

**Course Structure and Syllabus
of
B.Tech Programme
In
MECHANICAL ENGINEERING**



(Admission Batch: 2018-19 Onwards)

**INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG
(An Autonomous Institute of Government of Odisha)
Dhenkanal, Odisha- 759146
www.igitsarang.ac.in**

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG
Course Structure for 3rd Year B.Tech MECHANICAL ENGINEERING
(Admission Batch: 2018-19 Onwards)

Fifth Semester				Sixth Semester			
Theory				Theory			
Course Code	Course Name	L-T-P (Periods/Week)	Credits	Course Code	Course Name	L-T-P (Periods/Week)	Credits
	<i>Programme Core Subject</i>				<i>Programme Core Subject</i>		
PCME4306	Theory of Machine-II	3-0-0	3	PCME4309	Machine Design-I	3-0-0	3
PCME4307	Power Engineering	3-0-0	3	PCME4310	Product Design and Production Tooling	3-0-0	3
PCME4308	Manufacturing Technology-II	3-0-0	3				
(Any One)	Programme Elective I	3-0-0	3	(Any One)	Programme Elective II	3-0-0	3
PEME5301/	Micro-Electro Mechanical system/			PEME5304/	Advanced Mechanics of Material		
PEME5302/	Simulation, Modelling and Control/			PEME5305/	Mechanical Measurement and Control		
PEME5303/	Non- Conventional Energy Sources			PEME5306/	Machine Conditioning Monitoring		
(Any One)	Open Elective II	3-0-0	3	(Any One)	Open Elective III	3-0-0	3
	Refer list of Open Electives				Refer list of Open Electives		
	Mandatory Course V	2-0-0	0		Mandatory Course VI	2-0-0	0
MCGN9305/	Environmental Science/			MCHM9306	Universal Human Values/		
MCHM9306	Universal Human Values			/MCGN9305	Environmental Science		
	Total (Theory)	17	15		Total (Theory)	16	14
	Honours/ Minor	3-1-0	4		Honours/ Minor	3-1-0	4
HNME0304	Advanced Mechanics of Solids/			HNME0307	Advanced Fluid Mechanics		
HNME0305	Design of Machine Components/			HNME0308	Fluid Power and Turbo Machinery		
HNME0306	Experimental Stress Analysis			HNME0309	Power Plant Engineering		
MNME0303	Manufacturing Processes			MNME0304	Mechanics of Solid		
	Practical/ Sessional				Practical/ Sessional		
PCME7306	Machine Dynamics Lab - II	0-0-3	2	PCME7309	Machine Design Lab	0-0-3	2
PCME7307	Mechanical Engineering Lab - III	0-0-3	2	PCME7310	Advanced Manufacturing Lab	0-0-3	2
PCME7308	Manufacturing Technology-II Lab	0-0-3	2	HSHM3305	Business Communication & Interview Skills	0-0-3	1
	Total (Practical/ Sessional)	9	6	PJME8301	Skill Project	0-0-3	2
	TOTAL	26	21		Total (Practical/ Sessional)	12	7
					TOTAL	28	21
TOTAL SEMESTER CREDITS: 21				TOTAL SEMESTER CREDITS: 21			
TOTAL CUMULATIVE CREDITS: 104				TOTAL CUMULATIVE CREDITS: 125			

OPEN ELECTIVE SUBJECTS

OPEN ELECTIVE-II (OE-II) 5th Semester						
Sl. No.	Subject Code	Subject Name	Contact Hours	Credits	Departments to Teach the Subject	Students to whom Option is Open
1	OECH6311	Petroleum Refinery Engineering	3-0-0	3	Chemical Engg.	All branches
2	OECH6330	Green Technology	3-0-0	3	Chemical Engg, Civil Engg.	All branches
3	OECE6312	Mechanics of Solids	3-0-0	3	Civil Engg.	All branches
4	OECS6203	OOPs Using C++	3-0-0	3	CSE	CH, CS, EC, MM, PD
5	OECS6331	Cloud Computing	3-0-0	3	CSE	All branches
6	OEEE6313	Digital Signal Processing	3-0-0	3	Electrical Engg.	All branches
7	OEEC6314	Industrial Automation with PLC and SCADA	3-0-0	3	ETC Engg.	All branches
8	OEME6316	Introduction to Composite Materials	3-0-0	3	Mech. Engg.	All branches
9	OEMT6315	Nanomaterials	3-0-0	3	MME	All branches
10	OEPD6317	Powder Metallurgy	3-0-0	3	Prod. Engg.	All branches
11	OEMA6207	Numerical Methods	3-0-0	3	Mathematics	CE, EE, ME
OPEN ELECTIVE-III (OE-III) 6th Semester						
Sl. No.	Subject Code	Subject Name	Contact Hours	Credits	Departments to Teach the Subject	Students to whom Option is Open
1	OECH6318	Food Biotechnology	3-0-0	3	Chemical Engg.	All branches
2	OECH6319	Fluidization Engineering	3-0-0	3	Chemical Engg.	All branches
3	OECE6320	Structural Dynamics and Earthquake Engineering	3-0-0	3	Civil Engg.	All branches
4	OECS6321	Data Science	3-0-0	3	CSE	All branches
5	OEEE6322	Sensors and Transducers	3-0-0	3	Electrical Engg.	All branches
6	OEEC6324	Mechatronics	3-0-0	3	ETC Engg.	All branches
7	OEHM6325	Marketing Management	3-0-0	3	Humanities	All branches
8	OEMA6326	Optimization in Engineering	3-0-0	3	Mathematics	All branches
9	OEME6327	Industrial Engineering and Operation Research	3-0-0	3	Mechanical Engg.	All branches
10	OEMT6328	Biomaterials	3-0-0	3	MME	All branches
11	OEPD6329	Operation Research	3-0-0	3	Prod. Engg.	All branches

CE: Civil Engineering

EE: Electrical Engineering

ME: Mechanical Engineering

CH: Chemical Engineering

HM: Humanities

CS, CSE: Computer Science and Engineering

EC, ETC: Electronics and Telecommunication Engineering

MT, MME: Metallurgical and Materials Engineering

PD, Prod.: Production Engineering

MA: Mathematics

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG**B.TECH SYLLABUS for MECHANICAL ENGINEERING**

(Admission Batch: 2018-19 Onwards)

5th Semester

PCME4306	Theory of Machine - II	3-0-0	Credit-3
<p>Course Objective:</p> <ol style="list-style-type: none"> 1. To impart knowledge about dynamic analysis of mechanisms and balancing 2. To understand the principles of gyroscope and governors 3. To determine the static and dynamic forces for mechanical systems 4. To understand the principles of vibrations 5. To study tooth profiles of gears. <p>MODULE I (8 hours)</p> <p>Motor Vehicle Steering Gears: - Davis Steering Gear & Ackermann Steering Gear.</p> <p>Cams Design: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method.</p> <p>MODULE – II (10 hours)</p> <p>Turning Moment Diagram and Flywheel: Turning moment diagram. Turning moment diagrams for different types of engines, Fluctuation of energy and fluctuation of speed. Dynamic Theory of flywheel, Flywheel of an internal combustion engine and for a punch machine. Determination of flywheel size from Turning Moment Diagram.</p> <p>Gears : Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Force analysis, Path of contact, Arc of contact, Contact ratio, Interference and Undercutting, Methods for eliminating Interference, Minimum number of teeth to avoid interference.</p> <p>MODULE III (10hours)</p> <p>Governors - Watt, Porter, Proell, Hartnell, Wilson Hartnell Governor. Performance parameters: Sensitiveness, Stability, Hunting, Isochronism. Governor Effort and Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor and flywheel. Gyroscope: Introduction to Gyroscopes. Gyroscopic forces and Couple. Effect of Gyroscopic Couple on Aeroplanes, Gyroscopic stabilization of ship, Stability of Two Wheelers and Four Wheelers.</p> <p>MODULE IV (12hours)</p> <p>Balancing: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine Frame, Partial balance of</p>			

single cylinder engines. Primary and Secondary Balance of Multi-cylinder In-line Engines. Balancing of locomotive: variation of tractive force, swaying couple, and hammer blow. Direct and Reverse Crank method of balancing for radial engines. Balancing of V-engine. Balancing machines: Pivoted-Cradle Balancing Machine.

Vibrations: Introduction to Mechanical Vibration – Definitions, elements of vibratory system, Longitudinal, Torsional & Transverse Systems. Differential equations and solutions of motion for a coupled spring mass system. Determination of natural frequency of vibratory systems using energy method, equilibrium method and Rayleigh's method, Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Logarithmic decrement, Magnification factor, Vibration isolation and transmissibility, whirling of shafts and Evaluation of Critical Speeds of shafts.

Text Books

1. Theory of Machines by S.S. Rattan, Tata MacGraw Hill
2. Theory of Machines by Thomas Bevan, Publisher: Pearson Education India
3. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
4. Mechanism and Machine Theory by J.S.Rao and R.V. Dukipatti, New Age International.
5. Theory of Machine by R.K Bansal, Laxmi publication.

Reference Books:

1. Kinematics and Dynamics of Machinery by R.L. Norton, Tata Mac Graw Hill
2. Kinematics & Dynamics of Machinery-Charles E. Wilson & J. Peter Sessler, Pearson Ed.
3. Theory of Machine by R.S. Khurmi, Publisher: S Chand
4. Mechanism and Machines by Amitav Ghosh & Mallik, Publisher: Affiliated East-West Press

Course outcomes:

On successful completion of the course the student will be able to:

1. Perform static and dynamic analysis of mechanisms
2. Understand the issues related to balancing of reciprocating and rotating machinery
3. Know the working of gyroscopes and flywheels
4. Have understanding about the effect of vibration.

PCME4307	Power Engineering	3-0-0	Credit-3
<p>Course Objective:</p> <ol style="list-style-type: none"> 1. Understand the basic thermodynamics cycles 2. Understand the basic of fuel injection and stages of combustion 3. Understand the performance characteristics 4. Understand the working of Gas turbines. 			

MODULE – I**(11 hours)**

Introduction: Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles: Significance of Fuel-Air & Actual cycles of I.C. Engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction)

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

MODULE II**(12 hours)**

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System.

Ignition :Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism.

Combustion :Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers -Open and divided type, Air swirl turbulence-M. Type combustion chamber. Comparison of various types of combustion chambers.

Super Charging & Scavenging: Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2-stroke engines.

Module-III**(8 hours)**

Gas Turbines: Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle. Air Craft Propulsion: Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

Module-IV**(8 hours)**

Steam Power Plant :- Layout of modern steam power plant, Simple ideal Rankine cycle, Classification : impulse and reaction turbines, velocity diagrams, Steam Generator, Draught and its classification, Chimney height, Chimney Efficiency, Condition for maximum discharge.

Module-V (8 hours)

Classifications and essential components of nuclear reactor, Nuclear fuels, Nuclear fission, difference between fusion and fission, reactors: PWR, BWR CANDU reactors, light water reactor, gas cooled reactors, liquid metal fast breeder reactors, disposal of nuclear waste.

Text Books

1. IC Engines, Mathur & Sharma, Dhanpat Rai Publication
2. Internal Combustion Engines, V. Ganesan. Tata McGraw-Hill Education.
3. Gas Turbine, V Ganesan, McGraw-Hill Education.
4. Power Plant Engineering, Domkundwar Arora, Dhanpat Rai & Co

Upon successful completion of the course, student will have:

1. Ability to understand the working of IC engine and thermo dynamic cycles related to it.
2. Ability to solve the physical problem related to turbines.
3. Ability to understand different processes in Gas turbine and aircraft propulsion system.
4. Ability to know the nuclear power plant.

PCME4308	Manufacturing Technology - II	3-0-0	Credit-3
<p>COURSE OBJECTIVES: To understand the concept of mechanics of metal cutting, working of machine tools such as automats, major metal cutting processes and study the basics of nontraditional machining processes.</p> <p>UNIT I: THEORY OF METAL CUTTING (09 hours) Mechanism of metal cutting – types – cutting force – chip formation – Merchant's circle diagram – calculations – tool geometry – machinability – tool wear – tool life – cutting tool materials – cutting fluids – types.</p> <p>UNIT II: AUTOMATS, SHAPING AND PLANING MACHINES (09 hours) Capstan and turret lathes – construction - indexing mechanism - operations - working principle of single and multi-spindle automats – shaping and planing machines – types – construction - mechanism – principle of operation – different shaping operations - work holding devices.</p> <p>UNIT III: DRILLING, BROACHING AND GRINDING MACHINES (09 hours) Drilling machines – specifications, types - feed mechanism, operations – drill tool nomenclature –broaching – specifications, types, tool nomenclature, broaching operations – grinding – types of grinding machines – grinding wheels, specifications – bonds –mounting and reconditioning of grinding wheels.</p> <p>UNIT IV: MILLING AND GEAR GENERATING MACHINES (09 hours) Milling – specifications – types - cutter nomenclature – types of cutters – milling processes – indexing – gear forming in milling – gear generation - gear shaping and gear hobbing – specifications - cutters – cutting spur and helical gears - bevel gear generators – gear finishing methods.</p> <p>UNIT V: NON-TRADITIONAL MACHINING (09 hours) Classification of machining processes – process selection - ultrasonic machining – abrasive jet machining – water jet machining - laser beam machining – electron beam machining – plasma arc machining.</p>			

TEXT BOOKS

1. Hajra Choudhry S.K. and Bose S.K., "Workshop Technology Vol II", Media Promoters and Publishers Pvt. Ltd., Bombay, 2004
2. Sharma P.C., "A Text Book of Production Technology", S.Chand & Company Ltd., New Delhi, 10th Revised edition, 2010

REFERENCES

1. Serope Kalpakjian and Steven R.Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte Ltd, Delhi, 2009
2. Jain R.K. and Gupta S.C., "Production Technology", Khanna Publishers, New Delhi, 1999

COURSE OUTCOMES:

On completion of this course, students will be able to

1. Apply the concepts of theory of metal cutting in real life machining.
2. An elect machine tools for various requirements of products.

