Dr. MAHALINGAM
MCET
COLLEGE OF ENGINEERING AND TECHNOLOGY
Enlightening Technical Minds Estd. 1998
An Autonomous Institution
(Since 2011)

Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Affiliated to Anna University, Chennai; Approved by AICTE ; Accredited by NAAC with Grade 'A++'
Accredited by NBA - Tier1 (Mech, Auto, Civil, EEE, ECE, E&I and CSE)
Udumalai Road, Pollachi - 642 003 Tel: 04259-236030/40/50 Fax: 04259-236070 www.mcet.in

Curriculum and Syllabi

B.E. Mechatronics Engineering

Semesters I to VIII

Regulations 2016

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Mechatronics Engineering

Vision

To develop competent Mechatronics Engineers and Entrepreneurs with the social and environmental awareness

Mission

- To impart high quality inter disciplinary knowledge of Mechatronics Engineering through excellence in teaching, research and entrepreneurship.
- Develop Mechanical and Electronic design and test skills of the graduates to fulfill the industrial requirements.
- Create awareness among students for global needs of society and innovate machinery according to engineering needs.
- Enhance the Communication, learning and administrative skills of the graduates to become socially responsible engineers and entrepreneurs.

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.
(An autonomous institution approved by AICTE and affiliated to Anna University)

Programme: B.E. Mechatronics Engineering

Programme Educational Objectives (PEOs) - Regulations 2019

B.E. Mechatronics Engineering graduates will:

PEO1. Develop innovative and sustainable products with multidisciplinary Engineering expertise.

PEO2. Solve complex engineering problems by applying mechanical, electrical and computer knowledge and engage in lifelong learning in their profession.

PEO3. Work or pursue higher education in multicultural, multilingual and multinational environment with competent oral and written communication.

PEO4. Lead and contribute in a team entrusted with professional, social and ethical responsibilities.

Programme Outcomes (POs) - Regulations 2019

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

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

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

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

OBE Coordinator

Programme Coordinator

Head of the Department

Head - OBE

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

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

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

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

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

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

OBE Coordinator

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Programme Specific Outcomes (PSOs) - Regulations 2019

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

PSO1. Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO2. Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

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Dr. Mahalingam College of Engineering and Technology, Pollachi-642003.

Department of Mechatronics Engineering

Curriculum – Regulation 2016

SEMESTER - I

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16ENT11	Communication Skills – I	2	0	2	3	100
2	16MAT11	Engineering Mathematics – I	3	2	0	4	100
3	16PHT11	Applied Physics	3	0	0	3	100
4	16CYT11	Applied Chemistry	3	0	0	3	100
5	16GET11	Introduction to Engineering	2	0	2	3	100
PRACTICAL							
6	16EGL11	Engineering Graphics	2	0	4	4	100
7	16PCL11	Physics and Chemistry Laboratory	0	0	4	2	100
Professional Skills							
8	16PSL11	Promotion of Students' Wellness	0	0	2	1	100
		Total	15	2	14	23	800

Total Hours in a Week: 31

SEMESTER-II

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16ENT21	Communication Skills – II	2	0	2	3	100
2	16MAT21	Engineering Mathematics – II	3	2	0	4	100
3	16PHT21	Material Science	3	0	2	4	100
4	16GET21	Engineering Mechanics	4	0	0	4	100
5	16GET22	Engineering Metrology and Measurements	2	0	2	3	100
PRACTICAL							
6	16EPL21	Engineering Practices Laboratory	0	0	4	2	100
7	16CDL21	Computer aided drafting and modeling Laboratory	1	0	4	3	100
Professional Skills							
8	16PSL21	Sports for Wellness	0	0	2	1	100
		Total	15	2	16	24	800

Total Hours in a Week: 33

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SEMESTER-III

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16MAT31	Transforms and Partial Differential Equations	3	2	0	4	100
2	16AUT31	Engineering Thermodynamics	2	2	0	3	100
3	16AUT32	Fluid Mechanics and Machinery	2	2	0	3	100
4	16MCT31	Sensors and Signal Processing	3	0	2	4	100
5	16MCT32	Electric and Electronic circuits	3	0	2	4	100
6	16CST34	C Programming	3	0	0	3	100
PRACTICAL							
7	16AUL31	Fluid Mechanics and Machinery Laboratory	0	0	4	2	100
8	16CSL33	C Programming Laboratory	0	0	4	2	100
ONE CREDIT COURSES							
9	XXXX	OCC – I	0	0	2	1	100
PROFESSIONAL SKILLS							
10	16PSL31	Personal Effectiveness	0	0	2	1	100
		Total	16	6	16	27	1000

Total Hours in a Week: 38

SEMESTER-IV

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16MAT41	Numerical Methods	3	2	0	4	100
2	16MCT41	Strength of Materials	3	2	0	4	100
3	16MCT42	Theory of machines	3	0	2	4	100
4	16MCT43	Manufacturing Technology	3	0	0	3	100
5	16MCT44	Analog and Digital circuits	3	0	2	4	100
6	16EET45	Electrical Drives and Control	3	0	0	3	100
PRACTICAL							
7	16MCL41	Manufacturing Technology Laboratory	0	0	4	2	100
8	16EEL43	Electrical drives and control Laboratory	0	0	4	2	100
ONE CREDIT COURSES							
9	XXXX	OCC – II	0	0	2	1	100
PROFESSIONAL SKILLS							
10	16PSL41	Ethical and moral responsibility	0	0	2	1	100
		Total	18	4	16	28	1000

Total Hours in a Week: 38

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SEMESTER-V

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16EIT51	Control systems	3	2	0	4	100
2	16MET51	Design of Machine Elements	4	0	0	4	100
3	16MCT51	CAD/CAM/CIM	3	0	0	3	100
4	16MCT52	Microprocessor and Microcontroller	3	0	0	3	100
5	16MCT53	Virtual Instrumentation	3	0	0	3	100
6	XXXXXX	Professional Elective – I	3	0	0	3	100
PRACTICAL							
7	16MCL51	Microprocessor and Microcontroller Laboratory	0	0	4	2	100
8	16MCL52	CNC Programming Laboratory	0	0	4	2	100
ONE CREDIT COURSES							
9	XXXXX	OCC – III	0	0	2	1	100
PROFESSIONAL SKILLS							
10	16PSL51	Teamness and Interpersonal Skills	0	0	2	1	100
		Total	19	2	12	26	1000

Total Hours in a Week: 33

SEMESTER-VI

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16MCT61	Industrial Automation	3	0	0	3	100
2	16CET65	Environmental studies	3	0	0	3	100
3	16MCT62	Hydraulic and Pneumatic systems	3	0	0	3	100
4	16MCT63	Power Electronics	3	0	0	3	100
5	16MCT64	Embedded for Mechatronic systems	3	0	0	3	100
6	XXXXX	Professional Elective – II	3	0	0	3	100
PRACTICAL							
7	16MCL61	Mechatronic systems Design Laboratory	0	0	4	2	100
8	16MCL62	Industrial Automation Laboratory	0	0	4	2	100
ONE CREDIT COURSES							
9	XXXXX	OCC – IV	0	0	2	1	100
PROFESSIONAL SKILLS							
10	16PSL61	Campus to Corporate	0	0	2	1	100
		Total	18	0	12	24	1000

Total Hours in a Week: 30

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SEMESTER-VII

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	16MCT71	Automotive Electronics	3	0	0	3	100
2	16MCT72	Industrial Robotics and Machine Vision	3	0	0	3	100
3	XXXXXXX	Professional Elective – III	3	0	0	3	100
4	XXXXXXX	Open Elective	3	0	0	3	100
PRACTICAL							
5	16MCL71	Robotics and Control Laboratory	0	0	4	2	100
6	16MCL72	Automotive Electrical and Electronics Laboratory	0	0	4	2	100
7	16MCL73	Innovative and Creative Project	0	0	8	4	100
		Total	12	0	16	20	700

Total Hours in a Week: 28

SEMESTER-VIII

S.No	Course Code	Course Title	L	T	P	C	Marks
THEORY							
1	XXXXXXX	Professional Elective – IV	3	0	0	3	100
2	XXXXXXX	Professional Elective – V	3	0	0	3	100
3	XXXXXXX	Professional Elective – VI	3	0	0	3	100
PRACTICAL							
4	16MCL81	Project	0	0	20	10	200
		Total	9	0	20	19	500

Total Hours in a Week: 29

Total Credits - 191

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PROFESSIONAL ELECTIVE COURSES

S.No	Course Code	Course Title	L	T	P	C	Marks
DESIGN							
1	16MEE01	Design for Manufacture, Assembly and Environment	3	0	0	3	100
2	16MCE01	Design of Transmission system	3	0	0	3	100
3	16MCE02	Turbo Machinery	3	0	0	3	100
4	16MEE06	Automotive Engine and its systems	3	0	0	3	100
5	16MCE03	Finite Element Analysis	3	0	0	3	100
6	16MCE04	Design of Mechatronic systems	3	0	0	3	100
7	16MCE05	Product Design and Development	3	0	0	3	100
8	16MEE03	Composite Materials	3	0	0	3	100
MANUFACTURING AND MANAGEMENT							
9	16MEE19	Unconventional Machining Processes	3	0	0	3	100
10	16MEE20	Flexible Manufacturing systems	3	0	0	3	100
11	16MEE30	Additive Manufacturing	3	0	0	3	100
12	16MCE06	Automobile Engineering	3	0	0	3	100
13	16MCE07	Disaster Management	3	0	0	3	100
14	16MEE40	Principles of Management	3	0	0	3	100
15	16MEE42	Industrial safety Management	3	0	0	3	100
16	16MEE21	Non- Destructive Testing Methods	3	0	0	3	100
17	16MCE08	Maintenance Engineering	3	0	0	3	100
18	16MEE44	Quality Engineering	3	0	0	3	100
ELECTRONICS, CONTROL AND NETWORKING							
18	16MCE09	Machine Learning	3	0	0	3	100
19	16MCE10	Industrial Internet of Things	3	0	0	3	100
20	16MCE11	Micro Electro Mechanical systems	3	0	0	3	100
21	16MCE12	Hybrid Electric Vehicles	3	0	0	3	100
22	16MCE13	Digital control Engineering	3	0	0	3	100

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SEMESTER - I

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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 the course(s):

1. 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. Write appropriate business e mail, note, memo and letter.
4. Compute the solution of one dimensional and two dimensional heat flow equation.
5. Write simple and grammatically correct sentences.

UNIT I LISTENING **6+6 Hrs**

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 Hrs**

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 Hrs**

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 Hrs**

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 Hrs**

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.

Reference Books

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

1. www.cambridgeenglish.org/exams/business.../business-preliminary/
2. http://www.pearsonlongman.com/intelligent_business/bectests/preliminary.htm

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Course Code : 16MAT11	Course Title : ENGINEERING MATHEMATICS - I (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: Core	L : T : P: C	3: 2 : 0 : 4
Type: Theory	Total Contact hours:	75 Hours

Course Objectives

The course is intended to:

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

UNIT I EIGENVALUES AND EIGENVECTORS 9+6 Hrs

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 Hrs

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 Hrs

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 Hrs

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

UNIT V ORDINARY DIFFERENTIAL EQUATIONS OF FIRST ORDER 9+6 Hrs

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

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Course Outcomes

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

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

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

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

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

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

Text Books

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

Reference Books

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 References

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

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Course Code : 16PHT11	Course Title : APPLIED PHYSICS (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: Core	L : T : P: C	3: 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hours

Course Objectives

The course is intended to:

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

UNIT I BASICS OF MECHANICS **10 Hrs**

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 Hrs**

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 Hrs**

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 Hrs**

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

BoS Chairman

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

UNIT V LASER PHYSICS AND APPLICATIONS **8 Hrs**

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 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. BrijLal and Dr.N.Subrahmanyam, "Heat and Thermodynamics", S.Chand & Company Ltd., New Delhi, 1997.
3. Rajendran, "Engineering Physics", Tata McGraw Hill Publishing Company limited. New Delhi, 2009.

Reference Books

1. 'David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics Extended", Ninth Edition, Wiley India.
2. R.K.Gaur, S.L.Gupta, "Engineering Physics", DhanpatRai, 2013.
3. Jayakumar S, "Engineering Physics", R K Publishers, Coimbatore, 2007

Web References

1. http://nptel.ac.in/courses/115106061/
2. www.apsu.edu
3. www.physicsclassroom.com
4. www.study.com
5. www.physics.org

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Course Code : 16CYT11	Course Title : APPLIED CHEMISTRY (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: Core	L : T : P: C	3: 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hours

Course Objectives

The course is intended to:

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

UNIT – I WATER TECHNOLOGY **9Hrs**

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 Hrs**

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 Hrs**

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 Hrs**

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 plastics – Preparation, properties and uses of PE,

BoS Chairman

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 Hrs**

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).

Reference Books

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).
4. S.S.Dara "A Text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2006)
5. V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, "Polymer Science", New Age International P (Ltd.,), Chennai (2006).

Web References

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

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Course Code : 16GET11	Course Title : INTRODUCTION TO ENGINEERING (Common to AUTO, MECH & 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

UNIT I ENGINEERING EDUCATION **12 Hrs**

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 (Theory, 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 Hrs**

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 Hrs**

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 Hrs**

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 Hrs**

Awareness and effective use of resources for learning: - library resources, professional societies, centres 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.

Reference Books

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

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

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Course Code : 16EGL11	Course Title : ENGINEERING GRAPHICS (Common to AUTO, MECH & Mechatronics)	
Core / Elective: General (G)	L : T : P: C	2: 0 : 4 : 4
Type: Theory & 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 different forms of lines and plane surfaces.
4. Prepare development of lateral surfaces.
5. Prepare perspective.

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

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 Hrs**

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 Hrs**

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 **9 Hrs**

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 Hrs**

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: Sketch different forms of lines and plane surfaces.

CO4: Prepare development of lateral surfaces of simple objects.

CO5: Prepare development of lateral surfaces of simple objects.

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 Auto CAD" Tata McGraw Hill publishing Company Limited (2008).

Reference Books

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2nd Edition, 2015.
2. Cencil Jensen, Jay D. Helsel and Dennis R. "Short Engineering Drawing and Design". Tata McGraw Hill Publishing Company Limited, 2014.
3. John.K.C "Text book of Machine Drawing", Prentice-Hall of India Pvt.ltd,2013.

Publications of Bureau of Indian Standards

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

Web References

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

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Course Code : 16PCL11	Course Title : PHYSICS AND CHEMISTRY LABORATORY (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: Core	L : T : P: C	0: 0 : 4 : 2
Type: Practical	Total Contact hours:	45 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:

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

Reference Books

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 AUTO,MECH,CIVIL,EEE,Mechatronics & Prod.)	
Core / Elective: (G)	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.

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.

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.

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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)

Reference Books

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

End Semester 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

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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):

1. Communication Skills I

Course Objectives

The course is intended to:

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

UNIT I LISTENING **6+6 Hrs**

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 Hrs**

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 Hrs**

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.

UNIT IV WRITING **6+6 Hrs**

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.

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describing, summarizing) or proposals (e.g. describing, summarizing, recommending, persuading and negotiating).

UNIT V GRAMMAR **6+6 Hrs**

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.

Reference Books

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

1. www.cambridgeenglish.org/exams/business./business-preliminary/
2. http://www.examenglish.com/BEC/BEC_Vantage.html
3. www.splendid-speaking.com/exams/bec_speaking.htmlhtml

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Course Code : 16MAT21	Course Title : ENGINEERING MATHEMATICS-II (Common to AUTO, MECH & Mechatronics, Prod.)	
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):

1. 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.

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

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 Hrs

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 Hrs

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.

UNIT IV COMPLEX INTEGRATION 9+6 Hrs

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 Hrs

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.

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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.

Reference Books

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 References

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

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Course Code : 16PHT21	Course Title : MATERIALS SCIENCE (Common to AUTO, MECH & Mechatronics)	
Core / Elective: Core	L : T : P: C	3: 0 : 2 : 4
Type: Theory & Practical	Total Contact hours:	60 Hours

Prerequisites:

The student should have undergone the course(s):

1. 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.

UNIT I CRYSTAL STRUCTURE OF MATERIAL PROPERTIES 9 Hrs

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 allotrophy. Crystal imperfections: Point, line surface and volume, grain boundary and its role in mechanical properties.

UNIT II MECHANICAL PROPERTIES AND TESTING OF MATERIALS 9 Hrs

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 Hrs

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, Ferro magnetism, Domains and hysteresis, Soft and Hard magnetic materials, applications: motors, generators, and transformers. Anti-ferromagnetism, Ferri magnetism, Influence of temperature on magnetic behavior.

