAC- stepper motor- Interface stepper

UNIT III COMMUNICATION PROTOCOL **9**

Control networking- protocol- choosing protocol- Serial peripheral Interface (SPI) - Controller Area Network (CAN) - Local Interconnect Network (LIN) - FlexRay - Media Oriented Systems Transport (MOST)

UNIT IV ENGINE AND TRANSMISSION MANAGEMENT SYSTEM **9**

SI Engine management system, CI Engine management system including emission control, Transmission management system

UNIT V CHASSIS ELECTRONICS **9**

Tyre Slip- sensors in ABS- ABS- TCS- ESP- EBD. body electronics system such as wiper- door control- infotainment system- Navigation system.

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Course Outcomes

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

CO1: write simple program using microcontroller for controlling simple applications
CO2: write program to Interface the required peripherals with 8051 microcontroller for given application
CO3: Choose an appropriate protocol for data communication in the given automobile application
CO4: Explain the working principle of power train management system of an automobile
CO5: Explain the working principle of chassis electronics systems of an automobile

Text Books

1. Frank Vahid and Tony Givargis, "Embedded system design A unified Hardware/software Introduction", Wiley India pvt. Ltd., 2012
2. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.Mckinlay, " The 8051 Microcontroller and Embedded system using Assembly and C" 2nd Edition, Pearson education, 2009.

References

1. David E.Simon, "An Embedded software premier", Pearson education, 2010.
2. "Automotive Handbook" 7th edition, Bosch, 2011.

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Course Code:16CET65	Course Title : ENVIRONMENTAL STUDIES (Common to All B.E./B.Tech Programmes)	
Core / Elective: Core	L: T : P: C	3 : 0 : 0 : 3
Type :Theory	Total Contact hours:	45 Hours

Pre-requisites: None

Course Objectives

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 environmetnal pollution
4. Describe the importance of environmental protection in social and global context
5. Explain the relationship between environment and human beings

Course Content **Hours**

UNIT I MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES 9

Definition, scope and imporatnce; 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 ofthe following ecosystem - Forest, Grassland,Desert, Aquatic; Biodiversity and its conservation: Introduction; Biogeographical classification ofIndia; 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; Role of an individual in prevention of pollution; Pollution case studies; Disaster management : floods, earthquake, cyclone and landslides

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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 accidentsand 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.

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 ofenvironmetnal pollution
CO4: Describe the importance of environmental protection in social and global context
CO5: Explain the relationship between environment and human beings

Text Books:

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.
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.

WEB REFERENCES:

- http://nptel.ac.in/courses/122102006
- www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf

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Course Code:16MEL61	Course Title : SIMULATION AND ANALYSIS LABORATORY (Common to Automobile and Mechanical)	
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):

- Strength of Materials
- Kinematics of Machines

Course Objectives

The course is intended to:

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

LIST OF EXPERIMENTS

Simulation

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:16AUL61	Course Title : AUTOMOTIVE EMBEDDED SYSTEMS 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):

- Automotive Electrical
- Automotive Electronics

Course Objectives

The course is intended to:

1. Execute simple programs using Microcontroller
2. Interface the required peripherals with 8051 microcontroller
3. Explain procedure to execute program using IDE

LIST OF EXPERIMENTS:

1. Assembly language programming for Addition and Subtraction
2. Assembly language programming for Logical operation
3. Assembly language programming for Multiplication and Division
4. Data conversion using Microcontroller
5. Interfacing of Stepper Motor
6. Generate pulse width modulated signal for automobile Head light application
7. Interfacing of ADC with Manifold absolute pressure (MAP) sensor
8. Interfacing of Hall sensor to find speed of wheel
9. Interrupt programming using microcontroller
10. Study of IDE

Course Outcomes

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

CO1: Execute simple programs using Microcontroller for automotive application
CO2: Interface the required peripherals with 8051 microcontroller for given application
CO3: Explain procedure to execute program using IDE for assembly and C programming

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Course Code:16PSL61	Course Title : CAMPUS TO CORPORATE (Common to all B.E/B.Tech Programmes)	
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. Display gratitude and social responsibility
2. Understand various business environments – industry & function wise
3. Explain the transition from a campus mindset to corporate mindset
4. Be prepared to adapt to the future work culture
5. Choose to be presentable and agile

Course content

UNIT I GRATITUDE AND SOCIAL RESPONSIBILITY

Importance of gratitude; Finding opportunities to give back to society; Responsible behaviour 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 BEHAVIOURAL RESPONSES TO CERTAIN SPECIFICCONTEXTS)

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 MIND-SET TO CORPORATE MIND-SET

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 mind-set, 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;

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UNIT V PRESENTABLE AND AGILE

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);

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	Administratio n	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 membe rs	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 comprehensive review	Trained faculty membe rs	End of semester

Course Outcomes

At the end of the learning program, learners will

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

END OF THE SEMESTER VI

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Course Code: 16AUT71	Course Title : DESIGN OF AUTOMOTIVE CHASSIS COMPONENTS	
Core / Elective: Core	L: T : P: C	2:2 :0 : 4
Type :Theory	Total Contact hours:	60 Hours

Prerequisites:

The student should have undergone the course(s):

- Automotive Chassis
- Mechanics of Road Vehicles

Course Objectives

The course is intended to:

1. Design vehicle frames and steering system components.
2. Calculate the design parameters of axles and shafts.
3. Choose the appropriate clutch system for power transmission.
4. Design the gear box for vehicles.
5. Design the braking system for vehicles.

Course Content **Hours**

UNIT I VEHICLE FRAME AND STEERING COMPONENTS 12

Loads acting on frames, chassis operating conditions, Determination of CG, Design of frame for passenger and commercial vehicle - Condition for true rolling, calculation of Ackermann linkage geometry, steering box design.

UNIT II AXLES AND SHAFTS 12

Analysis of loads, moments and stresses at different sections of front axle, Design of front axle. Determination of bearing loads at Kingpin bearings, Design of propeller shaft- design details of final drive gearing, full-floating, semi-floating, three quarter floating rear axle and housings. Torsion bar.

UNIT III CLUTCHES 12

Types of friction clutches, Torque capacity of clutch, Design of single plate, multi-plate clutch, cone clutch and centrifugal clutch, Design of clutch components.

UNIT IV GEAR BOXES 12

Review of Gear terminology- Design of spur and helical gears - layout of gearboxes. Design of four speed and five speed gearboxes.

UNIT V BRAKES 12

Brakes function, weight transfer during braking, stopping distance, brake torque analysis of Internal expanding shoe brake. Calculation of mean lining pressure and heat generation during braking, design of disc brake, mechanics of hydraulic braking system and parking brake.

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Course Outcomes

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

CO1. Design vehicle frames and steering system components.
CO2. Calculate the design parameters of axles and shafts.
CO3. Choose the appropriate clutch system for power transmission.
CO4. Design the gear box for vehicles.
CO5. Design the braking system for vehicles.

Text Books:

1. Giri, N.K., "Automobile Mechanics", Khanna publishers, New Delhi, 2007.
2. Khurmi. R.S. & Gupta. J.K., "A textbook of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.

References:

1. Heldt, P.M., "Automotive Chassis", Chilton Book Co., 2012.
2. Dean Averns, "Automobile Chassis Design", Illife Book Co., 2009.
3. Shigley J.E and Mischke C.R, "Mechanical Engineering Design" 9th Edition, Tata McGraw-Hill,2011.
4. Lukin P, Gasparyants G, Rodionov V, "Automobile Chassis Design and Calculations", MIR Publishers, Moscow 1989.

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Course Code: 16AUT72	Course Title : AUTOMOTIVE POLLUTION CONTROL	
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):

- IC engines
- Automotive Fuels and Lubricants

Course Objectives

The course is intended to:

1. Apply the standards for emission control
2. Analyse the emissions in SI engines
3. Analyse the emissions in CI engines
4. Apply various emission control techniques
5. Demonstrate emission measurements and tests

Course Content **Hours**

UNIT I INTRODUCTION **6**

Pollutants – sources – formation – effects of pollution on environment - human – transient operational effects on pollution – Regulated – Unregulated emissions - Emission Standards.

UNIT II EMISSIONS IN SI ENGINES **10**

Chemistry of SI engine combustion – HC and CO formation in SI engines – NO formation in SI engines – Smoke emissions from SI engines – Effect of operating variables on emission formation.

UNIT III EMISSIONS IN CI ENGINES **10**

Basics of diesel combustion – Smoke emission and its types in diesel engines – NOx emission and its types from diesel engines – Particulate emission in diesel engines. Odour, sulphur and Aldehyde emissions from diesel engines - effect of operating variables on emission formation

UNIT IV EMISSION CONTROL TECHNIQUES **10**

Design modifications – Optimization of operating factors – Fuel modification – Evaporative emission control - Exhaust gas recirculation – SCR – Fumigation – Secondary Air injection – PCV system – Particulate Trap – CCS. Exhaust treatment in SI engines –Thermal reactors – Catalytic converters – Catalysts.

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UNIT V EMISSION MEASUREMENTS AND TESTS 9

NDIR analyser – Flame ionization detectors – Chemiluminescent analyser – Dilution tunnel – Gas chromatograph Smoke meters. Test procedures CVS1, CVS3 – Test cycles – IDC – ECE Test cycle – FTP Test cycle –SHED test.

Course Outcomes

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

CO1. Apply the standards for emission control
CO2. Analyse the emissions in SI engines
CO3. Analyse the emissions in CI engines
CO4. Apply various emission control techniques
CO5. Demonstrate emission measurements and tests

TEXT BOOKS:

1. Heywood,J.B., "Internal Combustion Engine Fundamentals", McGraw Hill Book Co., 2011.
2. B.P.Pundir, " IC Engines Combustion and Emissions", Narosa Publishers, 2010

REFERENCES:

1. Ramalingam. K.K., "Internal Combustion Engines", Scitech Publications, Chennai, 2003.
2. Ganesan,V., "Internal Combustion Engines", Tata McGraw Hill Co., 2008.

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Course Code: 16AUL71	Course Title : VEHICLE MAINTENANCE 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):

- Automotive Chassis
- IC Engines
- Automotive Transmission
- Automotive Electrical and Electronics

Course Objectives:
The course is intended to:

1. Recognize and Overhaul the faults in the vehicle systems

List of Experiments

1. Study and preparation of different statements/records required for the repair and maintenance works.
2. Minor and major tune up of gasoline and diesel engines.
3. Calibration of Fuel injection pump.
4. Fault diagnosis and service of steering system
5. Fault diagnosis and service of transmission system.
6. Fault diagnosis and service of suspension system.
7. Fault diagnosis and service of braking system.
8. Fault diagnosis and service of Electrical systems (battery, starting system, charging system)
9. Study and checking of wheel alignment - testing of camber, caster
10. Practice the following:
    - Adjustment of pedal play in clutch, brake and steering wheel play.
    - Air bleeding from hydraulic brakes, air bleeding of diesel fuel system.
    - Wheel bearings tightening and adjustment.
    - Adjustment of head lights beam.
    - Removal and fitting of tire and tube.

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

CO1. Recognize and Overhaul the faults in the vehicle systems

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Course Code: 16AUL72	**Course Title :** MODELLING AND ANALYSIS OF AUTOMOTIVE SUBSYSTEMS 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):

- Automotive Chassis
- Automotive Transmission
- Computer Aided Machine Drawing Laboratory
- Simulation and Analysis Laboratory

Course Objectives:

The course is intended to:

1. Develop part models of automotive subsystems.
2. Analyze part models of automotive subsystems

List of Experiments

1. Modelling and Analysis of Integral frame
2. Modelling and Analysis of Axle shaft for Commercial vehicles
3. Modelling and Analysis of Single plate clutch
4. Modelling and Analysis of Transfer case
5. Modelling and Analysis of brake components

Course Outcomes:

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

CO1. Develop part models of automotive subsystems.

CO2. Analyze part models of automotive subsystems

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Course Code: 16AUL73	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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END OF SEMESTER VII

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SEMESTER VIII

Course Code: 16AUL81	Course Title : PROJECT WORK	
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 prepares 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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END OF SEMESTER VIII

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DESIGN STREAM

Course Code:16AUE01	Course Title: ADVANCED THEORY OF IC 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):

- IC Engines
- Automotive Fuels and Lubricants
- Engineering Thermodynamics

Course Objectives

The course is intended to:

1. Calculate the combustion process parameters
2. Analyze various engine cycles
3. Model the combustion process of IC engines
4. Explain the non conventional IC engines combustion processes
5. Explain the techniques used to analyze combustion process

Course Content **Hours**

UNIT I COMBUSTION OF FUELS **9**

Chemical Composition and molecular structureand hydrocarbon fuels, Combustion stoichiometry of hydro carbon fuels- Chemical Energy and heat of reaction calculations - Chemicalequilibrium and adibatic flame temperature calculation. Theory of SI and CI Engine combustion - Flame velocity and area of flame front. Fuel spray characterstics - Droplet size , Depthof penetrationand atomization.

UNIT II ENGINE CYCLE ANALYSIS **9**

Ideal air, Fuel air cycle and actual Cycle analysis. Progressive combustion analysis in SI engines, Parametric Studies on work output, Efficiency and other engine performance.

UNIT III COMBUSTION MODELLING **9**

Basic Concepts of Engine simulation- Governing Equations , Classifications of Engine models- Thermodynamic models for intake and exhaust flow process- Quasi steady flow- Filling and Emptying- Gas dynamic models. Thermodynamic based in cylinder models for SI engine and CI Engines

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UNIT IV NON CONVENTIONAL IC ENGINES 9

Concept of L.H.R. Engine and its recent developments. Variable compression ratio engine and its use in engine research. Wankel rotafrycombustion engine. Dual fuel engine concept for multi fuel usage in CI Engine Performance studeis on dual fuel engines. Free piston Engine. Stratified charge and lean burn Engines. Locomotive and marine Engines.