PEME5301	Micro-Electro Mechanical System	3-0-0	Credit-3
-----------------	--	--------------	-----------------

OBJECTIVES

1. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. To educate on the rudiments of Micro fabrication techniques.
3. To introduce various sensors and actuators
4. To introduce different materials used for MEMS
5. To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT I INTRODUCTION**(9 hours)**

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS-I**(9 hours)**

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT III SENSORS AND ACTUATORS-II (9 HRS)

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric

effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT IV MICROMACHINING

(9 hours)

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS

(9 hours)

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

OUTCOMES

1. Ability to understand and apply basic science, circuit theory, Electro-magnetic field theory control theory and apply them to electrical engineering problems.
2. Ability to understand and analyse, linear and digital electronic circuits.

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
2. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2002.

REFERENCES:

1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002
3. Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2000
4. Nadim Maluf, “ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
5. Thomas M. Adams and Richard A. Layton, “Introduction MEMS, Fabrication and Application,” Springer 2012.

PEME5302	Simulation, Modelling and Control	3-0-0	Credit-3
Course Objective			
<ol style="list-style-type: none"> 1. Define the basics of simulation, modeling and replicating the practical situations in organizations. 2. Generate random numbers and random variates using different techniques. 3. Analysis of Simulation models using input analyzer, and output analyzer. 4. Explain Verification and Validation of simulation model. 			

Module 1:**(14 hours)**

Basic simulation modeling, Discrete event simulation, Simulation of queuing and Monte Carlo simulations. inventory systems, Continuous, Discrete-continuous and Mon Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution, Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness-of-fit tests, Multivariable time series models.

Module 2:**(12 hours)**

Overview of feedback control systems, Dynamics of mechanical systems, Differential equations and state variable form, Models of electromechanical, Heat-and fluid flow models, Linearization and scaling, Models from experimental data, Dynamic response using pole-zero locations, Time domain specifications, Classical 3-term controllers and its digital implementation, Stability analysis by Routh Criterion.

Module 3:**(10 hours)**

Simulation of manufacturing and material handling systems, Goals and performance measures, Modeling downtime and failures, Trace driven models, Case studies.

Text/Reference Books:

1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (Pearson Publications).
2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.
3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGraw Hill Publications.

Upon successful completion of the course, student will have the ability to:

1. Understand the techniques of modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems.
2. Simulate the models for the purpose of optimum control.
3. Interpret the model and apply the results to resolve critical issues in a real world environment.

PEME5303	Non- Conventional Energy Sources	3-0-0	Credit-3
<p>Course Objective:</p> <ol style="list-style-type: none"> 1. Ability to know the basic of Non-Conventional Energy Sources 2. Ability to know the basic of Solar Energy, Estimating Solar Radiation 3. Ability to solve problems on Solar Radiation 4. Ability to know the basic of Wind Energy, Biomass Conversion Technologies 5. Ability to know applications Geothermal Energy, Ocean Energy: Tidal Energy, Wave Energy <p>MODULE I (6 hours)</p> <p>Energy, Ecology and environment: Introduction, Classification of Energy Resources, Common Forms of</p>			

Energy, Energy Chain, Advantages and Disadvantages of Conventional Energy Sources, Importance and Salient Features of Non-Conventional Energy Sources, Environmental and ecological Aspects of Energy use, Environment-Economy-Energy and Sustainable Development, World Energy Status, Energy Scenario in India. Energy Conservation and Energy Storage: Salient Features of “Energy Conservation Act, 2001”, Various Aspects of Energy Conservation, Principles of Energy Conservation, General Electrical ECO’s (Energy Conservation Opportunities)

MODULE II**(15 hours)**

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums, Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under loudless and Cloudy Skies, Solar Radiation on Inclined Plane Surface only (empirical relations for numerical)

Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar Water Heater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water), Solar Photovoltaic Systems: Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Solar PV Systems, Solar PV Applications.

MODULE III**(8 hours)**

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications of Wind Power, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Effects of Wind Speed and Grid Condition (System Integration)

Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming.

MODULE IV**(8 hours)**

Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resource. Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages

TEXT BOOK

1. Solar Energy Technology: Sukhatme and Nayak, TMH
2. Renewable Energy Sources and Emerging Technology: D.P. Kothari and et al., PHI
3. Renewable Energy Sources & Conversion Technology: N.K. Bansal, Manfred, Kleenman & Michael Meliss, TMH Publication.
4. Non-Conventional Energy Sources: B.M Khan, TMH Publications

Upon successful completion of the course, student will have:

1. Ability to understand Non-Conventional Energy Sources and its applications

2. Ability to understand the advantages of application of Solar Energy, Wind Energy, Geothermal Energy etc.

MANDATORY COURSE

MCGN9305	Environmental Science	2-0-0	Credit-0
<p>Unit 1: Multidisciplinary nature of environmental studies Definition, scope and importance), Need for public awareness.</p> <p>Renewable and non-renewable resources Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.</p> <p>Unit 2: Ecosystems 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 ecosystems:-</p> <ol style="list-style-type: none"> Forest ecosystem Grassland ecosystem Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) <p>Unit 3: Biodiversity and its conservation</p> <ul style="list-style-type: none"> Introduction – Definition: genetic, species and ecosystem diversity. Bio geographical classification of India Biodiversity at global, National and local levels. India as a mega-diversity nation Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. <p>Unit 4: Environmental Pollution Cause, effects and control measures of :- Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.</p> <p>Unit 5: Social Issues and the Environment Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.</p> <p>Text Books</p> <ol style="list-style-type: none"> Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India. 			

MANDATORY COURSE

MCHM9306	Universal Human Values	2-0-0	Credit-0
<p>Objective:</p> <ol style="list-style-type: none"> 1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education. 2. To sensitize the student towards issues in society and nature. 3. To Strengthen self-reflection to know what the students ‘really want to be’ in their life and profession. 4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life. 			
<p>Module I 10 Hours</p> <ol style="list-style-type: none"> 1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process; 2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations. 3. Method to fulfill the human aspirations: understanding and living in harmony at various levels. 			
<p>Module II 10 Hours</p> <ol style="list-style-type: none"> 1. Human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Self (‘I’) and ‘Body’ - <i>Sukh</i> and <i>Suvidha</i> 2. Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), the characteristics and activities of ‘I’ and harmony in ‘I’, 3. Harmony of I with the Body: <i>Sanyam</i> and <i>Swasthya</i>; Needs of Body and Psyche: <i>Sanyam</i> and <i>Swasthya</i> 			
<p>Module III 12 Hours</p> <ol style="list-style-type: none"> 1. Harmony in the Family, values in human-human relationship; Trust (<i>Vishwas</i>) and Respect (<i>Samman</i>) as the foundational values of relationship, meaning of <i>Vishwas</i> and <i>Samman</i> 2. Harmony in the society: <i>Samadhan</i>, <i>Samridhi</i>, <i>Abhay</i>, <i>Sah-astitva</i>, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature 3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education, 			
<p>Module IV 08 Hours</p> <ol style="list-style-type: none"> 1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management 2. Strategy for transition from the present state to Universal Human Order 			

3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

Text Book:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References Books:

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

Course Outcome:

On completion of this course, the students will be able to:

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

HONOURS

HNME0304	Advanced Mechanics of Solids	3-1-0	Credit-4
-----------------	-------------------------------------	--------------	-----------------

Course Objective:

1. To study the methodologies in theory of elasticity at a basic level.
2. To describe the concept of “stress at a point” (state of stress and strain in 3D).
3. To get familiar with energy methods for solving structural mechanics problems.
4. To acquaint with the solution of advanced bending and axisymmetric problems
5. To study about Mechanics of Composite Materials and Fracture mechanics.

MODULE-I**(12 Hours)**

1. Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr’s Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress.
2. Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements.
3. Theories of Failure, Various yield criteria

MODULE-II**(12 Hours)**

1. Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems,
2. Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars.

MODULE-III (10 Hours)

1. Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit.
2. Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity.

MODULE-IV**(6 Hours)**

1. Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites.
2. Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

TEXT BOOK

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill.
2. Advanced Mechanics of Materials: Boresi and Schmidt, Willey.
3. Design o Machine Elements by V.B. Bhandari, Tata McGraw Hill.
4. Mechanics of Composite material by R.M.Jones, Taylor and Francis.
5. Elements of fracture mechanics by Prashant Kumar, McGraw Hill.

REFERENCE BOOKS

1. Advanced Mechanics of Materials : Siley and Smith
2. Strength of Materials Vol.II, by S.Timoshenko
3. Strength of Materials by G. H. Ryder, Macmillan Press
4. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
5. Mechanics of Materials by R.C.Hibbeler, Pearson Education
6. Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
7. Mechanics of Materials by James M. Gere, Thomson Learning
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India
9. Strength of Materials by S.S.Rattan, Tata Mc Graw Hill

Upon successful completion of the course, student will have:

1. The ability to apply the concepts of stress and strain analysis in solids.
2. The ability to use the procedures in theory of elasticity at a basic level.
3. The ability to solve general bending and axisymmetric problems.
4. The ability to apply energy methods in structural mechanics problems.
5. The ability to solve the problems related to fatigue, Mechanics of composite materials and fracture mechanics.

HONOURS

HNME0305	Design of Machine Components	3-1-0	Credit-4
<p>Course objective:</p> <p>Machine Design is concerned with the development of new or improved machine element to perform the desired function efficiently using scientific principles, technical information, creative thinking based on requirement of strength, Kinematics, manufacturing considerations and economics.</p>			
<p>Module I (10 hours)</p> <p>Theories of Failure, Application of Practical problems. Variables stresses (Fatigue), Endurance limit, S - N curve, Fatigue stress concentration factor, Goodman and Soderberg criteria, Application to Practical problems. Design of Flat Belt Drives and Flat Belt Pulleys. Design of V-Belt, Design of Rope Drives, Design of Chain Drives.</p>			
<p>Module II (8 hours)</p> <p>Design of Columns and Struts. Design of Flywheel, Illustrative problems with solutions.</p>			
<p>Module III (8 hours)</p> <ol style="list-style-type: none"> 1. Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Problem illustration. 2. Design of straight and Helical spur gears, bevel gears. Illustrative problems with solutions. 			
<p>Module IV (10 hours)</p> <p>Design of Engine components: Piston and Connecting Rod, Illustrative problems with solutions.</p>			
<p>TEXT BOOKS:</p> <ol style="list-style-type: none"> 1. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH 2. Machine Design, Pandya and Shah, Charotar Book Stall 3. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007. 4. A Text Book of Machine Design, R.S.Khurmi and J.K.Gupta, S.Chand Publication 			
<p>REFERENCE BOOKS:</p> <ol style="list-style-type: none"> 1. Machine Design, Robert L. Norton, Pearson Education Asia, 2001. 2. Machine Design, A CAD Approach: Andrew D Dimarogonas, John Wiley Sons, Inc, 2001. 3. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007 4. Machine Design, H.Timothy and P.E. Wentzell, Cengage Learning 5. Computer Aided Analysis and Design, S.P. Regalla, I.K. International Publishing 			
<p>DESIGN DATA HAND BOOKS:</p>			

1. Design Hand Book by S.M. Jalaluddin; Anuradha Agencies Publications Vidyal Karuppur, Tamil Nadu, Pin : 612605.
2. P.S.G. Design Data Hand Book, PSG College of Tech Coimbatore
3. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.

Course Outcome

On successful completion of the course students will be able to:

1. Select appropriate belt Drives for power transmission on the basis of given load and speed
2. Design rope drives based on the given conditions.
3. Select bearings for a given applications from the manufacturers catalogue.
4. Select and/or design belts and flywheel for given applications
5. Graduate will learn Gerber and Soderberg criteria.
6. Graduate will be familiar with Fatigue stress concentration factor.
7. Students will be able to understand selection of ball and roller bearings.
8. Select bearings for a given applications from the manufacturers catalogue.
9. Students will learn Piston and Connecting Rod.

HONOURS

HNME0306	Experimental Stress Analysis	3-1-0	Credit-4
<p>Course Objective: Imparts basic idea of experimental stress analysis, Stress analysis – Analytical, Numerical and Experimental approaches, and Specific domain of these approaches, Advantages and disadvantages.</p> <p>MODULE-I (12 Hours)</p> <ol style="list-style-type: none"> 1. Elementary elasticity: stress at a point, Principal stresses in 2D and 3D systems, strain and stress – strain relationships, principal strain, Plane stress and Plane strain conditions. 2. Photo elasticity: Theory of photo elasticity , Photo elasticity methods –light and optics as related to photo elasticity, polarization of light, plane and circularly polarized light, Stress-optic law, Plane Polariscope & Circular Polariscope, Light and dark field arrangement. <p>MODULE-II (10 Hours)</p> <ol style="list-style-type: none"> 1. Photoelastic model materials for 2D applications, Isoclinic & Iso chromatic fringes, Partial fringe value and compensation techniques, calibration methods, Analysis techniques, Separation of Principal stresses, Scaling models to prototype, Birefringent coatings and scattered light in photo elasticity, Reflection polariscope. <p>MODULE-III (13 Hours)</p> <ol style="list-style-type: none"> 1. Strain measurement methods and related instruments-Strain gauges – Types – Mechanical, Optical and Electrical strain gauges – Electrical resistance strain gauges – Gauge factor – Strain gauge circuitry – Temperature compensation, semiconductor strain gauge, Wheastone and potentiometer bridge circuit. 			

- Application of strain gauges :- Transverse sensitivity, Selection and mounting of strain gauges, Strain gauge rosettes , Recording equipment for static and dynamic strains , Strain gauge transducers .