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UNIT IV CERAMIC MATERIALS **9 Hrs**

Modern ceramic materials, Cermetsas 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 Hrs**

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

Laboratory-Practical Component

List of Experiments (Any Four) **Conduct hours : 15**

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 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.
3. Raghavan.V "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd., 2007.

Reference Books

1. Vijaya.M.S and G.Rangarajan, "Materials Science", Tata McGraw-Hill, 2007.
2. P.K.Palanisamy, "Material Science for Mechanical Engineers", Scitech Publication

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(India) Pvt Ltd, 2005.

Web References

1. www.nptel.ac.in
2. www.ocw.mit.edu

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Course Code : 16GET21	Course Title : ENGINEERING MECHANICS (Common to AUTO, MECH, Mechatronics & Prod.)	
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):

1. Engineering Graphics
2. Engineering Mathematics – I

Course Objectives

The course is intended to:

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

UNIT I EQUILIBRIUM OF RIGID BODIES 12 Hrs

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 Hrs

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

UNIT III PROPERTIES OF SURFACES AND SOLIDS 15 Hrs

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.

Properties of solid geometry - centroid and centre of gravity. Centre of gravity of simple solids. Mass moment of inertia for simple solids. PappusGuldinus theorem. Relation to area moment of

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inertia. Problems involving mass moment of inertia for composite solids consist of block, cylinder, cone, and sphere.

UNIT IV FRICTION **12 Hrs**

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 Hrs**

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

Course Outcomes

At the end of the course 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.

Reference Books

1. James L. Meriam and L.GlennKraige, "Engineering Mechanics (Statics and Dynamics)", John Wiley & Sons, 2008.
2. Shames.I.H, and Krishna MohanaRao.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.robotics

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Web References

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

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Course Code : 16GET22	Course Title: ENGINEERING METROLOGY AND MEASUREMENTS. (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: General (C)	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):

1. Applied Physics

Course Objectives

The course is intended to:

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

UNIT I INTRODUCTION TO ENGINEERING METROLOGY 6 Hrs

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 9 Hrs

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 Hrs

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 Hrs**

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

UNIT V LASER METROLOGY AND CMM **6 Hrs**

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.

Laboratory-Practical Component

List of Experiments **Conduct hours : 30**

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.

Text Books

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

BoS Chairman

Reference Books

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

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

BoS Chairman

Course Code : 16EPL21	Course Title : ENGINEERING PRACTICES LABORATORY (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: General (G)	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 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.

BoS Chairman

Reference Books

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

BoS Chairman

Course Code : 16CDL21	Course Title: COMPUTER AIDED DRAFTING AND MODELING LABORATORY. (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective: General (C)	L : T : P: C	1: 0 : 4 : 3
Type: Theory & Practical	Total Contact hours:	45 Hours

Prerequisites:

The student should have undergone the course(s):

1. Engineering Graphics

Course Objectives

The course is intended to:

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

UNIT I STANDARDS, SYMBOLS& CONVENTIONS 3Hrs

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 3Hrs

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 3Hrs

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 3Hrs

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 3Hrs

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

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LIST OF EXPERIMENTS **30 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 students will be able to:

CO1: Develop part and assembly models using CAD Software.

CO2: Prepare production drawing for manufacturing process using CAD software

Reference Books

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

BoS Chairman

Course Code : 16PSL21	Course Title : SPORTS FOR WELLNESS (Common to AUTO, CIVIL, MECH, EEE , Mechatronics, Prod.)	
Core / Elective: General (G)	L : T : P: C	0: 0 : 2 : 1
Type: PS	Total Contact hours:	30 Hours

Prerequisites:

The student should have undergone the course(s):

1. Promotion of Students Wellness

Course Objectives

The course is intended to:

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

UNIT I HEALTH

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

UNIT II FITNESS & WELLNESS

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

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

UNIT III FOOD & HEALTH

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

UNIT IV FITNESS & DEVELOPMENT I

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

Muscular strength – exercises (calisthenics): pull-up, sit-up, push-up and weight training.

Explosive power – exercises: vertical jump, long jump,

Cardio respiratory endurance – exercises: walking, jogging, treadmill, stair climbing, bicycling, and skipping.

Flexibility – exercises: stretching

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.

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Course Outcomes

At the end of the course 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.

Reference Books

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 exercises 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 major muscl	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

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SEMESTER – III

Course Code : 16MAT31	Course Title: TRANSFORMS AND PARTIALDIFFERENTIAL EQUATIONS (Common to AUTO, MECH, CIVIL & Mechatronics, Prod.)	
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):

1. Engineering Mathematics I
2. 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 aperiodic function.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+6 Hrs

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

UNIT II FOURIER SERIES 9+6 Hrs

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

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

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 9+6 Hrs

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 TRANSFORM **9+6Hrs**

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 aperiodic function using Fourier Integral theorem.

Text Books

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

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

BoS Chairman

Course Code : 16AUT31	Course Title : ENGINEERING THERMODYNAMICS (Common to AUTO, MECH & 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):

1. Applied Physics
2. 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 vapour power cycles.
4. Evaluate the properties of ideal, real gas and gas mixtures.
5. Estimate the heating and cooling loads for automotive, domestic and industrial air conditioning systems.

UNIT I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 12 Hrs

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 Hrs

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

UNIT III PROPERTIES OF PURE SUBSTANCE AND VAPOR POWER CYCLES 12 Hrs

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. Vapour power cycles - steam rate, heat rate, efficiency calculation of Rankine, Reheat cycles - Regenerative cycle (qualitative

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treatment only).

UNIT IV PROPERTIES OF GASES AND GAS MIXTURES **12 Hrs**

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

UNIT V PSYCHROMETRY **12 Hrs**

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

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

Course Outcomes

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

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

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

CO3: Evaluate the performance of Rankine, Reheat and Regenerative vapour powercycles 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, 6th Edition, 2017.
2. Yunus A. Cengel, Michael A. Boles, "Thermodynamics – An Engineering Approach",Tata McGraw Hill, New Delhi, 8th Edition ,2015.

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Reference Books

1. Holman.J.P., "Thermodynamics", New York McGraw-Hill, 4th Edition, 1988.
2. Richard E Sonntag Claus Borgnakke , "Fundamentals of Thermodynamics", Wiley Student Edition, 7th Edition, 2009.
3. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 1st Edition ,2014.

Web References

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

BoS Chairman

Course Code : 16AUT32	Course Title : FLUID MECHANICS AND MACHINERY (Common to AUTO, MECH & 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):

1. Engineering Mathematics – I
2. 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

UNIT I FLUID PROPERTIES AND STATICS 12 Hrs

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 Hrs

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

UNIT III FLOW THROUGH PIPES AND DIMENSIONAL ANALYSIS 12 Hrs

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 Hrs**

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 Hrs**

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, 9th Edition, 2017
2. Yunus.A.Cengel, John.M.Cimbalal, "Fluid Mechanics- Fundamentals and Applications", Tata McGraw-Hill Education, 3rd Edition, 2014.

Reference Books

1. Er.Rajput, R.K., "A Text Book of Fluid Mechanics", Chand S and Co. New Delhi, Edition 1998 , Revised 2015.
2. Som S. K, Biswas G, Suman Chakraborty "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 3rd Edition ,2016
3. Ramamrutham. S, "Hydraulics, Fluid Mechanics and Fluid Machines", Dhanpat Rai& Sons, Delhi, 9th Edition, 2014

Web References

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

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Course Code : 16MCT31	Course Title : SENSORS AND SIGNAL PROCESSING	
Core / Elective: Core	L : T : P: C	3: 0 : 2 : 4
Type: Theory & Practical	Total Contact hours:	75

Prerequisites:

The student should have undergone the course(s):

1. Engineering Physics
2. Introduction to Engineering

Course Objectives

The course is intended to:

1. Analyze the characteristics and performance of transducers.
2. Explain the principle and application of resistance transducers.
3. Describe the principle and application of variable inductance and capacitance transducers.
4. Illustrate the advanced types of transducers
5. Describe the principle of signal conditioning and data acquisition

UNIT I SCIENCE OF MEASUREMENT 9 Hrs

Generalized Measurement System – Static and dynamic characteristics of transducers – Mathematical model of transducer – Zero Order and First Order transducers - Response of transducers to impulse, step, ramp and sinusoidal inputs – Classification of transducers.

UNIT II VARIABLE RESISTANCE TRANSDUCERS 9 Hrs

Principle of operation, construction details, characteristics and application of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezo resistive sensor and humidity sensor.

UNIT III VARIABLE INDUCTANCE AND CAPACITANCE TRANSDUCERS 9 Hrs

Induction potentiometer – Variable reluctance transducers – EI pick up – Principle of operation, construction details, characteristics and application of LVDT –Capacitive transducer and types – Capacitor microphone – Frequency response.

UNIT IV SPECIAL TRANSDUCERS 9 Hrs

Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors – Radar and its applications – piezo electric transducers – hall effect transducers.

UNIT V SIGNAL CONDITIONING AND DATA ACQUISITION 9 Hrs

Amplification – Filtering – Sample and Hold circuits –ADC-DAC-Data Acquisition: Single channel and multi-channel data acquisition – Data logging.

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Laboratory-Practical Component

List of Experiments **Conduct hours : 30**

1. Strain gauge & load cell characteristics.
2. Characteristics of Capacitive transducers.
3. Characteristics of thermocouple and thermistor
4. Signal conditioning circuit for temperature sensor
5. Step response characteristics of RTD and thermocouple
6. Characteristics of Hall effect transducers.

Course Outcomes

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

CO1: Analyze the characteristics and performance of transducers.

CO2: Explain the principle and application of resistance transducers.

CO3: Describe the principle and application of variable inductance and capacitance transducers.

CO4: Illustrate the advanced types of transducers.

CO5: Describe the principle of signal conditioning and data acquisition.

Text Books

1. Renganathan.S., "Transducer Engineering", Allied Publishers, 1999.

Reference Books

1. Doebelin.E.A., 'Measurement Systems – Applications and Design', Tata McGraw Hill, New York, 2000.
2. Hermann K.P.Neubert, 'Instrument Transducers:an Introduction to their performance and design', Clarendon Press, 1975, 2nd edition, Illustrated.
3. Patranabis.D., 'Sensors and Transducers', Prentice Hall of India, 1999.
4. John A. Allocca, Allean Stuart 'Transducer Theory and Applications', Reston publishing Company, 1984.
5. Ramakant A. Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition, Pearson Education, 2003.
6. Roy Choudhary. D., Sheil B. Jani, 'Linear Integrated Circuits', II edition, New Age, 2003.

Web References

1. nptel.ac.in/courses/112103174
2. http://nptel.ac.in/courses/108105064
3. http://nptel.ac.in/courses/112106140

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Course Code : 16MCT32	Course Title : ELECTRIC AND ELECTRONIC CIRCUITS	
Core / Elective: Core	L : T : P: C	3:0:2:4
Type: Theory & Practical	Total Contact hours:	75

Prerequisites:

The student should have undergone the course(s):

1. Engineering Physics
2. Introduction to Engineering

Course Objectives

The course is intended to:

1. Analyze basic electric circuits.
2. Analyze DC and AC circuits.
3. Explain the concept of Resonance and transient circuits.
4. Compare the transistors working and biasing
5. Explain about amplifiers.

UNIT I BASIC CIRCUIT ANALYSIS AND CIRCUIT REDUCTION TECHNIQUES **9 Hrs**

Ohm's Law – Kirchoffs laws – DC and AC Circuit fundamentals – Phasor Diagram – Power, Power Factor and Energy of basic circuit elements. – Resistors, Inductors and Capacitors in series and parallel circuits – Source transformation – Series resistors and voltage division, Parallel resistors and current division, – Star delta conversion.

UNIT II CIRCUIT THEOREMS FOR DC AND AC CIRCUITS **9 Hrs**

Mesh current and node voltage method of analysis for D.C and A.C circuits – Superposition Theorem – Thevenin's and Norton's Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's Theorem

UNIT III RESONANCE AND TRANSIENT RESPONSE FOR DC CIRCUITS **9 Hrs**

Series and Parallel resonance–their frequency response – Quality factor and bandwidth. Transient response of RL, RC and RLC circuits using Laplace transform for DC input.

UNIT IV BJT AND FET BIASING **9 Hrs**

Need for biasing – operating point – Load line – Stability factor – Different types of biasing circuits for BJT and FET. Common Emitter Transistor Amplifier – Common Source Amplifier.

UNIT V POWER AMPLIFIERS **9 Hrs**

A.C Load line– Classification of Power amplifiers – Class A – Class B – Push-pull & Complementary symmetry amplifiers – Class AB amplifier.

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Laboratory-Practical Component

List of Experiments **Conduct hours : 30**

1. Verification of Kirchoff's Voltage Law.
2. Verification of Kirchoff's Current Law.
3. Verification of Superposition theorem.
4. Verification of Thevenin's theorem.
5. Transistor biasing circuits.
6. Common Emitter Amplifier.
7. Common Source Amplifier.
8. Complimentary symmetry Class B push-pull amplifier.

Course Outcomes

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

CO1: Analyze basic electric circuits using laws, mesh and node analysis.

CO2: Analyze DC and AC circuits using circuit theorems.

CO3: Explain the concept of Resonance and analyze the transient responses.

CO4: Compare different types of transistors working and their biasing.

CO5: Explain the performance of transistor amplifiers and classify the power amplifiers with their operation.

Text Books

1. WilliamH.Hayt, JackKemmerly, StevenM.Durbin "Engineering Circuit Analysis" Tata McGraw Hill publishers, Eigth edition, New Delhi, 2013.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth Edition, McGraw Hill, 2013.
3. David A.Bell, "Electronic Devices and Circuits", Prentice Hall of India, 2013

Reference Books

1. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, 6th Edition New Delhi, 2014.
2. MNahvi, Joseph Edminister, KUMARAO "Electric circuits", Schaum's series, Tata McGraw - Hill, Fifth Edition, New Delhi, 2010.
3. Rashid, "Micro Electronic Circuits" Thomson publications, 2014

Web References

1. http://nptel.ac.in/courses/117106101/
2. http://nptel.ac.in/courses/108102042/

BoS Chairman

Course Code : 16CST34	Course Title : C PROGRAMMING	
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. Implement modular programs using functions and files.
2. Apply the branching decision making and loop concepts for simple array operations
3. Apply pointers for effective memory usability
4. Apply string functions to manipulate the strings
5. Demonstrate the necessity of structures and unions

UNIT I INTRODUCTION 9 Hrs

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 9 Hrs

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 9 Hrs

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 9 Hrs

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 9 Hrs

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, 2013

Reference Books

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

Web References

1. http://nptel.ac.in/courses/106105085/2
2. http://nptel.ac.in/courses/106105085/3
3. http://www.cprogramming.com/

BoS Chairman

Course Code : 16AUL31	Course Title : FLUID MECHANICS AND MACHINERY LABORATORY (Common to AUTO, MECH & 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 for a fluid flow.
3. Determine the Reynolds Number.
4. Conduct performance tests on turbines.
5. Conduct performance tests on pumps.

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 PitotTube
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 theoretical discharge of fluid flow using various flow measuring devices.

CO2: Determine the actual discharge of fluid flow using various flow measuring devices.

CO3: Determine friction factor and Reynolds Number for a fluid flow through pipe.

CO4: Conduct performance tests and draw the characteristics curves of pumps.

CO5: Conduct performance tests and draw the characteristics curves of turbines.

Reference Books

1. Fluid Mechanics and Machinery Laboratory Manual Prepared by Mechatronics Department

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Course Code : 16CSL33	Course Title : C PROGRAMMING 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. Use different operators, formatting input and outputs.
2. Design programs involving decision making, loops and functions.
3. Develop array and pointers programs.
4. Develop programs using structures and unions.
5. Handle file I/O operations.

LIST OF EXPERIMENTS

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

Course Outcomes

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

CO1: Infer the skills in data processing

CO2: Develop program using suitable programming constructs

CO3: Write, compile and debug programs in C language.

CO4: Apply and practice logical ability to solve application oriented problems

CO5: choose appropriate programming components to solve real world computing problems.

Reference Books

1. C programming Laboratory Manual Prepared by Mechatronics Engineering Department

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Course Code : 16PSL31	Course Title : PERSONAL EFFECTIVENESS (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

Prerequisites:

The student should have undergone the course(s):

1. Promotion of Students Wellness

Course Objectives

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.

UNIT I THE IMPORTANCE OF ENVISIONING 6Hrs

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 6Hrs

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 6Hrs

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 6Hrs

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.