UNIT V COMBUSTION ANALYSIS IN IC ENGINES 9

Photo graphic studies of Combustion processes- Analysis of Pressure crank angle diagrams in SI and CI Engines. Knock studyfor pressure crank angle histories. Apparent heat release rate and Wiebe's Law analysis for combustion. Calculation of Ignition Delay and combustion duration- Hot wire and laser doppler anemometry and velocimetryfor flow and combustion analysis in IC Engines.

Course Outcomes

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

CO1: Calculate the combustion process parameters of SI and CI Engine combustion
CO2: Analyze various engine cycles to find the engine performance parameters
CO3: Model the intake and exhaust flow process and in-cylinder models for SI engine and CI Engines
CO4: Explain the non conventional IC engines combustion processes that improve the combustion efficiency.
CO5: Explain the techniques used to analyze pressure crank angle, knock study, heat release rate and mass flow rate of air

Text Books

1. Ganeshan V., "Internal Combustion Engines, Tata McGraw Hill Publishing Co., 1994.
2. Ganeshan V., "Computer simulation of Spark ignition engine process", Universities Press (I) Ltd, Hyderabad,1996.

References

1. Ramalingam K K" Internal Combustion Engine", Scitech Publications, chennai,2003
2. Ganeshan V "Compute Simulationof Compression Igniton Engine Process" Universities press (India) Ltd., Hyderabad,1996.
3. John B, Heywood, " Internal combustion Engine fundaments", Mc Graw Hill Publishing Co., New york,1990.

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Course Code:16AUE02	Course Title: ELECTRIC, HYBRID AND FUEL CELL VEHICLES	
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):

- IC Engines
- Automotive Electrical

Course Objectives

The course is intended to:

1. Explain the construction and working of power sources
2. Explain the performance characteristics and drives of electric vehicles
3. Explain the architecture of various hybrid vehicle designs
4. Explain the operating principle of fuel cells
5. Explain the regenerative braking system

Course Content **Hours**

UNIT I ENERGY SOURCES **9**

Peaking Power Sources and Energy Storages-Electrochemical Batteries-Electrochemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power and Energy Efficiency. Battery Technologies –Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Zinc-Air Battery

UNIT II ELECTRIC VEHICLES **11**

Configurations of EVs-Performance of EVs-Traction Motor Characteristics, Tractive Effort and Transmission Requirement and Vehicle Performance. Electric Propulsion Systems - DC Motor Drives-Induction Motor Drives- Induction Motor Drives- SRM Drives, Voltage-Balance Equation, Torque-Speed Characteristics

UNIT III HYBRID VEHICLES **9**

Concept of Hybrid Electric Drive Trains-Architectures of Hybrid Electric Drive Trains-Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains. Fuel Cell Hybrid Electric Drive Train Design

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UNIT IV FUEL CELLS 8

Operating Principles of Fuel Cells -Fuel Cell Technologies-Proton Exchange Membrane Fuel Cells, Alkaline Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells, Direct Methanol Fuel Cells. Fuel Supply and reforming techniques.

UNIT V REGENERATIVE BRAKING 8

Braking energy consumption - Brake System of EV, HEV, and FCV - Control strategy for braking performance. Parallel Hybrid Braking System - Fully Controllable Hybrid Brake System.

Course Outcomes

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

CO1: Explain construction and working of power sources with their parameters used for electric vehicles
CO2: Explain the performance characteristics to improve performance of EV and drives used in electric vehicles
CO3: Compare the architecture of various hybrid vehicle designs based on their layouts
CO4: Compare the operating principle of fuel cells with their applications
CO5: Compare braking performance of EV, HEV and FCV

Text Books

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid and Fuel CellVehicles: Fundamentals, Theory and Design", CRS Press, 2004.
2. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", utterworth- Heinemann, 2001

References

1. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002
2. James Larminie and John Loury, "Electric Vehicle Technology-Explained", John Wiley &Sons Ltd.,2003.
3. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Second Edition, CRC Press, 2011

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Course Code:16AUE03	Course Title: : VEHICLE SAFETY AND COMFORT 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):

- Automotive chassis
- Automotive Electricals
- Automotive Electronics

Course Objectives:
The course is intended to:

1. Explain the engineering principles that are necessary for the design of an automobile for the safety and comfort of the occupants and other road users.
2. Explain the role and use of safety systems.
3. Explain crashworthiness and failure analysis.
4. Explain the role and use of comfort systems .
5. Explain the importance of ergonomics and NVH.

Course Content **Hours**

UNIT I INTRODUCTION TO SAFETY SYSTEMS 9

Vehicle safety system – History, Role of material science in design, Material selection - automotive structure and safety - safety aspects of design for BIW,

UNIT II CONSTRUCTION AND OPERATION OF SAFETY SYSTEMS 9

Construction and operation of safety systems such as: airbags, safety cage, roof crush, crumple zones, seat belts, bumper, bonnet and impact bars.

UNIT III CRASHWORTHINESS AND FAILURE ANALYSIS 9

Crashworthiness legislation, Crash analysis; front crash, rear crash and side crash, The role of HMI Systems in safety aspects of automotive systems, CAE/FEA in analysis of vehicle structure, Fatigue failure analysis for vehicle structure, The role of different vehicle systems in safety aspects

UNIT IV INTRODUCTION TO COMFORT SYSTEMS 9

Embedded Systems (automotive electronics), Interior cabin comfort systems, including seating, lighting, thermal comfort

UNIT V VEHICLE ERGONOMICS AND NVH 9

Vehicle ergonomics and human factors, Human Machine Interface (HMI), automotive sound quality and NVH, Perceived quality, smart driving technologies

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Course Outcomes:

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

CO1: Explain the engineering principles that are necessary for the design of an automobile for the safety and comfort of the occupants and other road users.
CO2: Explain the role and use of safety systems in vehicle engineering.
CO3: Explain crashworthiness and failure analysis of a vehicle.
CO4: Explain the role and use of comfort systems in vehicle engineering.
CO5: Explain the importance of ergonomics and NVH in vehicle comfort system.

Text Books:

1. George A. Peters, Barbara J. Peters, "Automotive Vehicle Safety", Taylor & Francis, 2002
2. Jack Erjavec, "Automotive Technology: A Systems Approach", Volume 2, Delmar Cengage Learning, 1992

References

1. Ulrich W. Seiffert, Mark Gonter , "Integrated Automotive Safety Handbook", SAE International,2013
2. Robert Bosch "Safety, Comfort and Convenience Systems" 3rd Edition, Wiley-Blackwell 2006.

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Course Code:16AUE04	Course Title:HYDRAULIC AND PNEUMATIC 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):

- Fluid Mechanics and Machinery
- Kinematics of Machines

Course Objectives
The course is intended to:

1. Explain different fluid power systems and its applications.
2. Explain various hydraulic system components and applications.
3. Design the hydraulic circuits for desired application.
4. Explain various pneumatic system components and applications
5. Design the pneumatic circuits for desired application.

Course Content **Hours**

UNIT I FLUID POWER SYSTEM AND FUNDAMENTALS **9**

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components -Pneumatic system components - Application of Pascal's Law in hydraulics-Advantages of fluid power system -Applications of Fluid power system - Properties of hydraulic fluids - Types of fluids.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS **9**

Pumping theory - Pump classification - Construction and working of gear pumps, Vane pumps, Piston pumps - Construction and working of linear actuators - Special cylinder - Rotary actuator – Construction and operation of direction control valves (DCV), Pressure control valve, Flow control valve – Construction and operation of accumulators, Intensifiers.

UNIT III DESIGN OF 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.

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UNIT IV PNEUMATIC SYSTEM AND COMPONENTS 9

Properties of air – Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Constriction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols

UNIT V DESIGN OF 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 advantages and applications.
CO2: Explain construction and working of hydraulic system components.
CO3: Design hydraulic circuit to perform the desired function.
CO4: Explain construction and working of pneumatic system components
CO5: Design of pneumatic circuit to perform the desired function.

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/
- http://www.nitc.ac.in/dept/me/jagadeesha/mev303/Chapter2_Hydraulics_control_in_machine_tools.pdf
- http://maysaaiat.weebly.com/uploads/5/8/8/3/5883161/atm1122_hydraulics_module_1.pdf

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Course Code: 16AUE08	Course Title: AUTOMOTIVE AERODYNAMICS	
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 and Machinery
- Mechanics of Road Vehicle
- vehicle dynamics

Course Objectives:
The course is intended to:

1. Describe the Potential of vehicle aerodynamics
2. Calculate the drag coefficient of cars
3. Explain the shape optimization of cabs
4. Calculate forces and moments due to side winds
5. Demonstrate the use of wind tunnel for automotive aerodynamics

Course Content **Hours**

UNIT I INTRODUCTION **9**

Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics.

UNIT II AERODYNAMIC DRAG OF CABS **9**

Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.

UNIT III SHAPE OPTIMIZATION OF CABS **9**

Front and modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap configuration – effect of fasteners.

UNIT IV VEHICLE HANDLING **9**

The origin of force and moments on a vehicle – side wind problems – methods to calculate forces and moments – vehicle dynamics under side winds – the effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.

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UNIT V WIND TUNNELS FOR AUTOMOTIVE AERODYNAMICS 9

Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.

Course Outcomes:

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

CO1. Describe the Potential of vehicle aerodynamics
CO2. Calculate the drag coefficient of cars
CO3. Explain the shape optimization of cabs
CO4. Calculate forces and moments due to side winds
CO5. Demonstrate the use of wind tunnel for automotive aerodynamics

Text Book:

1. Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co. Ltd., 1997.

References:

1. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994.
2. Automotive Aerodynamics: Update SP-706, SAE, 1987.
3. Vehicle Aerodynamics, SP-1145, SAE, 1996.

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Course Code: 16AUE09	Course Title: NOISE, VIBRATION AND HARSHNESS	
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):

- Vehicle Dynamics
- Mechanics of Road Vehicle
- Automotive Electrical
- Automotive Electronics

Course Objectives:

The course is intended to:

1. Describe the sources of noise and vibration
2. Explain the effects of NVH on people
3. Explain the effects of noise and vibration on external environment
4. Explain the effects of noise and vibration on internal environment
5. Explain the measurement methods of noise and vibration

Course Content **Hours**

UNIT I FUNDAMENTALS OF ACOUSTICS AND NOISE, VIBRATION 8

Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to Sound, General Introduction to Vibration, Vibration of Simple Discrete and Continuous Systems, Random Vibration, Response of Systems to Shock, Passive Damping

UNIT II EFFECTS OF NOISE, BLAST, VIBRATION, AND SHOCK ON PEOPLE 7

General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Sleep Disturbance due to Transportation Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Auditory Hazards of Impulse and Impact Noise, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.

UNIT III TRANSPORTATION NOISE AND VIBRATION 10

Introduction to Transportation Noise and Vibration Sources, Internal Combustion Engine Noise Prediction and Control—Diesel, Exhaust and Intake Noise and Acoustical Design of Mufflers, Tire/Road Noise—Generation, Measurement, and Abatement, Aerodynamic Sound Sources in Vehicles—Prediction and Control, Transmission and Gearbox Noise and Vibration Prediction and Control, Brake Noise Prediction and Control.

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UNIT IV INTERIOR TRANSPORTATION NOISE AND VIBRATION 10

Introduction to Interior Transportation Noise and Vibration Sources, Automobile, Bus, and Truck Interior Noise and Vibration Prediction and Control, Noise and Vibration in Off-Road Vehicle Interiors- Prediction and Control

UNIT V NOISE AND VIBRATION TRANSDUCERS 10

General Introduction to Noise and Vibration Transducers, Measuring Equipment, Measurements, Signal Acquisition, and Processing, Acoustical Transducer Principles and Types of Microphones, Vibration Transducer Principles and Types of Vibration Transducers, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, Equipment for Data Acquisition, Noise and Vibration Measurements, Determination of Sound Power Level and Emission Sound Pressure Level, Sound Intensity Measurements, Noise and Vibration Data Analysis, Calibration of Measurement Microphones, Calibration of Shock and Vibration Transducers, Metrology and Traceability of Vibration and Shock Measurements.

Course Outcomes:

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

CO 1. Describe the sources of noise and vibration
CO 2. Explain the effects of NVH on people
CO 3. Explain the effects of noise and vibration on external environment
CO 4. Explain the effects of noise and vibration on internal environment
CO 5. Explain the measurement methods of noise and vibration

Text Books:

1. Clarence W. de Silva , "Vibration Monitoring, Testing, and Instrumentation ",CRC Press, 2007
2. David A.Bies and Colin H.Hansen "Engineering Noise Control: Theory and Practice"Spon Press, London, 2009

References:

1. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
2. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989

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Course Code: 16AUE10	Course Title: : SUPERCHARGING AND SCAVENGING	
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):

- IC Engines
- Design of IC Engine Components

Course Objectives:
The course is intended to:

1. Describe the effect of supercharging on I.C engine performance and emissions
3. Describe the effect of turbocharging on I.C engine performance and emissions
4. Describe scavenging process
5. Design Intake and Exhaust Systems for two stroke engines
6. Describe the experimental techniques for evaluating scavenging

Course Content **Hours**

UNIT – I SUPERCHARGING **8**

Definition and Engine modification required - effects on Engine performance - Thermodynamics Mechanical Supercharging. Types of compressors – Positive displacement blowers – Centrifugal compressors – Performance characteristic curves – Suitability for engine application – Matching of supercharger compressor and Engine.

UNIT – II TURBOCHARGING **8**

Turbocharging – Turbocharging methods - Thermodynamics – Engine exhaust manifolds arrangements. – Waste gate, Variable nozzle turbochargers, Variable Geometry Turbocharging – Surging - Matching of compressor, Turbine and Engine.