MODULE-IV**(5 Hours)**

- Other Stress analysis techniques - Brittle coating technique for stress analysis, behaviour of stress coats and its application, Moire fringe method –grid technique of displacement/strain analysis.

TEXT BOOK

- Dalley and Riley, “Experimental stress Analysis”, McGraw Hill, 1991.
- Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 1996.
- Dove and Adams, “Experimental Stress Analysis and Motion measurement”, Prentice Hall, 1965

REFERENCE BOOKS

- Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, McGraw Hill Book Co, Ny, 1951
- Durelli, A.J., Phillips, E. and tsaο, C.H., Introduction to the Theoretical and Experimental Analysis of stresses and strain, McGraw Hill Book Co, Ny, 1958
- Hetenyi, “Handbook of Experimental stress Analysis”, John Wiley, 1960.
- Perry and Lissener, “Strain gauge Primer”, McGraw Hill, 1962.

Upon successful completion of the course, student will have:

- The ability to demonstrate a basic understanding of experimental methods (e.g. strain gauges, photo elasticity, image correlation) commonly used in experimental mechanics.
- The ability to complete a detailed laboratory report and present their findings in a structured, logical manner.
- The ability to analyse experimental data and develop appropriate, logical conclusions based on comparisons to theoretical results and other experimental evidence.

MINOR

MNME0303	Manufacturing Processes	3-1-0	Credit-4
<p>Course Objective: To expose the students to various casting, joining, metal forming and metal cutting (turning) processes</p> <p>UNIT I: METAL CASTING PROCESSES (09 hours) Introduction to Concepts of Manufacturing Process -Sand casting – Sand moulds -Type of patterns – Pattern materials – Pattern allowances – Types of Moulding sand –Properties – Core making – Methods of Sand testing – Moulding machines – Types of moulding machines - Melting furnaces – Sand Casting defects – Inspection methods</p> <p>UNIT II: JOINING PROCESS (10 hours) Fusion welding processes – Types of Gas welding – Equipment used – Flame characteristics – Filler and Flux materials - Arc welding equipment - Electrodes –Coating and specifications – Principles of Resistance welding</p>			

– Spot/butt, seam welding – Percussion welding - Gas metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG welding- Adhesives : Types and applications- Brazing and soldering process.

UNIT III: DEFORMATION PROCESSES

(09 hours)

Hot working and cold working of metals – Forging processes – Open and close die forging – Types of Forging Machines – Typical forging operations – Rolling of metals – Flat strip rolling – Types of Rolling mills – Tube piercing – Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion – Principle of rod and wire drawing.

UNIT IV: SHEET METAL FORMING AND PLASTIC COMPONENTS

(09 hours)

Typical shearing operations, bending and drawing operations – Formability of sheet metal – Metal spinning – Magnetic pulse forming – Super plastic forming – Types and characteristics of plastics- Moulding of Thermoplastic-Working principle and application of Injection moulding, compression moulding and transfer moulding.

UNIT V: METAL CUTTING (TURNING) PROCESS

(08 hours)

Various types of lathe- CNC lathe, Turing centre- Construction details of centre Lathe-Work holding devices: self-centering three jaw chuck, independent four jaw chuck, collets, face plates, dog carriers, centers and mandrels- Lathe operations.

Text Book

1. Hajra Choudhury, “Elements of Workshop Technology”, Media Promotors Pvt.Ltd., Mumbai, 2001.
2. P.N.Rao, “Manufacturing Technology”, Tata McGraw-Hill, 2002.
3. P.C. Sharma, “Production Technology”, S. Chand, New Delhi, 2007.

Reference Book

1. Serope Kalpajian and Steven R.Schmid, “Manufacturing Engineering and Technology”, Pearson Education, 2002.
2. B.S. Magendran Parashar and R.K. Mittal, “Elements of Manufacturing Processes”, Prentice Hall of India, New Delhi, 2003.
3. Begman, “Manufacturing Process”, John Wiley & Sons, 2004.

COURSE OUTCOMES:

On completion of this course, students will be able to

1. Apply manufacturing methods such as casting and metal joining process for real time requirements
2. Select appropriate manufacturing techniques like sheet metal processes and metal cutting processes

PRACTICAL / SESSIONAL

PCME7306	Machine Dynamics Lab - II	0-0-3	2 Credits
<ol style="list-style-type: none"> 1. Design of any one working model related to Mechanisms and Machines i.e., Module I and II. 2. Design of any one working model related to Mechanisms and Machines i.e., Module III and IV. 3. Determination of gyroscopic couple using gyroscopic test rig. 4. Performance characteristics of a spring loaded governor 5. Experiment on Cam Analysis Apparatus 6. Determination of critical speed of rotating shaft 7. Experiment on static and dynamic balancing apparatus 8. Determination of natural frequencies of un-damped as well as damped vibrating systems. 9. Experiment on evaluation of damping in a vibrating system 10. Study of interference and undercutting for gear drives 			

PCME7307	Mechanical Engineering Lab - III	0-0-3	2 Credits
<p>List of Experiment:</p> <ol style="list-style-type: none"> 1. Valve timing diagram of an IC engine. 2. Study of a modern carburetor (e.g. Solex Carburtor). 3. Study of fuel injection system of a diesel engine 4. Analysis of exhaust gas of automobile. 5. Load test on 4-stroke single cylinder C.I. engine. 6. Load test on 4-stroke single cylinder S.I. engine. 7. Morse Test on multi-cylinder S.I. or C.I. engine 8. Load test on variable compression ratio S.I. engine. 9. Load test and Heat balance on 2 strokes S.I. Engine. 10. To study the different processes on Steam Power Plant. 			

PCME7308	Manufacturing Technology - II Lab	0-0-3	2 Credits
<p>COURSE OBJECTIVES: To practice operations in radial drilling, shaper, grinder, milling machine and gear cutting, milling machines.</p> <p style="text-align: center;">(Minimum 08 Experiments/Studies)</p> <p>LIST OF EXPERIMENTS:</p> <ol style="list-style-type: none"> 1. Job on lathe with taper turning, thread cutting, knurling and groove cutting (3 experiments). 2. Gear cutting (with index head) on milling machine 3. Working with shaper, Planner and slotting machine. 4. Working with surface and cylindrical grinding. 5. Determination of cutting force using Lathe tool dynamometer. 6. Determination of cutting force in drilling using drill tool dynamometer. 7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM) 8. Study of CNC Lathe and demonstration of making job in CNC lathe. 9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine. <p>COURSE OUTCOMES: On completion of this course, students will be able to</p> <ol style="list-style-type: none"> 1. Operate machines like shaper, grinding and milling machine for various applications. 2. Prepare gears using forming and generating methods of gear manufacturing and CNC operations 			

OPEN ELECTIVE-II (OE-II) 5th Semester

OECH6311	Petroleum Refinery Engineering	3L-0T-0P	3 Credits
<p>Course objectives: The objectives of this course are</p> <ol style="list-style-type: none"> 1. Indicate what crude oils consists of and how crude oils are characterized based on their physical properties. 2. Demonstrate how a petroleum refinery works and sketch a flow diagram that integrates all refining processes and the resulting refinery products. 3. Examine how each refinery process works and how physical and chemical principles are applied to achieve the objectives of each refinery process. 			
<p>Module-1 (4 weeks/12 Hours) Overview of Petroleum Refinery its Products and Properties</p> <p>Unit I (6 Hours/ 2 weeks): Origin and formation of petroleum, reserves and deposits of the world, Indian petroleum industries, Composition and Compounds of Petroleum, Crude pre-treatment: Desalting and Dehydration, Petroleum Refinery Units.</p> <p>Unit II (6 Hours/ 2 weeks): Properties of Crude oil, Test Methods for Gasoline and Diesel, Refinery Products: Gasoline and its Specification, Distillate Fuels, Residual Fuel Oils, LPG, ASTM and TBP Distillation, Octane and Cetane number.</p> <p>Module-2 (4 weeks/12 Hours) Refinery Processes Units</p> <p>Unit III (6 Hours/ 2 weeks):Coking and Thermal Processes, Catalytic Cracking</p> <p>Unit IV (6 Hours/ 2 weeks): Catalytic Hydrocracking, Hydro processing and Resid Processing.</p> <p>Module-3 (4 weeks/12 Hours) Refinery Processes Units</p> <p>Unit V (6 Hours/ 2 weeks): Hydro treating, Catalytic Reforming and Isomerization</p> <p>Unit VI (6 Hours/ 2 weeks): Alkylation and Polymerization, Visbreaking.</p> <p>Module-4 (2 weeks/6 Hours) Treatment of Products</p> <p>Unit VII (6 Hours/ 2 weeks): Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.</p> <p>Text book :</p> <ol style="list-style-type: none"> 1. 'Petroleum Refining: Technology and Economics', 5th ed. by J H Gary, G E Handwerk, and M J 			

Kaiser, CRC Press.

Reference Books :

1. 'Modern Petroleum Refining Processes', 6th ed. by B K B Rao, Oxford & IBH.
2. 'Petroleum Refinery Engineering', W L Nelson, McGraw-Hill.
3. 'Handbook of Petroleum Processing', 2nd ed. by S A Treese, P R Pujado and D S J Jones, Springer.

Course Outcomes (CO):

At the end of the course, students

1. Have introductory information about petroleum and refinery.
2. Learn the history of refinery development and composition of petroleum.
3. Learn refinery products, test methods and petroleum properties.
4. Should have knowledge about the different process units involved in refinery to get the valuable products like Gasoline, Diesel etc. that can be directly use by the consumers.

OECH6330	GREEN TECHNOLOGY	3L-0T-0P	3 Credits
<p>Objectives:</p> <ol style="list-style-type: none"> 1. To present different concepts of green technologies. 2. To acquire principles of Energy efficient technologies. 3. To learn the importance of green fuels and its impact on environment. 			
<p>Module-1 (4 weeks/12 Hours) Unit I: Principles of green technology and engineering. Unit II: Principles of atom and mass economy, E-factor.</p> <p>Module-2 (4 weeks/12 Hours) Unit III: Design of greener and safer chemicals, Solvent-free methods: Microwave, Ultraviolet, and Solar. Unit IV: Green catalysts: ionic liquids, zeolites, photo catalyst, PEG, nano catalyst, and biocatalyst.</p> <p>Module-3 (4 weeks/12 Hours) Unit V: Green solvents: Supercritical fluids, fluoruous phase, and non-aqueous solvents. Unit VI: Scale-up effect, reactors, separators, Process intensification.</p> <p>Module-4 (2 weeks/6 Hours) Unit VII: Bio-conversion of renewable. Comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts.</p>			
<p>Reference Books:</p> <ol style="list-style-type: none"> 1. Handbook of Green Chemistry, Vol. 1 to 9 by P T Anastas, Wiley VCH. 2. Green Chemistry and Engineering: A Practical Design Approach by C J González and D J C Constable, Wiley. 			

3. Green Chemistry and Engineering: A Pathway to Sustainability by A E Marteel Parrish and M A Abraham, Wiley.
4. Green Chemistry for Environmental Sustainability by S K Sharma and A. Mudhoo, CRC Press.
5. Green Engineering: Environmentally Conscious Design of Chemical Processes by D T Allen and D R Shonnard, PHI.

Course outcomes:

1. Enlist different concepts of green technologies in a project.
2. Understand the principles of Energy efficient technologies.
3. Recognize the benefits of green fuels with respect to sustainable development.

OECE6312	Mechanics of Solids	3-0-0	Credit-3
<p>Module – I Stress, St. Venant's principle, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, stresses due to freely falling weight.</p> <p>Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.</p> <p>Analysis of Biaxial Stress. Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress.</p> <p>Strain Deformation: Two dimensional state of strain, Mohr's circle for strain, Principal strains and principal axes of strain, strain measurements, Calculation of principal stresses from principal strains.</p> <p>Module – II Stresses in thin cylinders, thin spherical shells under internal pressure -wire winding of thin cylinders. Thick cylinders subjected to internal and external pressures, compound cylinders. Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting.</p> <p>Module – III Theory of Columns: Eccentric loading of a short strut, Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio. Close - coiled helical springs.</p> <p>Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum strain theory, total strain energy theory, maximum distortion theory, octahedral shear stress theory graphical representation and comparison of theories of failure.</p>			

Module IV

Unsymmetrical bending: Properties of beam cross section, slope of neutral axis, stresses and deflection in unsymmetrical bending, shear centre.

Curved Beam: Bending of beam with large initial curvature, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links.

Text Books/Reference Books:

1. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East-West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
4. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
5. Mechanics of Materials by R.C. Hibbeler, Pearson Education
6. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley Student Edition
7. Mechanics of Materials by James M. Gere, Thomson Learning
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India
9. Strength of Materials by S.S. Rattan, Tata McGraw Hill
10. Strength of Materials by R. Subramaniam, Oxford University Press
11. Advanced mechanics of solids by L.S. Srinath, McGraw Hill.
12. Advanced mechanics of materials, Kumar & Ghai, Khanna Publishers.

OECS6203	OOps Using C++	3-0-0	Credit-3
<p>Course Objective: This course is aimed at mastering object oriented programming technique in software development and demonstrates these techniques in solution to different types of problems.</p> <p>Module –I (10 Hours) Introduction to OOP, OOP Concepts, Overview of C++, C++ fundamentals, Classes, Objects, Inline functions, function Overloading, Scope Resolution Operator, Constructors ,Destructors, Static Members, Passing objects to functions, Function returning objects.</p> <p>Module – II (10 Hours) Arrays, Pointers, this pointer, References, Dynamic memory Allocation, functions Overloading, Default arguments, Overloading Constructors, copy constructors, Pointers to Functions, Ambiguity in function overloading.</p> <p>Module –III (10 Hours) Operator Overloading, Overloading of some special operators, Inheritance, Types of Inheritance, Protected members, Polymorphism, Virtual base Class, Virtual functions, Pure virtual functions, Abstract classes.</p>			

Module – IV**(8 Hours)**

Class template, Generic classes, Function template, generic functions, Exception Handling, Exception handling options, Streams, Formatted I/O, C++ File I/O, Array based I/O, Standard Template Library (STL).