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UNIT V PUTTING INTO PRACTICE 6 Hrs

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

Course Outcomes

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

CO1: Identify one's strengths, weaknesses and opportunities.

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

CO3: Establish the road map to realize the goals.

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

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

Course handouts (compiled by PS team, MCET)

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

Further Reading

1. Stephen R Covey, "First things first", Simon & Schuster Uk, Aug 1997.
2. Sean Covey, "Seven habits of highly effective teenagers", Simon & Schuster Uk, 2004.
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 days 7 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

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Assessments:

Assessment	Details	Weightage	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%	Pen and paper	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.

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END OF SEMESTER- III

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SEMESTER - IV

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SEMESTER IV

Course Code : 16MAT41	Course Title : NUMERICAL METHODS (Common to MECH & 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):

1. Engineering Mathematics I
2. Engineering Mathematics II
3. Engineering Mathematics III

Course Objectives

The course is intended to:

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

UNIT I SOLUTION OF SYSTEM OF LINEAR EQUATIONS 9+6 Hrs

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

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

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

UNIT III INTERPOLATION, NUMERICAL DIFFERENTIATION & INTEGRATION 9+6 Hrs

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+6 Hrs

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+6 Hrs

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: Determine the solution of linear equations and calculate the dominant Eigen value using standard techniques.

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

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

CO4: Compute the solution of first order ordinary differential equations using numerical techniques.

CO5: Compute the solution of partial differential equations using numerical techniques.

Text Books

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

Reference Books

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.
3. Sastry.S.S "Introductory Methods of Numerical Analysis", 3rd Edition, PHI, 2003

Web References

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

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Course Code : 16MCT41	Course Title : STRENGTH OF MATERIALS	
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):

1. 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 beams and stability of columns.
5. Solve problems on circular shafts and close coil helical springs.

UNIT I STRESS AND STRAIN OF SOLIDS 9+3 Hrs

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+3 Hrs

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+3 Hrs

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+3 Hrs

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+3 Hrs

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

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to compressive loads.

Course Outcomes

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

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

CO2: 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 deflectionon circular shafts subjected to torsion and close coil helical springs subjected to compressive load.

Text Books

1. Russel.C. Hibbeller , "Mechanics of Materials", Prentice-Hall of India, New Delhi, 9th Edition, 2017.
2. James M.Gere, Barry J Goodno, " Mechanics of Materials", Cengage Delmar Learning, India pvt.ltd, 8th Edition, 2016.

Reference Books

1. Rattan SS, "Strength of Materials" Tata McGraw-Hill Education Pvt Ltd.,New Delhi, 2nd Edition 2015.
2. Beer F. P. and Johnston R," Mechanics of Materials", McGraw-Hill Book Co, 7th Edition, 2015.
3. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York,4th Edition, 2004.

Web References

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

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Course Code : 16MCT42	Course Title : THEORY OF MACHINES	
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):

1. Engineering Mathematics I
2. Engineering Mechanics

Course Objectives

The course is intended to:

1. Calculate the kinematic parameters of simple mechanisms.
2. Calculate the kinematic parameters of gears and gear trains
3. Understand the force – motion relationship in components subjected to external forces and standard mechanisms.
4. Analyze the rotating unbalances masses.
5. Calculate the damped & un-damped vibration parameters.

UNIT I BASICS OF MECHANISMS **9 Hrs**

Machine Structure - Kinematic link, pair and chain -Grueblers criteria -Constrained Motion Degrees of freedom - Slider crank and crank rocker mechanisms -Inversions - Applications - Kinematic analysis of simple mechanisms-Determination of velocity and acceleration.

UNIT II KINEMATICS OF GEARS AND GEAR TRAINS **9 Hrs**

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

UNIT III FORCE ANALYSIS **9 Hrs**

Dynamic force analysis – Inertia force and inertia torque – D Alembert's principle – Dynamic analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod – Bearing loads – Crank shaft torque – Turning moment diagrams – Fly wheels – Fly wheels of punching presses.

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UNIT IV BALANCING **9 Hrs**

Static and dynamic balancing - balancing of rotating masses - balancing of single rotating mass by a single mass in the same plane. Balancing of single rotating mass by two masses in different plane and balancing of several rotating masses in the same plane, balancing of several masses in different planes.

UNIT V VIBRATION **9 Hrs**

Free, forced and damped vibrations of single degree of freedom systems - Force transmitted to supports - Vibration isolation - Vibration absorption.

Laboratory-Practical Component

List of Experiments **Conduct hours : 30**

1. Draw models and simulate the following mechanisms:
    a) Four bar mechanisms
    b) Double rocker mechanism
    c) Crank rocker mechanism
    d) Double crank mechanism
    e) Slider crank mechanism
2. Perform an experiment on the Cam follower setup and plot the follower displacement against the crank rotation.
3. Do a study of differential gear train setup, identify the different gears and draw a neat sketch of the gear train
4. Balancing of reciprocating masses and rotating masses.
5. Vibrating system – spring mass system –Determination of damping co-efficient of single degree of freedom system.
6. Determination of transmissibility ratio - vibrating table.

Course Outcomes

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

CO1: Calculate the position, velocity and acceleration parameters of the given simple mechanism using graphical method.

CO2: Calculate the kinematic parameters of spur gear and velocity ratio of simple, compound and epicyclic gear trains.

CO3: Calculate static and dynamic forces of mechanisms.

CO4: Analyze the rotating unbalances masses in single & different planes.

CO5: Calculate the vibration parameters of damped & un-damped free and forced longitudinal SDOF.

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Text Books

1. Ambekar A. G., "Mechanism and Machine Theory", Prentice Hall of India, New Delhi,1st Edition, 2009.
2. Rattan S S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd, New Delhi,4th Edition, 2016.

Reference Books

1. UickerJ.J.Pennock G.R., Shigley J.E., "Theory of Machines and Mechanisms"(Indian Edition), Oxford University Press,4th Edition, 2014.
2. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 3rd Edition 2010.
3. Sadhu Singh, "Theory of Machines", Pearson Publishers, 3rd Edition, 2011.

Web References

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

Text Books

7. "Theory of Machines Laboratory manual" prepared by Department of Mechatronics.

Web References

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

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Course Code : 16MCT43	Course Title : MANUFACTURING TECHNOLOGY	
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):

1. Material Science
2. 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. Select various Unconventional Machining processes.

UNIT I THEORY OF METAL CUTTING **9 Hrs**

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

UNIT II MACHINING CYLIDRICAL FEATURES **9 Hrs**

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 Hrs**

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 Hrs**

Grinding: Types of grinding machines, Types of grinding wheels, Grinding wheel designation, Classification of grinding machines and grinding wheels, Constructional features of cylindrical

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grinding machines, Surface grinding machines, Process parameters.

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

UNIT V UNCONVENTIONAL MACHINING PROCESS 9 Hrs

Ultrasonic Machining process, abrasive jet machining process, water jet machining process, Electric discharge machining(EDM) – wire cut EDM, chemical machining process, electro chemical machining, electron beam machining, laser beam machining-principles, working process , applications, merits and demerits.

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: Compare various energy based unconventional machining processes.

Text Books

1. Rao P N, "Manufacturing Technology, Vol 2, Metal Cutting and Machine Tools", , Tata McGraw Hill, New Delhi, 3rd Edition, 2013.
2. Serope Kalpakjian, Steven Schmid, "Manufacturing Engineering and Technology", Addison Wesley Publishing Company, 7th edition, 2013.
3. Vijay.K.Jain "Advanced Machining Processes" Allied Publishers Pvt.ltd, New Delhi, 2014.

Reference Books

1. Rajput R K, "A Text Book of Manufacturing Technology (Manufacturing Process)", Laxmi Publications (P) Ltd., New Delhi, Reprint 2015.
2. Sharma P C, "A Text book of Production Engineering", S.Chand & Co Ltd., 8th Edition Revised, 2017.

Web References

1. http://nptel.ac.in/courses/112105126/
2. http://nptel.ac.in/courses/112105127/

BoS Chairman

Course Code : 16MCT44	Course Title : ANALOG AND DIGITAL CIRCUITS	
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):

1. Electric and Electronic Circuits

Course Objectives

The course is intended to:

1. Explain the concepts of operational amplifier.
2. Classify the different types of operational amplifier.
3. Understand the various number systems and codes.
4. Implement the various combinational and sequential circuits.
5. Explain the basics about synchronous and Asynchronous circuits

UNIT I OPAMP AND ITS CHARACTERISTICS **9 Hrs**

Basics of BJT Differential amplifier-Internal stages of opamp-Ideal opamp characteristics and its equivalent circuits-DC characteristics- AC characteristics-Concept of frequency compensation and slew rate.

UNIT II APPLICATION OF OPAMP **9 Hrs**

Sign Changer, Scale Changer, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Comparators, Schmitt trigger.

UNIT III MINIMIZATION TECHNIQUES AND LOGIC GATES **9 Hrs**

Number systems, Basic digital circuits: Logic circuits - universal building block construction using logic gates - Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions min term (SOP) max term (POS) - K Map representation of logic functions - simplification of logic functions using K Map – Don't care conditions - Five variable K maps.

UNIT IV COMBINATIONAL AND SEQUENTIAL CIRCUITS **10 Hrs**

Combinational Circuits: Half And Full Adders-Half And Full Subtractors -4 bit Adder & Subtractor – Multiplexer, De-multiplexer – Encoder, Decoder - Code Converters – BCD Adder

Sequential Circuits: SR Latch - Flip-Flops: SR, JK, T, D - Level Triggering, Edge Triggering-Register: Shift Registers – 4 bit binary Counters.

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UNIT V **SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS** **8 Hrs**

Design of synchronous and asynchronous sequential circuits - parity checker - sequence detector - Race conditions and Cycles – Hazards.

Laboratory-Practical Component

List of Experiments **Conduct hours : 30**

1. Design and verification of inverting, non-inverting and differential amplifier.
2. Design and verification of integrator and differentiator.
3. Design of full adder and subtractor using logic gates.
4. Design of full adder and subtractor using logic gates.
5. Design of Encoder using logic gates.
6. Design of multiplexer using logic gates.
7. Design of binary counter.

Course Outcomes

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

CO1: Analyze the characteristics of operational amplifier in terms of AC & DC parameters.

CO2: Examine the various applications of operational amplifier.

CO3: Examine the structure of various number systems and its application in digital logic design.

CO4: Create a gate-level implementation of a combinational and sequential logic function.

CO5: Differentiate synchronous and asynchronous circuits in a logic design.

Text Books

1. Roy Choudhary.D.,SheilB.Jani,"Linear Integrated Circuits",IIedition.New Age,2003.
2. M. Morris Mano, Michel D. Ciletti, Digital Design, Pearson Education, New Delhi, 2012.

Reference Books

1. Ramakant A. Gayakward,"Op-amps and Linear Integrated Circuits", IV edition, Pearson Education,2003.
2. Anil.K.Maini,"DigitalElectronis",First Edition, wiley India Pvt,Ltd.,2011
3. Salivaganan. S and Arivazhagan.S., "Digital circuits and design" Fourth Edition 2012.
4. Donald G.Givone, "Digital principles and Design", Tata McGraw Hill 2002.

Web References

1. http://nptel.ac.in/courses/117106086/1
2. http://nptel.ac.in/courses/117106114/
3. http://nptel.ac.in/courses/117107094/
4. https://freevideolectures.com/course/2261/basic-electronics-and-lab

BoS Chairman

Course Code : 16EET45	Course Title : ELECTRICAL DRIVES AND CONTROL (Common to MECH & Mechatronics)	
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):

1. Introduction to Engineering
2. Electrical & Electronics Circuits

Course Objectives

The course is intended to:

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

UNIT I INTRODUCTION **9 Hrs**

Fundamentals of electric drives – Characteristics of loads – different types of mechanical loads – four quadrant operation of electric drive – Control circuit components: Fuses, circuit breakers, contactors, relays.

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

Constructional features and working principle of a DC machine – speed torque characteristics of DC shunt & series motor – methods of speed control – Solid state DC drives: bridge rectifier fed DC drives, Chopper fed DC drives, Static ward Leonard method.

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

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

UNIT IV SPECIAL ELECTRICAL DRIVES & CONTROLS **9 Hrs**

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

UNIT V CONTROL AND SELECTION OF ELECTRIC DRIVES **9 Hrs**

BoS Chairman

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

Course Outcomes

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

CO1: Explain an electrical drives and its control to operate in different modes.

CO2: Explain the characteristics of DC drives with different control techniques such as field and armature control.

CO3: Explain the characteristics of AC drives with different stator side control.

CO4: Explain the operating principle of special electrical drives such as stepper, BLDC and servo drive.

CO5: Choose an electrical drive for an applications such as residential and industrial.

Text Books

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

Reference Books

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

Web References

1. http://nptel.ac.in/courses/108108077
2. https://en.wikipedia.org/wiki/Solid-state drive
3. nptel.ac.in/syllabus/108104011/

BoS Chairman

Course Code : 16MCL41	Course Title : MANUFACTURING TECHNOLOGY LAB	
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. Develop process sequence for manufacturing a machined part.
2. Use Lathe, Automat, Drilling, Milling, Slotting and grinding machines.
3. Demonstrate the cutting processes.
4. Demonstrate the shaping, reaming and tapping processes.
5. Demonstrate the assembly process for machines components.

List of Experiments **60 Hrs**

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

Course Outcomes

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

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

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

CO3: Demonstrate the cutting processes of components.

CO4: Demonstrate the shaping, reaming and tapping processes for machine components.

CO5: Demonstrate the assembly process for machines components.

Text Books

1. "Manufacturing Technology Laboratory manual" prepared by Department of Mechatronics.

BoS Chairman

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

Course Objectives

The course is intended to:

1. Analyze the DC motor to verify its mechanical characteristics.
2. Demonstrate the speed control methods of DC motor and Induction motor.
3. Demonstrate the stepper motor drives.
4. Demonstrate the megger, multi-meter and control circuit components.
5. Demonstrate the starters for D.C Motors and Induction motors.

List of experiments **60 Hrs**

1. Draw the load characteristics of DC shunt motor.
2. Draw the load characteristics of DC series motor.
3. Draw the load characteristics of 3 phase Induction motor.
4. Draw the speed control curves of DC shunt motor.
5. Draw the speed control curves of 3 phase Induction motor using VFD.
6. Draw the speed control curves of DC shunt motor using Bridge rectifier.
7. Draw the speed control curve of DC shunt motor using chopper.
8. Demonstrate the position control of stepper motor.
9. Demonstrate insulation testing of motors using megger.
10. Demonstrate the star-delta starter and Three point starter.

Course Outcomes

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

CO1: Analyze the DC motor to verify its mechanical characteristics.

CO2: Demonstrate the DC motor and Induction motor to operate in different speeds.

CO3: Demonstrate the stepper motor drives to operate in various speeds.

CO4: Demonstrate the megger, multi-meter and control circuit components to measure and control various electric parameters.

CO5: Demonstrate the three point starter for D.C Motors starting and Star-Delta starter for Induction motor starting.

Text Books

1. "Electrical Drives and Control Laboratory Manual" prepared by Department of Mechatronics Engineering.

BoS Chairman

Web References

1. http://iitg.vlab.co.in/?sub=61&brch=168
2. http://em-iitr.vlabs.ac.in/index.php?section=List%20of%20experiments

BoS Chairman

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

Prerequisites:

The student should have undergone the course(s):

1. Promotion of Students Wellness

Course Objectives

The course is intended to:

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

UNIT I ETHICAL PRACTICES - IMPORTANCE 6Hrs

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 6Hrs

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 6Hrs

Importance of code of conduct and its role; Evolving draft Code of conduct for different roles – son/daughter, student, future employee & citizen; Reflection on 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.

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UNIT IV PROFESSIONAL PRACTICES AT WORK **6Hrs**

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.

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

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.

Course handouts (compiled by Professional Skills team, MCET)

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

Further Reading

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

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END OF SEMESTER- IV

BoS Chairman

SEMESTER-V

BoS Chairman

SEMESTER-V

Course Code :16EIT51	Course Title: CONTROL SYSTEMS (Common to EEE,EIE, Mechatronics)	
Core / Elective : Core	L : T : P: C	3 : 2 : 0 : 4
Type: Theory	Total Contact hours:	75 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Engineering Mathematics – I & II

Course Objectives

The course is intended to:

1. Model electrical and mechanical systems using transfer function.
2. Determine the time response and time domain specifications of first order and second order systems.
3. Analyse the given first order and second order system with their frequency domain specifications.
4. Analyse the stability of the given system.
5. Design compensator using bode plot technique

UNIT I CONTROL SYSTEM MODELING **9+6 Hrs**

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

UNIT II TIME RESPONSE ANALYSIS **9+6 Hrs**

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

UNIT III FREQUENCY RESPONSE ANALYSIS **9+6 Hrs**

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

UNIT IV STABILITY ANALYSIS **9+6 Hrs**

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

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UNIT V COMPENSATOR DESIGN **9+6 Hrs**

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

Course Outcomes

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

CO1: Model electrical and mechanical systems using transfer function.