UNIT – III SCAVENGING OF TWO STROKE ENGINES **12**

Features of two stroke cycle engines – Classification of scavenging systems - Charging Processes in two stroke cycle engine – Terminologies – Sankey diagram – Relation between scavenging terms – scavenging modeling – Perfect displacement, Perfect mixing – scavenging models. Mixture control through Reed valve induction.

UNIT – IV PORTS AND MUFFLER DESIGN **8**

Porting – Port flow characteristics-Design considerations – Design of Intake and Exhaust Systems – Tuning- Kadenacy system.

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UNIT – V EXPERIMENTAL METHODS AND RECENT TRENDS 9

Experimental techniques for evaluating scavenging – Firing engine tests – Non firing engine tests - Development in two stroke engines for improving scavenging. Direct injection two stroke concepts.

Course Outcomes:

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

CO1. Describe the effect of supercharging on I.C engine performance and emissions
CO2. Describe the effect of turbocharging on I.C engine performance and emissions
CO3. Describe scavenging process
CO4. Design Intake and Exhaust Systems for two stroke engines
CO5. Describe the experimental techniques for evaluating scavenging

Text Books:

1. R.S. Benson and N.D. White house, Internal Combustion engines, First edition, Pergamon press, 1979.
2. John B.Heywood, Two Stroke Cycle Engine, SAE Publications, 1997.

References

1. G P Blair, Two stroke Cycle Engines Design and Simulation, SAE Publications, 1997.
2. Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, 2002.

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Course Code: 16AUE11	Course Title: ADVANCED VEHICLE 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):

- Automotive Electrical
- Automotive Electronics
- Automotive Embedded Systems

Course Objectives

The course is intended to:

1. Explain the operation of DTS ignition, VVT, Camless, GDI and CRDI engines
2. Explain the working of various vehicle safety systems
3. Explain the working of vehicle security and comfort system
4. Explain the operation of vehicle information and communication systems
5. Explain the working of various intelligent transportation systems

Course Content **Hours**

UNIT I POWERTRAIN **9**

Modern Engine Technologies Like Digital Twin Spark ignition (DTS-I) , Digital Twin Spark Fuel Injection (DTS-Fi), Digital Twin Spark swirl induction (DTS-Si), Variable Valve Timing (VVT), Camless Engine, Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI)

UNIT II VEHICLE SAFETY **9**

Antilock braking systems- Traction control system- Electrohydraulic brakes- Occupant safety systems- Air bags, Seatbelt tightening system, Collision warning systems, Child Lock- Power Windows- PowerSun roof-Seat and steering column- Bio metric Systems- Driver Assistance systems- Adaptive cruise control

UNIT III VEHICLE SECURITY AND COMFORT SYSTEM **9**

Vision Enhancement, Road recognition system, AntiTheft Technologies, Smart card system, Number plate coding, Locking system - Central locking system- acoustic signalling devices Active suspension system,requirement and characterstics, different types, vehicle handling and ride characterstics of road vehicle, Pitch, Yaw, Bounce Control, Climate Control Management system

UNIT IV VEHICLE INFORMATION AND COMMUNICATION **9**

Instrumentation- Vehicle information system- Trip Recorders- Parking systems- Analog and digital signal transmission - Automotive sound systems- Mobile and data radio - Mobile information services- Navigationsystems-Traffic Telematics- Multimedia Systems. OBD- I Engine diagnostic system- OBD-II Engine control systems-SAE DTC standards- Scan Tools- Strategy based diagnosis- Engine and vehicle Performance problems.

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UNIT V INTELLIGENT TRANSPORTATION SYSTEM 9

Traffic routing system- Automated highway systems - Lane warning system - Driver Information System- Driver assistance systems- Driver Conditioning warning - Route Guidance and navigation systems- Hybrid/ Electric and future cars.

Course Outcomes

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

CO1. Explain the operation of DTS ignition, VVT, Camless, GDI and CRDI engines
CO2. Explain the working of various vehicle safety systems
CO3. Explain the working of vehicle security and comfort system
CO4. Explain the operation of vehicle information and communication systems
CO5. Explain the working of various intelligent transportation systems

TEXT BOOKS

1. Nadovich, C., " Synthetic instruments concepts and Applications". Elsevier, 2005
2. Bitter, R., Mohiuddin T and Nawricki M., " Labview Advanced Programming Techniques",CRC Press, 2 nd Edition,2007

REFERENCE

1. Robert N Brandy, " Automotive Electronics and Computer systems", Prentice Hall,2001

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Course Code: 16AUE12	Course Title: OFF ROAD VEHICLES	
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):

- Automotive Chassis
- Automotive Transmission

Course Objectives

The course is intended to:

1. Explain the construction and layout of earth moving equipments
2. Explain the construction and layout of constructional equipments
3. Explain the construction and layout of farm equipments
4. Explain the construction and layout of industrial vehicles
5. Explain the construction and layout of military and combat vehicles

Course Content **Hours**

UNIT I EARTH MOVING EQUIPMENTS **9**

Construction Layout, Capacity and applications of earth movers like dumpers, Front End loaders, Bull Dozers, Backhoe Loaders, Scrappers, Bucket Conveyors Etc., Selection Criteria of prime mover for dumper and front end loaders based on vehicle performance characteristics

UNITII CONSTRUCTIONAL EQUIPMENTS **9**

Layout of constructional equipments, Excavators, Jip Cranes, Hoist motor graders, Mixing machine, Concrete ready mixers, Drillers, Ramming machines for constructions of bridges and working principles, Power generators

UNIT III FARM EQUIPMENTS **9**

Classification of tractors - Main components of tractor. Working attachment of tractors- Auxiliary equipment - Trailers and body tipping mechanism- Ploughing - Paddy plantation machine harvesting machines, sugarcane harvesting, and Power trailers.

UNIT IV INDUSTRIAL APPLICATIONS **9**

Constructional Features, Capacity and stability of Jib Cranes, Vibratory compactors, Fork Lifts. Towing Vehicles, Case Studies

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UNIT V MILITARY AND COMBAT VEHICLES 9

Ride and stability characteristics, Power take off, Special Implementations. Special Features and constructional details of tankers, Gun carriers and transport vehicles, Bridge builders, Communication Vehicles.

Course Outcomes

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

CO1. Explain the construction and layout of earth moving equipments
CO2. Explain the construction and layout of constructional equipments
CO3. Explain the construction and layout of farm equipments
CO4. Explain the construction and layout of industrial vehicles
CO5. Explain the construction and layout of military and combat vehicles

Text Books:

1. Abrosimov.K, Bran Berg A and Katayer K., "Road making machinery", MIR Publishers, Moscow, 1971.
2. Wong J T .,"Theory of ground Vehicles"., John wiley & sons,Newyok,1987

References

1. Bart H vanderveen, Tanks and transport vehicles, Fresderic warne and CO ltd., London
2. Kolchin A and Demidov V "Design of Automotive Engines for Tractor", MIR Publishers, 1972.

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Course Code: 16AUE13	Course Title: VEHICLE CONTROL 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):

- Automotive Electrical and Electronics II
- Automotive Embedded Systems

Course Objectives

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

1. Explain the basic concepts of vehicle control systems
2. Develop empirical models from vehicle systems data
3. Explain the hardware components of vehicle control systems
4. Explain the working of various controllers for vehicle control systems
5. Explain the working of various engine control systems
6. Explain the working of vehicle drive line, braking and suspension control systems

Course Content **Hours**

UNIT 1 INTRODUCTION TO VEHICLE CONTROL SYSTEM 9

Steps in vehicle control system design- Influence of vehicle system design on vehicle control examples with respect to vehicle sub system - Degree of freedom for vehicle control - Calculation of the control degree of freedom - Effect of feedback on control degree of freedom - Selection of controlled, manipulated, Measured disturbance - classification of the variables in various automotive systems like engines, suspension, braking, air conditioning- General types of vehicle controller configurations-Feedback, inferential, Feed-Forward, Ratio control

UNIT II DYNAMIC BEHAVIOUR AND HARDWARE OF VEHICLE CONTROL SYSTEMS 9

Transfer function and state-space models - Dynamic behaviour of first order and second order vehicle systems- standard vehicle system inputs - dynamic responses characteristics of more complicated vehicle system- Development of empirical models from vehicle system data Hardware elements like vehicle plant, Measuring instruments, transducers, transmission lines, controller, final control elements, recording elements- use of digital computers in vehicle control

UNIT III FEEDBACK AND ADVANCED CONTROLLERS FOR VEHICLE CONTROL SYSTEM 9

Introduction- Basic control modes- Proportional control- Integral control- Reset windup - Derivative control - Various forms of PID Control - Enhancement of PID Controllers - On-Off Controllers- Typical responses of feedback control systems- Digital version of PID controllers

Feed - Forward control - Cascade control - Design Considerations for cascade control. Time delay compensation, Inferential Control - Nonlinear control-Adaptive control

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UNIT IV ENGINE CONTROL SYSTEMS 9

Fuel Control- Ignition Control- Lambada control- Idle Speed control - Knock Control- Adaptive Knock control- Combustion torque estimation

UNIT V VEHICLE DRIVE LINE, BRAKING AND SUSPENSION CONTROL SYSTEM 9

Driveline Modelling - Modelling for neutral gear -driveline control- drive line speed control- Drive line control for gear shifting- Active suspension control
Antilock braking control- Traction control-Electronic stability program control

Text Books:

1. Uwe Kiencke and Lars Nielson, Automotive Control Systems, SAE Publications,2006
2. Bosch Automotive Handbook, Sixth Edition, 2004

References:

1. Katsuhiko Ogata, System dynamics, Prentice Hall International, Inc. Third Edition,1998
2. Benjamin C.Kuo and Farid Golnaraghi, Automatic Control Systems, John Wiley & Sons, Eighth Edition,2003
3. Richard C.Kuo and Farid Golnaraghi, Automatic Control System, John Wiley & Sons, Eighth Edition, 2003

Course Outcomes

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

CO1. Explain the basic concepts of vehicle control systems
CO2. Develop empirical models from vehicle systems data
CO3. Explain the hardware components of vehicle control systems
CO4. Explain the working of various controllers for vehicle control systems
CO5. Explain the working of various engine control systems
CO6. Explain the working of vehicle drive line, braking and suspension control systems

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Course Code: 16AUE14	Course Title: PRODUCT DESIGN AND DEVELOPMENT	
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. Understand the process to plan and develop products.
2. List the process of collecting information and develop product specifications.
3. Discuss the concept generation, selection and testing processes.
4. Explain the concepts of industrial design and design for manufacture.
5. Describe the basics of prototyping, economic analysis and project planning

Course Content **Hours**

UNIT I INTRODUCTION **9**

Product Development process – Product development organizations, Gather raw data – Interpret raw data- organize the needs into a hierarchy – Relative importance of the needs, voice of customer

UNIT II PRODUCT SPECIFICATIONS **9**

Establishing the product specifications, – Target specifications – Refining specification Concept generation-Clarify the problem – Search internally – Search externally – Explore systematically.

UNIT III COMPONENT CONCEPT SELECTION **9**

Concept selection- Screening – scoring, Product architecture – Implication of architecture – Establishing the architecture – Related system level design issues.

UNIT IV INDUSTRIAL DESIGN **9**

Need for industrial design – Impact of industrial design – Industrial design process – Management of industrial design process – Assessing the quality of industrial design, design for manufacturing- cost considerations, Impact of DFM decisions on other factors.

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UNIT V PROTOTYPING & COST ANALYSIS 9

Principles of prototyping – Planning for prototypes, economics of product development projects, Elements of economic analysis – Base – Case financial model – Sensitivity analysis – Influence of the quantitative factors.

Course Outcomes:

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

CO1. Understand the process to plan and develop products.
CO2. List the process of collecting information and develop product specifications.
CO3. Discuss the concept generation, selection and testing processes.
CO4. Explain the concepts of industrial design and design for manufacture.
CO5. Describe the basics of prototyping, economic analysis and project planning

Text Books:

1.Karal, T.Ulrich Steven D.Eppinger, Product Design and Development, McGraw Hill,
International Editions, 2003.
2.Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004

References:

1. S.Rosenthal, Effective Product Design and Development, Irwin, 1992.
2. Charles Gevirtz Developing New products with TQM, McGraw Hill International Editions, 1994.
3. Dieter.G.E., "Engineering Design," McGraw Hill Company International Edition
4. Ullman D.G., "The Mechanical Design Process", McGraw Hill Company International Edition

WEB REFERENCES

- http://users.encs.concordia.ca/~andrea/inse6411/Lecture2.pdf.
- http://www.me.umn.edu/courses/me4054/lecnotes/archive.html

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Course Code: 16AUE15	Course Title: FAILURE ANALYSIS AND DESIGN	
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):

- Strength of Materials
- Design of Machine Elements

Course Objectives:

The course is intended to:

1. Explain the concepts of reliability
2. Explain the mechanics of fracture
3. Explain the characteristics of fatigue failure and fatigue testing methods
4. Explain the characteristics of Wear and corrosion failure
5. Explain the characteristics of creep failure

Course Content **Hours**

UNIT I RELIABILITY **9**

Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability - bath tub curve - parallel and series system - mean time between failures and life testing. Introduction to FMEA

UNIT II INTRODUCTION TO SOLID MECHANICS AND FRACTURE FAILURE **9**

Stresses in a body - Two dimensional and three dimensional state of stress, Mohr's circle in two and three dimensions, hydrostatic stress, Von-mises, maximum shear stress (Tresca), octahedral shear stress, torsional stresses for large plastic strain. Fracture -Types of fracture, Griffith crack theory, stress analysis of cracks, metallographic aspects of fracture. Brittle, ductile fractures, notch effects, fracture curve, R curve, fracture under combined stresses, probabilistic aspects of fracture mechanics, toughness of materials.