Text Books

1. H. Schildt - C++ The Complete Reference, 4th Edition, Tata McGraw-Hill, New Delhi.

Reference Books

1. A. N Kanthane, Object Oriented Programming with ANSI & Turbo C++, Pearson Education, New Delhi.
2. Object Oriented Programming with C++, E. Balagurusamy, McGraw Hill Education
3. Object Oriented Programming in C Robert Lafore – SAMS Publishing.

Course Outcomes: Students will be able to -

1. Familiar with issues with software design.
2. Be familiar to key concepts of object oriented programming.
3. Have knowledge about C++ concepts related to good modular design.
4. Implement patterns involving realization of abstract interfaces and polymorphism.
5. Learn how to utilize Exceptions and standard template library.

OECS6331	CLOUD COMPUTING	3-0-0	Credit-3
<p>Course Objective: This course gives students an insight into the basics of cloud computing along with virtualization, cloud computing is one of the fastest growing domain from a while now. It will provide the students basic understanding about cloud and virtualization along with it how one can migrate over it.</p> <p>Module-I 10 Hrs Evolution of Computing Paradigms - Overview of Existing Hosting Platforms, Grid Computing, Utility Computing, Autonomic Computing, Dynamic Datacenter Alliance, Hosting/ Outsourcing, Introduction to Cloud Computing, Workload Patterns for the Cloud, “Big Data”, IT as a Service, Technology Behind Cloud Computing,</p> <p>Module-II 10 Hrs A Classification of Cloud Implementations- Amazon Web Services - IaaS, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), VMware v Cloud - IaaS, v Cloud Express, Google AppEngine - PaaS, The Java Runtime Environment.</p> <p>Module-III 10 Hrs The Python Runtime Environment- The Datastore, Development Workflow, Windows Azure Platform - PaaS, Windows Azure, SQL Azure, Windows Azure AppFabric, Salesforce.com - SaaS / PaaS, Force.com, Force Database - the persistency layer, Data Security, Microsoft Office Live - SaaS, LiveMesh.com, Google Apps -</p>			

SaaS, A Comparison of Cloud Computing Platforms, Common Building Blocks.

Module-IV**8 Hrs**

Cloud Security – Infrastructure security – Data security – Identity and access management Privacy- Audit and Compliance.

Text Book:

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, “Distributed and Cloud Computing from Parallel Processing to the Internet of Things”, Morgan Kaufmann, Elsevier, 2012

Reference Books

1. Barrie Sosinsky, “Cloud Computing Bible” John Wiley & Sons, 2010
2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, “Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance”, O'Reilly 2009

OEEE6313	Digital Signal Processing	3-0-0	3 Credits
<p>Course Objectives: To impart knowledge about the following topics:</p> <ol style="list-style-type: none"> 1. Signals and systems & their mathematical representation. 2. Discrete time systems. 3. Transformation techniques & their computation. 4. Filters and their design for digital implementation. <p>MODULE I (12 Hours)</p> <p>Introduction: Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, aliasing effect.</p> <p>The Z-Transform and Its Application: Z-transform and its properties, inverse z-transforms; difference equation–Solution by z-transform, application to discrete systems–Stability analysis, frequency response–Convolution.</p> <p>MODULE II (12 Hours)</p> <p>The Discrete Fourier Transform: Its Properties and Applications: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.</p>			

Implementation of Discrete-Time Systems:

Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures;

Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

MODULE III**(12Hours)****Discrete Fourier Transform & Computation:**

Discrete Fourier Transform-properties, magnitude and phase representation-Computation of DFT using FFT algorithm-DIT & DIF using radix 2 FFT-Butter fly structure.

Design of Digital Filters:

FIR & IIR filter realization-Parallel & cascade forms. FIR design: Windowing Techniques-Need and choice of windows-Linear phase characteristics. Analog filter design-Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.

MODULE IV**(6Hours)****Adaptive Filters:**

Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Text Books:

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
3. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.

Reference Books:

1. Digital Signal Processing, Manson H. Hayes, Schaum's Outlines, TMH.
2. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
3. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
5. A.V. Oppenheim and R. W. Schaffer, "Discrete Time Signal Processing", Prentice Hall, 1989.
6. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
7. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
8. D. J. De Fatta, J. G. Lucas and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Program Outcomes:

1. Ability to understand the importance of Fourier transform, digital filters.
2. Ability to acquire knowledge on Signals and systems & their mathematical representation.
3. Ability to understand and analyze the discrete time systems.
4. Ability to analyze the transformation techniques & their computation.

5. Ability to understand the types of filters and their design for digital implementation.

OEEC6314	Industrial Automation with PLC & SCADA	3-0-0	Credits 3
<p>COURSE OBJECTIVES</p> <ol style="list-style-type: none"> 1. Gain the Knowledge of various skills necessary for Industrial applications of Programmable logic controller (PLC) 2. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC) 3. Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices. <p>MODULE-I (12 Hours)</p> <p>Unit 1 What is A PLC, Technical Definition of PLC, What are its advantages, characteristics functions of A PLC, Chronological Evolution of PLC, Types of PLC, Unitary PLC, Modular PLC, Small PLC, Medium PLC, Large PLC.</p> <p>Unit 2 Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Processor Software / Executive Software, Multi asking, Languages, Ladder Language.</p> <p>MODULE-II (12 Hours)</p> <p>Unit 3 Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format.</p> <p>Unit 4 Introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder design. Examples: Training Stopping, Multiplexer, DE multiplexers</p> <p>MODULE-III (12 Hours)</p> <p>Unit 5 PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Count down (CTD).</p> <p>Unit 6 PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems.</p> <p>MODULE-IV (8 Hours)</p> <p>Unit 7 SCADA Systems</p>			

Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages, disadvantages and applications of SCADA. SCADA Architecture (First generation-Monolithic, Second Generation-Distributed, Third generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System.

Text Books:

1. Madhu Chhanda Mitra, S.S Gupta, "PLC and Industrial automation", Pernam International pub. (Indian) Pvt. Ltd., 2011.

Reference Books:

1. Ronald L Krutz, "Securing SCADA System", Wiley Publication, 2012.
2. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd edition, 2006.

Course Outcomes:

1. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC).
2. Compute the extent and nature of electronic circuitry in Programmable logic controller (PLC) and SCADA including monitoring and control circuits for Communication and Interfacing.

OEME6316	Introduction to Composite Materials	3-0-0	Credit-3
<p>Course objective:</p> <ol style="list-style-type: none"> 1. Introduce students to the concepts of modern composite materials. 2. Equip them with knowledge on how to fabricate and carry out standard mechanical test on composites. 3. To make student understand the basic stress and strain relations in composite materials. <p>Module I (10hours) Introduction: Classification and characteristics of composite materials, mechanical behaviour of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites. Processing – Pultrusion; Filament winding; Prepreg technology; Injection & compression moulding; Bag moulding; Resin transfer moulding.</p> <p>Module II (12hours) Macromechanics of a Lamina: Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.</p> <p>Module III (12hours) Micromechanics of a Lamina: Rule of mixture; Volume & mass fractions; Density & void content. Evaluation of the nine mechanical and four hygrothermal constants: four elastic moduli(Strength of Materials Approach), five strength parameters, two coefficients of thermal expansion and two coefficients of moisture expansion of</p>			

a unidirectional lamina from the individual properties of the fiber and the matrix.

Module IV

(10hours)

Analysis: Classical lamination theory; Stress analysis of composite laminates; Failure predictions – Maximum stress theory; Maximum strain theory; Tsai-Hill theory; Modes of failure of composites; First ply failure; Partial ply failure; Total ply failure.

Text Books:

1. Mechanics of Composite Materials, R.M. Jones, Mc. Graw Hill Book Co.
2. Mechanics of Composite Materials, A. K. Kaw, CRC Press.
3. Mechanics of composite materials & structures, M Mukhopadhyay, Universities Press.

COURSE OUTCOME

1. (Knowledge based) identify and explain the types of composite materials and their characteristic features;
2. Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application;
3. Understand and explain the methods employed in composite fabrication;
4. Appreciate the theoretical basis of the experimental techniques utilized for failure mode of composites.
5. (Skills) develop expertise on the applicable engineering design of composite;
6. Learn simple micromechanics and failure modes of composites.

OEMT6315	Nanomaterials	3-0-0	Credits 3
<p>Objectives of the Course: To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications.</p> <p>Module 1: (12 Hours) Introduction: Types of nanomaterials, emergence of nanotechnology, bottom-up and top-down approaches, challenges in nanotechnology. Nanoparticles: synthesis of metallic nanoparticles, semiconductor nanoparticles, oxide nanoparticles (sol-gel processing); vapour phase reactions, solid phase segregation. Nanowires: Synthesis of nanowires by evaporation – condensation growth, VLS or SLS growth, high energy ball milling, cryo rolling, and equal channel angular extrusion, template based synthesis, electrospinning, types of lithography. Thin Films: fundamentals of film growth, PVD, CVD and ALD.</p> <p>Module-II (12 Hours) Specific nano materials and their applications: Carbon nanostructures (Nanotubes, nanohorns, graphene, buckyballs etc.), Semiconducting nanomaterials – Quantum confinement, Quantum wells, quantum wires and quantum dots. Magnetic nanomaterials – super paramagnetism Ferroelectric, nano ceramics Super plasticity Nanocomposites and their types.</p>			

Module III:**(12 Hours)**

Thermodynamics of nanomaterials, Mechanical property aspects of nanomaterials, inverse Hall-Petch relationship, nano indentation, electrical properties of nanomaterials, optical properties of nanomaterials, magnetic properties of nanomaterials, Characterization techniques from the perspective of nanomaterials: BET, XRD, SEM, TEM, AFM, EDS, WDS, LEED, XPS etc.

Module IV:**(06 Hours)**

Application of nanomaterials such as medicine, energy, environment, information and communication technology.

Suggested text books:

1. Rishal Singh, S.M. Gupta, Introduction to nanotechnology, Oxford university press, (2016).
2. Dieter Vollath._ Nanomaterials: An Introduction to Synthesis, Properties and Applications, Second Edition. Published 2013 by Wiley-VCH Verlag GmbH & Co. KGaA.

Suggested reference books:

1. Charles Poole and Frank Owens, Introduction to Nanomaterials, Wiley 2007
2. Cao G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press
3. Gagotsi Y., Nanomaterials Handbook, (Ed.), Taylor and Francis.
4. Edlstein and Cammarate, Nano Materials Synthesis, Properties and Applications.
5. Bandyopadhyay A.K., Nano Materials, New age Publications.
6. Pradeep T., Nano - The Essentials, TMH.
7. Koch,C. Nanostructured Materials: Processing, Properties and applications, William Andrew Publishing.

Course Outcomes

After completing this course, the student should be able to:

1. Indicate the differences between nanomaterials and conventional materials
2. Indicate how specific synthesis techniques can result in nanomaterials
3. Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
4. Describe how specific characterization techniques can be used to analyze nanomaterials

OEPD6317	POWDER METALLURGY	3L-0T-0P	3 Credits
<p>Course Objective</p> <p>The course is a specialized course of the metallic materials area. The scope is to provide the necessary knowledge on the metallic part production by metal powders. It covers subjects such as metal powder characterization, metal powder production methods, and powder metallurgy processing steps.</p>			

Module I**[12]**

Introduction Historical and modern developments in Powder Metallurgy. Advantages, limitations and applications of Powder Metallurgy. Basic Steps for Powder Metallurgy. Characteristics of metal powder Chemical composition, Particle size, shape and size distribution, Characteristics of powder mass such as apparent density, tap density, flow rate, friction index. Properties of green compacts and sintered compacts

Module II**[10]**

Powder Characterization Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, compressibility, green Strength, pyro phorocity and toxicity.

Module III**[10]**

Powder Compaction Methods Basic aspects, types of compaction presses, compaction tooling and role of lubricants, Single and double die compaction, isostatic pressing, Hot pressing. Powder Forming Powder rolling, powder forging, powder extrusion and explosive forming technique

Module IV**[10]**

Sintering Definition, stages, effect of variables, sintering atmospheres and furnaces, Mechanism, liquid-phase sintering, Secondary operations. Sintered Products Study of sintered bearings, cutting tools, metallic filters, friction and antifricion parts and electrical contact materials. Defects in Powder metallurgy processed materials and their processing to minimize defects: Friction stir processing etc.

Text Books:

1. Introduction to Powder Metallurgy, A. K. Sinha, Dhanpatrai Publication.
2. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, CRC Press
3. Powder Metallurgy, ASM Handbook, Vol-VII.

Reference Books:

1. Powder Metallurgy: Science, Technology and Applications, P. C. Angelo, R. Subramanian
2. Powder Metallurgy, W.D. Jones
3. Principles of Powder Metallurgy, T. Shukerman
4. Handbook of Powder Metallurgy :- H.H. Hausner

Course Outcomes:

Upon successful completion of the course, student will able to:

1. Acquire the knowledge of Powder Metallurgy History, Applications and its importance.
2. Measure the various powder characteristics like apparent density; tap density, flow rate, friction index.
3. Acquainted the knowledge of metal powder production methods.
4. Aware about the powder characterization techniques.
5. Understand the basic methods of Powder compaction for green compact.