CO2: Determine the time response and time domain specifications of first order and second order systems.

CO3: Analyse the given first order and second order system with their frequency domain specifications.

CO4: Analyse the stability of the given system.

CO5: Design compensator using bode plot technique.

Text Books

1. J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 6th Edition, 2017.
2. Benjamin C. Kuo, 'Automatic Control systems', Pearson Education, New Delhi, 10th Edition, 2017.

Reference Books

1. Norman S. Nise, 'Control Systems Engineering', John Wiley, New Delhi, Sixth Edition, 2011.
2. Samarajit Ghosh, 'Control systems Theory and Applications ', Pearson Education, New Delhi, Second Edition 2012.
3. M. Gopal, 'Control Systems, Principles and Design', Tata McGraw Hill, New Delhi, 4th Edition 2012.
4. K. Ogata, 'Modern Control Engineering', Pearson Education India, New Delhi, 5th Edition 2015.
5. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems ", Pearson Prentice Hall, 13th Edition 2016.

Web References

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

BoS Chairman

Course Code : 16MET51	Course Title : DESIGN OF MACHINE ELEMENTS (Common to AUTO, MECH & 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):

1. Theory of Machines
2. Strength of Materials

Course Objectives

The course is intended to:

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

UNIT I DESIGN FOR STATIC LOAD OR STEADY STRESSES 12 Hrs

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 Hrs

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 Hrs

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

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UNIT IV DESIGN OF SPRINGS **12 Hrs**

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

UNIT V DESIGN OF BEARING **12 Hrs**

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 edition 2014.
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 BookCo., 2010.
3. Spotts M.F., Shoup T.E "Design and Machine Elements" Pearson Education,2012.

Web References

1. http://nptel.ac.in/courses/112105124/
2. http://www.nptel.ac.in/downloads/112105125/

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3. http://nptel.ac.in/courses/112106137/
4. http://www.skf.com/in/index.html

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Course Code : 16MCT51	Course Title : CAD/CAM/CIM	
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):

1. Manufacturing Technology

Course Objectives

The course is intended to:

1. Explain the computer aided design principles.
2. Distinguish different CNC machines.
3. Explain the different part program of CNC Lathe and CNC Machining centre.
4. Defining manufacturing planning and control.
5. Explains process planning and product planning.

UNIT I COMPUTER AIDED DESIGN **9 Hrs**

Introduction to CAD -Types of CAD system – 2D&3D Transformations – translation - scaling-rotation – Geometry Modelling techniques - Wireframe modelling - surface modelling - solid modelling - Boundary Representation – CSG – Comparison – Graphics Standard – GKS - IGES.

UNIT II DESIGN FEATURES OF CNC MACHINES **9 Hrs**

Working principles of - CNC turning centre- machining centre-pneumatic and hydraulic control system - Open loop and closed loop systems-microprocessor based CNC systems - Selection of CNC machine tools – structure - drive kinematics - gear box - main drive - selection of timing belts and pulleys - spindle bearings arrangement - Re-circulating ball screws - linear motion guide ways - tool magazines – ATC – APC - chip conveyors tool turrets - spindle encoder.

UNIT III PART PROGRAMMING **9 Hrs**

CNC turning centre programming - G and M functions-tool offset information - tool nose radius compensation - long turning cycle - facing cycle - threading cycle - peck drilling cycle - part programming examples. CNC Milling Programming - Co-ordinate systems - cutter diameter compensation - fixed cycles - drilling cycle - tapping cycle - boring cycle - part programming examples.

UNIT IV COMPUTER INTEGRATED MANUFACTURING **9 Hrs**

Brief introduction to Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements

BoS Chairman

of an Automated system – Levels of Automation – Lean Production and Just-In Time Production.

UNIT V PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING **9 Hrs**

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

Course Outcomes

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

CO1: Explain the computer aided design principles such as transformations, geometry modelling technique and graphics standard.

CO2: Explain the construction and features of CNC machines.

CO3: Develop a part program to produce a component by CNC lathe and Machining centre.

CO4: Categorizing CIM concepts.

CO5: Explains process planning and product planning for different manufacturing process.

Text Books

1. Mikell.P. Groover "Automation, Production Systems and Computer Integrated Manufacturing"4th Edition, Pearson India Pvt. ltd, 2016.
2. Radhakrishnan P, SubramanyanS. and Raju V., "CAD/CAM/CIM", 4th Edition, New Age International (P) Ltd, New Delhi, 2018.

Reference Books

1. Kant Vajpayee. S., "Principles of Computer Integrated Manufacturing", Prentice Hall of India, 2010.
2. Yorem Koren, "Computer Control of Manufacturing System", McGraw Hill, 2017.

Web References

1. https://nptel.ac.in/courses/112102101
2. https://nptel.ac.in/courses/112102103
3. https://nptel.ac.in/courses/112104230

BoS Chairman

Course Code : 16MCT52	Course Title : MICROPROCESSOR AND MICROCONTROLLER	
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):

1. Analog and Digital circuits

Course Objectives

The course is intended to:

1. Distinguish the feature of the 8085 microprocessor, Hardware Architecture and PIN diagram.
2. Demonstrate programming proficiency using the various addressing modes and instructions of 8085 microprocessor
3. Distinguish the feature of the 8051 microcontroller, Hardware Architecture and PIN diagram.
4. Illustrate the interrupts handling and demonstrate peripherals applications in different IC and Know about A/D and D/A converters.
5. Apply the PIC programming concepts to interface the hardware units with microprocessor and PIC Microcontroller.

UNIT I 8085 PROCESSOR 9 Hrs

Hardware Architecture, Pin Diagram – Functional Building Blocks of Processor – Memory Organization – I/O Ports and Data Transfer Concepts–Interrupts.

UNIT II PROGRAMMING OF 8085 PROCESSOR 9 Hrs

Instruction - Format and Addressing Modes – Assembly Language Format – Data Transfer, Data Manipulation & Control Instructions – Programming: Loop structure with Counting & Indexing – Look up table - Subroutine Instructions - Stack.

UNIT III 8051 MICRO CONTROLLER 9 Hrs

Hardware Architecture, Pin Diagram – Memory Organization – I/O Ports and Data Transfer Concepts– Serial Communication – Interrupts.

UNIT IV PERIPHERAL INTERFACING 9 Hrs

Introduction on Architecture, Configuration and Interfacing, with ICs: 8255, 8259, 8237, 8251, 8279, A/D and D/A Converters.

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UNIT V **PIC MICRO CONTROLLER PROGRAMMING AND APPLICATIONS** **9 Hrs**

Introduction to PIC Microcontroller, Hardware Architecture , Pin Diagram, Key Board and Display Interface – Closed Loop Control of Servo motor- Stepper Motor Control –Washing Machine Control.

Course Outcomes

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

CO1: Distinguish the feature of the 8085 microprocessor by indicating various functional blocks using hardware architecture and PIN diagram.

CO2: Demonstrate programming proficiency of 8085 microprocessor to develop assembly language programming using various addressing modes and Instructions.

CO3: Distinguish the feature of the 8051 microcontroller by indicating various functional blocks using hardware architecture and PIN diagram.

CO4: Illustrate the interrupts handling and demonstrate peripherals applications for various interfacing using different IC's.

CO5: Apply the PIC programming concepts to interface the hardware units with microprocessor and PIC Microcontroller.

Text Books

1. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. Muhammad Ali Mazidi& Janice GilliMazidi, R.D. Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

Reference Books

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.
2. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, 'Microprocessors and Microcontrollers', Oxford, 2013.
3. Valder – Perez, "Microcontroller – Fundamentals and Applications with PIC", Yeesdee Publishers, Taylor & Francis, 2013.
4. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013
5. Kenneth J. Ayala, "The 8051 Microcontroller. Architecture, Programming and Applns", West publishing company 2014.

BoS Chairman

Web References

1. https://nptel.ac.in/courses/108107029/
2. https://www.tutorialspoint.com/microprocessor
3. http://www.circuitstoday.com/basics-of-microcontrollers

BoS Chairman

Course Code : 16MCT53	Course Title : VIRTUAL INSTRUMENTATION	
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):

1. Sensors and Signal processing
2. C programming

Course Objectives

The course is intended to:

1. Summarizing the need for Virtual Instrumentation
2. Create and modify the virtual instruments with program control structures of LabVIEW.
3. Choose the appropriate functions for handling Arrays, Strings and File I/O tasks.
4. Illustrate different communication Interfaces for Virtual Instrumentation.
5. Build a vision system for an automated inspection.

UNIT I GRAPHICAL SYSTEM DESIGN **9 Hrs**

Graphical System Design Model – Virtual Instrumentation – Virtual Instrument and Traditional Instrument – Hardware and software in virtual instrumentation – Virtual instrumentation for test, control and Design – Conventional and Graphical programming.

UNIT II CONTROL DESIGN **9 Hrs**

Front Panel and Block Diagram – Tools, Controls and Functions palette. Modular programming – SubVI. Structures – FOR, WHILE Loops, Case, Sequence, event structures, Formula node.

UNIT III ALGORITHM DEVELOPEMENT **9 Hrs**

Data types, Arrays, Clusters, Strings, File I/O, Time and Dialog controls, Waveform chart, Graph, XY Graph and operations, Web Publishing tool.

UNIT IV DATA ACQUISITION SYSTEM **9 Hrs**

Instrument control: GPIB – VISA – Instrument drivers – Serial Port communication. Data Acquisition: Review of Transducers and signal conditioning, DAQ hardware – AI, AO, DIO. DAQ Assistant and configuration.

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UNIT V LABVIEW APPLICATIONS **9 Hrs**

Vision Builder for Automated Inspection-Checking for the Presence of a Part-Inspecting Objects for Correct Measurements-Inspecting an Object that Spans Two Image Frames-Branching and Decision Making.

Course Outcomes

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

CO1: Illustarte the advantages of the Virtual Instrumentation.
CO2: Apply program control structures in LabVIEW.
CO3: Identify appropriate tools for arrays, strings and File I/O tasks.
CO4: Select data acquisition system interfaces based on the requirement
CO5: Construct vision inspection system for automated inspection of objects.

Text Books

1. Jovitha Jerome, 'Virtual Instrumentation using LABVIEW' PHI Learning Private Limited, New Delhi, Second Printing, 2011
2. Gary W Johnson, Richard Jennings, 'LABVIEW Graphical Programming' Fourth Edition, McGraw Hill, 2006

Reference Books

1. Sanjay Gupta, Joseph John, 'Virtual Instrumentation using LabVIEW' Tata McGraw Hill, 5th Reprint, 2010.
2. Robert H Bishop. 'Learning with LabVIEW 2009' Pearson Education, 2010.
3. Salivaganan. S and Arivazhagan.S., "Digital circuits and design" Fourth Edition 2012.
4. Donald G.Givone, "Digital principles and Design", Tata McGraw Hill 2002.

Web References

1. http://www.ni.com/getting-started/labview-basics/environment
2. http://www.ni.com/getting-started/set-up-hardware/
3. http://www.ni.com/getting-started/set-up-hardware/data-acquisition/sensors
4. http://www.ni.com/pdf/manuals/373379h.pdf

BoS Chairman

Course Code : 16MCL51	Course Title : MICROPROCESSOR AND MICROCONTROLLER 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):

1. Analog and Digital circuits

Course Objectives

The course is intended to:

1. Develop a simple arithmetic and control instructions of 8085 Microprocessor.
2. Develop for interfacing A/D and D/A converter and traffic light controller.
3. Build a program for the simulator and emulator for I/O Serial communication.
4. Explain the basic instruction set of 8051 Microcontroller.
5. Apply the concepts of programming on real-time applications

LIST OF EXPERIMENTS **60 Hrs**

1. Simple arithmetic operations: Addition / Subtraction / Multiplication / Division.
2. Programming with control instructions:
   (i) Ascending / Descending order, Maximum / Minimum of numbers
   (ii) Programs using Rotate instructions
   (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments: with 8085
   (i) A/D Interfacing
   (ii) D/A Interfacing
4. Traffic light controller.
5. I/O Port / Serial communication
6. Programming Practices with Simulators/Emulators/open source
7. Read a key, interface and display
8. Demonstration of basic instructions with 8051 Microcontroller execution, including:
   (i) Conditional jumps, looping
   (ii) Calling subroutines
9. Programming I/O Port 8051
   (i) Interfacing with A/D & D/A
   (ii) Interfacing with DC & AC motor
10. Mini project development with processors.

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Course Outcomes

CO1: Explain simple program for arithmetic operations using assembly language

CO2: Develop a program and interface A/D and D/A converters and traffic light controllers.

CO3: Develop an interface using emulator for serial communication

CO4: Program 8051 Microcontroller using program control instructions such as Conditional jumps, looping and Calling subroutines.

CO5: Select the hardware interface for microcontroller-based systems

Text Books

1. "Microprocessor and Microcontroller Laboratory manual" prepared by Department of Mechatronics Engineering.

BoS Chairman

Course Code : 16MCL52	Course Title : CNC PROGRAMMING 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):

1. Manufacturing Technology

Course Objectives

The course is intended to:

1. Outline the importance of CNC lathe and CNC Milling Machine.
2. Explain G codes and M codes used in CNC Machines for programming.
3. Develop the programming skills and create a component for required drawing.
4. Simulate the manual part programme for CNC turning centre using software.
5. Simulate the manual part programme for CNC Milling centre using software.

LIST OF EXPERIMENTS **60 Hrs**

1. Study exercise on CNC machines and Programming codes.
2. Write part program for simple facing and turning operation and simulate by using software.
3. Write part program for box facing operation and simulate by using software.
4. Write part program for step turning operation and simulate by using software.
5. Write part program for taper turning operation and simulate by using software.
6. Write part program for multiple facing operation and simulate by using software.
7. Write part program for multiple turning operation and simulate by using software.
8. Write part program for external grooving and simple threading operation and simulate by using software.
9. Write part program for drilling operation and simulate by using software.
10. Write part program for profile milling and circular pocketing operation and simulate by using software.

Course Outcomes

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

CO1: Classify the importance of CNC lathe and CNC Milling Machine.

CO2: Interpret G codes and M codes used in CNC Machines for programming.

CO3: Develop the CNC program and create a component for required drawing.

CO4: Develop the manual part programme simulation for CNC turning centre using software.

CO5: Develop the manual part programme simulation for CNC milling centre using software.

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Text Books

1. "Computer Numerical Control Laboratory Manual" prepared by Department of Mechatronics Engineering.

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Course Code : 16PSL51	Course Title : TEAMNESS AND INTERPERSONAL SKILLS (Common to all B.E/B.Tech Programmes)	
Core / Elective: General	L : T : P: C	0: 0 : 2 : 1
Type: PS	Total Contact hours:	30 Hours

Course Objectives

The course is intended to:

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

UNIT I HARMONY WITH SELF **6Hrs**

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

UNIT II HARMONY WITH OTHERS **6Hrs**

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 **6Hrs**

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 **6Hrs**

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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Course Outcomes

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

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

MODE OF DELIVERY

1. A 2 – day learning workshop
    a. Activities (Experiential learning)
    b. Audio visuals (Affective learning)
    c. Case Discussions (Cognitive learning)
    d. 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

EVALUATION:

Sl. No.	Evaluation	Criterion	Total marks		Remarks
1	Continuous Evaluation	KT SKT Evaluation during workshop Weekly review of journal	KT SKT Work book Journal	- 10 marks - 15 marks - 20 marks - 30 marks	KT=Knowledge Test SKT=Scenario based Knowledge Test
			Total	- 75 marks	
2	End semester Evaluation	Comprehensive Examination and Viva voce	KT & SKT, short questions Viva voce	- 10 marks - 15 marks	Conducted for 25 marks
			Total	- 25 marks	
		Total marks for the course	100 marks		
		Condition for clearing the course	50 marks as a whole; but student should have attended the ESE.		

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END OF SEMESTER – V

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SEMESTER - VI

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SEMESTER-VI

Course Code :16MCT61	Course Title: INDUSTRIAL AUTOMATION	
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):

1. Analog and Digital circuits.

Course Objectives

The course is intended to:

1. Explain the building blocks of Programmable Logic Controllers.
2. Illustrate the types of PLC programming languages.
3. Apply the concept of timer in programmable logic controllers.
4. Apply the concept of counter in programmable logic controllers.
5. Explain the Interface of the peripheral devices with Programmable logic controllers.