UNIT III FATIGUE AND FATIGUE TESTING **9**

Fatigue - Statistical nature of fatigue, S-N curve, LCF, HCF, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints. Fatigue tests - Purpose, specimen, fatigue test procedures, evaluation of fatigue test results, crack growth measurement

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UNIT IV WEAR AND CORROSION FAILURE 9

WEAR FAILURES: Type of wear, role of friction in wear, lubricated and non-lubricated wear, analysing wear failures, wear tests SOAP, ferrography. CORROSION FAILURES: Factors influencing corrosion failures, analysis of corrosion failures, overview of various types of corrosion, stress corrosion cracking - sources, characteristics of stress corrosion cracking, procedure of analysing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventive action

UNIT V CREEP FAILURE 9

ELEVATED TEMPERATURE FAILURES: Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure, elevated temperature effects on certain gas turbine components and petroleum refinery components, tests for analysis of failure at elevated temperatures.

Course Outcomes:

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

CO1. Explain the concepts of reliability
CO2. Explain the mechanics of fracture
CO3. Explain the characteristics of fatigue failure and fatigue testing methods
CO4. Explain the characteristics of Wear and corrosion failure
CO5. Explain the characteristics of creep failure

Text Books:

1. Richard W Hertzberg, "Deformation and Fracture Mechanism of Engineering Materials", John Wiley & Sons, Inc., 1995.
2. Jaap Schijve, "Fatigue of Structures and Materials", Kluwer Academic Publishers, 2001.

References:

1. ASM Metals Handbook, "Failure Analysis and Prevention", ASM Metals Park, USA, Vol. 10, 10th Edition, 1995.
2. George E Dieter, "Mechanical Metallurgy", McGraw Hill Book Company, 1988.
3. John M. Barsom, Stanley Theodore Rolfe "Fracture and Fatigue Control in Structures: Applications of Fracture Mechanics " ASTM International, 1999
4. Prasanta sahoo" Engineering Tribology" PHI Learning pvt. Ltd, 2005

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Course Code: 16AUE18	**Course Title :** PRODUCT INNOVATION THROUGH TRIZ	
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 Outcomes

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

1. Explain the fundamentals of product innovation
2. Explain the basic concepts of TRIZ
3. Solve inventive or non-routine technical problems within the framework of TRIZ
4. Apply ARIZ algorithm for inventive problem solving
5. Apply the evolution patterns for system development

Course Content **Hours**

UNIT I INTRODUCTION TO TRIZ **9**

Introduction to Product Innovation – Relationship between Invention and Innovation – Theories of Innovation, TRIZ – Theory to resolve Inventive Problems, Historical Development – Essence of TRIZ. Techniques for Breaking Psychological Inertia.

UNIT II CONCEPT OF TRIZ **9**

Ideal final Result – Problem formulation and Functional analysis – Ideality – Contradiction; Physical and Technical – Resolving Contradiction – 39 Contradicting Parameters – Contradiction Matrix – Use of S Curve and Technology Evolution Trends, Quality Function Deployment.

UNIT III INVENTIVE PRINCIPLES AND STANDARD SOLUTIONS **9**

Definition of 40 Inventive Principles – Definition of 76 Standard Solutions – Improving the System with no brittle change (13) – Improving the system by changing the system (23) – System Transitions (6) – Detection and Measurement (17) – strategies for simplification and improvement – Case Studies.

UNIT IV ARIZ ALGORITHM **9**

ARIZ – The Algorithm for Inventive Problem Solving – ARIZ frame work; Restructuring of the original problem – Removing the Physical Contradiction – Analyzing the Solution – Macro flow Chart of ARIZ– Case Studies

UNIT V EVOLUTION PATTERNS FOR SYSTEM DEVELOPMENT **9**

Introduction-Uneven Evolution of Systems, Transition to Macro level, Transition to Micro level, Increase of interactions, Expansion and Convolution, Benefits from understanding the patterns of evolution, Application of Evolution Patterns.

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Course Outcomes

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

CO1. Explain the fundamentals of product innovation
CO2. Explain the basic concepts of TRIZ
CO3. Solve inventive or non-routine technical problems within the framework of TRIZ
CO4. Apply ARIZ algorithm for inventive problem solving
CO5. Apply the evolution patterns for system development

Text Books:

1. Michael A Orloff, Inventive thinking through TRIZ, Springer, 2012.
2. Kalevi Rantanen and Ellen Domb, Simplified TRIZ-New Problem Solving Applications for Engineers and Manufacturing Professionals, Auerbach Publications 2008.

References:

1. Semyon D and Savransky, Engineering of Creativity - Introduction to TRIZ Methodology of Inventive Problem Solving, CRC Press LLC, 2000.
2. Genrich Altshuller, TRIZ Keys to Technical Innovation, Technical Innovation Center, 2002.

WEB REFERENCES

- www.triz-journal.com.

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Course Code: 16AUE19	Course Title : OPTIMIZATION TECHNIQUES	
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):

- Strength of Materials
- Design of Machine Elements

Course Outcomes

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

CO1. Apply the principles of constrained optimization techniques in solving problems.

CO2. Apply the principles of unconstrained optimization techniques in solving problems.

CO3. Apply the dynamic programming concepts in solving the multi objective and multi stage problems.

CO4. Solve the optimization problems using unconventional optimization techniques.

CO5. Solve simple design problems using optimization techniques.

COURSE CONTENT **Hours**

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 9

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods. **(Condense)**

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 9

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming, Introduction to Design of experiments and analysis of variance.

UNIT III DYNAMIC PROGRAMMING 9

Multi stage optimization – dynamic programming; stochastic programming; Multi objective Optimization.

UNIT IV UNCONVENTIONAL OPTIMIZATION TECHNIQUES 9

Genetic algorithms, Simulated Annealing and Ant Colony techniques; Neural network & Fuzzy logic principles in optimization

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UNIT V DESIGN 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.

Course Outcomes

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

CO1. Apply the principles of constrained optimization techniques in solving problems.

CO2. Apply the principles of unconstrained optimization techniques in solving problems.

CO3. Apply the dynamic programming concepts in solving the multi objective and multi stage problems.

CO4. Solve the optimization problems using unconventional optimization techniques.

CO5. Solve simple design problems using optimization techniques.

Text Book:

1. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. Ltd. 2006
2. Saravanan.R, "Manufacturing optimization through intelligent techniques",Taylor and Francis Publications,CRC Press,2006.

REFERENCES:

1. SingaresuS.Rao, "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Goldberg, D.E., "Genetic algorithms in search, optimization and machine", Barnen, Addison-Wesley, New York, 1989

WEB REFERENCES:

1. https://en.wikipedia.org/wiki/Mathematical_optimization
2. https://mech.iitm.ac.in/nspch52.pdf

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Course Code: 16AUE20	**Course Title :** DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	
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:

- Manufacturing Processes - I
- Manufacturing Processes – II
- Design of Machine Elements

Course Objectives

The course is intended to:

1. Apply the basic locating and clamping principles in designing general jigs and fixtures.
2. Design a jig for a simple components
3. Design a fixtures for the milling , turning ,welding and grinding operations
4. Design progressive, compound and combination dies for simple components.
5. Design dies for bending, forming and drawing operations

Course Content **Hours**

UNIT I LOCATING AND CLAMPING PRINCIPLES 9

Objectives of Tool design – Function and advantages of Jigs and fixtures - Materials used in Jigs and Fixtures – principles of location – Locating methods and devices - Principles of clamping- Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.

UNIT II JIGS 9

Different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs-Indexing jigs ,Drill bushes, Automatic drill jigs-Rack and pinion operated, Air operated Jigs components. Design and development of Jigs for given components.

UNIT III FIXTURES 9

General principles of boring, lathe, milling and broaching fixtures- Grinding, planing and shaping fixtures, assembly, Inspection and welding fixtures- Modular fixtures- Quick change fixtures. Design and development of fixtures for given component.

UNIT IV PRESS WORKING AND ELEMENTS OF CUTTING DIES 9

Press working terminology-Operations-Types of Presses and press accessories- Computation of capacities and tonnage requirements. Elements of progressive and compound dies: Die block, die shoe. Bolster plate-punch plate - punch holder-guide pins and bushes – strippers –knockouts-stops – pilots-Selection of standard die sets

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Design and development of progressive and compound dies for Blanking and piercing operations ,strip lay out-strip lay out calculations

UNIT V BENDING, FORMING AND DRAWING DIES 9

Bending ,forming and drawing operations –Blank development for above operations- Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect - pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing and combination dies – Blank development for axi-symmetric, rectangular and elliptic parts – Single and double action dies. Design considerations in forging, extrusion, casting and plastic dies

Course Outcomes

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

CO1: Apply the basic locating and clamping principles in designing general jigs and fixtures.

CO2: Design a jig for a simple components

CO3: Design a fixtures for the milling , turning ,welding and grinding operations

CO4: Design progressive, compound and combination dies for simple components.

CO5: Design dies for bending, forming and drawing operations

Text Book:

1. Edward G Hoffman, "Jigs & Fixture Design", Thomson – Delmar Learning, 2004
2. Donaldson.C,"ToolDesign",TataMcGraw-Hill,1986

References:

1. Kempster, "Jigs & Fixtures Design", The English Language Book Society, 1978
2. Joshi, P.H., "Jigs & Fixtures", Second Edition, Tata McGraw-Hill Publishing Company Limited, 2004

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Course Code:16MAE01	Course Title : NUMERICAL METHODS	
Core / Elective: Elective	L: T : P: C	2 : 2 : 0 : 3
Type :Theory	Total Contact hours:	60 Hours

Prerequisites

The student should have undergone the course:

- Engineering Mathematics I
- Engineering Mathematics II

Course Objectives

The course is intended to:

1. Solve the system of linear equations and calculate the dominant Eigen value
2. Solve the non-linear equations and apply the principle of least squares to fit a curve for the given data.
3. Predict the unknown values from the given set of data and to evaluate integrals.
4. Solve first order ordinary differential equation using numerical techniques
5. Solve partial differential equation using numerical techniques.

Course Content **Hours**

UNIT I SOLUTION OF SYSTEM OF LINEAR EQUATIONS 9

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 thecorresponding Eigen vector.

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

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 NTERPOLATION, NUMERICAL DIFFERENTIATION & INTEGRATION 9

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.

UNIT IV SOLUTION OF FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS 9

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.

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UNIT V SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS 9

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 students will be able to:

CO1: Solve the system of linear equations and calculate the dominant Eigen value

CO2: Solve the non-linear equations and apply the principle of least squares to fit a curve for the given data.

CO3: Predict the unknown values from the given set of data's; apply numerical techniques to find derivatives and to evaluate integrals.

CO4: Solve first order ordinary differential equation using numerical techniques

CO5: Solve partial differential equation 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", Wiley Eastern Company.

WEB REFERENCES

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

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Course Code:16MEE01	Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT (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 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.

Course Content **Hours**

UNIT I INTRODUCTION **9**

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability–Machine Capabilities-Geometric Dimensioning & Tolerancing(GD&T)- Symbols- Definitions- Datum-Functional Tolerances- IS/ISO/ASME/DIN Standards for tolerances.

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 - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification byamalgamation - Design for machinability - Design for economy - Design for assembly- Assembly Index.Evaluation Methods of Hitachi, Boothroyd Dewhurst Method and Lucas.

UNIT IV COMPONENT DESIGN:CASTING & WELDING CONSIDERATION **9**

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Types of Welds-Minimizing Distortion-Weld Strength-Cost Reduction- Electron andLaser Beam Weldments - Design for welding- Design recommendations for welding.

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UNIT V DESIGN FOR 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-Group technology - Computer Applications for DFMA.

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, clamp-ability, 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 Manufactureand Assembly, Third Edition, CRC Press, 2010
2. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004

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, 1995
3. Fixel, J. Design for the Environment McGraw hill., 1996

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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

Course Content **Hours**

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 modelling concepts to study the system behaviour.
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, 2009.
2. K.U. Siddiqui and Manojkumarsingh, "Mechanical system Design"-New Age international Publishers, 2010.

References

1. S.S.Rao "Engineering Optimization-Theory and Practice" New Age international Publishers, 1996.
2. S.Kalavathy "Operations Research" Vikas Publishing House,2012
3. RamachandranAryasry&VV.Ramana Murthy, "Engg Economics & Financial Accounting", Tata McGraw-Hill Company, NewDelhi, 2004.

Web References

- http://content.asce.org/files/pdf/team2010-2Mechanical_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 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):

- Materials Science
- Strength of Materials
- Metallurgical Engineering.

Course Objectives

The course is intended to:

1. Classify different types of Matrix and Reinforcements
2. Explain different types Fibres and Matrices
3. Explain different types of methods to fabricate composites
4. Explain the mechanics of Fibre reinforced composites
5. Explain the load bearing behavior of Composite structures.

Course Content **Hours**

UNIT I INTRODUCTION **9**

Definition – Classification of Composite materials based on structure – based on matrix. Advantages of composites – application of composites – functional requirements of reinforcement and matrix. Reinforcement types – Fibres – continuous, particulate and whisker reinforcements – Properties -Applications – Comparison of fibre strengths –. Matrix materials – Properties. Wettability fibre with matrix – Effect of surface roughness – Interfacial bonding

UNIT IIREINFORCEMENTS AND MATRICES **9**

Different types of fibers - Manufacturing, properties and applications of glass fibers, carbon fibers, Kevlar fibers. Thermoset and thermoplastic matrices - properties of polyester, epoxy and nylon matrices, polypropylene and PEEK matrices.