OEMA6207	Numerical Methods	3-0-0	Credit-3
<p>Module –I (12 Hours)</p> <p>Number system, Floating point arithmetic, Errors, truncation error, Bisection method, Scant method, Regula-Falsi Method, Newton-Raphson method, Muller method, Rate of Convergence, Lagranges’s interpolation, Newton divided difference interpolation, Newton’s forward and backward interpolation, Piecewise and Spline interpolation.</p> <p>Module -II : (12 Hours)</p> <p>Numerical integration: Romberg integration, Gaussian Quadrature (2-point, 3-point), Newton- Cotes rules. Numerical solution to ordinary differential equations: Taylor’s series methods, Euler method, modified Euler method Runge - Kutta methods, predictor- corrector method, multistep methods.</p> <p>Module -III: (8 Hours)</p> <p>Matrix eigen value problem, power method, Rayleigh Quotient, shifted power method, inverse power method, QR method.</p> <p>Module IV: (8 Hours)</p> <p>Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method. Hyperbolic Partial Differential Equation: Explicit Method, Implicit method. Elliptic Partial Differential Equation: Finite-difference method.</p> <p>Text Books</p> <ol style="list-style-type: none"> 1. Jain M.k, Iyengar S.R.K & Jain R.K, Numerical methods for Scientific and Engineering Computation, 6th Edition, New Age International(P) Ltd. 2. Atkinson Kendall E, An introduction to Numerical Analysis, 2nd Edition, John Wiley & Sons <p>Reference Books</p> <ol style="list-style-type: none"> 1. Fusset L.V, Applied numerical Analysis Using MATLAB, 2nd Edition, PEARSON 2. Chapra Steven C & Canale Raymond P., Numerical methods for Engineers, 7th Edition, McGraw Hill Education. 			

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG**B.TECH SYLLABUS for MECHANICAL ENGINEERING**

(Admission Batch: 2018-19 Onwards)

6th Semester

HSHM3306	Enhancing Soft Skills and Personality	2-0-0	Credit-2
<p>Course Objective</p> <p>The course aims to cause an enhanced awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality. Hard or technical skills help securing a basic position in one's life and career. But only soft skills can ensure a person retain it, climb further, reach a pinnacle, achieve excellence, and derive fulfillment and supreme joy. Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The focus of this course is on interpersonal and management skills.</p> <p>Module I 10 Hours</p> <ul style="list-style-type: none"> •Highlights of Developing Soft Skills and Personality Course-1-24 •Highlights of Developing Soft Skills and Personality Course-25-48 •Definitions and Types of Mindset •Learning Mindsets •Secrets of Developing Growth Mindsets •Importance of Time and Understanding Perceptions of Time •Using Time Efficiently •Understanding Procrastination •Overcoming Procrastination •Don't Say "Yes" to Make Others Happy! <p>Module II: 10 Hours</p> <ul style="list-style-type: none"> • Types of People • How to Say "No" • Controlling Anger • Gaining Power from Positive Thinking-1 • Gaining Power from Positive Thinking-2 • What Makes Others Dislike You? • What Makes Others Like You?-1 • What Makes Others Like You?-2 • Being Attractive-1 • Being Attractive-2 <p>Module III 10 Hours</p> <ul style="list-style-type: none"> • Common Errors-1 			

- Common Errors-2
- Common Errors-3
- Common Errors-4
- Common Errors-5
- Humour in Communication
- Humour in the Workplace
- Function of Humour in the Workplace
- Money and Personality
- Managing Money

Module IV**10 Hours**

- Health and Personality
- Managing Health-1: Importance of Exercise
- Managing Health-2: Diet and Sleep
- Love and Personality
- Managing Love
- Ethics and Etiquette
- Business Etiquette
- Managing Mind and Memory
- Improving Memory
- Care for Environment
- Highlights of the Course

Books for Reference:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: Harper Collins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

PCME4309	Machine Design - I	3-0-0	Credit-3
<p>Course objective: Machine Design is concerned with the development of new or improved machine element to perform the desired function efficiently using scientific principles, technical information, creative thinking based on requirement of strength, Kinematics, manufacturing considerations and economics.</p>			
Module I			(10 hours)

Stages in design, Standardization, Interchangeability, Preferred numbers, Engineering materials, Ferrous, Non-ferrous, Non-metals, Indian standard specifications for Ferrous materials, Fundamentals of Machine Design, Allowable stress, Factor of safety.

Design of Joints: Reveted, Welded and bolted joints based on different types of loading. Illustrative problems with solutions.

Module II

(8 hours)

Design of Cotter joints with socket and spigot, with a Gib. Design of knuckle joint. Illustrative problems with solutions.

Design of shafts, solid and hollow based on strength and on rigidity. Illustrative problems with solutions.

Design of keys and pins, Sunk key, Feather key, Taper pin. Illustrative problems with solutions.

Module III

(8 hours)

Design of shaft couplings: Rigid Flange coupling, Flexible Flange coupling.

Design of circular section, Helical, Tension and compression springs, Design of leaf springs : Cantilever and semi-elliptical types. Illustrative problems with solutions.

Module IV

(10hours)

Levers, classification, Design of levers – Foot lever, Hand lever, Cranked lever, Lever of lever loaded – safety - valve. Power screw design with square thread, such as screw jack. Illustrative problems with solutions.

TEXT BOOKS:

1. Mechanical Engineering Design, J.E. Shigley, C.R. Mischke, R.G. Budynas and K.J. Nisbett, TMH
2. A Text Book of Machine Design, R.S. Khurmi and J.K. Gupta, S. Chand Publication

REFERENCE BOOKS:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.
2. Machine Design, P.C. Sharma and D.K. Agrawal, S.K. Kataria & Sons
3. Machine Design, Pandya and Shah, Charotar Book Stall
4. Machine Design, Robert L. Norton, Pearson Education Asia, 2001.
5. Machine Design, A CAD Approach: Andrew D Dimarogonas, John Wiley Sons, Inc, 2001.
6. Fundamentals of Machine Component Design, Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007
7. Machine Design, H. Timothy and P.E. Wenzel, Cengage Learning
8. Computer Aided Analysis and Design, S.P. Regalla, I.K. International Publishing

DESIGN DATA HAND BOOKS:

1. Design Hand Book by S.M. Jalaluddin; Anuradha Agencies Publications Vidyal Karuppur, Tamil Nadu, Pin : 612605.
2. P.S.G. Design Data Hand Book, PSG College of Tech Coimbatore
3. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.

COURSE OUTCOME

On successful completion of the course students will be able to:

1. Demonstrate understanding of various design considerations.
2. Illustrate basic principles of machine design.
3. Design machine elements for static loading.
4. Design machine elements on the basis of strength/ rigidity concepts
5. Use design data books in designing various machine elements.
6. Acquire skill in preparing production drawings pertaining to various designs

PCME43010	Product Design and Production Tooling	3-0-0	Credit-3
<p>Module I (8 hours) Product design, product development considerations, production planning, value analysis, product specification. Role of computer in product design. Product design for sand casting: design of gating system and risering.</p> <p>Module II (12 hours) Forging design: allowances, die design for drop forging, design of flash and gutter, upset forging die design. Sheet metal working: Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers , stops, strip layout.</p> <p>Module III (16 hours) Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods, Drill Jig bushing, Indexing type drilling Jig. Design of single point cutting tool, broach and form tool. Design of limit gauges. Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation, Tooling design for turret lathe and automats.</p> <p>Text Books:</p> <ol style="list-style-type: none"> 1. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co. 2. Manufacturing Technology, P.N. Rao , Tata McGraw Hill 3. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co 4. A Bhattacharyya, Metal Cutting Theory and Practice - Central Book Publishers, Calcutta 2000 <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition, PHI. 2. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc Graw Hill 3. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill 4. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning 			

PEME5304	Advanced Mechanics of Material	3-0-0	Credit-3
-----------------	---------------------------------------	--------------	-----------------

Course Objective:

1. To enable students understand the concept of forces, equilibrium condition, resolution and composition, moments.
2. To study the methods to determine centre of gravity and moment of inertia of a body.
3. To enable students understand the concept of stress and strain in different types of structure/machine under different loading conditions
4. To study engineering properties of materials, force-deformation and stress-strain relationship.
5. To analyze thin cylinder and column.

MODULE-I**(10Hours)**

1. Concurrent forces on a plane – Composition and resolution of forces and equilibrium of concurrent coplanar forces, Methods of moment.
2. Parallel forces in a plane- Two parallel forces, General case of parallel forces, Center of parallel forces in a plane and center of gravity- centroids of composite plane figure and curves, Distributed parallel forces in a plane. General case of forces in a plane- composition of forces in a plane and equilibrium of forces in a plane.

MODULE-II**(10 Hours)**

1. Moments of Inertia- Plane figure with respect to an axis in its plane and perpendicular to the plane-parallel axis theorem, Moment of Inertia of material bodies.
2. Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads.

MODULE-III**(10 Hours)**

1. Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.
2. Biaxial State of Stress: Analysis of Biaxial Stress. Plane stress, Principal plane, Principal stress, Mohr's Circle for Biaxial Stress. Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

MODULE-IV**(10 Hours)**

1. Biaxial State of Strain: Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.
2. Theory of Columns: Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio, Eccentric loading of short column

TEXT BOOK

1. Engineering Mechanics by S Timoshenko, D.H Young and J.V. Rao, Revised 4th edition (Special Indian Edition), McGraw Hill.

2. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East West Press
3. Strength of Materials by G. H. Ryder, Macmillan Press
4. Strength of Materials by R. Subramaniam, Oxford University Press

REFERENCE BOOKS

1. Engineering mechanics statics and dynamics by A.K.Tayal, Umesh Publication.
2. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
3. Mechanics of Materials by R.C. Hibbeler, Pearson Education
4. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley
5. Mechanics of Materials by James M. Gere, Thomson Learning
6. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
7. Strength of Materials by S.S. Rattan, Tata McGraw Hill
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India

Upon successful completion of the course, student will have:

1. The ability to understand the concept of forces, equilibrium conditions and methods to find out C.G and MOI of a body.
2. The ability to analyze the behaviour of structural and machine components subjected to various loading and support conditions based on principles of equilibrium and material constitutional relationships.
3. The ability to understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, biaxial load and at any plane.
4. To solve practical problems through evaluating the relationship between stress and strain.
5. The ability to analyse thin cylinder and column problems.

PEME5305	Mechanical Measurement and Control	3-0-0	Credit-3
<p>Module I (14 hours)</p> <p>Introduction to Instruments and their Representation: Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Brief Description of the Functional Elements of the Instruments, Classification of Instruments, Microprocessor -Based Instrumentation, Standards and Calibration. Static and Dynamic Characteristics of Instruments: Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications of Instruments, Dynamic Response, and Compensation.</p> <p>Transducer Elements: Analog Transducers, Digital Transducers, Basic detector transducer elements: Electrical transducer, Sliding Contact devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.</p> <p>Intermediate Elements: Amplifier, Operational Amplifier, Differential and Integrating Elements, Filters, A-</p>			

D and D-A Converters The simple current sensitive circuit, the ballast circuit, the voltage-dividing potentiometer circuit, the voltage balancing potentiometer circuit, Resistance bridges.

Indicating, Recording and Display Elements: Meter Indicators. The vacuum tube voltmeter, CRO, Electronic Switch, CRO recording techniques, Oscillographs, Digital Recorders.

Module II

(12 hours)

Measurement of Surface Finish:

Introduction, Different surface texture, elements of surface texture, factors affecting surface finish, reasons for controlling surface texture, methods of measuring surface finish, indication of surface roughness symbols used.

Measurement of Pressure:

Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.

Measurement of Fluid Flow:

Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturi meter and Pitot tube, the variable-area meter, Turbine Flow meters.

Temperature Measurement:

Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

Force, Power, Speed and Torque Measurement:

Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument- Vibrometers and accelerometers.

Module III

(8 hours)

Description of open and closed loop control systems and their block diagrams. Use of block diagram and signal flow graph to find overall transfer function.

1st and 2nd order systems and their response to step and sinusoidal input, error analysis, static and dynamic error coefficients.

Module IV

(4 hours)

Routh's stability criterion. The Root-Locus method, Bode Plot and Nyquist plot, Gain margin and phase margin.

Text books:

1. Instrumentation Measurement and Analysis, B.C. Nakra and K.K. Chaudhry, Tata Mc Graw Hill, Third Edition.

Reference books:

1. Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing co.
2. Modern Control Engineering, K.K. Ogata, prentice Hall India

--

PEME5306	Machine Conditioning Monitoring	3-0-0	Credit-3
<p>Course objective: To presents fundamentals to a modern treatment of vibrations, placing the emphasis on analytical developments and computational solutions. This course will provide the detail knowledge about nonlinear and random vibration with fault diagnosis of machinery using vibration signature analysis.</p>			
<p>Module I (10 hours) Introduction to maintenance and condition based maintenance; Definition, system approach, objectives, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability, implementation of CBM, comparison of CBM with other maintenance techniques and case studies (overview). Introduction to condition monitoring; Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring.</p>			
<p>Module II (6 hours) Basic signal processing techniques; Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. Wavelet Transform; Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete, Wavelet Transform (DWT), Wavelet Packet Transform (WPT), types of wavelets – Haarwavelets, Shannon wavelets, Meyer wavelets, Daubechies wavelets, Coifmann wavelets and applications of wavelets.</p>			
<p>Module III (8 hours) Vibration Monitoring; Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration analysis. Rotating and reciprocating machines; Vibration signals from rotating and reciprocating machines – signal classification, signals, generated by rotating machines, signals generated by reciprocating machines</p>			
<p>Module IV (6 hours) Mechanical fault diagnosis; Wear monitoring and lubricant analysis - sources of contamination, techniques, Spectrometric, Oil Analysis Procedure (SOAP) and ferrography. Nondestructive testing techniques; Measurement of surface and subsurface flaws – liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection Condition monitoring of rolling element bearings and gear; Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring; Introduction, techniques and case studies</p>			

TEXT BOOKS:

1. Machinery condition Monitoring principles and Practices, Amiya R. Mohanty ,CRC Press
2. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial,
3. Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
4. Mechanical Fault Diagnosis, R.A.Collacot – Chapman and Hall Ltd., 1977.
5. ISTE Course material on Condition Monitoring.
6. Maintenance Engineering and Management, R.C.Mishra, K.Pathak –,Prentice Hall

Course Outcome

On successful completion of the course students will be able to:

1. Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
2. Implement the basic signal processing techniques.
3. Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
4. Understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
5. Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

MANDATORY COURSE

MCGN9305	Environmental Science	2-0-0	Credit-0
<p>Unit 1: Multidisciplinary nature of environmental studies Definition, scope and importance), Need for public awareness.</p> <p>Renewable and non-renewable resources Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.</p> <p>Unit 2: Ecosystems 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 ecosystems:-</p> <ol style="list-style-type: none"> Forest ecosystem Grassland ecosystem Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) <p>Unit 3: Biodiversity and its conservation</p> <ul style="list-style-type: none"> Introduction – Definition: genetic, species and ecosystem diversity. Bio geographical classification of India Biodiversity at global, National and local levels. India as a mega-diversity nation Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. <p>Unit 4: Environmental Pollution Cause, effects and control measures of :- Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.</p> <p>Unit 5: Social Issues and the Environment Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.</p> <p>Text Books</p> <ol style="list-style-type: none"> Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India. 			