UNIT I BASICS OF PLC **9 Hrs**

Introduction of PLC – PLC vs. Computers – PLC size and application - H/W Components of PLC-I/O Modules – Sourcing and Sinking – CPU – Memory – Communication Interface –Types of Addressing

UNIT II PLC PROGRAMMING **9 Hrs**

Relay ladder logic – Symbols of I/O types – Digital Logic – The Binary Concept. Relay Ladder programming vs. PLC ladder Programming. Program Scan – Types of PLC Programming - exercises on LD, ST and FBD.

UNIT III PROGRAMMING TIMERS **9 Hrs**

Introduction to Time delay – Mechanical timing relay –Timer instructions – ON Delay – OFF Delay – Real time Clock – Practices on Real time Applications using ON delay and OFF delay timers.

UNIT IV PROGRAMMING COUNTERS **9 Hrs**

Introduction to Counters – Types of counters - UP counter, Down counter and UP down Counters – Incremental Encoder applications - Program Control Instruction.

UNIT V PLC INTERFACING **9 Hrs**

Interfacing of PLC with Sensorics –Speed measurement and Distance measurement - Interfacing of PLC with Pneumatic System -control of linear actuators.

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Course Outcomes

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

CO1: Illustrate the architecture of PLC

CO2: Explain the types of I/O's and understanding the difference between various PLC programming

CO3: Compare with different PLC timer concepts.

CO4: Compare with different PLC counter concepts.

CO5: Program PLC with interfacing concepts.

Text Books

1. Frank D. Petruzella, 'Programmable Logic Controllers', Fourth edition, Tata McGraw Hill, 2010.
2. John W. Webb, Ronald A. Reis 'Programmable Logic Controllers and Applications', PHI Learning, Fifth Edition, 2009.

Reference Books

1. T. Hughes, 'Programmable Logic Controllers', ISA press, 4th edition, 2008.
2. W.Bolton, "Programmable Logic Controllers" Newness (an imprint of Butterworth-Heinemann Ltd)Fifth Edition, 2009.

Web References

1. https://nptel.ac.in/courses/112102011/1
2. https://nptel.ac.in/courses/108106022/8
3. https://nptel.ac.in/courses/112104040/29
4. https://www.tutorialspoint.com/simulation_with_logo_soft/index.asp

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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

Prerequisites:

The student should have undergone the course(s):

1. Applied Chemistry

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

UNIT I MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES 9 Hrs

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

UNIT II ECOSYSTEMS AND BIODIVERSITY 9 Hrs

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

UNIT III ENVIRONMENTAL POLLUTION 9 Hrs

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,

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cyclone and landslides

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT **9 Hrs**

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

UNIT V HUMAN POPULATION AND THE ENVIRONMENT **9 Hrs**

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 of environmental pollution

CO4: Brief the importance of environmental protection in social and global context

CO5: Explain the relationship between environment and human beings

Text 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.

Reference Books

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

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Web References

1. https://nptel.ac.in/courses/120108004/
2. https://nptel.ac.in/courses/122102006/

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Course Code : 16MCT62	Course Title : HYDRAULIC AND PNEUMATIC SYSTEMS	
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):

1. Fluid Mechanics and Machinery

Course Objectives

The course is intended to:

1. Explain the fluid power systems.
2. Explain the construction and working of hydraulic components.
3. Develop a hydraulic circuit.
4. Explain construction and working of pneumatic components.
5. Develop a pneumatic circuit.

UNIT I FUNDAMENTALS OF HYDRAULIC AND PNEUMATIC SYSTEMS 9 Hrs

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components - Pneumatic system components - Symbols - 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 Hrs

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 valves, Flow control valves – Construction and operation of Accumulators, Intensifiers and Servo & Proportional valves.

UNIT III HYDRAULIC CIRCUITS 9 Hrs

Hydraulic symbols - Hydraulic circuits for linear actuators - Hydraulic circuits using different actuating devices - Speed control circuits - Sequencing circuit - Synchronizing circuit - Regenerative circuit - Accumulator circuit - circuit – Application of intensifier - Hydraulic circuit for Milling operation, Grinding Machine - Hydraulic braking in Automobile.

UNIT IV PNEUMATIC SYSTEM AND COMPONENTS 9 Hrs

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.

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UNIT V PNEUMATIC CIRCUITS **9 Hrs**

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 and KV map method - Hydro-Pneumatic circuit - Material handling system circuit - Multiple operation Machining.

Course Outcomes

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

CO1: Explain the fluid power systems with fluid properties and applications.

CO2: Explain the construction and working of linear actuators, Rotary actuators, Direction control valves, and Pressure control valves Flow control valves, Accumulators and servo & proportional valves.

CO3: Develop a hydraulic circuit for milling, grinding and automobile braking application.

CO4: Explain the construction and working of Linear actuators, Rotary actuators, Direction control valves and Accumulators.

CO5: Develop a pneumatic circuit for material handling and machining application.

Text Books

1. Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2013.
2. Majumdar, S.R., "Oil Hydraulic Systems – Principles and Maintenance", Tata McGraw-Hill, New Delhi, 2017.

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, 2012

Web References

1. http://www.nptel.ac.in/courses/112106175/
2. http://nptel.ac.in/courses/112105046/

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Course Code : 16MCT63	Course Title : POWER 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):

1. Analog and Digital circuits

Course Objectives

The course is intended to:

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

UNIT I POWER SWITCHES **9 Hrs**

Power Diode: reverse recovery characteristics, types

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

TRIAC & GTO: Construction, dynamic behavior and driver circuit

MOSFET& IGBT: Construction, dynamic behavior and driver circuit

UNIT II CONTROLLED RECTIFIERS **9 Hrs**

Controlled Rectifiers: 1 pulse, 2 pulse, 3 pulse and 6 pulse converters with R and RL loads, dual converter, performance parameters, estimation of average load voltage and effect of source impedance.

UNIT III DC-DC CONVERTERS **9 Hrs**

Choppers: Principle of step-up and step-down operation, Time ratio control and current limit control, types, forced commutation techniques (voltage, current and load).

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

UNIT IV INVERTERS **9 Hrs**

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

UNIT V AC CONVERTERS **9 Hrs**

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

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Cycloconverter: single phase and three phase cyclo converters

Course Outcomes

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

CO1: Explain the operation of various power switching devices and their dynamic characteristics.

CO2: Compute the performance parameters of controlled rectifiers.

CO3: Identify a DC-DC converter for a given application.

CO4: Explain the modulation techniques of PWM inverter and harmonic reduction methods.

CO5: Describe the operation of AC voltage controller and cycloconverter.

Text Books

1. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, Third Edition (reprint), 2011.
2. P. S. Bimbhra, "Power Electronics", Khanna Publishers, Third Edition, 2004.

References

1. Ned Mohan, T.M. Undeland, W.P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, Third Edition (reprint), 2009..
2. Joseph Vithayathil, "Power Electronics: Principles and Applications",Tata McGraw-Hill, New Delhi,2010.
3. M.D. Singh and K.B. Khanchandani, 'Power Electronics', Tata McGraw Hills Publishing Company Limited, Second Edition, 2006.
4. Philip T. Krein, 'Elements of Power Electronics', Oxford University Press, First Edition, 2012.
5. Cyril W Lander: Power Electronics, Third Edition, McGraw Hills International Editions, 1993.

Web References

1. http://nptel.ac.in/courses/108101038/1
2. http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html
3. http://cusp.umn.edu/power_electronics.php
4. http://ecee.colorado.edu/copec/book/slides/slidedir.html

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Course Code : 16MCT64	Course Title : EMBEDDED FOR MECHATRONIC SYSTEMS	
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):

1. Microprocessor and Microcontroller

Course Objectives

The course is intended to:

1. Illustrate an embedded system and compare with general purpose System.
2. Explain the memory organization of the embedded system.
3. Compare the various Input and output devices and Network protocols
4. Explain the operating systems and related mechanisms
5. Choose the Design methodologies for the real time application

UNIT I INTRODUCTION TO EMBEDDED SYSTEM 9 Hrs

System Design: Definitions - Classifications and brief overview of micro-controllers - Microprocessors and DSPs - Embedded processor architectural definitions - Typical Application scenarios of embedded systems.

UNIT II PROCESSOR AND MEMORY ORGANIZATION 9Hrs

Bus Organization - Memory Devices and their Characteristics - Instruction Set Architecture [RISC, CISC] - Basic Embedded Processor/Microcontroller Architecture [8051, ARM, DSP, PIC] – Memory system architecture [cache, virtual, MMU and address translation] - DMA, Co-processor and Hardware Accelerators – Pipelining.

UNIT III I/O DEVICES AND NETWORKS 9 Hrs

I/O Devices[Timers, Counters, Interrupt Controllers, DMA Controllers, A/D and D/A Converters, Displays, Keyboards, Infrared devices] - Memory Interfacing - I/O Device Interfacing [GPIB,FIREWIRE, USB, IRDA] - Networks for Embedded systems (CAN, I2C, SPI, USB, RS485, RS 232)-Wireless Applications [Bluetooth, Zigbee].

UNIT IV OPERATING SYSTEMS 9 Hrs

Basic Features of an Operating System - Kernel Features [polled loop system, interrupt driven system, multi rate system] - Processes and Threads - Context Switching - Scheduling[RMA, EDF, fault tolerant scheduling] - Inter-process Communication - Real Time memory management [process stack management, dynamic allocation] - I/O[synchronous and

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asynchronous I/O, Interrupts Handling, Device drivers] - RTOS [VxWorks, RT-LINUX].

UNIT V EMBEDDED SYSTEM DEVELOPMENT 9 Hrs

Design Methodologies [UML as Design tool, UML notation, Requirement Analysis and Use case Modeling] - Design Examples [Telephone PBX, Inkjet Printer, PDA, Elevator Control System, ATM System] - Fault-tolerance Techniques - Reliability Evaluation Techniques.

Course Outcomes

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

CO1: Define the concept of graphical systems and its functional blocks.

CO2: Examine the various applications of operational amplifier.

CO3: Identify appropriate tools for arrays, strings and File I/O tasks.

CO4: Apply knowledge of operating system for embedded applications

CO5: Design and develop a simple embedded system.

Text Books

1. Wayne Wolf Computers as components: Principles of Embedded Computing System. Design The Morgan Kaufmann Series in Computer Architecture and Design, 2008
2. Jane W. S., Liu, Real time systems, Pearson Education, 2000

Reference Books

1. Raj Kamal, Embedded systems Architecture, Programming and design, Second Edition, 2008
2. Robert Ashby, Designer's Guide to the Cypress PSoC Newnes, 2005
3. Microblaze processor Reference guide, Xilinx
4. NIOS II Processor reference Handbook, ALTERA

Web References

1. https://onlinecourses.nptel.ac.in/noc17_me31/cours
2. https://nptel.ac.in/courses/106105159/
3. https://www.quora.com/How-do-I-download-all-of-the-lectures-for-a-course-in-NPTEL

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Course Code : 16MCL61	Course Title : MECHATRONIC SYSTEMS DESIGN 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):

1. Hydraulic and Pneumatic Systems
2. Electrical Drives and Control.

Course Objectives

The course is intended to:

1. Develop a hydraulic circuit and pneumatic circuit for the Mechanical actuation.
2. Develop a hydraulic circuit for Speed regulation of double-acting cylinder.
3. Develop a hydraulic circuit and pneumatic circuit for the Electrical actuation.
4. Develop a Control of servo system for single axis and Multi-axis position and Motion control.
5. Develop a cascading operation and linear motion control of pneumatic system.

LIST OF EXPERIMENTS **60 Hrs**

1. Develop a hydraulic circuit for the Mechanical actuation of hydraulic cylinder using Software and trainer kit.
2. Develop a hydraulic circuit for the Electrical actuation of hydraulic cylinder using software and trainer kit.
3. Develop a hydraulic circuit for Speed regulation of double-acting cylinder using software and trainer kit. (Meter in &Meter out).
4. Develop a Pneumatic circuit for the Electrical actuation of single and double acting Cylinder using software and trainer kit.
5. SCR based speed control.
6. Relay and TRIAC based ON-OFF control.
7. Single-axis position and motion control.
8. Multi-axis position and motion control.
9. Multi-axis motion synchronization using Motion controller.
10. Cascading operation of a double acting cylinder with pneumatic sensors and Electronic sensors.
11. Linear motion control of pneumatic system.

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Course Outcomes

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

CO1: Develop a hydraulic circuit and pneumatic circuit for practical applications.

CO2: Develop a control circuit for the speed regulation of the double-acting cylinder.

CO3: Develop a Electrical actuation circuit in Hydraulics and Pneumatics

CO4: Develop a Servo control actuation

CO5: Build a pneumatic circuit for linear motion control

Text Books

1. "Mechatronics System Design Laboratory manual" prepared by Department of Mechatronics Engineering.

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Course Code : 16MCL62	Course Title : INDUSTRIAL AUTOMATION 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):

1. Analog and Digital circuits
2. Electrical Drives and Control.

Course Objectives

The course is intended to:

1. Illustrate digital logics using PLC.
2. Develop a simple program in PLC for simple applications.
3. Implement the concepts of cascade control scheme.
4. Build a speed control of servo systems and connect PLC via OPC server.
5. Explain sequential and Batch Control applications and to automate it.

LIST OF EXPERIMENTS **60 Hrs**

1. Realization of logic gates using PLC
2. Latching, Interlocking by PLC programming
3. Pneumatic pressing implementation by PLC
4. Implementation of cascade control of Double acting cylinder using PLC
5. Operator panel development using HMI
6. Control of a Servo system by PLC and HMI
7. Conveyor Speed control using VFD and PLC
8. Remote panel development by SCADA Programming
9. Sequential control operation for sorting objects in conveyor system using PLC and SCADA.
10. Batch control of Mechatronic system by PLC programming and SCADA programming.

Course Outcomes

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

CO1: Interpret the logic output using PLC.

CO2: Develop a program in PLC for Latching, Interlocking, Motor forward reverse applications.

CO3: Implement Cascade control scheme for single acting cylinder.

CO4: Develop a program in PLC for servo control, speed control and connect PLC with OPC server.

CO5: Develop a simple program for sequential and Batch control applications using PLC.

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Text Books

1. "Industrial Automation Laboratory Manual" prepared by Department of Mechatronics Engineering.

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

Course Objectives

The course is intended to:

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

UNIT I GRATITUDE AND SOCIAL RESPONSIBILITY 6Hrs

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

UNIT II THE WORLD OF BUSINESS (GET TO THE SPECIFICS OF BEHAVIORAL RESPONSES TO CERTAIN SPECIFIC ONTEXTS) 6Hrs

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

UNIT III TRANSITION FROM A CAMPUS MINDSET TO CORPORATE MINDSET 6Hrs

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

UNIT IV PREPAREDNESS TO ADAPT TO WORK CULTURE 6Hrs

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;

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Handling peer influence; Conducting sensitively with subordinates, peers &boss; Managing personal finance; Maintaining work-life balance – work & social life, hobbies etc;

UNIT V GRATITUDE AND SOCIAL RESPONSIBILITY 6Hrs

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

Course Outcomes

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

CO1: Display gratitude and social responsibility.

CO2: Understand various business environments – industry & function wise.

CO3: Explain the transition from a campus mindset to corporate mindset.

CO4: Be prepared to adapt to the future work culture.

CO5: Choose to be presentable and agile.

MODE OF DELIVERY

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

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ASSESSMENTS AND EVALUATION:

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

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END OF SEMESTER - VI

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SEMESTER VII

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SEMESTER VII

Course Code : 16MCT71	Course Title: AUTOMOTIVE ELECTRONICS	
Core / Elective : Core	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Electric and Electronic circuits
2. Sensors and Signal Processing
3. Analog and Digital Circuits

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 sensor for automobile system
4. Select appropriate actuator for automobile system
5. Choose the electrical wires, fuses and lighting systems

UNIT I ELECTRONIC DEVICES **9 Hrs**

BJT, FET, DIAC, TRIAC and IGBT construction and characteristics. Drivers circuit, electronic devices, automobile application.

UNIT II INTRODUCTION TO DIGITAL ELECTRONICS **9 Hrs**

Logic gates, AND, OR, NOT, NAND, NOR, convert circuit using NAND and NOR, half adder and full adder, decoder, encoder – MUX- DeMUX, flip flop, 4 bit counter.

UNIT III SENSORS **9 Hrs**

Hall inductive, resistance temperature detector (RTDS), Negative temperature coefficient (NTC), Positive temperature coefficient sensor (PTC). Seebeck and peltier effect application. Manifold absolute pressure sensor, knock sensor, mass air flow sensor, oxygen sensor.