UNIT III MANUFACTURING OF COMPOSITES **9**

Polymer matrix composites: Preparation of Moulding compounds and pre-pregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding.

UNIT IV MECHANICS 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.

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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. Classify different types of Matrix and Reinforcements
CO2. Explain different types Fibres and Matrices
CO3. Explain different types of methods to fabricate composites
CO4. Explain the mechanics of Fibre reinforced composites
CO5. Explain the load bearing behavior of Composite structures.

TEXT BOOKS

1. Krishnan K.Chawla, "Composite Materials Science and Engineering", Springer.
2. Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design",Maneel Dekker Inc, 1993.

REFERENCES

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites",John Wiley and Sons, New York, 1990.
2. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994,Second Edition

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 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):

- 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.

Course Content **Hours**

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: 16MEE09	**Course Title:** DESIGN FOR WELDING (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 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.

Course Content **Hours**

UNIT I INTRODUCTION **9**

Fundamentals of Arc Welding Process – Arc Welding Processes Principle and operation - Advantages and Limitations of Processes - Characteristics of each process - Power sources and other subsystems of Welding process and their Influence on the Process behavior - MIG / MAG Welding - Various types of GMAW process and its applications - Process requirements of GMAW process - Impact of Process parameters - Defects of GMAW, Causes and their remedies - Resistance Welding - Various types of Resistance welding process and its applications - Consumables of the processes - Process requirements of Resistance Welding process - Impact of Process parameters - 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 - Behavior of Tubular Weld Joint - Procedure to perform Tubular Weld Joints -Influence of Attributes on Material - Effect of Temperature on Metallurgical properties - Causes of Distortion - Analysis of Distortion using FEA - Causes for Residual Stresses - Process development for Component specification - Quality requirement for Welders and Process - Skills required by a operator - Qualification Tests for Operator - Qualification Tests for Process - Optimization of Weld Process - Various automation and Mechanization techniques - Estimation of Welding Costs for a given application.

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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 welding fixture accessories used for different welding application - Raw material used for welding fixture - Manufacturing process for different welding fixture elements. Welding Fixtures Application -Types of welding application -Different types of welding fixtures for Resistance welding application (Manual/Auto) -Different types of welding fixtures for MIG welding application.

UNIT IV DESIGN OF FIXTURES FOR WELD PARTS 9

Critical & Major dimension of the part -Datum used in the weld part - Location, orientation, resting & clamping for the weld part - Design of welding fixture concept for given part- Design FMEA for the pre designed concept fixture -Welding distortion control by using fixture clamping - Design of Assembly welding fixture drawing for a given part - Design of Elemental drawing of given welding fixture.

UNIT V INSPECTION AND VALIDATION OF WELDING FIXTURES 9

Inspection & method of Inspection -Critical fit function of fixture hold part - fixture dimension & tolerance - fixture inspection procedure - Possible failure modes while inspection - Fixture validation - 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 a suitable welding process based on the given part geometry, material and desired weld quality.
CO2: Identify the potential failure modes of a weld joint based on the given constraints.
CO3: Explain the types of fixtures used in Manual/Auto welding processes.
CO4: Design a suitable welding fixture based on the type of weld and geometry.
CO5: Explain inspection, maintenance and calibration procedure for weld 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.

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Course Code:16MEE11	**Course Title:** DESIGN FOR SHEET METAL (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 courses:

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

Course Objectives

The course is intended to:

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

Course Content **Hours**

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.

UNIT IV TUBE BENDING PROCESS AND EQUIPMENTS 9

Tube bending process -Types of tube bending operation - 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. Equipment's of Tube

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bending – Conventional type pipe bending machine - clamp - wiper shoe - Bend form – Mandrel, Single axis pipe bending machine, 3 axis & 5 axis pipe bending machine.

UNIT V TOOL COSTING AND SELECTIONS 11

Cost drivers for formed part – Tool cost estimation - Trial & Inspection cost overhead cost & profit. 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 - stripping force - 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).

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, 1986.

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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MANUFACTURING STREAM

Course Code: 16AUE21	Course Title: RAPID PROTOTYPING AND TOOLING	
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 importance of Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle and cost.
2. Explain various liquid based and solid based rapid prototyping systems.
3. Explain data preparation for rapid prototyping technologies.
4. Explain Three Dimensional Printing process.
5. Explain the classification of Rapid tooling and case studies on applications in industries

Course Content **Hours**

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 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. Explain various liquid based and solid based rapid prototyping systems.
CO3. Explain data preparation for rapid prototyping technologies.
CO4. Explain Three Dimensional Printing process.
CO5. Explain the classification of Rapid tooling and case studies on applications in industries

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. Terry wohlers, "Wohlers Report 2000", Wohlers Associates, 2000.

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.
4. Ali K. Kamrani, Emad Abouel Nasr, "Rapid Prototyping and Tooling, Industrial Design Centre, IIT, 1983.
5. Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.

WEB REFERENCES

- https://www.nde-ed.org/index_flash.htm

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Course Code: 16AUE22	Course Title: PLANT LAYOUT AND MATERIAL HANDLING	
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 concept of plant layout and required equipments for plant operations
2. Explain the techniques for developing various types of layouts and layout planning procedure
3. Identify the suitable environment for industrial buildings and utilities
4. Understand the benefit of an efficient material handling system
5. Understand difficulties in material handling system on process layout

Course Content **Hours**

UNIT I PLANT LOCATION AND PHYSICAL FACILITIES 9

Factors to be considered – Influence of location on plant layout, selection of plant site,consideration in facilities planning and layout – Equipment required for plant operation,Capacity, Serviceability and flexibility and analysis in selection of equipments, space and man power requirements

UNIT II PLANT LAYOUT 9

Need for layout, types of layout, factors influencing product, process, fixed and combination layout, tool and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models – machine data. Layout planning procedure – visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines

UNIT III INDUSTRIAL BUILDINGS AND UTILITIES 9

Centralized electrical, pneumatic, water line systems. Types of buildings, lighting, heating, air-conditioning and ventilation utilities – planning and maintenance, waste handling, statutory requirements, packing and storage of materials: Importance of packaging, layout for packaging – packaging machinery – wrapping and packing of materials, cushion materials.

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UNIT IV MATERIAL HANDLING 9

Importance and Scopes – Principles of material handling – engineering and economic factors - planning, relationship to plant layout – types and selection of material handling systems, factors influencing their choice – concept of containerization and palletization.

UNIT V ANALYSIS OF MATERIAL HANDLING 9

Factors involved – motion analysis, flow analysis, graphical analysis, safety analysis, equipment cost analysis, palletization analysis, analysis of operation, material handling surveys – Designing of material handling systems – System equation - Planning chart, Unit load design – principle - efficiency of containers, pallet sizes.

Course Outcomes

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

CO1: Understand the concept of plant layout and required equipments for plant operations
CO2: Explain the techniques for developing various types of layouts and layout planning procedure
CO3: Identify the suitable environment for industrial buildings and utilities
CO4: Understand the benefit of an efficient material handling system
CO5: Understand difficulties in material handling system on process layout

Text Books:

1. G.K Agrawal, "Plant Layout and Material Handling", Jain Publishing, 2012
2. Khanna, O. P., "Industrial Engineering and Management", Dhanpatrai and Sons, 2003.

References:

1. James A. Tompkins , John A. White, Yavuz A. Bozer and J. M. A. Tanchoco "Facilities Planning", 3rd edition , John Wiley & Sons, 2003.
2. Fred E Meyers, "Plant Layout and Material Handling", 2nd edition, Prentice Hall, 1999.

WEB REFERENCES

- https://en.wikipedia.org/wiki/Plant_layout_study
- https://en.wikipedia.org/wiki/Material_handling

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Course Code: 16AUE23	Course Title: MICRO MANUFACTURING	
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
- Material Science

Course Objectives:

The course is intended to:

1. To understand the properties, design and behaviour of various micro materials.
2. To analyze the microscopic and macroscopic properties of micro materials.
3. To understands the concept of various micro fabrication processes.
4. To impart the principles of different micro machining process.
5. To understands the principles and applications of Micro Electro Mechanical Fabrication Systems.

Course Content **Hours**

UNIT I INTRODUCTION **9**

Introduction to Micro System design, Material properties, micro fabrication Technologies. Structural behavior, sensing methods, micro scale transport – feedback systems

UNIT II MICROMECHANICS **9**

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 III 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.

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UNIT IV MECHANICAL MICROMACHINING 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

UNIT V MICRO ELECTRO MECHANICAL SYSTEM FABRICATION 9

Introduction – advance in Microelectronics – characteristics and Principles of MEMS – Design and application of MEMS: Automobile, defense, healthcare, Aerospace, industrial properties etc., - Materials for MEMS – MEMS fabrication- Bulk Micro Machining-LIGA – Microsystems packaging- Future of MEMS.

Course Outcomes:

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

CO1. Describe the properties, design and behaviour of various micro materials.
CO2. Explain the microscopic and macroscopic properties of micro materials.
CO3. Describe the concept of various micro fabrication processes.
CO4. Describe the principles of different micro machining process.
CO5. Explain the principles and applications of Micro Electro Mechanical Fabrication Systems.

Text Books:

1. Sámi Franssila, "Introduction to Micro Fabrication", John Wiley and sons Ltd., UK, 2004, ISBN: 978-0-470-85106-7.
2. Madore J, "fundamental of Micro fabrication", CRC Press, 2002.

References:

1. Mark J. Jackson, "Micro fabrication and Nano manufacturing", CRC Press, 2006.
2. Peter Van Zant, "Microchip fabrication", McGraw Hill, 2004.
3. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, 2006.

WEB REFERENCES

- https://en.wikipedia.org/wiki/Microfabrication
- http://www.micromanufacturing.net/didactico/Desarollo/microforming/1-introduction

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Course Code: 16AUE24	Course Title: PRODUCTION PLANNING AND CONTROL	
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
- Engineering economics and cost analysis.

Course Objectives

The course is intended to:

1. Outline the fundamentals of production planning control.
2. Apply work measurement techniques and method-study for productivity improvement.
3. Infer steps in product planning using product information.
4. Solve Problems related to production scheduling.
5. Discuss the effect of demand on inventories and recent trends in production process control

Course Content **Hours**

UNIT I INTRODUCTION **9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect-aesthetic aspect. Profit consideration- Standardization, Simplification & specialization-Break even analysis-Economics of a new design.

UNIT II WORK STUDY **9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study - work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING **9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing - Pre requisite information needed for process planning - Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi-product system.

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UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance - Flow production scheduling- Batch production scheduling-Product sequencing - Production Control systems-Periodic batch control- Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system -Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis-Recorder procedure-Introduction to computer integrated production planning systems- elements of Just in time systems Fundamentals of MRP II and ERP.

Course Outcomes

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

CO1. Outline the fundamentals of production planning control.
CO2. Apply work measurement techniques and method-study for productivity improvement.
CO3. Infer steps in product planning using product information.
CO4.Solve Problems related to production scheduling.
CO5. Discuss the effect of demand on inventories and recent trends in production process control

Text Books:

1. Martand Telsang, "Industrial Engineering and Production Management", First Edition, S. Chand and Company, 2000.
2. James.B.Dilworth,"Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International Edition1992.

References:

1. Andrew Sloss, Dominic Symes& Chris Wright, "ARM system Developer's guide", Elsevier.2005.1. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
2. Elwood S.Buffa, and RakeshK.Sarin, "Modern Production / b Operations Management", 8th Ed.John Wiley and Sons, 2000.
3. KanishkaBedi, " Production and Operations management", 2nd Edition, Oxford university press,2007.

WEB REFERENCES

- http://www.managementstudyguide.com/production-planning-and-control.htm
- http://www.tandfonline.com/toc/tppc20/current

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Course Code:16MEE18	**Course Title:** PROCESS PLANNING AND COST ESTIMATION (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 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

Course Content **Hours**

UNIT I 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 COMPUTER AIDED PROCESS PLANNING ESTIMATING 9

Retrieval type/variant approach, group technology – generative approach, logics decision tress and tables, axiomatic approach – AI expert systems – feature recognition – applications Concepts, differences.

UNIT III DIRECT AND INDIRECT COST COMPONENTS 9

Different costing methods – classification of costs – cost grid-problems. Labour cost–direct, indirect–estimation–Labour norms–time study rating – Labour cost- material cost –problems. Overhead cost - Elements – factory, administrative, sales and distribution expenses–methods of absorbing overheads – Direct Labour, Direct Material Machine Hour Rate methods – problems.

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UNIT IV COST CALCULATIONS 9

Machined components (lathe operation , drilling , milling) –welded components (Gas and Arc) , forged components , calculation of sales cost, case studies, use of computers in cost estimation, cost of rejection - 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: Prepare process planning sheet for various machining processes
CO2: Evaluate the various approaches of manual and computer aided process planning.
CO3: Differentiate various cost drivers involved in direct and indirect costs.
CO4: Calculate the cost involved in different manufacturing process.
CO5: Analyze various types of Cost Management and Break Even Analysis

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.

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
- https://en.wikipedia.org/wiki/Cost_estimate

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Course Code:16MEE19	**Course Title:**UNCONVENTIONAL MACHINING PROCESSES (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 processes

Course Objectives

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

Course Content **Hours**

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 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

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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.

Text Books:

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007
2. 2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi (2007).

References:

1. Benedict.G.F."Nontraditional Manufacturing Processes" Marcel Dekker Inc., New York (1987).
2. 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.
3. 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

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Course Code:16MEE21	**Course Title:**NON-DESTRUCTIVE TESTING METHODS (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 Metrology and Measurements.