MANDATORY COURSE

MCHM9306	Universal Human Values	2-0-0	Credit-0
<p>Objective:</p> <ol style="list-style-type: none"> 1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education. 2. To sensitize the student towards issues in society and nature. 3. To Strengthen self-reflection to know what the students ‘really want to be’ in their life and profession. 4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life. 			
<p>Module I 10 Hours</p> <ol style="list-style-type: none"> 1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process; 2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations. 3. Method to fulfill the human aspirations: understanding and living in harmony at various levels. 			
<p>Module II 10 Hours</p> <ol style="list-style-type: none"> 1. Human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Self (‘I’) and ‘Body’ - <i>Sukh</i> and <i>Suvidha</i> 2. Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), the characteristics and activities of ‘I’ and harmony in ‘I’, 3. Harmony of I with the Body: <i>Sanyam</i> and <i>Swasthya</i>; Needs of Body and Psyche: <i>Sanyam</i> and <i>Swasthya</i> 			
<p>Module III 12 Hours</p> <ol style="list-style-type: none"> 1. Harmony in the Family, values in human-human relationship; Trust (<i>Vishwas</i>) and Respect (<i>Samman</i>) as the foundational values of relationship, meaning of <i>Vishwas</i> and <i>Samman</i> 2. Harmony in the society: <i>Samadhan</i>, <i>Samridhi</i>, <i>Abhay</i>, <i>Sah-astitva</i>, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature 3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education, 			
<p>Module IV 08 Hours</p> <ol style="list-style-type: none"> 1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management 2. Strategy for transition from the present state to Universal Human Order 			

3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

Text Book:

2. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References Books:

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

Course Outcome:

On completion of this course, the students will be able to:

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

HONOURS

HNME0307	Advanced Fluid Mechanics	3-1-0	Credit-4
-----------------	---------------------------------	--------------	-----------------

Course Objective:

1. Ability to know the basic one & two-dimensional flow analysis.
2. Ability to know Viscous flow and Boundary Layer Theory-Formation.
3. Ability to solve pipe design problems.
4. Ability to know compressibility fluid flow.

MODULE-I**(10 Hours)**

Description of fluid flow: with reference to translation, rotation and deformation concept of continuum, control mass and control volume approach, Reynolds transport theorem. Steady flow and uniform flow. Velocity field, one & two-dimensional flow analysis, circulation and vorticity, stream function and velocity potential function, potential flow, standard flow patterns, combination of flow patterns, flow net. Dimensional Analysis as a tool in design of experiments, identification of non-dimensional numbers and their significance, dimensional analysis methods.

MODULE-II**(12 Hours)**

Equations of motion for laminar flow of a Newtonian fluid - Viscous flow – Navier-Stoke’s equations, simple exact solutions. Boundary Layer Theory-Formation, growth and separation of boundary layer-Integral momentum principles to compute drag and lift forces Mathematical models for boundary layer flows. Turbulence, Origin of turbulence universal velocity distribution laws of turbulence, smooth rough and transitional turbulent flow in pipes, pipe resistance equation for pipes design of pipe networks. Diffusion and dispersion of pollutants in natural streams.

MODULE-III**(08 Hours)**

Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle–Mach Cone – Stagnation State.

MODULE-IV**(08 Hours)**

Compressible Fluid Flow – II: Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

TEXT BOOK

1. Som S. K and Biswas G “Introduction to Fluid Mechanics and Fluid Machines”, TMH.
2. Schlichting: “Boundary Layer theory”, International Text – Butterworth.
3. Fluid Mechanics and Machines/Modi and Seth/Standard Book House.
4. White F.M. “Viscous Fluid Flow”, McGraw Hill Pub. Co, N York.

REFERENCE BOOKS

1. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
2. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
3. Rouse H. “Advanced Fluid Mechanics”, John Wiley & Sons, N York.

Upon successful completion of the course, student will have:

1. Ability to understand one & two-dimensional flow analysis and their significance.
2. Ability to understand boundary layer theory and compressible fluid flow.

HONOURS

HNME0308	Fluid Power and Turbo Machinery	3-1-0	Credit-4
Course Objective:			
<ol style="list-style-type: none"> 1. Ability to know the basics of Hydropower Station. 2. Ability to know the basics of turbo machine and steam nozzle. 3. Ability to know the basics of centrifugal compressor, gas dynamics and gas turbines. 			

MODULE-I**(10 HRS.)**

1. Hydropower Station: Principles of generation of hydropower, components of the plant, layout of plant, various types of hydro power plants.
2. Impact of Jet: Impact of jet on different types of flat and curved plates, fixed and moving, single and series of plates, derivation of efficiency, condition for maximum efficiency and value of maximum efficiency, hinged plate and pipe bends, water jet propulsion, principle and propulsion of ships.

MODULE-II**(12 HRS.)**

1. FUNDAMENTALS OF TURBO MACHINES: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines
2. STEAM NOZZLES: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure of analysis. Designs of nozzles.
3. Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

MODULE-III**(08 HRS.)**

1. Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slipfactor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance.
2. AXIAL FLOW COMPRESSORS: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance.
Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

MODULE-IV**(08 HRS)**

1. AXIAL FLOW GAS TURBINES: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifel's relation, Design cascade analysis, Soderberg, Hawthorne, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

TEXT BOOKS

1. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
2. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
3. Principles of Turbo Machines/DG Shepherd / Macmillan.
4. Element of Gas Dynamics/Yahya/TMH.

REFERENCE BOOKS

1. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons.

2. Turbines, Pumps, Compressors/Yahya/TMH
3. Practice on Turbo Machines/ G.Gopal Krishnan &D.Prithviraj/ Sci Tech Publishers, Chennai
4. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
5. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/Newyork
6. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications.

Upon successful completion of the course, student will have:

1. Ability to understand hydro power plant.
2. Ability to understand different types of turbo machines.

HONOURS

HNME0309	Power Plant Engineering	3-1-0	Credit-4
<p>Course Objective:</p> <ol style="list-style-type: none"> 1. Ability to know about layout of power plants and their operations. 2. Ability to describe about steam generators and combustion equipment. 3. Ability to study and solve problems of the steam power cycles, flow through nozzles and steam turbines. 4. Ability to know about the various aspects of nuclear power plant, its reactors and waste disposal and economics power plant. 			
<p>MODULE-I (10 HRS.)</p> <p>Introduction:-Energy sources for generation of electric power, principal types of power plant, their special features and an introduction to pollution control.</p> <p>Steam Power Plant: Overall view and general layout of modern steam power plant. Steam generators:- classification (La-mont, Lancashire, Babcox-Wilcox boiler),boiler mountings and accessories. Combustion equipment:-air supply system (natural and mechanical draught system), pulverized coal burning system, fluidized bed combustion system. Boiler performance calculation problems.</p>			
<p>MODULE-II (12 HRS.)</p> <p>Steam Power Plant Cycles: Rankine cycles, reheat cycles, regenerative cycles.</p> <p>Introduction To Steam Flow Through Nozzles:- Types of nozzles, Isentropic flow through nozzles, Effect of friction, Nozzle efficiency, Critical Pressure ratio and maximum discharge, throat and exit area.</p> <p>Steam turbines:- Classification: impulse and reaction turbines, difference between two, velocity diagrams of both, calculation of turbine power and related problems.</p>			
<p>MODULE-III (08 HRS.)</p> <p>Nuclear Power Plant:- Classifications and essential components of nuclear reactor, Nuclear fuels, Nuclear fission, difference between fusion and fission, reactors: PWR, BWR CANDU reactors, light water reactor, gas cooled reactors, liquid metal fast breeder reactors, disposal of nuclear waste .</p>			

MODULE-IV	(08 HRS)
Power Plant Economics: Plant investment cost, fixed costs, operating costs, energy cost and depreciation, factors of affecting economics of the generation and distribution.	
TEXT BOOK	
<ol style="list-style-type: none"> 1. Power plant Engineering:- By P.K. Nag (2nd Edition)TMH. 2. Power plant Engineering:- By Arora & Domkundwar, Dhanpat Rai publications. 	
REFERENCE BOOKS	
<ol style="list-style-type: none"> 1. Power plant engineering book by R.K. Rajput. 2. Power plant technology by E.I. Wakil TMH 	
Upon successful completion of the course, student will have:	
<ol style="list-style-type: none"> 1. A brief idea about various aspects and working of different power plants. 	

MINOR

MNME0304	Mechanics of Solid	3-1-0	Credit-4
Course Objective:			
<ol style="list-style-type: none"> 1. To study the methods to determine moment of inertia of a body. 2. To enable students understand the concept of stress and strain in different types of structure/machine under different loading conditions 3. To study engineering properties of materials, force-deformation and stress-strain relationship. 4. To analyze thin cylinder and sphere 5. To have an understanding the relationship between shear force and bending moments, Bending stress and shear stress distribution in beams. 			
MODULE-I		(08 HRS.)	
<ol style="list-style-type: none"> 1. Moments of Inertia- Plane figure with respect to an axis in its plane and perpendicular to the plane-parallel axis theorem, Moment of Inertia of material bodies. 2. Load, Stress, Principle of St. Venant, Principle of Superposition, Strain, Modulus of Elasticity, Stress-Strain Diagrams, Hooke's law, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads. 			
MODULE-II		(08HRS.)	
<ol style="list-style-type: none"> 1. Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants. 2. Biaxial State of Stress: Analysis of Biaxial Stress. Plane stress, Principal plane, Principal stress, Mohr's 			

Circle for Biaxial Stress.

MODULE-III**(08 HRS.)**

1. Biaxial State of Strain: Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.
2. Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

MODULE- IV**(12 HRS)**

1. Shear Force and bending moment for beams, Types of load, support, support reactions, Shear force and bending moment diagram for different cases, Relationship between Shear force, bending moment and distributed loads.
2. Simple bending of Beams, Theory of simple bending, of initially straight beams, Bending stresses, Section Modulus, Distribution of Normal and shear stresses in beam, Composite beams.

TEXT BOOK

1. Engineering Mechanics by S Timoshenko, D.H Young and J.V.Rao, Revised 4th edition (Special Indian Edition), McGraw Hill.
2. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East West Press
3. Strength of Materials by G. H. Ryder, Macmillan Press
4. Strength of Materials by R. Subramaniam, Oxford University Press

REFERENCE BOOKS

1. Engineering mechanics statics and dynamics by A.K. Tayal, Umesh Publication.
2. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
3. Mechanics of Materials by R.C. Hibbeler, Pearson Education
4. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley
5. Mechanics of Materials by James M. Gere, Thomson Learning
6. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
7. Strength of Materials by S.S. Rattan, Tata McGraw Hill
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India

Upon successful completion of the course, student will have:

1. The ability to understand the concept of forces, equilibrium conditions and methods to find out C.G and MOI of a body.
2. The ability to analyze the behaviour of structural and machine components subjected to various loading and support conditions based on principles of equilibrium and material constitutional relationships.
3. The ability to understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, biaxial load and at any plane.
4. To solve practical problems through evaluating the relationship between stress and strain.
5. The ability to analyse thin cylinder and column problems.

PRACTICAL / SESSIONAL

PCME7309	Machine Design Lab	0-0-3	2 Credits
<ol style="list-style-type: none"> 1. Assembly drawing of tail-stock of lathe with bill of materials 2. Assembly drawing of screw jack with bill of materials 3. Design & drawing of Riveted joint 4. Design and drawing of cotter joint 5. Design and drawing of knuckle joint 6. Design of shafts subjected to combined loading 7. Design and drawing of flange coupling 8. Design of lever <p>Total number of Design: 6 nos. Total No. of Drawing: 4 sheets (Two sheets for assembly drawing as per Sl no. 1 and 2 and two sheets for design, under Sl. No. 3, 4, 5 and 7)</p> <p>DESIGN DATA HAND BOOKS:</p> <ol style="list-style-type: none"> 1. Design Hand Book by S.M. Jalaluddin; Anuradha Agencies Publications Vidyal Karuppur, Tamil Nadu, Pin : 612605. 2. P.S.G. Design Data Hand Book, PSG College of Tech Coimbatore 3. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003. 			