UNIT IV ACTUATORS **9 Hrs**

Solenoid working principle, latching relay, bi-polar and uni-polar latching relay, linear unipolar relay, linear bipolar relay, piezoelectric injector, solenoid injector. Introduction to magneto rheological fluids

UNIT V WIRING HARNESS AND INDICATORS **9 Hrs**

Introduction to wiring harness, EMC, odometer, speedo meter, 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 students will be able to:

CO1: Explain the construction and characteristics of basic electronic devices used in automobiles

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

CO3: Select appropriate sensor to acquire the required parameter from automobile system.

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

CO5: Choose the electrical wires, fuses and lighting systems for the give 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

Reference Books

1. Salivahanan S, "Electronic devices and circuit", Tata McGraw – Hill education 2011
2. Robert Bosch GmbH., Reil K, Dietsche KH, " Automotive hand book", Robert bosch Gmbh: 2014

Web References

1. https://nptel.ac.in/courses/108103009/
2. https://tifac.org.in//index.php/8-publication/151-automotive-electronics?showall=1

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Course Code : 16MCT72	Course Title: INDUSTRIAL ROBOTICS AND MACHINE VISION	
Core / Elective : Core	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Sensors and signal processing
2. Basics of computer programming
3. Hydraulics and Pneumatics
4. Theory of machines

Course Objectives
The course is intended to:

1. Make use of different configurations of robot system for the industrial problems
2. To select the appropriate robot end effector based on the type of materials to be handled
3. Apply the knowledge of mechanics in robot movements
4. Develop a robot programming for required applications
5. Utilize machine vision systems in robotics applications

UNIT I BASICS OF ROBOTICS **8 Hrs**

Brief History, Laws of robots, Types of robots, Overview of robot system and subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Drive mechanisms and transmission. Present status and future of robots.

UNIT II ROBOT END EFFECTORS **6 Hrs**

Introduction, need of End effectors, types – Design of finger gripper- Different types of grippers – Mechanical, vacuum, Magnetic and other methods of gripping, actuation methods for mechanical gripper, gripper force analysis, selection of grippers, tools as an end effector

UNIT III ROBOT KINEMATICS **12 Hrs**

Rotation and Translation of Homogeneous coordinates multiple transformations. Transformation Matrices, Forward and Inverse kinematics of robots, Degrees of freedom (2, 3, 4, 5, and 6 DOF), Denavit-Hartenberg convention, kinematic solution for articulated robot. Degeneracy and dexterity. Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories.

UNIT IV ROBOT PROGRAMMING AND APPLICATIONS **10 Hrs**

Methods of robot programming – manual and textual programming, robot control system, Robot work cell, Point to point programming and continues path programming. Application of robots in material handling, entertainment, medical and security fields

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UNIT V MACHINE VISION AND APPLICATIONS 9 Hrs

Active vision system, Machine vision components, hardware's, Image acquisition. Industrial machine vision, structure of industrial machine vision, generic standards, data reduction, segmentation, feature extraction, object recognition, application of machine vision such as in inspection and identification.

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

CO1: Explain the different configurations of robot system in appropriate places

CO2: Select suitable robot end effector.

CO3: Apply the knowledge of mechanics and identifying path of robots.

CO4: Construct robot programming to meet desired applications

CO5: Use the machine vision system in robots

Text Books

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
2. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison- Wesley, 1999.

Reference Books

1. S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning, 2009.
3. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing using MATLAB", Main purpose-Practical
4. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
5. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.
6. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
7. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987
8. Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985

Web References

1. https://nptel.ac.in/courses/112/105/112105249/
2. https://nptel.ac.in/courses/112101099/

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3. https://nptel.ac.in/courses/112108093/
4. https://ai.google/research/teams/brain/robotics/
5. https://www.robotics.org/

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Course Code : 16MCL71	Course Title : ROBOTICS AND CONTROL 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):

1. Sensors and signal processing
2. Basics of computer programming
3. Hydraulics and Pneumatics
4. Theory of machines

Course Objectives

The course is intended to:

1. Make use of different configurations of robot system for the industrial problems.
2. Select the appropriate robot end effector based on the type of materials to be handled.
3. Verify different types of simulations for robot applications.
4. Develop a robot program for point to point applications.
5. Develop a robot program for continuous part applications.

LIST OF EXPERIMENTS **60 Hrs**

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Study and selection of Gripper
5. Robot programming for pick and place
6. Robot programming for welding
7. Construction of different configurations of robot using RoboAnalyzer
8. Determination of DH parameters
9. Robot programming for writing practice
10. Robot programming for Drawing practice

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Course Outcomes

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

CO1: Explain the different configurations of robot system in appropriate places

CO2: Select suitable robot end effector.

CO3: Construct robot programming to meet desired applications.

CO4: Develop program for different point to point applications

CO5: Develop program for continuous part applications

Text Books

1. Robotics Laboratory Manual Prepared by Department of Mechatronics Engineering Department.

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Course Code : 16MCL72	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):

1. Electric and Electronic circuits
2. Analog and Digital circuits
3. Electrical Drives and Controls

Course Objectives

The course is intended to:

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

LIST OF EXPERIMENTS **60 Hrs**

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

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Course Outcomes

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

CO1: Diagnose the fault in the car electrical system following the standard procedure

CO2: Determine the status of given Alternator and Starter motor used in Automobile by conducting suitable experiments

CO3: Construct logic circuit to carry out basic mathematical operations

CO4: Design of rectifier circuits for power supply

CO5: Construct simple power supply unit for car electrical system

Text Books

1. Tom Denton, "Automobile Electrical and Electronic Systems", Fourth Edition, Routledge, 2013.
2. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 1996

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END OF SEMESTER – VII

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SEMESTER – VIII

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Course Code : 16MCL801	Course Title : PROJECT	
Core / Elective: Core	L : T : P: C	0 : 0 : 20 : 10
Type: Practical	Total Contact hours:	300 Hours

Course Objectives

The course is intended to:

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

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

Course Outcomes

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

CO1: Take up any challenging practical problems and find solution by formulating proper methodology.

CO2: Work collaboratively on a team to successfully complete a design project.

CO3: Effectively communicate the results of projects in a written and oral format.

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PROFESSIONAL ELECTIVE COURSES

DESIGN

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

Prerequisites:

The student should have undergone the course(s):

1. Metal Forming, Joining and Casting Processes.
2. Metal Cutting Processes.
3. Design of Machine Elements.

Course Objectives

The course is intended to:

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

UNIT I INTRODUCTION **9 Hrs**

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

UNIT II FACTORS INFLUENCING FORM DESIGN **9 Hrs**

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 Hrs**

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

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

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

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

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application Design for energy efficiency – Design to regulations and standards. AT&T life cycle assessment methods.

Course Outcomes

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

CO1: Explain the design principles for manufacturability considering strength, process capability and tolerances.

CO2: Describe the factors influencing form design of castings, forgings and welding.

CO3: Explain the machining consideration while design such as machinability, economy, clampability, accessibility and assembly.

CO4: Optimize the given casting part by applying design principles.

CO5: Explain the environmental consideration in design while using DFMA tools.

Text Books

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

Reference Books

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

Web References

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

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Course Code : 16MCE01	Course Title: DESIGN OF TRANSMISSION SYSTEMS	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Theory of Machines
2. Design of Machine Elements

Course Objectives

The course is intended to:

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

UNIT I SELECTION OF FLEXIBLE ELEMENT DRIVES 9 Hrs

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

UNIT II DESIGN OF SPUR GEAR AND HELICAL GEAR DRIVES 9 Hrs

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

UNIT III DESIGN OF BEVEL AND WORM GEAR DRIVES 9 Hrs

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

UNIT IV DESIGN OF SLIDING MESH GEAR BOX 9 Hrs

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

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

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

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

Course Outcomes

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

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

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

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

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

CO5: Design single, multi plate clutch and brakes such as shoe brake, band brake, block brake, disc brake and internal expanding type brakes for given applications.

Text Books

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

Reference Books

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

Web References

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

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Course Code : 16MCE02	Course Title: TURBO MACHINERY	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Fluid Mechanics and Machinery

Course Objectives

The course is intended to:

1. Explain the principles and terminologies of turbo machines.
2. Compare different types of fans and blowers used in fluid machinery.
3. Analyze the performance of centrifugal compressors
4. Estimate the characteristics of Axial flow compressors using performance curves.
5. Explain the losses and performance characteristics of Axial and Radial flow turbines.

UNIT I PRINCIPLES OF TURBO MACHINERY **9 Hrs**

Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines.

UNIT II CENTRIFUGAL FANS AND BLOWERS **9 Hrs**

Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise, Construction and classification; Power required, pressure rise, efficiency calculations; Applications in boilers, cooling towers.

UNIT III CENTRIFUGAL COMPRESSOR **9 Hrs**

Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves, Surging and choking of compressors; Compressor performance and characteristic curves

UNIT IV AXIAL FLOW COMPRESSOR **9 Hrs**

Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, Simple design calculations; Surging and stalling of compressors; Compressor performance and characteristic curves

UNIT V AXIAL AND RADIAL FLOW TURBINES **9 Hrs**

Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.

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Course Outcomes

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

CO1: Summarize the important terms associated with turbo machines Classify various types of centrifugal fans and blowers.

CO2: Select the construction details and performance of centrifugal fans and blowers

CO3: Explain different performance characteristics of centrifugal compressor

CO4: Solve the design problems in axial flow compressor.

CO5: Explain the performance, losses of axial and radial flow turbines.

Text Books

1. Yahya, S.M., "Turbines Compressor and Fans ", Tata McGraw-Hill Publishing Company, 2010.

Reference Books

1. Fundamentals of Turbo machinery: William W Peng, John Wiley & Sons, Inc. 2008.
2. Dixon, S.I., "Fluid Mechanics and Thermodynamics of Turbomachinery ", Pergamon Press, 1990.
3. .Ganesan .V. "Gas Turbines ", Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 1999.

Web References

1. https://www.docsity.com/en/subjects/turbomachinery/
2. https://lecturenotes.in/materials/24627-notes-for-turbomachine
3. https://nptel.ac.in/courses/101101058/32

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

Prerequisites:

The student should have undergone the course(s):

1. Engineering Thermodynamics
2. Automobile Engineering

Course Objectives

The course is intended to:

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

UNIT I INTRODUCTION TO POWER TRAIN **9 Hrs**

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

UNIT II COMBUSTION AND EMISSION IN IC ENGINES **9 Hrs**

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

UNIT III ENGINE SUBSYSTEMS **9 Hrs**

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

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Schematic layout of exhaust system (2W and 4W)

UNIT IV PERFORMANCE CHARACTERISTICS **9 Hrs**

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

UNIT V ADVANCED ENGINE CONCEPTS **9 Hrs**

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

Course Outcomes

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

CO1: Explain the construction details of the power train such as Valve & crank train layout used in four stroke IC engines.

CO2: Describe the combustion characteristics such as chemistry, knocking, temperature & fuel and emission characteristics such as norms, environmental effects, after treatment devices of four stroke IC engines.

CO3: Describe the functions of various engine subsystems such as cooling system, induction system and exhaust system of an automobile.

CO4: Explain the performance characteristics like volumetric efficiency, ram effect, engine tuning, Fuel control systems of the vehicle considering the relationship between volumetric efficiency of engine and emission norms.

CO5: Examine various advanced engines like Wankel, lean burn, GDI, HCCI and alternate fuels like alcohol, vegetable oils, LPG, CNG used in automobiles.

Text Books

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

Reference Books

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

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Automotive Engineers, Incorporated 1999.

Web References

1. https://nptel.ac.in/courses/112104033/2
2. https://nptel.ac.in/courses/112104033/15

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Course Code : 16MCE03	Course Title: FINITE ELEMENT ANALYSIS	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Engineering Mathematics – I
2. Numerical Methods
3. Strength of Materials

Course Objectives

The course is intended to:

1. Explain the physical problem using mathematical models
2. Solve the one dimensional structural problems
3. Solve the 2D vector variable problems
4. Solve the 1D and 2D scalar variable problems
5. Solve the shape function, Jacobean matrix, element stiffness matrix for 2D Quadrilateral element

UNIT I FINITE ELEMENT FORMULATION **9 Hrs**

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 **9 Hrs**

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

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UNIT III **TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS USING CONSTANT STRAIN TRIANGLES** **9 Hrs**

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

UNIT IV **HEAT TRANSFER / SCALAR VARIABLE PROBLEM 1 D & 2D** **9 Hrs**

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

UNIT V **TWO DIMENSIONAL VECTOR VARIABLE PROBLEM USING QUADRILATERAL ELEMENTS** **9 Hrs**

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: Explain the 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: Solve 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. Tirupathi R. Chandrupatla, Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Fourth Edition, Pearson, 2016.
2. Logan D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.

Reference Books

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

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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

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

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Course Code : 16MCE04	Course Title: DESIGN OF MECHATRONIC SYSTEMS	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Virtual Instrumentation
2. Hydraulic and Pneumatic systems

Course Objectives

The course is intended to:

1. Explain with the basics of design of Mechatronic systems and advanced approaches
2. Explain the concepts of system modelling , validation and application
3. Model the Mechatronic systems in Labview and Vim-Sim Environments.
4. Apply the design concepts and simulation in realtime examples in simulation environment.
5. Explain the Micro Mechatronic system design concepts for Mechatronics application.

UNIT I INTRODUCTION TO MECHATRONIC SYSTEMS **9 Hrs**

Key elements – Mechatronics Design process – Design Parameters – Traditional and Mechatronics Designs – Advanced Approaches in Mechatronics - Industrial Design and Ergonomics, Safety.

UNIT II SYSTEM MODELLING **9 Hrs**

Introduction - Model Categories - Fields of Application - Model Development - Model Verification-Model Validation - Model Simulation - Design of Mixed Systems - Electro Mechanics Design - Model Transformation- Domain-Independent Description Forms - Simulator Coupling.

UNIT III REAL TIME INTERFACING **9 Hrs**

Introduction - Selection of Interfacing Standards Elements of Data Acquisition and Control Systems- Over View of I/O Process, General purpose I/O card and its installation, Data conversion process, Application Software- Lab view Environment and its applications, Vim-Sim Environment and its Applications - Man machine interface.

UNIT IV CASE STUDIES ON MECHATRONIC SYSTEMS **9 Hrs**

Introduction –Fuzzy based Washing machine – pH control system – Autofocus Camera, exposure control–Motion control using D.C Motor and Solenoids – Engine management systems.– Controlling temperature of a hot/cold reservoir using PID Controller - Control of pick and place robot – Part identification and tracking using RFID – Online surface measurement using image processing

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UNIT V MICRO MECHATRONIC SYSTEM **9 Hrs**

Introduction- System principle - Component design – System design – Scaling laws – Micro actuation Micro robot – Micro pump – Applications of micro mechatronic components.

Course Outcomes

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

CO1: Explain the key elements of Mechatronic systems.

CO2: Model any Electro mechanical systems.

CO3: Build the controller and Data Acquisition system concepts in simulation using Labview and Vim-Sim platform.

CO4: Choose a Mechatronic system for real time problems.

CO5: Explain the Micro Mechatronic systems components for Mechatronic application.

Text Books

1. Devdas shetty, Richard A. Kolk, "Mechatronics System Design", 2nd Edition, Cengage Learning 2011.
2. Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL's, John wiley and sons Ltd, 2003.

Reference Books

1. Bishop, Robert H, "Mechatronics Hand book", CRC Press, 2002.
2. Bradley, D. Dawson, N.C. Burd and A.J. Loader, "Mechatronics: Electronics in Products and Processes", CRC Press 1991, First Indian print 2010.
3. De Silva, "Mechatronics: A Foundation Course", Taylor & Francis, Indian Reprint, 2013

Web References

1. https://ocw.tudelft.nl/courses/mechatronic-system-design/
2. http://www.tesla-institute.com/index.php/mechatronic-articles/95-mechatronics-design-process-system

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Course Code : 16MCE05	Course Title: PRODUCT DESIGN AND DEVELOPMENT	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. CAD/ CAM/ CIM

Course Objectives

The course is intended to:

1. Explain the basic concepts of product design and product features.
2. Select the suitable concept.
3. Define the basic concepts of product architecture.
4. Identify the Requirements of Industrial design.
5. Compare the design with product development.