Course Objectives

The course is intended to:

1. Explain Visual Inspection and Eddy Current Testing Method.
2. Prepare Magnetic Particle Testing Method
3. Prepare Liquid Reentrant Testing Method
4. Plan for Ultrasonic Testing Method
5. Plan for Radiographic Testing Method

Course Content **Hours**

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, Flexi scope, 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, emulsifiers developers, lint free cloth-Basic Principle, applications and limitations of liquid penetrant testing(LPT)-different LPT methods-Post-Emulsification Fluorescent penetrant process, Reverse Fluorescent Dye penetrant process, Visible Dye penetrant process, Water-Emulsification visible Dye penetrant process, solvent clean visible Dye penetrant process.

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UNIT IV ULTRASONIC TESTING METHOD 9

Basic properties of sound beam-sound waves-velocity of ultrasonic waves, Acoustic Impedance behavior 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-Penetrometer-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.

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.

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- https://www.nde-ed.org/index_flash.htm
- http:// http://117.55.241.6/library/E-Books/NDT%20Notes.pdf
- http:// www.slideshare.net/ndtindia123/introduction-uses-of-non-destructive-testing-24377016

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Course Code: 16MEE27	Course Title: LEAN MANUFACTURING	
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 the need for Lean Manufacturing.
2 Describe the tools and methodologies of Lean Manufacturing.
3 Describe the value stream management in Lean Manufacturing.
4 Explain the implementation of Lean Manufacturing in manufacturing and service industries.
5 Calculate the various lean metrics.

Course Content **Hours**

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 , Genchi Genbutsu, 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 need for Lean Manufacturing.
CO2 Describe the tools and methodologies of Lean Manufacturing.
CO3 Describe the value stream management in Lean Manufacturing.
CO4 Explain the implementation of Lean Manufacturing in manufacturing and service industries.
CO5 Calculate the various lean metrics.

Text Books:

1. Don Tapping, Tom Luyster, and Tom Shuker, Value stream Management Eight steps to planning, Mapping and sustaining Lean Improvements,2002, Productivity Press,New York.
2. N.Gopalakrishnan, Simplified Lean Manufacture Elements, Rules, Tools and Implementation, 2010, PHI Learning, New Delhi.

References:

1. James P. Womack, Daniel T Jones, Daniel Ross The Machine That Change the world,2007, Free Press trade paperback edition, U.S.A.
2. Ronald G. Askin & Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems,2003, John Wiley & Sons.
3. Rother M. and Shook J, 'Learning to See: Value Stream Mapping to Add Value and Eliminate Muda' , Lean Enterprise Institute, 1999, Brookline, MA.

WEB REFERENCES

- https:// www.learning –to-see.co.uk.
- https://www.lean.org.

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Course Code:16MEE28	Course Title:COMPUTER INTEGRATED MANUFACTURING (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 processes

Course Objectives

The course is intended to:

1. Explain NC, DNC and CNC used in CIM.
2. Apply the features of CAD System in design and modeling and understanding the integration of CAE
3. Explain the role of AGVs, AS/RS and Robots in material handling and Storage System.
4. Describe Group Technology and Classification of Coding system.
5. Explain Artificial Intelligent system, Expert system and FMS.

Course Content **Hours**

UNIT I INTRODUCTION **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, COMPUTER AIDED ENGINEERING 9

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD - typical CAD command structure - Types CAD modeling - wire frame modeling, surface modeling and solid modeling-Reverse engineering -Modeling of geometry of parts -Modeling of assemblies and disassemblies –Sustainable engineering –Differentmodeling packages -Data exchange standards between different software -Use of analysis software (FEA)-Use of CAE software –Case studies

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

GroupTechnology– RoleofG.TinCAD/CAM Integration, partfamilies, part Classificationandcoding–DCLASSandMICLASSandOPITZcodingsystems - facility designusingG.T, benefitsofG.T - Cellular Manufacturing.

UNIT V ARTIFICIAL INTELLIGENT SYSTEM, EXPERT SYSTEM ANDFMS 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: Explain NC, DNC and CNC used in CIM.
CO2: Apply the features of CAD System in design and modeling.
CO3: Explain the role of AGVs, AS/RS and Robots in material handling and Storage System.
CO4: Describe Group Technology and Classification of Coding system.
CO5: Explain Artificial Intelligent system, Expert system and FMS.

Text Books:

1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2001.
2. Mikell. P. Groover and Emory Zimmers Jr.,"CAD/CAM", Prentice hall of India Pvt. Ltd., 1998.

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.

WEB REFERENCES

- https://en.wikipedia.org/wiki/Computer-integrated_manufacturing
- https://en.wikipedia.org/wiki/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):

- Kinematics of Machines
- Metal Forming, Joining and Casting Processes
- Metal Cutting Processes

Course Objectives:

The course is intended to:

1: Explain the fundamentals of robot.
2: Describe the working of various robot drive systems and end effectors
3: Discuss the working principle of various sensors.
4: Explain the concepts of robot kinematics and robot programming.
5: Understand the implementation of robotics in industries.

Course Content **Hours**

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), 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

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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:

CO 1: Explain the fundamentals of robot.
CO 2: Describe the working of various robot drive systems and end effectors
CO 3: Discuss the working principle of various sensors.
CO 4: Explain the concepts of robot kinematics and robot programming.
CO 5: Understand the implementation of robotics in industries.

Text Book:

1. M.P.Groover, "Industrial Robotics – Technology, Programming and Applications", McGraw-Hill, 2001.

References:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw-Hill Book Co., 1987
2. Yoram Koren, "Robotics for Engineers", McGraw-Hill Book Co., 1992
3. Janakiraman.P.A., "Robotics and Image Processing", Tata McGraw-Hill, 1995
4. S.R.Deb and Shanka Deb "Robotics Technology and Flexible Automation", TATA Mc Graw Hill, 2009.
5. Richard D.Klafter "Robotic Engineering an integrated approach", Prentice Hall,1989.

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: 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.

Course Contents **Hours**

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 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

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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.

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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):

- Nil

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.

Course Content **Hours**

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 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. 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.

Reference Books:

1. Christopher M, "Logistics and Supply Chain Management - Creating Value Adding Networks", Prentice Hall, 2010.
2. Prauss L,"The Green Multiplier - a Study of Environmental Protection and Supply Chain", Antonn Rauss Limited, Palgrave Macmillan, 2005.
3. 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):

- Nil

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.

Course Contents **Hours**

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 MANAGEMENT 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.

UNIT III FLOW PRODUCTION AND MULTI PROCESS OPERATION 10

Introduction to flow production- flow production within factories & between factories- precautions and procedures for developing multi-process operations- level production,-various ways to create production schedules- leveling techniques- difference between shish-kabob production and level production.

UNIT IV BASICS OF KANBAN, KAIZEN AND JIDOKA 10

Differences between kanban and conventional systems -functions and rules of kanban- variety and quantity of kanban, administration of kanban, visual controls – andons, changeover improvement kaizen- seven rules for improving changeover- steps toward jidoka -difference between jidoka and automation - functions of jidoka, extension of jidoka to the assembly lines - labour cost reduction steps.

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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 - engineering related forms -JIT Introduction related 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 Companies Inc, 2008.
2. Paneer Selvam R "Production and Operations Management" Prentice Hall of India, 2010.
3. Hiroyuki Hirano, "JIT Implementation Manual", English Translation Copy Right Productivity Press, 1990.

Reference Books:

1. Kotsundo Hitomis'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, 1992.
3. Samuel Eilon, "Elements of Production Planning and control", 1st edition, Collier Macmillan Ltd, 1962.
4. Chary "Theory and Problems in Production and Operations Management" Tata Mc-Hraw Hill, 2009.
5. Buffa E.S. and Sarin, R.K, "Modern Production/Operations Management" Eighth edition, John Wiley & Sons, 1987.

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THERMAL, QUALITY AND MAINTENANCE STREAM

Course Code:16AUE05	**Course Title:** ALTERNATIVE FUELS FOR IC 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):

- IC Engines
- Automotive fuels and lubricants

Course Objectives

The course is intended to:

1. Explain the performance and emission characteristics of alcoholic fuels
2. Explain the performance and emission characteristics of vegetable oils
3. Explain the performance and emission characteristics of Biogas, CNG, and LPG
4. Explain the performance and emission characteristics of hydrogen
5. Explain the performance and emission characteristics of synthetic fuels.

Course Content **Hours**

UNIT I ALCOHOLS **9**

Introduction to alternative fuels. - Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation, oxygenated additives. Performance and emission characteristics alcohols as fuels in CI and SI engines.

UNIT II VEGETABLE OILS **9**

Various vegetable oils and their properties. Different methods of using Straight vegetable oils in engines -Blending, preheating, Problems of using SVO. Biodiesel production- trans esterification of vegetable oils - advantages of biodiesel Performance and Emission Characteristics of biodiesel in diesel engines.

UNIT III BIOGAS, NATURAL GAS AND LPG **9**

Production methods of biogas- and its characteristics- compressed natural gas and LPG. Properties of gaseous fuels - modification required to use gaseous fuels in SI and CI engines- performance and emission characteristics of CNG and LPG in SI and CI engines.

UNIT IV HYDROGEN **9**

Production methods of hydrogen. Properties of hydrogen- different methods of using hydrogen in SI and CI engines. performance and emission characteristics of hydrogen in engines. Hydrogen storage - safety aspects of hydrogen- Problems associated with hydrogen as fuel

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UNIT V SYNTHETIC ALTERNATIVE FUELS 9

Properties of Di-Methyl Ether (DME) - Diethyl Ether (DEE) - Performanceand emission characteristics in CI and SI engines. Biomass to Liquid (BTL) - Gas to Liquid (GTL) - Synthesis methods – Pyrolysis, Fischer-Tropsch (FT) - Wood Pyrolysis Oil (WPO) - Tyre Pyrolysis Oil (TPO)- Plastic Fuel

Course Outcomes

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

CO1: Describe the performance and emission characteristics of IC engines with pure and blended alcoholic fuels
CO2: Explain the trans esterification of vegetable oils and their performance and emission characteristics while used as fuel in of IC engines.
CO3: Explain the modification required in engines, performance and emission characteristics while using biogas, CNG, and LPG in SI and CI Engines
CO4: Explain the safety aspects, performance and emission characteristics of hydrogen used as IC engine fuel
CO5: Explain the performance and emission characteristics of different synthetic fuels used in IC engines.

Text Books:

1. A S Ramadhas," Alternative Fuels for Transportation ", CRC Press, 2010.
2. S.S. Thipse, "Alternative Fuels Concepts, Technologies and Developments", Jaico Publishing House, 2010.

References:

1. James Speight, " Synthetic Fuels Handbook: Properties, Process, and Performance ", McGraw Hill Professional, 2008.
2. "The properties and performance of modern alternate fuels" - SAE PaperNo.841210.
3. Keith owen and Trever Coley, "Automotive Fuels Reference Book", SAE 1995.

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Course Code:16AUE06	Course Title:RELIABILITY AND MAINTENANCE 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 Practices Laboratory
- Material Science
- Metal Forming, Joining and casting processes
- Metal cutting processes

Course Objectives

The course is intended to:

1. Explain the principle involved in reliability and maintainability
2. Improve reliability of system by applying redundancy techniques.
3. Evaluate system reliability from reliability of sub systems.
4. Implement maintenance policies for the successful management of maintenance activities.
5. Conduct hazard and safety analysis for material handling equipments

Course Content **Hours**

UNIT I BASIC CONCEPTS OF RELIABILITY MAINTENANCE AND AVAILABILITY **9**

Reliabilty –Definition, Reliability vs quality, Failure and failure modes,Bath tub curve,causes of failures and unreliability. Maintainability, Availability- Concepts, Definition. System down time, uptime – MTBF,MTTR,MTBM. Types of availability- Inherent availability, Achieved availability and Operation availability. Reliability and Maintanability trade off.

UNIT II DESIGN FOR RELIABILITY **9**

Reliability analysis, Mathematical models and numerical evaluation. Designing for higher reliability. Redundancy Techniques, Application. Various forms of redundancy.

UNIT III SYSTEM RELIABILITY **9**

Determination of system reliability from subsystems. Series configuration, Parallel configuration, Mixed configuration, R out of N structure. Component redundancy vs Unit redundancy, Stand by redundancy, Mixed redundancy- Simple problems to calculate system reliability. Reliability cost trade off.

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UNIT IV MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE 9

Maintenance categories – comparative merits of each category – preventive maintenance, maintenance schedules, repair cycle – Principles and methods of lubrication – TPM.

UNIT V SAFETY AND OTHER ASPECTS OF MAINTENANCE 9

Repair methods for material handling equipment – Equipment records – Job order systems – use of computer in maintenance.

Course Outcomes

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

CO1: Explain the principle involved in reliability and maintainability
CO2: Improve reliability of system by applying redundancy techniques
CO3: Evaluate system reliability from reliability of sub systems.
CO4: Implement maintenance policies for the successful management of maintenance activities.
CO5: Conduct hazard and safety analysis for material handling equipments in line with industrial standards.

Text Books:

1. Srivastava S.K., "Industrial Maintenance Management", - S. Chand and Co., 1981
2. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., 1995

References:

1. White E.N., "Maintenance Planning", I Documentation, Gower Press, 1979.
2. Mishra R.C. and Pathak K. "Maintenance Engineering and Management" Prentice Hall of India Pvt. Ltd. 2007. 3 Garg M.R., "Industrial Maintenance", S. Chand & Co., 1986.
3. Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill, 5th Edition, 1988

WEB REFERENCES

- http://catalog.flatworldknowledge.com/bookhub/reader/5?cid=41991&e=carpenter-ch01
- http://www.nios.ac.in/media/documents/VocInsServices/m1-4f.pdf

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Course Code: 16AUE07	Course Title: VEHICLE BODY 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):

- Automotive Chassis

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

1. Illustrate the various types of car body.
2. Classify the different constructions of bus body
3. Classify the type of commercial vehicles.
4. Describe the aerodynamic effect.
5. Describe the various materials used for body construction

Course Content **Hours**

UNIT I CAR BODY **9**

Car body terminology- Types of car: sedan limousine, convertible, hatch back car, station wagon, racing car- Visibility regulations- Tests for visibility, Methods to improve visibility, Safety regulations, Factors considering the safety design- Crumple zone- Safety features in car.