PCME7310	Advanced Manufacturing Lab	0-0-4	2 Credits
<p>Course Objective: To learn about the convectional as well as non-convectional machining methods.</p> <p>List of Experiments</p> <ol style="list-style-type: none"> 1. Metal Casting process by using bottom pour stir casting machine. 2. Gear cutting in milling machine by using indexing mechanism. 3. Measurement of cutting forces by tool force dynamometer (turning/milling). 4. Study of mechanical working of metals (Rolling/Forging/Extrusion/Wiredrawing), any one method. 5. 3D modeling of mechanical parts (AUTOCAD/CATIA/SOLIDWORKS). 6. Study of additive manufacturing and preparation of job by using 3D printing. 7. Practice and preparation of job in WEDM. 8. CNC programming (preparation of job in CNC lathe machine). 			

HSHM3305	Business Communication & Interview Skills	0-0-3	Credit-1
-----------------	--	--------------	-----------------

COURSE OBJECTIVES

1. To develop communicative competence in prospective engineers.
2. To train them to participate in Group Discussion, presentation & face interview
3. To understand team dynamic & effectiveness.
4. To learn leadership qualities and practice them.
5. To develop basic personality traits.

Detailed Syllabus

Emphasis will have to be given to practice sessions in the class room by the learners

Module –I**(08 Hours)**

1. Soft Skills: An introduction-Definition and Significance of Soft Skills; Importance and Measurement of Soft Skill Development, Role of effective communication in professional life.
2. Self-Discovery: Discovering the Self; Beliefs, Values, Attitude, Virtue,
3. Being Creative: Out of the box thinking, Lateral Thinking and its use.

Module-II**(12 hours)**

1. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.
2. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; being a team player, Concept of Leadership and developing Leadership skills
3. Group Discussion: Importance, Planning, Elements and Skills. GD as part of a selection process: Evaluation and Analysis

Module-III**(12 hours)**

1. Interview Skills: Interviewee-in-depth perspectives, Types of Interview- In Campus / Onsite/ Telephonic, Before, During and After the Interview. Tips for Success.
2. Presentation Skills: Types, Content, Audience Analysis, Essential Tips-Before, During and After, Overcoming Nervousness/ reducing stage fright, visualization strategies, on camera techniques.
3. Preparing Curriculum Vitae, Resume, Bio-data, Job Application

Module-IV**(08 hours)**

1. Stress/ Time Management: Definition, Nature, types, Symptoms and Causes; Stress Analysis Models and Impact of Stress; Measurement and Management of Stress. Effective utilization of Time as a resource, Managing Time
2. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Types of Leadership behavior; Assertiveness Skills.
3. Emotional Intelligence: Meaning, Features, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

Reference Books:

1. Managing Soft Skills for Personality Development-edited by B.N. Ghosh, McGraw Hill India, 2012.

2. English and Soft Skills-S.P. Dhanavel, Orient Blackswan India, 2012.
3. Personality Development and Soft Skills by Barun Mitra OUP
4. Communication Skills second edition Kumar Lata OUP
5. Crash Course in Personal Development- Brian Clegg Kogan Page Publication
6. Lateral Thinking by Edward De Bono Penguin Books

COURSE OUTCOMES

By the end of course, students shall be able to:

1. Understand the significance and essence of a wide range of soft skills. Learn how to apply soft skills in a wide range of routine social and professional settings.
2. Learn how to employ soft skills to improve interpersonal relationships. Learn how to use soft skills to enhance employability and ensure workplace and career success.
3. Participate in different types of Group Discussions/ Activities effectively, presenting a topic and face interviews with confidence.

OPEN ELECTIVE-III (OE-III) 6th Semester

OECH6318	Food Biotechnology	3L-0T-0P	3 Credits
Objective of the course: To study the aspects of production, composition and design of food products.			
<p>Module-I (12 Hours/4 Weeks)</p> <p>Unit – 1 (6 Hours/2 Weeks) Food quality and Production technology: Analysis of food, major ingredients present in different product, Food additives: colour, flavour, vitamins, Single cell protein, mushroom.</p> <p>Unit – 2 (6 Hours/2 Weeks) Fermentative production of food, Pickling and alcoholic beverages, genetically manipulated crops-based food, oriental foods, probiotics and prebiotics in food products.</p> <p>Module-II (12 Hours/4 Weeks)</p> <p>Unit – 3 (6 Hours/2 Weeks) Technology for improved process: Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production.</p> <p>Unit – 4 (6 Hours/2 Weeks) Utilization of food waste for production of value-added products, enzymes in sugar syrup, genetically modified food.</p> <p>Module-III (12 Hours/4 Weeks)</p> <p>Unit – 5 (6 Hours/2 Weeks) Food spoilage and control: Spoilage of food, Microbiology of water, meat, milk, vegetables, microbial safety of food products.</p> <p>Unit – 6 (6 Hours/2 Weeks) Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation.</p> <p>Module-IV (6 Hours/2 Weeks)</p> <p>Unit – 7 (6 Hours/2 Weeks) Canning, dehydration, ultrafiltration, sterilization, irradiation.</p>			
<p>Text Books</p> <ol style="list-style-type: none"> 1. Modern Food Microbiology, 7th ed. by J M Jay, M J Loessner, and DA Golden, Springer. 2. Food Microbiology, 5th ed. by W C Frazier and D C Westhoff, McGraw-Hill. 3. Prescott & Dunn's Industrial Microbiology by G Reed, CBS. 4. Technology of Food Preservation, 4th ed. by N W Desrosier and J N Desrosier, Avi Publishing Co Inc. 5. Introduction to Food Engineering, 5th ed. by R P Singh and D R Heldman, Academic Press. 			
<p>Course Outcomes:</p> <p>At the end of the course, the student should be able to</p> <ol style="list-style-type: none"> 1. Understand the process used to enhance the production, nutritional value, safety and taste of food. 2. Know about the modern biotechnological techniques applied to food science. 3. Know about improving crops so that they need fewer pesticides. 4. Design product & functionality, understand food innovation and marketing. 5. Gain knowledge about the rapid detection techniques of foodborne pathogens and chemical senses. 			

6. Know about the requirements for careers in the dynamic food sector as well as for research and development.

OECH6319	Fluidization Engineering	3L-0T-0P	3 Credits
<p>Course objectives: The objectives of this course are to introduce</p> <ol style="list-style-type: none"> 1. Basics of fluidization and various industrial application of fluidization; 2. Various fluidization regime, classification of particles; 3. Describe the staging of fluidized bed reactor. 			
<p>Module-1 (4 weeks/12 Hours) Basics of fluidization, types, behaviour, and parameters Unit I (6 Hours/2 weeks): Introduction to fluidization, types of fluidization, gross behavior of fluidized beds, minimum fluidization velocity. Unit II (6 Hours/2 weeks): Pressure drops in fluidized beds, bed voidage, transport disengaging height, viscosity and fluidity of beds, bubble behavior, bed expansion, distributor design.</p> <p>Module-2 (4 weeks/12 Hours) Mathematical treatment and calculations Unit III (6 Hours/2 weeks): Simple mathematical treatment, Solid transport: flow and fluidized solids, solids transfer, terminal velocity, particle entrainment and elutriation. Unit IV (6 Hours/2 weeks): Simple calculations relating to solid transport.</p>			
<p>Module-3 (4 weeks/12 Hours) Heat and mass transfer in fluidized beds Unit V (6 Hours/2 weeks): Heat and mass transfer in fluidized beds: Heat transfer mechanism, principles of gas-solid and bed surface transfer, heat transfer to liquid fluidized systems. Unit VI (6 Hours/2 weeks): Generalized correlation for fluidized bed mass transfer and its limitations.</p>			
<p>Module-4 (2 weeks/6 Hours) Semi-fluidization and fluidized bed reactors Unit VII (6 Hours/2 weeks): Semi-fluidization: principles, estimation of various bed parameters, Industrial applications; Design of fluidized bed reactors: Concept of RTD, basic design principles for fluidized bed.</p>			
<p>Text books :</p> <ol style="list-style-type: none"> 1. 'Fluidization Engineering', 2nd ed. by D Kunii and O Levenspiel, Butterworth Heinemann. 			
<p>Reference Books :</p> <ol style="list-style-type: none"> 1. 'Fluidization' by M Leva, McGraw-Hill. 2. 'Fluidization' by J F Davidson and D Harrison, Academic Press. 			

Course Outcomes (CO):

At the end of the course, students would be able to understand about

1. Concept of fluidization
2. Applications of fluidization
3. Semi-fluidization
4. Fluidized bed reactors

OECE6320	Structural Dynamics and Earthquake Engineering	(3-0-0)	Credit-03
<p>Module I Elements of Earthquake origin & Propagation: Elements of Seismology, Earthquakes, Structure of the Earth, History of the Earth, Earthquake Mechanism, Propagation of Seismic Waves, Earthquake Phenomena, Earthquake Measurements, Definitions of magnitude, intensity, epicentre etc; Plate tectonics, seismographs, liquefaction, Types, effects and controlling factors</p> <p>Module II Theory of Vibration Effects: Dynamic Loads. D'Alembert's Principle and inertia forces, Stiffness and flexibility of elastic structures, Theory of Vibrations, Free vibrations of single and multiple degree freedom systems, computations of dynamic response to time dependent forces, mass and stiffness matrices, natural frequencies, Plate Tectonics Theory.</p> <p>Module III Earthquake Resistant Design: Principles of Earthquake Resistant Design, Response spectrum theory. Time – Acceleration method, Application of response spectrum theory to seismic design of structures.</p> <p>Module IV Earthquake Damages: Earthquake Damages to Various Civil Engineering Structures, Case Histories Earthquake, Earthquake response of structures, Soft storey collapse, Slender structures, unsymmetrical structures. Methods of disaster prevention: Earthquake resistant building Regulations, specification, guidelines for construction – Materials selection.</p> <p>Reference Books</p> <ol style="list-style-type: none"> 1. A K. Chopra (2003), Dynamics of Structures-Theory and Applications to Earthquake Engineering, Second Edition, Prentice-Hall India Pvt Ltd. 2. Pauley & Priestly (1995), Seismic design of reinforced concrete and masonry buildings, John Wiley & Sons. 3. Stratta. J.L. (2000), Manual of Seismic Design, Prentice-Hall India Pvt Ltd. 4. Kramer. S.L. (2000), Geotechnical Earthquake Engineering, Prentice-Hall India Pvt Ltd. 5. Agarwal & Shrinkardo (2006), Earthquake Resistant design of structures, Prentice-Hall India. 			

OECS6321	Data Science	3-0-0	Credit-03
<p>Prerequisite: Brief knowledge in programming in C, C++ with great interest in quantitative/statistical analysis and a student having degree in BTech in any branch of Engineering, MCA, M.Tech, MS having occasionally programming knowledge may enrol for this subject. As this is just an introductory to data science techniques even a simple graduate student may take this course.</p>			
<p>Module I: 10 Hrs. Benefits and uses of data science and big data, Data Science steps, Facets of data, Structured data, Unstructured data, Natural language , Machine-generated data, Graph-based or network data, Audio, image, and video, Streaming data, The data science process, Setting the research goal, Retrieving data, Data preparation, Data exploration, Data modelling or model building, Presentation and automation, The big data ecosystem and data science, Distributed file systems, Distributed programming framework, Data integration framework, Python Environment set-up, Jupyter overview, Python Numpy, Python Pandas, Python Matplotlib.</p>			
<p>Module II: 8 Hrs. An introduction to R, Data structures in R, Data visualization with R, Data analysis with R, Data science using MS-excel, Important statistical concepts used in data science, Difference between population and sample, Types of variables, Measures of central tendency, Measures of variability, Coefficient of variance, Skewness and Kurtosis, Normal distribution, Test hypotheses, Central limit theorem, Confidence interval, F-test, T-test, Chi-square test, Type I and II errors, Student's T distribution.</p>			
<p>Module III: 10 Hrs. Regression, ANOVA,R square, Correlation and causation, Exploratory data analysis, Data visualization, Missing value analysis, The correction matrix, Outlier detection analysis, Supervised machine learning, Python Scikit tool, Neural networks, Support vector machine, Logistic and linear regression, Decision tree classifier, Tableau, Working with Tableau, Deep diving with data and connection, Creating charts, Mapping data in Tableau, Dashboards and stories.</p>			
<p>Module IV: 10 Hrs. Machine learning on cloud, ML on cloud platform, ML on AWS, ML on Microsoft Azure, Understanding NoSQL databases and why they're used today, Identifying the differences between NoSQL and relational databases, Defining the ACID principle and how it relates to the NoSQL BASE principle, Learning why the CAP theorem is important for multi-node database setup, Applying the data science process to a project with the NoSQL database Elastic search, The rise of graph data bases, graph mining, test mining and analysis, Natural Language Toolkit(NLTK),Data visualization to the end user, Dashboard development tools.</p>			
<p>Text Books: There is no text book for the course. A teacher may use lecture notes and videos, read research papers and Web Pages, which will be freely available on internet websites.</p>			
<p>Reference Books: 1. Introducing Data Science BIG DATA, MACHINE LEARNING, AND MORE, USING PYTHON TOOLS by DAVY CIELEN ARNO, D. B. MEYSMAN and MOHAMED ALI, MANNING</p>			

SHELTER ISLAND

2. Introduction to Probability – By Joseph K. Blitzstein and Jessica Hwang
3. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data 1st Edition, by Hadley Wickham
4. Python Data Science Handbook, Jake Vander Plas, *O'reilly*
5. Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, Aurélien Géron (Author), *O'reilly*

OEEE6322	Sensors and Transducers	3-0-0	3 Credits
<p>Module -I [12 Hours]</p> <p>Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. (Bentley: Chapters 1-4)</p> <p>Techniques for dynamic compensation, Loading Effects and Two-port Networks (Bentley: Sections 4.4 and 5.1-5.2)</p> <p>Module-II [12 Hours]</p> <p>Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric;</p> <p>Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors. (Bentley: Sections 8.1 to 8.6)</p> <p>RVDT, Hall Effect sensors (Bentley: Sections 8.3 and 8.10)</p> <p>Piezoelectric sensing elements, Piezo-resistive sensing elements. (Bentley: Sections 8.7 and 8.8)</p> <p>Module-III [12 Hours]</p> <p>Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity.</p> <p>Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation (Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)</p> <p>Current transmitters, Oscillators and resonators (Bentley: Sections 9.4 and 9.5)</p>			

Module-IV**[6 Hours]**

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.

IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

(Ghosh: Section 10.3 to 10.4)

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.

Reference Books:

1. Measurement Systems Application and Design- E.O. Doebelin (4/e), McGraw-Hill, International, NY.
2. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

OEEC6324	Mechatronics	3-0-0	Credits 3
<p>COURSE OBJECTIVES</p> <ol style="list-style-type: none"> 1. Understand key elements of Mechatronics system, its block diagram representation. 2. Understand principles of sensors, transducers, encoders and actuators and its characteristics. 3. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial applications. 4. Understand the system modelling and analysis in time domain and frequency domain. <p>MODULE-I (12 Hours)</p> <p>Unit 1</p> <p>Fundamental of Mechatronics: Definition and concepts of Mechatronics, Conventional system vs. mechatronic system, Evolution of Mechatronics.</p> <p>Unit 2</p> <p>Hardware components for Mechatronics. Need and Role of Mechatronics in Design, Manufacturing and Factory Automation.</p> <p>MODULE-II (12 Hours)</p> <p>Unit 3</p> <p>Sensors:</p> <p>An introduction to sensors. Principle of operation, Difference between transducer and sensors. Sensor types-</p>			

Transducer signal conditioning sensor, velocity and motion sensor, force sensor, fluid pressure sensor, liquid flow sensor, liquid level sensor, temperature sensor.

Unit 4

Transducers:

Introduction to transducers. Transducer types – photo emissive transducer, photo conductive transducer, photovoltaic transducer, thermistors, thermocouple, inductive transducer, capacitive transducer, piezoelectric transducer, hall effect transducers, ionization transducer, Use of sensor and transducer for specific purpose in mechatronics.

MODULE-III

(12 Hours)

Unit 5

Actuators and encoders:

Electric motors: D.C. Motors, Stepper motor. Hydraulic actuators, Pneumatic actuators. Principle of operation of encoders, Types of encoders- incremental encoder, optical encoder, bimetallic strip encoder, strain gauge encoder, load cell encoder.

Unit 6

Programmable Logic Controller:

Basic Structure- Programming: Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling, Analog input / output , PLC Selection & Application.

MODULE-IV

(8 Hours)

Unit 7

MEMS and Microsystems:

Overview of MEMS and Microsystems. Micromachining techniques: silicon as a material for micromachining, photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, wafer bonding, packaging.

Microsystems modelling and Design:

Mechanics of deformable bodies. Energy method. Estimation of stiffness and damping for different microstructures. Modelling of electromechanical system, it's analysis in time domain and frequency domain, pull-in voltage. Applications of MEMS.

Text Books:

1. Mahalik N.P, "Mechatronics: Principles, Concepts and applications", Tata McGraw Hill, 3rd edition (Indian), 2012.
2. Appu Kuttan, "Introduction to Mechatronics", Oxford University, 2007.

Reference Books:

1. RK Rajput, "A Textbook of Mechatronics", S. Chand Publishing, 1st Edition, 2007.
2. Ananthasuresh & Gopalkrishnan, "Micro and Smart Systems", Wiley India, 2012
3. A. Smaili & F Mrad, "Applied Mechatronics", Oxford University Press, 1st Edition 2007.
4. S. D. Senturia, "Microsystem Design", Springer, 1st edition 2nd reprint 2004

Course Outcomes:

1. To model, analyze, and control engineering systems.
2. Identify sensors, transducers, and actuators to monitor and control the behaviour of a process or product.
3. Develop PLC programs for a given task.
4. Evaluate the performance of mechatronics systems.

OEHM6325	MARKETING MANAGEMENT	3-0-0	Credit-3
<p>Course Objectives</p> <ol style="list-style-type: none"> 1. To understand the concepts of marketing management 2. To learn about marketing process for different types of products and services 3. To understand the tools used by marketing managers in decision situations 4. To understand the marketing environment <p>Course Content</p> <p>UNIT 1: Basic Concepts of Marketing Definition, Concept of Exchange-Needs & Wants, Marketing Concept, Process ,Marketing environment, Elements of macro and micro environment, Competition analysis, Factors contributing to competition, Porters five forces model, identifying and analyzing competitors, Marketing planning process, Market research and information system, Research process, consumer behavior, factors influencing consumer behavior.</p> <p>UNIT 2: Market segmentation, targeting and positioning Definition, Bases of segmenting consumer and industrial market, Target market strategies, Market positioning, Market demand forecasting :forecasting tools, short term tools, Moving average and exponential smoothing methods, Long term forecasting tools- time series analysis, Econometric method, Qualitative methods– Buying intention survey, sales force opinion, Delphi techniques, Product planning-Product planning and new product planning process.</p> <p>UNIT 3: Price decision Objectives and factors influencing price, Pricing methods and strategies, Integrated marketing communication (IMC), Concept of IMC, The marketing communication process, Promotion mix, Elements of promotion mix, Channel of distribution: types of intermediaries, functions of distribution channels, channel levels, physical distribution, supply chain management (basic only)</p> <p>Text Books</p> <ol style="list-style-type: none"> 1. Kotler, P., Keller, K. L., Koshy, A., & Jha, M. (2012), Marketing Management A South Asian Perspective, 14th Edition, Pearson Education, New Delhi. 2. Ramaswamy, V. S., & Namakumari, S. (2017), Marketing Management: Indian Context with Global 			

Perspective, McGraw hill.

Reference Books

1. Kotler, Philip. Marketing Management, Millennium Edition. Intl ed. US: Prentice Hall, 2002. ISBN: 8120316096.
2. Principles of Marketing, Kotler and Armstrong, Pearson, 12th edition., 2008, ISBN: 978-81- 317-1547-5

Course Outcomes

On completion of this course, the students will be able to:

- CO 1. Demonstrate strong conceptual knowledge in the functional area of marketing management.
- CO 2. Demonstrate effective understanding of relevant functional areas of marketing management and its application.
- CO 3. Demonstrate analytical skills in identification and resolution of problems pertaining to marketing management

OEMA6326	Optimization in Engineering	3-0-0	Credit-3
<p>Module-I. (12 Hours) Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling. Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.</p>			
<p>Module-II. (12 Hours) Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment Problems Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems.</p>			
<p>Module-III. (13 Hours) Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.</p>			
<p>Module-IV. (8 Hours) Queuing models: General characteristics, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline. Introduction to Genetic Algorithm.</p>			
<p>Text Books:</p> <ol style="list-style-type: none"> 1. A. Ravindran, D. T. Philips, J. Solberg, Operations Research- Principle and Practice, Second 			

edition, Wiley India Pvt. Ltd.

2. Prabhakar Pai, Operation Research, Oxford University Press.
3. H.A. Taha, A.M. Natarajan, P. Balasubramanie, A. Tamilarasi Operations Research, Pearson Education, Eighth Edition.

Reference Books:

1. Stephen G. Nash, A. Sofer Linear and Non-linear Optimization, McGraw Hill, 2nd Edition.
2. A. Ravindran, K.M. Ragsdell, G.V. Reklaitis, Engineering Optimization, Wiley India Pvt. Ltd, Second edition.
3. F.S. Hiller, G.J. Lieberman, Operations Research, Tata McGraw Hill, Eighth Edition. .

OEME6327	Industrial Engineering and Operation Research	3-0-0	Credit-3
<p>Product Design and Development: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives.</p> <p>Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity – concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.</p> <p>Facility Design: Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems.</p> <p>Operation Research: Linear programming – problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; Markovian queuing models; dynamic programming; simulation – manufacturing applications. Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource levelling. Production control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; routing, scheduling and priority dispatching; Push and pull production systems, concept of JIT manufacturing system; Logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic inventory models, quantity discount; perpetual and periodic inventory control systems.</p> <p>Project management – PERT and CPM.</p> <p>Text Book:</p> <ol style="list-style-type: none"> 1. Production & operations management, K. Aswathappa, K.S. Bhat, Himalaya Publishing House, edition 2012. 2. R. Paneerselvam, Production operations Management 			

3. Operations Research, D.S.Hira, Gupta, S Chand Publisher
4. Industrial Engineering & Management, O P Khanna, Dhanpat Rai & Sons
5. WORK STUDY & TIME STUDY, ILO

OEMT6328	Biomaterials	3-0-0	Credits 3
<p>Objectives of the Course:</p> <ol style="list-style-type: none"> 1. To introduce the student to the range of biomaterials and the science and engineering of biomaterials. 2. To understand constraints associated with the use of biomaterials <p>Module 1: (12 Hours) Introduction to basic concepts of Materials Science, Salient properties of important material classes Property requirement of biomaterials, Concept of biocompatibility, Structure and properties of biological cells & tissues, Cell fate processes (cell migration, cell differentiation, cell apoptosis, cell division), Cell signaling processes, Cell-material interactions and foreign body response</p> <p>Module 2: (12 Hours) Bone tissue–structure, bone tissue-property, assessment of biocompatibility of biomaterials, in vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation- ALP assay; Biomineralisation - Osteocalcin assay), In vivo testing and histocompatibility assessment, Genotoxicity assessment,</p> <p>Module 3: (12 Hours) Important biometallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys Bioinert, Bioactive and Bioresorbable ceramics, Processing and properties of different hydroxyapatite (HA)-based biocomposites, Synthesis of biocompatible coatings on structural implant materials, Fabrication of porous scaffold materials using electrospinning and 3D printing, Microstructure and properties of glass-ceramics; biodegradable polymers, Processing and Properties of some Polymer-based Biocomposites,</p> <p>Module 4: (06 Hours) Design concept of developing new materials for bio-implant applications</p> <p>Suggested Text Books:</p> <ol style="list-style-type: none"> 1. Introduction to Biomaterials: Basic Theory with Engineering Applications; C.L Agrawal, J.L. Ong, Mark R Appleford, Gopinath Mani, Cambridge University Press, 2013 <p>Suggested Reference Books:</p> <ol style="list-style-type: none"> 1. Biological Performance of Materials: Fundamentals of Biocompatibility (Third Edition, Revised and Expanded); Author: Jonathan Black; Publisher - Marcel Dekker, 1999 2. Biomaterials Science and Biocompatibility; Authors: Frederick H. Silver and David L. Christiansen; Publisher: Springer-Verlag New York, 1999 			

3. Biomaterials Science: An Introduction to Materials in Medicine; Editors: Buddy D. Ratner, Allan S. Hoffman, Fredrick J. Schoen and Jack E. Lemons; Publisher: Elsevier Inc., 2004
4. Molecular Biology of the Cell; Fourth edition; Authors: Bruce Alberts, Alexander Johnson, Julian Lewis, Keith Roberts and Peter Walter; Publisher: Taylor & Francis, New York, 2002
5. B. Basu, D. Katti and Ashok Kumar; Advanced Biomaterials: Fundamentals, Processing and Applications; John Wiley & Sons, Inc., USA, September, 2009.

Course Outcomes:

After completing the course, the student will be able to:

1. Explain the types of Biomaterials and their relative advantages and disadvantages
2. Indicate the constraints placed on the use of materials in biological environments
3. Explain the characterization of materials from the perspective of application as a
4. Biomaterial

OEPD6329	OPERATION RESEARCH	3L-0T-0P	3 Credits
<p>Course Objective Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively; knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry; skills in the use of Operations Research approaches and computer tools in solving real problems in industry; Mathematical models for analysis of real problems in Operations Research. Identify and develop operational research models from the verbal description of the real system.</p> <p>Module I [12] Introduction: Definition, Characteristics and phases, Applications of OR. Linear Programming: Problem Formulation, Graphical solution, Simplex method - Artificial variables technique (i.e. Big M method only) - Duality principle, simple problems on dual formulation only, sensitivity analysis.</p> <p>Module II [10] Transportation Model: Formulation, IBFS-North West Corner method, LCEM, VAM, Unbalanced transportation problem, Optimality test by MODI method. Assignment Model - Formulation - Optimal solution by Hungarian method – Unbalanced Assignment problem- Restricted case.</p> <p>Module III [10] Queuing Models: Introduction – Kendall’s Lee notation- single channel with infinite population, Multichannel with infinite population Networking Model: PERT, CPM</p> <p>Module IV [08] Theory of Games: Introduction-classification of games- 2 person zero sum games- Assumptions -solution of</p>			

games with saddle points - Rectangular games without saddle points, dominance principle - 2 X 2 games by Algebraic method, m X 2 & 2 X n games by graphical method.

Text Books:

1. Operation Research by Panarsalvam
2. Operation Research by Kalavathy

Reference Books:

1. Hiller & Libermann, "Introduction to Operations Research", 8th ed., Tata McGraw Hill, 2010.
2. D.S. Hira and R.K. Gupta, "Operations Research", 5th ed., S.Chand & Co., 2008.
3. Taha, "Introduction to Operations Research." 8th ed., PHI Publications, 2008.
4. S.D. Sharma, "Operations Research", 8th ed., Kedarnath Publishers, 2007.

Course Outcomes:

Upon successful completion of the course, student will able to:

1. Recognize the importance and value of Operations Research and mathematical modelling in solving practical problems in industry.
2. Formulate a managerial decision problem into a mathematical model;
3. Understand Operations Research models and apply them to real-life problems;
4. Use computer tools to solve a mathematical model for a practical problem.
5. Cognitive skills (thinking and analysis)
6. Be able to build and solve Transportation Models and Assignment Models.
7. Be able to understand the characteristics of different types of decision.