UNIT I INTRODUCTION **9 Hrs**

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier and process planner, Competitor and customer – behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements -Organization process management and improvement

UNIT II CONCEPT GENERATION AND SELECTION **9 Hrs**

Plan and establish product specifications. Task - Structured approaches - clarification -search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change -variety - component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE **9 Hrs**

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions - related system level design issues - secondary systems -architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN **9 Hrs**

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically -Need for industrial design-impact – design process - investigation of customer needs -conceptualization -refinement -management of the industrial design process -technology driven products - user - driven products - assessing the quality of industrial design.

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UNIT V **DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT** **9 Hrs**

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity - Prototype basics - Principles of prototyping -Planning for prototypes - Economic Analysis - Understanding and representing tasks baseline project planning - accelerating the project-project execution.

Course Outcomes

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

CO1: Construct product development process.

CO2: Select suitable concept and testing methodologies.

CO3: Demonstrate the fundamental architecture of product.

CO4: Choose the requirements of industrial product design

CO5: Apply the design knowledge on manufacturing in product development.

Text Books

1. Kari T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw-Hill, Fifth edition, 2016.

Reference Books

1. Integrated Product Development/Concurrent Engg. Kemnneth Crow, DRMAssociates, 6/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
2. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992.

Web References

1. https://nptel.ac.in/courses/112107217/
2. https://www.alskar.com/product-design-and-development.html

BoS Chairman

Course Code : 16MEE03	Course Title: COMPOSITE MATERIALS (Common to AUTO, MECH, Mechatronics)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Materials Science
2. Strength of Materials

Course Objectives

The course is intended to:

1. Explain the properties of matrices and reinforcements.
2. Explain the various types of composite materials.
3. Explain the fabrication and testing of composites.
4. Explain the mechanics and lamination theory of fibre reinforced composites.
5. Explain the load bearing behaviour of composite and composite structures.

UNIT I MATRICES AND REINFORCEMENTS **9 Hrs**

Definition –Classifications of composite materials, Matrix materials, Functions of a Matrix, desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers etc., Mechanical properties of fibres.

UNIT II TYPES OF COMPOSITES **9 Hrs**

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

UNIT III FABRICATION AND TESTING OF COMPOSITES **9 Hrs**

Fabrication methods: hand layup, Autoclave, filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer. Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

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UNIT IV MECHANICS AND LAMINATION THEORY OF COMPOSITES 9 Hrs

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi - Empirical model - Longitudinal Young's modulus-transverse Young's modulus – major Poisson's ratio-In- plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina – laminates – lamination theory, Inter laminar stresses.

UNIT V COMPOSITE STRUCTURES 9 Hrs

Fatigue – S-N curves – Fatigue behaviors of CMCs – Fatigue of particle and whisker reinforced composites. Introduction to structures - selection of material, manufacturing and laminate configuration -design of joints - bonded joints - bolted joints - bonded and bolted.

Course Outcomes

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

CO1: Explain the properties of matrices and reinforcements

CO2: Explain the various types of composite materials

CO3: Explain the fabrication and testing of composites.

CO4: Explain the mechanics and lamination theory of fiber reinforced composites.

CO5: Explain the load bearing behavior of composite and composite Structures

Text Books

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

Reference Books

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

Web References

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

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MANUFACTURING AND MANAGEMENT

Course Code : 16MEE19	**Course Title: UNCONVENTIONAL MACHINING PROCESSES** (Common to AUTO, MECH, Mechatronics)	
Core / Elective : Elective	**L : T : P: C**	**3 : 0 : 0 : 3**
Type: Theory	**Total Contact hours:**	**45 Hrs**

Prerequisites:
The student should have undergone the course(s):

1. Manufacturing Technology.
2. Metal Cutting Processes.
3. Applied Chemistry

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

UNIT I INTRODUCTION **9 Hrs**

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 Hrs**

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 Hrs**

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

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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

UNIT IV CHEMICAL & ELECTRO CHEMICAL ENERGY BASED UCM PROCESSES **9 Hrs**

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 Hrs**

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

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Text Books

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

Reference Books

1. Paul De Garmo, J.T. Black, and Ronald. A. Kohser, "Material and Processes in manufacturing" Prentice Hall of India Pvt. Ltd., New Delhi, Eigth edition, 2001.
2. Ghosh, Malik, "Manufacturing Science", First edition., EWP Private Ltd., 2008

Web References

1. https://nptel.ac.in/courses/112105126/
2. https://nptel.ac.in/courses/112107077/26
3. https://nptel.ac.in/courses/112107077/23
4. http://mechteacher.com/manufacturing-technology/
5. http://www.engineershandbook.com/MfgMethods/nontraditionalmachining

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Course Code : 16MEE20	Course Title: FLEXIBLE MANUFACTURING SYSTEMS (Common to MECH, Mechatronics)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Manufacturing Technology.
2. CAD/CAM/CIM

Course Objectives

The course is intended to:

1. Classify and distinguish FMS and other manufacturing systems
2. Explain processing stations and material handling systems used in FMS environments.
3. Summarize the tool management and analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.
4. Explain the concepts of group technology in FMS.
5. Analyze FMS using simulation and analytical techniques.

UNIT I UNDERSTANDING AND CLASSIFICATION OF FMS **9 Hrs**

Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type Classification of FMS Layout - Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc

UNIT II PROCESSING STATIONS AND MATERIAL HANDLING SYSTEM **9 Hrs**

Processing stations: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station. Material Handling System: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS)

UNIT III MANAGEMENT TECHNOLOGY **9 Hrs**

Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS

UNIT IV GROUP TECHNOLOGY **9 Hrs**

Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT

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UNIT V DESIGN OF FMS **9 Hrs**

Performance Evaluation of FMS, Analytical model and Simulation model of FMS, Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database.

Course Outcomes

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

CO1: Classify FMS and other manufacturing systems

CO2: Explain processing stations and material handling systems used in FMS environments

CO3: Explain the tool management and the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS

CO4: Explain the concepts of group technology in FMS

CO5: Analyze FMS using simulation and analytical techniques

Text Books

1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 1991
2. Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd. New Delhi 2009.

Reference Books

1. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991.
2. John E Lenz "Flexible Manufacturing" Marcel Dekker Inc New York, 1989.

Web References

1. https://nptel.ac.in/courses/112107143/36
2. https://nptel.ac.in/courses/112104228/31

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Course Code : 16MEE30	Course Title: ADDITIVE MANUFACTURING (Common to MECH, Mechatronics)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Manufacturing Technology.
2. CAD/CAM/CIM

Course Objectives

The course is intended to:

1. Explain the importance of Rapid Prototyping Technology.
2. Select liquid based and solid based Rapid Prototyping.
3. Design RPT solutions for data preparation.
4. Understand 3D printing
5. Familiarize with Rapid tooling

UNIT I INTRODUCTION **6 Hrs**

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 Hrs**

Classification of RP systems, Fusion Deposition Modeling – Principle – process parameters – Applications. Laminated Object Manufacturing – Principle – process parameters – Applications, Stereo lithography systems – Principle – process parameters –process details – Applications.- Selective laser sintering (SLS) - Direct Metal Laser Sintering (DMLS) system – Direct Metal Deposition- Principle –process parameters –Applications-Solid ground curing.

UNIT III DATA PREPARATION FOR RAPID PROTOTYPING TECHNOLOGIES **10 Hrs**

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.

UNIT IV THREE DIMENSIONAL PRINTING **10 Hrs**

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

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Manufacturing (SDM): Introduction, basic process, shape decomposition, mold, SDM and applications. Selective Laser Melting, Electron Beam Melting – Rapid manufacturing.

UNIT V RAPID TOOLING **9 Hrs**

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

Course Outcomes

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

CO1: Explain the importance of Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle and cost.

CO2: Select appropriate liquid based and solid based rapid prototyping systems such as Stereo lithography, Selective laser sintering, Direct Metal Laser Sintering and Direct Metal Deposition for modeling.

CO3: Design RPT solutions such as Model Slicing, direct slicing and adaptive slicing and Tool path generation for data preparation.

CO4: Select a suitable three Dimensional Printing from Selective Laser Melting and Electron Beam Melting for Shape Deposition Manufacturing for making prototype.

CO5: Design RPT solutions for automotive, aerospace and electrical industry.

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Second edition, World Scientific Publishers, 2010
2. Pham, D.T. and Dimov. S.S., "Rapid manufacturing", Springer-Verlag, 2001.

Reference Books

1. Andreas Gebhardt, Hanser "Rapid prototyping", Gardener Publications, 2003.
2. LiouW.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
3. Paul F Jacobs, "Rapid Prototyping and manufacturing – Fundamentals of Streolithography", Society of Manufacturing Engineering Dearborn, 1992.

Web References

1. https://www.nde-ed.org/index_flash.htm
2. https://nptel.ac.in/courses/112102103/16

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Course Code : 16MCE06	Course Title: AUTOMOBILE ENGINEERING	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Manufacturing Technology
2. Engineering Thermodynamics
3. Fluid Mechanics and Machinery
4. Design of Machine Elements

Course Objectives

The course is intended to:

1. Explain the vehicle structure and components.
2. Explain the IC Engines and lubricating systems.
3. Explain the construction and working principle of Transmission system.
4. Explain the construction and working principle of steering, braking and suspension system.
5. Explain electrical system, accessories and emission norms.

UNIT I VEHICLE STRUCTURE AND ENGINES **9 Hrs**

Types of automobiles , vehicle construction and different layouts chassis, frame and body, resistances to vehicle motion and need for a gearbox, Introduction to IC Engines-types, working principles, components of engines-their forms functions and materials.

UNIT II FUELS AND LUBRICATION SYSTEM **9 Hrs**

Petrol fuel feed system: Feed pump – mechanical, electrical type – Carburetors – fixed venturi type (carter), variable venturi type (SU), multiple barrel type (Solex, Mikuni), carburetors for two wheelers -Petrol injection – Multi Point Fuel Injection (MPFI), VVT (petrol engines),Turbo chargers, Diesel fuel system: Jerk type fuel injection pump–Methods of fuel injection–common rail, distributor types-Nozzles–Cold starting aids, Cooling system: Direct and indirect cooling, Lubricating system: Mist, wet and dry sump.

UNIT III TRANSMISSION SYSTEMS **9 Hrs**

Clutch-types and construction , gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel –torque converter, propeller shaft, slip joints, universal joints ,Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS **9 Hrs**

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and

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Traction Control.

UNIT V ELECTRICAL SYSTEMS, ACCESSORIES AND EMISSION NORMS **9 Hrs**

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

Course Outcomes

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

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

CO2: Describe the fuels and lubrication system used in SI & IC engines. viz carburetors, APFI, VVT, Turbo charger, CRDI, Lubrication system viz mist, wet and dry sump system

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

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

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

Text Books

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

Reference Books

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

Web References

1. https://nptel.ac.in/courses/108103009/
2. https://nptel.ac.in/courses/112107144/
3. https://nptel.ac.in/courses/112102015/17

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Course Code : 16MCE07	Course Title: DISASTER MANAGEMENT	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Environmental science and Engineering

Course Objectives

The course is intended to:

1. Define relationship between vulnerability, disasters, disaster prevention and risk reduction
2. Define the approaches of Disaster Risk Reduction (DRR).
3. Develop awareness of institutional processes in the country
4. Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.
5. Identify the different disaster management techniques.

UNIT I INTRODUCTION TO DISASTERS **9 Hrs**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc – Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability – Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) **9 Hrs**

Disaster cycle – Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT **9 Hrs**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India – Relevance of indigenous knowledge, appropriate technology and local resources.

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UNIT IV DISASTER RISK MANAGEMENT IN INDIA **9 Hrs**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy – Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS **9 Hrs**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

Course Outcomes

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

CO1: Compare the types of disasters, causes and their impact on environment and society.

CO2: Explain vulnerability and various methods of risk reduction measures as well as mitigation.

CO3: Identify the hazard and vulnerability profile of India, Scenarios in the Indian context.

CO4: Classify Disaster damage assessment and management.

CO5: Select a suitable disaster management techniques.

Text Books

1. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012.
2. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011.
3. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

Reference Books

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.

Web References

1. https://nptel.ac.in/courses/105104183/7

BoS Chairman

Course Code : 16MEE40	Course Title: PRINCIPLES OF MANAGEMENT (Common to AUTO, MECH, Mechatronics)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Teamness and Interpersonal skills
2. Personal effectiveness

Course Objectives

The course is intended to:

1. Describe the role of managers.
2. Explain the significance of planning, decision making and strategies for international business
3. Explain the significance of organizing the tasks
4. Explain the motivational theories
5. Explain the control techniques

UNIT I OVERVIEW OF MANAGEMENT **9 Hrs**

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

UNIT II PLANNING **9 Hrs**

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 Hrs**

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 Hrs**

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

BoS Chairman

UNIT V CONTROLLING **9 Hrs**

Process of controlling – Types of control – Budgetary and non-budgetary control techniques – Managing Productivity – Cost Control – Purchase Control – Maintenance Control – Quality Control – Planning operations.

Course Outcomes

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

CO1: Describe the role of managers with reference to an organization context and business.

CO2: Explain the significance of planning, decision making and strategies for international business to accomplish the organizational goal.

CO3: Explain the significance of organizing the tasks to accomplish the organizational goal.

CO4: Explain the motivational theories to increase the productivity and retention rate of employees.

CO5: Explain the control techniques such as budgetary, maintenance, quality to accomplish the organizational goal.

Text Books

1. Stephen P. Robbins and Mary Coulter, "Management", Prentice Hall of India, 8th edition, 2009.
2. Charles W.L Hill, Steven L McShane, "Principles of Management", Mcgraw Hill Education, 2007.

Reference Books

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

1. http://www.managementstudyguide.com/all-subjects.htm

BoS Chairman

Course Code : 16MEE42	Course Title: INDUSTRIAL SAFETY MANAGEMENT (Common to AUTO, MECH, Mechatronics, Prod.)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Disaster Management
2. Manufacturing Technology

Course Objectives

The course is intended to:

1. Explain the importance of safety management
2. Explain the measurement and monitoring techniques
3. Explain the roles and responsibilities of Safety department
4. Describe the importance of Industrial safety acts
5. Explain the classes of fires and controlling techniques.

UNIT I INTRODUCTION TO SAFETY MANAGEMENT **9 Hrs**

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 Hrs**

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 Hrs**

Role and responsibilities of management and line staffs Supervisors and Employees, Safety committee, Motivation, budgeting for safety, safety policy, Safety Education and Training, Importance of training-identification of training needs- Training methods –programme, seminars, conferences, role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training, Personal Protective Equipment (PPE) - Requirements of PPE, Selection and Usage of PPE, Importance of IS Standard, Types of PPE

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UNIT IV INDUSTRIAL ACTS **9 Hrs**

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 Hrs

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.

Reference Books

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

1. http://www.icebookshop.com
2. http://nptel.ac.in/courses/112107143/40

BoS Chairman

Course Code : 16MEE21	Course Title: NON – DESTRUCTIVE TESTING METHODS (Common to AUTO, MECH, Mechatronics)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Unconventional Machining Processes
2. Engineering Metrology and Measurements

Course Objectives
The course is intended to:

1. Explain the testing procedure for Visual Inspection and Eddy Current Testing Method.
2. Explain testing procedure for Magnetic Particle Testing Method.
3. Explain testing procedure for Liquid Penetrant Testing Method.
4. Plan inspection sequence for Ultrasonic Testing Method.
5. Plan inspection sequence for Radiographic Testing Method.

UNIT I VISUAL INSPECTION AND EDDY CURRENT TESTING METHOD **9 Hrs**

Scope and advantages of NDT-Compare NDT with DT-Principle of Visual Inspection theory-Optical aids used for Visual Inspection-Microscope, Boroscope, Endoscope, Flexiscope, Telescope and Hollography- Principles of Eddy Current Theory-surface mounted coils-Encircling coils-types of Probes-Eddy current sensing Probes-Flux leakage sensing Probes-Eddy Current Techniques, Advanced Eddy Current Techniques-applications, Limitations and standards.

UNIT II MAGNETIC PARTICLE TESTING METHOD **9 Hrs**

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 Hrs**

Physical properties of liquid penetrant-penetrant testing materials-penetrants, cleaners, emlusifiers developers, lint free cloth-Basic Principle, applications and limitations of liquid penetrant testing(LPT)-different LPT methods-Post-Emulsification Fluorescent penetrant process, Reverse Fluorescent Dye penetrant process, Visible Dye penetrant process, Water-Emulsification visible Dye penetrant process, solvent clean visible Dye penetrant process.