UNIT II BUS BODY **9**

Bus body terminology- Types of bus based on size: minibus, town, mofussil, luxury bus- Types of bus based on shape: single deck, double deck, articulated bus- body on frame construction-integral type of construction- double skin bus body construction- Bus body layout: entrance and exit location, engine location, bus floor height- bus body building process.

UNIT III COMMERCIAL VEHICLE BODY **9**

Types of LCV: pickup van, auto rickshaw cargo truck- Types of MCV: dropside, box van- Types of HCV: flat platform, tipper, tanker, draw bar trailer- Design factors of driver cab and seat- Types of driver cab: normal control, forward control, semi forward control

UNIT IV VEHICLE AERODYNAMICS **9**

Objective of aerodynamics- Types of aerodynamic forces and moments- Effect of forces and moments on vehicle body- Types of aerodynamic drag- drag reduction methods- closed circuit wind tunnel test- flow visualization methods

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UNIT V BODY MATERIALS, RECONSTRUCTION AND TRIMS 9

Types and properties of body materials: steel sheet, timber, polymers, FRP- body collision reconstruction- panel replacement reconstruction-types of paints-body painting process- anti corrosion coating methods- body trims

Course Outcomes

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

CO1. Illustrate the various types of car body and ergonomic design aspects.
CO2. Classify the different constructions of bus body based on size and shape of body.
CO3. Classify the type of commercial vehicles based on body structure.
CO4. Describe the aerodynamic effect of forces on vehicle body.
CO5. Describe the various materials used for body construction and body repairing methods.

Text books:

1. John Fenton, Vehicle Body layout and analysis, Mechanical Engg. Publication Ltd., London., London.
2. James E Dufly, Body Repair Technology for 4-Wheelers, Cengage learning, 2009.

References:

1. Powloski J. Vehicle Body Engineering, Business Books Ltd., 1998.
2. Giles, G J., Body construction and design, Illiffe Books Butterworth & Co.,1991.
3. Dieler Anselm., The Passenger car body, SAE International, 2000.

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Course Code: 16AUE15	Course Title: AUTOMOTIVE INSTRUMENTATION AND CONTROL	
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):

- Automotive Electrical and Electronics - II
- Automotive Chassis

Course Objectives

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

1. Explain the working of various measuring instruments
2. Describe the working of engine system analyzer
3. Explain wheel alignment, wheel balancing and wind tunnel testing
4. Explain NVH measurement and chassis dynamometers
5. Explain the basics of control systems

Course Content **Hours**

UNIT I INTRODUCTION **10**

Transducers, types, thermistor, LVDT, inductive pickup, capacitance, strain gauges, semiconductors, photocells, piezoelectric accelerometer, proximity sensors, micro switches, encoders, piezo-electric pressure sensors, instruments, ammeter, voltmeter, odometer, speedometer, fuel level indicator, pressure gauge, vacuum gauge, analog and digital, calibration, cathode ray oscilloscope, study of microprocessors 8085, micro controller, PLC.

UNITII ENGINE SYSTEM ANALYZER **10**

Introduction, exhaust gas analyzer, emission norm standards, flasher instrumentations, accelerometer, real time DAQ , fuel injection calibration, calibration rig ignition timer calibration, stroboscope, smoke meter, macro inspection of interior parts using fiber optics.

UNIT III CHASSIS INSTRUMENTATION **8**

Introduction Wheel alignment gauges, laser alignment, measurement different wheel parameters system wheel balancing, calibrations, wind tunnel testing and drag estimation and profile optimization

UNIT IV NVH, DYNAMOMETERS AND GAUGES **8**

Sound level meters, acoustic measurement, FFT analyzer, anechoic chamber, varechoic chamber, sound level measurements, NVH standards. Torque measuring instruments, Study of different dynamometers, chassis dynamometer for two and four wheelers

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UNIT V CONTROL SYSTEMS FUNDAMENTALS 9

Basics of controls systems –different types , PID controller, sliding mode control-design and analysis, automotive applications of control systems

Course Outcomes

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

CO1. Explain the working of various measuring instruments used in automobiles.
CO2. Describe the working of engine system analyzer
CO3. Explain wheel alignment, wheel balancing and wind tunnel testing
CO4. Explain NVH measurement and chassis dynamometers
CO5. Explain the basics of control systems in automotive application

Text Books:

1. Beckwith T G and Buck N L "Mechanical Measurements " Wesley publishing company limited, USA,1995.
2. UWE Kiencke , Lars Nielsen: Automotive control systems Springer-Springer-Verlag

References:

1. Peter Elgan "Sensors for Measurements and control", 2nd edition, Pearson Education Limited, England,2001.
2. Holman "Experimental methods for engineers"- McGraw hill publishing company,1994.
3. Ernest O Doebelin "Measurement systems – Application and Design "McGraw hill publishing company, 1990.

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Course Code: 16AUE16	Course Title: VEHICLE MAINTENANCE	
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):

- IC Engines
- Automotive Chassis
- Automotive Transmission

Course Objectives

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

1. Explain the maintenance practices, safety and tools used
2. Explain the engine and engine subsystem maintenance
3. Explain the transmission and driveline maintenance
4. Explain the steering, brake, suspension and wheel maintenance maintenance
5. Explain the electrical and air conditioning maintenance

Course Content **Hours**

UNIT I MAINTENANCE WORKSHOP PRACTICES SAFETY AND TOOLS 9

Maintenance- Need, Importance, Primary and secondary functions, Policies,- Classifications of maintenance work - Vehicle Insurance - basic Problem Diagnosis. Automotive Service procedures- Work shop operations - Workshopmanual- Vehicle identification.Safety- Personnel, Machines, and equipment, vehicles, fire safety- Firstaid. Basic tools - Special service tools- Mesuring instruments- Conditionchecking of seals, gaskets and sealants. Scheduldedmaintenance services- service intervals - towing and recovering.

UNIT II ENGINE AND ENGINE SUBSYSTEM MAINTENANCE 9

General Engine service- Dismantling of Engine components- Engine repair - Working on the underside, front,top, ancillaries- serviceof basic engine parts, cooling and lubricating system, Fuel system, Intake and exhaust system, Electrical system- Electronic fuel injection and engine management service - Fault diagnosis -servicing emission controls

UNITIII TRANSMISSION AND DRIVELINE MAINTENANCE 9

Clutch- general checks, adjustment and service -Dismantling, Identifying, Checking and reassembling of transmission, transaxle- road testing -removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joint - Rear axle service points -Removing axle shaft and bearings- servicing differential assemblies- fault diagnosis

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UNIT IV STEERING BRAKE SUSPENSION WHEEL MAINTENANCE 9

Inspection, maintenance and service of hydraulic brake, drum brake,disc brake, parkingbrake, bleeding of brakes. Inspection, Maintenance and service of Mc Pherson strut, coilspring, leaf spring, shock absorber,Dismantling and assembly procedures.

Wheel alignment and balance, Removingand fitting of tyres,tyre wear and tyre rotation.

Inspection,Maintennace and service of steering linkage, steering linkage, steering column, rack and pinion steering, recirculating ball steering service- worm type steering, power steering system

UNIT V ELECTRICAL AND AIR CONDITIONING MAINTENANCE 9

Maintenance of batteries, starting system, charging system and body electrical- Fault Diagnosis using scan tools. Maintenance of Air conditioning parts like compressor, condensor, expansion valve, evaporato- replacement of hoses- leak detection - AC Charging - Fault Diagnosis. Vehicle Body repair like panel beating, tinkering,soldering,polishing, painting.

Course Outcomes

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

CO1. Explain the maintenance practices, safety and tools used in workshop
CO2. Explain the engine and engine subsystem maintenance procedure
CO3. Explain the transmission and driveline maintenance procedure
CO4. Explain the steering, brake, suspension and wheel maintenance maintenance procedure
CO5. Explain the electrical and air conditioning maintenance procedure

TEXT BOOKS:

1. Ed May, Autmobile Mechanics Volume one, Mc Graw Hill Publications, 2003
2. Crouse W H, "Automotive Transmissions and Power Trains", McGraw Hill Book Co.,5th edition, 1976

REFERENCE

1. Bosch automotive handbook , Sixth Edition,2004.

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Course Code: 16AUE17	Course Title: TRANSPORT MANAGEMENT	
Core / Elective: Elective	L: T : P: C	3 :0: 0 : 3
Type : Theory	Total Contact hours:	45 Hours

Prerequisites:

- NIL

Course Outcomes

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

1. Explain the legislative laws
2. Explain the types of vehicle insurance
3. Explain the operation of passenger transport system
4. Explain the operation of goods transport system
5. Describe taxation and traffic management

Course Content **Hours**

UNIT I MOTOR VEHICLE ACT **9**

Motor Vehicle Act: Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Offences, penalties & procedures, Different types of forms. Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles

UNIT II INSURANCE AND ROAD SAFETY **9**

Insurance types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Surveyor's report

UNIT III PASSENGER TRANSPORT OPERATION **9**

Structure of passenger transport organizations, typical depot layouts, requirements, Fleet maintenance - Scheduling operation & control.Propaganda, passenger amenities, Parcel traffic. Theory of fares, Basic principles of fare charging , Needs, straight and tapered scales, Differential rates for different types of services, Depreciation & debt charges, operation cost, Economics & records.

UNIT IV GOODS TRANSPORT OPERATION **9**

Structure of goods transport organizations, Typical depot layouts, requirements ,scheduling of goods transport, materials Handling equipments in the goods transport operation, , storage & transportation of petroleum products

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UNIT V TAXATION AND TRAFFIC MANAGEMENT 9

Objectives, Structure & methods of laving taxation, One-time tax, Tax Exemption & tax renewal, Global positioning system- Traffic navigation, advanced traffic control devices.

Course Outcomes

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

CO1. Explain the legislative laws governing the use of motor vehicle
CO2. Explain the types of vehicle insurance and the importance of road safety
CO3. Explain the operation of passenger transport system
CO4. Explain the operation of goods transport system
CO5. Describe taxation and traffic management

Text Books:

1. Motor Vehicle Act - Govt. of IndiaPublications.
2. Santosh Sharma, "Productivity in Road Transport", 2nd Edition, Association of StateRoad Transport Undertakings, NewDelhi.

References:

1. P.G.Patankar, "Road Passenger Transport in India", CIRT,Pune.
2. Transport Development in India", S. Chand & Co. Pvt. Ltd., NewDelhi.

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Course Code:16MEE39	Course Title:REFRIGERATION AND AIR CONDITIONING	
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

Course Objectives

The course is intended to:

1. Calculate the performance of vapor compression refrigeration systems.
2. Explain the major components in vapor compression refrigeration systems.
3. Estimate the heating and cooling loads in air-conditioning systems.
4. Explain the various applications of refrigeration and air conditioning systems.
5. Explain the installation and servicing methods used in refrigeration and air conditioning systems.

Course content **Hours**

UNIT I REFRIGERATION **9**

Thermodynamic principles of refrigeration – Types of Refrigeration Systems – Vapour compression refrigeration cycle, use of Ts and P-H diagrams, Performance calculation – Refrigerants: Primary& secondary refrigerants, Nomenclature of Refrigerants, properties and selection – Environment friendly alternatives.

UNIT II COMPONENTS OF REFRIGERATION SYSTEM **9**

Refrigerant Compressors- Different Types, Performance, Capacity Control – Evaporators, Evaporators Circuitry, Different Types and application – Condensers- Types-air cooled- water cooled - evaporative condensers- Optimum Cooling Water Rate and Velocity – Expansion Devices.

UNIT III AIR CONDITIONING SYSTEM AND ITS COMPONENTS **9**

Characteristics of Human comfort condition – Different types of Air Conditioner , Construction Details of Room Air Conditioner , Window Type, Package Type, Split Type Central Units – Automotive Heater –Air conditioning Equipments , air filters , humidifiers & dehumidifiers, fans & blowers , control system – Thermal insulation and Ventilation in air conditioning system – 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 – Solar Air Conditioning, Solar dehumidifier – Automobile air conditioning, Refrigerated trucks, Aircraft air conditioning, Railway Refrigerator Cars, Marine Air conditioning

UNIT V INSTALLATION AND SERVICING 9

Duct installation - Charging of refrigerant - Servicing of central, packaged, split air-conditioning, – Safety procedures, Leak detection procedures- safety controls, trouble shooting. – Basic Elements of Control systems - temperature control, Bimetal thermostat, Electric resistance thermostat, Electronic thermostat- Humidity control elements- Automatic Dew point recorder - Energy conservation methods.

Course Outcomes

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

CO1: Explain the concepts of refrigeration system and evaluate 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: Calculate the heating and cooling loads in an air conditioning system using psychrometric concepts.

CO4: Discuss 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 temperature and humidity control methods

Text books:

1. Manohar Prasad, "Refrigeration and Air Conditioning", New Age International, 2004
2. Arora. C.P., "Refrigeration and Air conditioning", 2nd edition. Tata McGraw-Hill, 2000.