UNIT IV ULTRASONIC TESTING METHOD **9 Hrs**

Basic properties of sound beam-sound waves-velocity of ultrasonic waves, Acoustic Impedance behaviour of ultrasonic waves-ultrasonic transducers-characteristics of ultrasonic beam, Flaw sensitivity, Beam divergence, Attenuation-Principle of ultrasonic testing methods, applications

BoS Chairman

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 Hrs**

Basic Principle of Radiography-Electromagnetic radiation sources-X ray source, Gamma ray source-properties of X and Gamma rays-Radiographic Imaging-Geometrical factors-radiographic film-film density-Radiographic sensitivity- Penetrameter-Radiographic Inspection Techniques-single wall single image technique, wall penetration technique, Latitude technique-Applications and Limitations of Radiographic Inspection Techniques.

Course Outcomes

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

CO6: Explain the testing procedure for Visual Inspection and Eddy Current Testing Method in Quality Assurance.

CO7: Explain testing procedure for Magnetic Particle Testing Method for Quality Assurance.

CO8: Explain testing procedure for Liquid Re-entrant Testing Method for Quality Assurance.

CO9: Plan inspection sequence for Ultrasonic Testing Method for Quality Assurance.

CO10: 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-Hill Education Private Limited, 2003.

Reference Books

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.
4. J Prasad, C G K Nair, "Non-Destructive Testing and Evaluation of Materials", Tata McGraw-Hill Education Private Limited, 2003.

Web References

1. https://www.nde-ed.org/index_flash.htm
2. http://117.55.241.6/library/E-Books/NDT%20Notes.pdf
3. http:// www.eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf
4. http://www.hse.gov.uk/comah/sragtech/ndt2.pdf

BoS Chairman

Course Code : 16MCE08	Course Title: MAINTENANCE ENGINEERING	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Design of Machine Elements

Course Objectives
The course is intended to:

1. Define the principles, functions and practices adapted in industry for the successful management of maintenance activities.
2. Explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.
3. Illustrate some of the simple instruments used for condition monitoring in industry.
4. Identify fault location and methods for Machine elements
5. Identify the repair methods for Material handling equipments

UNIT I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING 9 Hrs

Scope and advantages of NDT-Compare NDT with DT-Principle of Visual Inspection theory-Optical aids used for Visual Inspection-Microscope, Boroscope, Endoscope, Flexiscope, Telescope and Holography- Principles of Eddy Current Theory-surface mounted coils-Encircling coils-types of Probes-Eddy current sensing Probes-Flux leakage sensing Probes-Eddy Current Techniques, Advanced Eddy Current Techniques-applications, Limitations and standards.

UNIT II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE 9 Hrs

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

UNIT III CONDITION MONITORING 9 Hrs

Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.

UNIT IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9 Hrs

Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT 9 Hrs

Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

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Course Outcomes
At the end of the course students will be able to:
CO1: Select the maintenance function and different practices in industries

CO2: Explain the maintenance categories on Preventive maintenance.

CO3: Identify the maintenance categories on monitoring and condition of the system.

CO4: Explain the repair methods for basic machine elements.

CO5: Select the repair methods for Job Order systems.

Text Books

1. Srivastava S.K., "Industrial Maintenance Management", S. Chand and Co., 1981
2. Venkataraman .K "Maintenance Engineering and Management", PHI Learning, Pvt. Ltd., 2007.

Reference Books

1. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., 1995
2. White E.N., "Maintenance Planning", I Documentation, Gower Press, 1979.
3. Garg M.R., "Industrial Maintenance", S. Chand and Co., 1986.
4. Higgins L.R., "Maintenance Engineering Hand book", 5th Edition, McGraw Hill, 1988.
5. Armstrong, "Condition Monitoring", BSIRSA, 1988.
6. Davies, "Handbook of Condition Monitoring", Chapman and Hall, 1996.
7. "Advances in Plant Engineering and Management", Seminar Proceedings - IIPE, 1996.

Web References

1. https://nptel.ac.in/courses/112107238/1
2. https://nptel.ac.in/courses/112105232/2

BoS Chairman

Course Code : 16MEE44	Course Title: QUALITY ENGINEERING (Common to AUTO, MECH, Mechatronics & Prod.)	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Engineering Metrology and Measurements
2. Manufacturing Technology

Course Objectives

The course is intended to:

1. Explain the need of quality and customer satisfaction.
2. Explain the basics of Quality cost with classification
3. Explain the concept of total quality management relevant to both manufacturing and service industry.
4. Explain the various tools used in Quality Engineering and Management.
5. Explain the steps used for Designing for Quality.

UNIT I INTRODUCTION **9 Hrs**

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 Hrs**

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

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UNIT III TOTAL QUALITY MANAGEMENT **9 Hrs**

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

UNIT IV QUALITY ENGINEERING AND MANAGEMENT TOOLS **9 Hrs**

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 **9Hrs**

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 students will be able to:

CO1: Explain the need of quality and customer satisfaction

CO2: Explain the basics of Quality cost with classification

CO3: Explain the concept of total quality management relevant to both manufacturing and service industry

CO4: Explain the various tools used in Quality Engineering and Management

CO5: Explain the steps used for Designing for Quality

Text Books

1. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers
2. Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Education
3. Quality Management by Kanishka Bedi
4. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd

BoS Chairman

5. Total Quality Management by K C Arora, S K Kataria & Sons.
6. Statistical Quality Control by M. Mahajan, Dhanpat Rai & Co. (P) Ltd

Reference Books

1. Quality planning and Analysis, Juran and Gryna, TMH, New Delhi
2. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India.

Web References

1. http://www.nptel.ac.in
2. http://www.ocw.mit.edu

BoS Chairman

ELECTRONICS, CONTROL AND NETWORKING

Course Code : 16MCE09	Course Title: MACHINE LEARNING	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Engineering Mathematics I
2. C Programming

Course Objectives

The course is intended to:

1. Explain the basic concepts and techniques of Machine Learning.
2. Compare the Supervised and Unsupervised learning techniques.
3. Explain the various probability based learning techniques
4. Identify suitable Dimensionality Reduction and evolutionary models
5. Explain graphical models of machine learning algorithms

UNIT I INTRODUCTION **9 Hrs**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT II LINEAR MODELS **9 Hrs**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

UNIT III TREE AND PROBABILISTIC MODELS **9 Hrs**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

UNIT IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS **9 Hrs**

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring; -

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Genetic Operators

UNIT V GRAPHICAL MODELS **9 Hrs**

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

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

CO1: Apply Machine learning concepts and Techniques.

CO2: Compare supervised, unsupervised and semi-supervised learning.

CO3: Explain various probability based techniques.

CO4: Outline the graph models of machine learning.

CO5: Develop machine learning algorithms to improve classification efficiency.

Text Books

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective"ǁ, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, "Machine Learningǁ", First Edition, McGraw Hill Education, 2013.

Reference Books

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals"ǁ, First Edition, Wiley, 2014.
3. Ethem Alpaydin", "Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)", Third Edition, MIT Press, 2014.

Web References

1. https://nptel.ac.in/courses/106105152/
2. https://nptel.ac.in/courses/106106202/48

BoS Chairman

Course Code : 16MCE10	Course Title: INDUSTRIAL INTERNET OF THINGS	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:

The student should have undergone the course(s):

1. Microprocessor and Microcontroller

Course Objectives

The course is intended to:

1. Define the need of Internet of Things and Industrial Internet of Things.
2. Illustrate the architecture of Internet of Things.
3. List the Internet of Things protocols.
4. Identify the tools and techniques that enable Internet of Things solution and security.
5. Apply Internet of Things in appropriate places.

UNIT I INTRODUCTION **9 Hrs**

Introduction to IoT, What is IIoT? IoT Vs. IIoT, History of IIoT, Components of IIoT - Sensors, Interface, Networks, People &Process, Hype cycle, IoT Market, Trends& future Real life examples, Key terms – IoT Platform, Interfaces, API, clouds, Data Management Analytics, Mining & Manipulation; Role of IIoT in Manufacturing Processes Use of IIoT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IIoT.

UNIT II ARCHITECTURE **9 Hrs**

Overview of IoT components; Various Architectures of IoT and IIoT, Advantages & disadvantages, Industrial Internet - Reference Architecture; IIoT System components: Sensors, Transducers, Classification, Roles of sensors in IIoT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IIoT sensors, Role of actuators, types of actuators. Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IoT.

UNIT III PROTOCOLS AND CLOUD **9 Hrs**

Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, IIoT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIoT cloud platforms : Overview of cots cloud platforms, predix, thingworks, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas. Hardwire the sensors with different protocols.

UNIT IV PRIVACY, SECURITY AND GOVERNANCE **9 Hrs**

Introduction to web security, Conventional web technology and relationship with IIoT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques.

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Management aspects of cyber security.

UNIT V IOT ANALYTICS AND APPLICATIONS **9 Hrs**

IoT Analytics: Role of Analytics in IoT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications : Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIoT in Manufacturing Sector.

Course Outcomes

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

CO1: Describe Internet of Things and Industrial Internet of Things.

CO2: Explain the architecture of IoT, roles of sensors in Internet of Things.

CO3: Select the protocols and cloud platform for Internet of Things concepts.

CO4: Analyze various Internet of Things platforms and Security.

CO5: Develop a Internet of Things application in manufacturing industrial sector and home automation.

Text Books

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", John Wiley and Sons, 2013.
2. Dieter Uckelmann, Mark Harrison, Florian, Michahelles, "Architecting the Internet of Things", Springer-Verlag Berlin Heidelberg 2011.

Reference Books

1. Hakima Chaouchi, "The Internet of Things Connecting Objects", John Wiley & Sons, 2013.
2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Second edition, John Wiley & Sons, 2011.

Web References

1. https://nptel.ac.in/noc/individual_course.php?id=noc19-cs32

BoS Chairman

Course Code : 16MCE11	Course Title: MICRO ELECTRO MECHANICAL SYSTEMS	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Manufacturing Technology
2. Additive Manufacturing

Course Objectives
The course is intended to:

1. Identify semiconductors and solid mechanics to fabricate MEMS devices.
2. List various sensors and actuators in MEMS.
3. Explain Micro fabrication techniques.
4. Explain the different manufacturing system of MEMS.
5. Apply MEMS concepts in various disciplines and its applications.

UNIT I INTRODUCTION **9 Hrs**

Overview-Microsystems and microelectronics -definition-MEMS materials-scaling laws-scaling in geometry-scaling in rigid body dynamics- scaling in electrostatic forces- scaling in electricity scaling in fluid mechanics- scaling in heat transfer.

UNIT II MICRO SENSORS AND ACTUATORS **9 Hrs**

Working principle of Microsystems - micro actuation techniques - micro sensors-types - Microactuators – types – micropump – micromotors – micro – valves – microgrippers –micro accelerometers.

UNIT III FABRICATION PROCESS **9 Hrs**

Substrates-single crystal silicon wafer formation-Photolithography-Ion implantation-Diffusion – Oxidation-CVD-Physical vapor deposition-Deposition by epitaxy-etching process.

UNIT IV MICRO SYSTEM MANUFACTURING **9 Hrs**

Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging materials- die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing.

UNIT V MICRO SYSTEM DESIGN **9 Hrs**

Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aero space-telecommunications.

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

CO1: Explain semiconductors and solid mechanics to fabricate MEMS devices.

CO2: Analyze the use of various sensors and actuators in MEMS.

CO3: Select the Micro fabrication techniques.

CO4: Explain the different manufacturing system for MEMS

CO5: Develop a Microsystem layout in automotive, Bio-medical, aerospace and Telecommunication.

Text Books

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", Tata McGraw-Hill, First edition, 2017.

Reference Books

1. Mohamed Gad-el-Hak, "The MEMS Hand book", Third Volume, CRC press.2005.
2. Julian W. Gardner, Vijay K. Varadan, Osama O. AwadelKarim, "Microsensors, MEMS, and Smart Devices", John Wiley & Sons Ltd, 2001.
3. Sergej Fatikow, Ulrich Rembold, "Microsystem Technology and Microrobotics", Springer-Verlag Berlin Heidelberg.Newyork, 1997
4. Francis E.H Tay and W.O Choong, Microfludics and BioMEMS Applications, Springer, 2002.

Web References

1. https://nptel.ac.in/courses/117105082/
2. https://www.lboro.ac.uk/microsites/mechman/research/ipm-ktn/pdf/Technology_review/an-introduction-to-mems.pdf

BoS Chairman

Course Code : 16MCE12	Course Title: HYBRID ELECTRIC VEHICLES	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Electrical Drives and Control

Course Objectives
The course is intended to:

1. Explain the basics of electric vehicles
2. Illustrate the concepts of hybrid vehicles.
3. Analyze the different electric propulsion methods.
4. Identify the different control methods
5. Choose the energy storage mediums.

UNIT I ELECTRIC VEHICLES **9 Hrs**

Electric vehicle layout, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components, electronic control system, safety and challenges in electric vehicles.

UNIT II HYBRID VEHICLES **9 Hrs**

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, hybrid electric drive train design, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles.

UNIT III ELECTRIC PROPULSION SYSTEMS **9 Hrs**

DC motors, AC motors, permanent magnet motors, brushless DC and reluctance motors, characteristics and regenerative braking.

UNIT IV MOTOR CONTROLLERS AND CONTROL SYSTEMS **9 Hrs**

Control system principles, speed and torque control –DC motors and AC motors.

UNIT V ENERGY STORAGE DEVICES **9 Hrs**

Electromechanical batteries- types of batteries –lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultra-capacitors.

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

CO1: Explain working of different configurations of electric vehicles.

CO2: Explain hybrid vehicle configuration and its components, performance analysis.

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CO3: Analyze the electric drive systems.

CO4: Build a control system to control speed and torque.

CO5: Select different types of batteries for energy storage.

Text Books

1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Second edition Cengage Learning, 2012.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals, Second edition, CRC Press, New York, 2010.

Reference Books

1. Seref Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.
2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007.
3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.

Web References

1. https://nptel.ac.in/courses/108103009/

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Course Code : 16MCE13	Course Title: DIGITAL CONTROL ENGINEERING	
Core / Elective : Elective	L : T : P: C	3 : 0 : 0 : 3
Type: Theory	Total Contact hours:	45 Hrs

Prerequisites:
The student should have undergone the course(s):

1. Engineering Mathematics I & II
2. Control systems

Course Objectives
The course is intended to:

1. Explain the basics of digital control system and sampling.
2. Explain the digital control algorithm.
3. Develop a basic knowledge of representing the system in state variable form.
4. Outline the concept of stability of the discrete data systems and analysis.
5. Model digital control systems using various techniques.

UNIT I INTRODUCTION **9 Hrs**

Digital control systems – basic concepts of sampled data control systems – principle of sampling,– Sample and Hold circuits – Practical aspects of choice of sampling rate –Basic discrete time signals.

UNIT II MODELS OF DIGITAL CONTROL DEVICES AND SYSTEMS **9 Hrs**

Z domain description of sampled continuous time plants – models of A/D and D/A converters – Z Domain description of systems with dead time – Implementation of digital controllers – Digital PID controllers –Position, velocity algorithms – Tuning – Zeigler – Nichols tuning method.

UNIT III DISCRETE STATE-VARIABLE TECHNIQUE **9 Hrs**

State space representation of discrete time systems – Solution of discrete time state space equation – State transition matrix – Decomposition techniques

UNIT IV STABILITY ANALYSIS **9 Hrs**

Mapping between S plane and Z plane– Jury's stability test – Bilinear transformation and extended Routh array– Root Locus Method –Liapunov Stability Analysis of discrete time systems.

UNIT V DESIGN OF DIGITAL CONTROL SYSTEM **9 Hrs**

Z plane specifications of control system design – Digital compensator design – Frequency response method – State feedback – Pole placement design.

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Course Outcomes
At the end of the course students will be able to:
CO1: Analyze the discrete data systems and choosing sampling rate for different systems

CO2: Explain the digital control algorithm.

CO3: Model the system in discrete state space, solution of state transition matrix.

CO4: Analyze the stability of the discrete data system and analysis using various methods.

CO5: Develop controllers using different techniques and digital compensator design.

Text Books

1. M. Gopal "Digital Control and State Variable methods", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India, 2003.

Reference Books

1. B. C. Kuo, "Digital Control Systems", Oxford University Press, Second edition, Indian Edition, 2007.
2. K. Ogata "Discrete Time Control Systems", Prentice Hall International, New Jersey, USA, 2002.
3. C.H. Houpis and C.B Lamont., "Digital Control Systems", Tata Mc Graw Hill, 1999.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems", Addison-Wesley; Third edition, 1997, Pearson Education, Asia, Third edition, 2000.
5. K. J. Astroms and B. Wittenmark, "Computer Controlled Systems - Theory and Design", Prentice Hall, Third edition, 1997.

Web References

1. https://nptel.ac.in/courses/108103008/4
2. http://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlDigital

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