References:

1. Dossat, R.J. "Principles of Refrigeration", Prentice-Hall, 1997.
2. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", McGraw Hill Education (Asia) 2nd Edition 2001
3. ASHRAE 2012 Hand book (Fundamentals & Equipments)

WEBREFERENCES

- http://nptel.ac.in/courses/112105128/

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Course Code: 16MEE40	**Course Title:** PRINCIPLES OF MANAGEMENT (Common to Automobile and Mechanical Engg)	
Core / Elective: Elective	**L: T : P: C**	3 :0: 0 : 3
Type : Theory	Total Contact hours:	45 Hours

Course Objectives

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

1. Describe the overview of management
2. Explain the planning process, policy and decision making
3. Explain the human resource structure and policy
4. Explain the motivational theories for management
5. Explain the control techniques for operations

Course content **Hours**

UNIT I OVERVIEW OF MANAGEMENT **9**

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business.

UNIT II PLANNING **9**

Nature and Purpose planning – Planning process – Types of plans – Objectives – Managing by objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision –Decision Making Process - Rational Decision Making Process – Decision Making under different conditions.

UNIT III ORGANISING **9**

Nature and purpose of organizing – Organization structure – Formal and informal groups / organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recruitment – Orientation Career Development – Career stages – Training – Performance Appraisal.

UNIT IV DIRECTING **9**

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – Organization Culture – Elements and types of culture – Managing cultural diversity

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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 overview of management
CO2. Explain the planning process, policy and decision making
CO3. Explain the human resource structure and policy
CO4. Explain the motivational theories for management
CO5. Explain the control techniques for operations

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 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 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

Course content **Hours**

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

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discard, The P-F interval and P-F curves, linear as non linear PF curves , Default actions, RCM Decision diagrams.

UNIT IV TPM AND GLOBAL TRENDS **9**

Concept of TPM, Characteristics of TPM, Zero breakdown concepts, Zero Defects and TPM, FMECA – Maintainability prediction– Design for maintainability, Maximizing equipment effectiveness, Autonomous maintenance program, Five pillars of TPM, TPM Small group activities. Implementing TPM.Philosophy / Indications of TPM. TPM Development - Preparation phase, Master Plan, Initiatives, Promotion, Planning, Organization, Awareness, Training, Establishment of basic policies and goals, TPM organization, Implementation phase; Consolidation phase. Measuring TPM effectiveness: Measuring TPM effectiveness Indicators, Plant effectiveness and Measuring; TPM Benefits and Global trend

UNIT V CONDITION MONITORING IN MAINTENANCE **9**

Condition Based Maintenance: Machine signatures, Signature Analysis-MMIS Expert systems, Temperature noise, vibration and wear particle analysis, on line and off line techniques. Online Monitoring Condition Monitoring Techniques, Vibration Monitoring and Signature Analysis. Wear Debris Monitoring, Maintenance Management Information System, Expert systems, Corrosion Monitoring and Control, Case Studies in Maintenance, Measurement and benchmarking of performance, MIS for maintenance.

Course Outcomes

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 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 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.

Course content **Hours**

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, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme,

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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: 16MEE44	Course Title: QUALITY ENGINEERING (Common to Mechanical, ECE, EEE & EIE)	
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.

Course content **Hours**

UNIT I INTRODUCTION **9**

Introduction – Need for quality – Evolution of quality – Different Definitions and Dimensions of Quality– Concepts of Product and Service Quality– Contributions of Deming, Juran and Crosby – Barriers to Quality – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention – Costs of Poor quality.

UNIT II QUALITY COSTS **9**

Basic Concept Quality Costs: Fitness for Use, Quality Characteristics, Parameters of Fitness for use-Quality functions, Concept of Quality assurance and Quality control, Quality costs concept, Quality cost categories, Examples of Quality cost studies, Securing the Cost figures, Pareto Analysis, Cost reduction Programs and economics of quality.

UNIT III TOTAL QUALITY MANAGEMENT **9**

Total quality Management- Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Modern Quality Management Techniques-Benchmarking, QFD, Taguchi quality loss function TPM,Lean Manufacturing continuous improvement techniques, JIT systems, Cause and effect diagrams, Scatter diagram, Run charts, Affinity diagrams, Inter-relationship diagram, Process decision program charts, PDCA Concept

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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 .

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
3. List of Open Source Software/learning website:
   a. http://www.nptel.ac.in
   b. http://www.ocw.mit.edu

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Course Code:16MEE49	Course Title:ENGINEERING ECONOMICS AND COST ANALYSIS (Common to Mechanical, ECE, EEE & EIE)	
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

Course Objectives

The course is intended to:

1. Categorize different cost and calculate the breakeven point for a given business situation
2. Apply different interest formulae and their application in decision making process.
3. Evaluate present value, future value and annual worth analysis on one or more economic alternatives.
4. Determine the economic value of an asset and develop a better replacement policy for given equipment.
5. Evaluate the depreciation of equipment per period.

Course Content **Hours**

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 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 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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Open Electives

Course Code:16OE01	Course Title: AUTOMOTIVE INFOTRONICS	
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. Describe about advanced driver assistance systems.
2. Explain about telematics
3. Explain about safety systems
4. Explain about comfort systems
5. Explain about security systems

Course Content **Hours**

UNIT I DRIVER ASSISTANCE SYSTEMS 9

Driver information, driver perception, driver convenience, driver monitoring, general vehicle control, longitudinal and lateral control, collision avoidance and vehicle monitoring.

UNIT II TELEMATICS 9

Global positioning system, geographical information systems, navigation system, architecture, automotive vision system and road recognition.

UNIT III SAFETY SYSTEMS 9

Active and passive safety, airbags, seat belt tightening system, forward collision warning systems, child lock, anti-lock braking systems, EBD, ESP, traction control system and lane departure warning system.

UNIT IV COMFORT SYSTEMS 9

Adaptive cruise control system, active suspension system, power steering, collapsible and tilt-able steering column and power windows, adaptive lighting system.

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UNIT V SECURITY SYSTEMS 9

Anti-theft technologies – mechanical, electromechanical and electronic immobilizers, alarm system, stolen vehicle tracking system, remote keyless entry, smart card system and number plate coding

Course Outcomes

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

CO1. Describe about advanced driver assistance systems to aid the vehicle control.
CO2. Explain about telematics used in automobiles
CO3. Explain about safety systems employed in automobile
CO4. Explain about vehicle comfort systems for passengers
CO5. Explain about security systems usage in vehicle

Text Books:

1. LjuboVlacic, Michel Parent and Fumio Harashima, "Intelligent Vehicle Technologies", Butterworth-Heinemann Publications, Oxford, 2001.
2. Robert Bosch, "Automotive Hand Book", SAE, 2000

References:

1. Ronald K Jurgen, "Navigation and Intelligent Transportation Systems – Progress in Technology", Automotive Electronics Series, SAE, USA, 1998.
2. William B R, "Understanding Automotive Electronics", Butter worth Heinemann Woburn, 1998.
3. Bechhold, "Understanding Automotive Electronics", SAE, 1998.
4. Allan W M B, "Automotive Computer Controlled Systems", Elsevier Butterworth-Heinemann, 2011 .

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Course Code:16OE02	Course Title: AUTOMOTIVE SENSORS	
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 the evolution of automotive sensors.
2. Describe about pressure sensors.
3. Describe about speed and position sensors.
4. Describe about temperature sensors.
5. Describe about sensors for after-treatment.

Course Content **Hours**

UNIT 1 INTRODUCTION TO AUTOMOTIVE SENSORS 9

The evolution of automotive sensors, sensor applications in the vehicle, active and passive sensors, power supply, ratio-metric output, automotive systems and electromagnetic compatibility (EMC), importance of EMC in the automotive industry, the EMC model as applied to the automotive systems

UNIT II PRESSURE SENSORS 9

Manifold absolute pressure (MAP) sensor, TMAP sensor, BAP sensor, fuel tank pressure sensor, oil pressure sensor, common rail pressure sensors, tyre pressure monitoring sensor (TPMS), brake fluid pressure sensor – construction, working principle and performance characteristics.

UNIT III SPEED AND POSITION SENSORS 9

Engine rpm sensor, crankshaft position sensor, and camshaft position sensor, throttle position sensor, pedal position sensor, steering position sensor – construction, working principle and performance characteristics.

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UNIT IV TEMPERATURE SENSORS 9

Inlet air temperature sensor, coolant temperature sensor, engine oil temperature sensor, exhaust gas temperature sensor - construction, working principle and performance characteristics

UNIT V SENSORS FOR AFTER TREATMENT 9

O2 sensor, NOx sensor, ammonia sensor, differential pressure sensor, soot sensor - construction, working principle and performance characteristics.

Course Outcomes

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

CO1. Explain the evolution of automotive sensors and their application in automobiles.
CO2. Describe about pressure sensors, their construction, working principle and performance characteristics.
CO3. Describe about speed and position sensors, their construction, working principle and performance characteristics.
CO4. Describe about temperature sensors, their construction, working principle and performance characteristics.
CO5. Describe about sensors for after treatment with their construction, working principle and performance characteristics.

Text Books:

1. Tom Denton, "Automotive Electrical and Electronics", Butterworth Heinemenn, 2014.

References:

1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer International Publishing, Switzerland 2016.
2. Eric Chowanietz, "Automobile Electronics" SAE Publications, 2014.

Learning Resources

- MCET-TUV Automotive Training Center
- MCET-BOSCH Joint Certification Center

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Course Code: 16OE03	Course Title: ELECTRONICS IN AUTOMOBILES	
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. Illustrate the layout of automobile systems
2. Explain about electronic gasoline control system
3. Explain about electronic diesel control system
4. Explain about electronic suspension and steering system
5. Explain about brake and stability control systems

Course Content **Hours**

UNIT I AUTOMOBILE SYSTEM LAYOUT 9

SI and CI engine, working principle. Engine emissions and standards. Suspension system layout. Steering system layout. Brake system layout.

UNIT II ELECTRONIC GASOLINE CONTROL 9

Layout of SI engine management systems, Multi-Point Fuel Injection (MPFI), Gasoline Direct Injection (GDI) – electric fuel pump, piezo-injector, pencil coil, electronic throttle control, electronic ignition systems, spark timing control.

UNIT III ELECTRONIC DIESEL CONTROL 9

Layout of CI engine management systems , CRDI, engine control units in CAN databus, metering regulation, injection regulation, Exhaust gas recirculation control, charge pressure control, pre glow system, idling speed control, cruise control.

UNIT IV ELECTRONIC SUSPENSION AND STEERING SYSTEM 9

Electronic suspension system, components – height sensor, vehicle speed sensors, acceleration sensors, steering wheel rotation sensor, electric power steering – working. Non-contact torque sensor – principle of operation.

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UNIT V ABS, TCS AND ESP SYSTEMS 9

Anti-lock Braking System (ABS), need, layout and working, wheel speed sensor, pressure modulator valve. Traction Control System (TCS), layout and working, wheel speed control – operation modes. Electronic Stability Control (ESP), need, layout and working.

Course Outcomes

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

CO1. Illustrate the layout of automobile systems to identify the location of sensors.

CO2. Explain the electronic gasoline control system to control emission to meet the emission standards.

CO3. Explain the electronic diesel control system to control emission to meet the emission standards.

CO4. Explain the components of electronic suspension and steering and their working principle.

CO5. Explain the layout and working of brake and stability control systems.

Text Books:

1. Eric Chowanietz "Automobile Electronics" SAE Publications, 2014
2. William B Ribbens "Understanding Automotive Electronics", SAE Publications, 2008

References:

1. Robert Bosch "Diesel Engine Management" SAE Publications, 2006.
2. Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006.

Learning Resources

- MCET-TUV Automotive Training Center
- MCET-BOSCH Joint Certification Center

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Course Code: 16OE04	Course Title: MANUFACTURING OF AUTOMOTIVE ELECTRICAL AND ELECTRONICS PARTS	
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 the characteristics and effects of components on circuit board.
2. Explain the parameters and methods involved in integration of electrical and electronics parts
3. Explain the steps involved in fabrication of Electrical parts
4. Explain the steps involved in fabrication of Electronic parts
5. Explain the process involved in manufacturing of lighting system

Course Content **Hours**

UNIT I BASICS OF ELECTRICAL AND ELECTRONICS **6**

Introduction of Resistor, capacitor, inductor and characteristics under AC & DC, Power dissipation, Fuse and fuse selection, Electromagnetic compatibility (EMC), Interference.

UNIT II INTEGRATION OF ELECTRICAL & ELECTRONIC PARTS ON VEHICLE **10**

Overview of ADV, Prod Quality Planning /New Prod Develop, Vehicle Integration-Mounting methods, Routing methods, Fastening, Clearance/Interference fit.

UNIT III MANUFACTURING OF AUTOMOTIVE ELECTRICAL PARTS **10**

Process flow, process specifications and Inspection methodologies for Starter motor, Relay, Horn, Switches, Magneto and Wiring Harness.

UNIT IV MANUFACTURING OF AUTOMOTIVE ELECTRONIC PARTS **10**

Process flow, Manufacture of PCB, PCB assembly and Testing, Electronic Packaging.

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UNIT V MANUFACTURING OF AUTOMOTIVE LIGHTING SYSTEM 9

Basic principles and working of lighting system, Process flow and process specifications for automotive lighting system

Course Outcomes

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

CO1: Explain the characteristics and effects of components on circuit board that are used in a motorcycle

CO2: Explain the parameters and methods involved in integration of electrical and electronics parts in a motorcycle

CO3: Explain the steps involved in fabrication of Electrical parts used in a motorcycle

CO4: Explain the steps involved in fabrication of Electronic parts in a motorcycle

CO5: Explain the process involved in manufacturing of lighting system used in a motorcycle

Text Books:

1. Raymond H. Clark, "Handbook of Printed Circuit Manufacturing" Springer 1st edition, 1985.
2. H. Richard Stillwell, "Electronic Product Design for Automated Manufacturing" CRC Press, 1st edition, 1988.

Reference Books:

1. V.K. Mehta Rohit Mehta, "Principles of Electrical Engineering and Electronics" 3rd edition, S Chand Publishers, 2014.

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