Semester VIII [Fourth year]
Branch/Course: Mechanical Engineering

Sl. No.	Category	Code	Course Title	Hours per week			Total contact hours	Credits
				L	T	P		
1	Professional Elective Courses	PEC- MEL 431– 435	Elective V	3	0	0	3	3
2	Professional Elective Courses	PEC-MEL 431- 435	Elective VI	3	0	0	3	3
3	Open Elective courses	OEC- ME 201-205	Open Elective-IV	3	0	0	3	3
4	Open Elective courses	OEC-ME MOOCs-III	Open Elective-V	12 WEEK				3
5	Project	PROJ-ME 404	Project-II	12				6
							Total credits:	**18**

PEC-MEL 431	Principles of Management	3L:0T:0P	3 credits

Objectives:

To understand the principles of management and their application to the functioning of an organization

Contents:

Module: 1

Definition of management, science or art, manager vs entrepreneur; Types of managers- managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management. **(Lectures 8)**

Module: 2

Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. **(Lectures 6)**

Module: 3

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management. **(Lectures 10)**

Module: 4

Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication. **(Lectures 8)**

Module: 5

Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting. **(Lectures 8)**

Course Outcomes:

Upon completion of this course, the students will get a clear understanding of management functions in an organization

Text Books:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed.,2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education,2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill,1999.

PEC-MEL 432	Design of Transmission Systems	3L:0T:0P	3 credits

Objectives:

To learn about the design procedures for mechanical power transmission components

Contents:

Module : 1

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets. **(Lectures 4)**

Module : 2

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. **(Lectures 10)**

Module : 3

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. **(Lectures 10)**

Module : 4

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. **(Lectures 10)**

Module : 5

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake. **(Lectures 8)**

Course Outcomes:

Upon completing this course the students will be able to design transmission systems for engines and machines.

Text Books:

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill,2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley,2010.
3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

PEC-MEL 433	Total Quality Management	3L:0T:0P	3 credits

Objectives:

To facilitate the understanding of total quality management principles and processes

Contents:

Module : 1

Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs toquality. **(Lectures 8)**

Module : 2

TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition andreward,performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection. **(Lectures 8)**

Module : 3

The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types. **(Lectures 8)**

Module : 4

TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures. **(Lectures 8)**

Module : 5

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation,; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and servicesectors. **(Lectures 8)**

Course Outcomes:

Upon completion of this course, the students will be able to use the tools and techniques of TQM in manufacturing and service sectors.

Text Books:

1. Besterfield D.H. et al., Total qualityManagement, 3rd ed., Pearson Education Asia,2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning,2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India,2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India,2006.

PEC-MEL 434	Energy Conservation and Management	3L:0T:0P	3 credits

Objectives:

To understand the energy data from industries and carry out energy audit for energy savings

Contents:

Module : 1

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energyauditing. **(Lectures 8)**

Module : 2

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting. **(Lectures 10)**

Module : 3

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories. **(Lectures 10)**

Module : 4

Energy Conservation in major utilities, pumps, fans, blowers, compressed, air systems, Refrigeration & Air Conditioning system, Cooling Towers, DG sets. **(Lectures 6)**

Module : 5

Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept. **(Lectures 6)**

Course Outcomes:

Upon completion of this course, the students will be able to perform of energy auditing for the energy consumption ofindustries.

Text Books:

1. Witte L.C. , Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington,1988..
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London,1987.
4. Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanagertraining.com).

PEC-MEL 435	Gas Dynamics and Jet Propulsion	3L:0T:0P	3 credits

Objectives:

1. To understand the features of compressible isentropic flows and irreversibility like shocks.
2. To provide a basic knowledge of jet and rocket propulsion technologies.

Contents:

Module : 1

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow, Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow. **(Lectures 12)**

Module : 2

Non-isentropic flow in constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables. **(Lectures 8)**

Module : 3

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines. **(Lectures 10)**

Module : 4

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.

(Lectures 10)

Course Outcomes:

Upon completion of this course, the students will be able to apply gas dynamics principles to jet and space propulsion systems.

Text Books:

1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press,2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley,1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York,1986.

OPEN ELECTIVE COURSES

Note: -

1. Out five Open Elective, Open Elective- I & V must be done through MOOCs (Massive Open Online Courses) or SWAYAM.
2. It must be a certificate course of required credit.
3. Open Elective-I should be selected from Humanities, Social Sciences or Management course.
4. Open Elective-V should be selected from any Engineering discipline available at MOOCs portal.

OEC-ME 201	Renewable Energy Systems	3L:0T:0P	3 credits

Pre-requisite: Basics of Thermodynamics, Heat Transfer and Electricity Generation.

Objective: An exposure of renewable energy systems and techniques to generate electricity on account of renewable energy sources.

Outcome: Knowledge of electricity generation from renewable energy sources such as solar, hydraulic, wind and bio-mass.

Module :1

Principles of Renewable Energy: Introduction, Energy and sustainable development, Fundamentals, Scientific principles of renewable energy, Technical implications, Social implications, Problems.

(**Lectures 6)**

Module :2

Solar radiation: Introduction, Extra-terrestrial solar radiation, Components of radiation, Geometry of collector and the solar beam, Effects of the Earth's atmosphere Measurements of solar radiation, Estimation of solar radiation, Solar water heating: Introduction, Calculation of heat balance: general remarks, Uncovered solar water heaters – progressive analysis, Improved solar water heaters, Evacuated collectors, Buildings and other solar thermal applications, Air heaters, Crop driers, Space cooling, Water desalination, Solar ponds, Solar concentrators, Solar thermal electric power systems, Problems. (**Lectures 12)**

Module: 3

Photovoltaic generation: Introduction, The silicon p–n junction, Photon absorption at the junction, solar radiation absorption, Maximizing cell efficiency, Solar cell construction, Applications, Problems.

(**Lectures 4)**

Module: 4

Hydro-power: Introduction, Principles, Assessing the resource for small installations, An impulse turbine Reaction turbines, Hydroelectric systems,The hydraulic ram pump, Problems. (**Lectures 6)**

Module: 5

Power from the wind: Introduction, Turbine types and terms, Linear momentum and basic theory, Dynamic matching, Blade element theory, Contents Characteristics of the wind, Power extraction by a turbine, Electricity generation, Mechanical power, Problems. (**Lectures 6)**

Module: 6 Biomass and Biofuels: Introduction, Biofuel classification, Biomass production for energy farming, Direct combustion for heat, Pyrolysis (destructive distillation), Further thermochemical processes, Alcoholic fermentation, Anaerobic digestion for biogas, Wastes and residues, Vegetable oils and biodiesel, Problems. (**Lectures 8)**

Text/Reference Books:

1. Renewable Energy Resources by Johan Twidell and Tony Weir, Taylors and Francis Publication
2. Solar Energy by G N Tiwari, Narosa Publication
3. Green Power: The Eco-Friendly Energy Engineering by Nikolai V.Khartchenko, Tbi Publication
4. Duffie J. A. & Beckman W.A., Solar engineering of thermal processes, Wiley- international Publication
5. Solar Energy principal of thermal collector and storage by SP Sukhatme and JK Nayak, TMH Publication
6. Renewable Energy Resources by G N Tiwari and M K Ghosal, Narosa Publication
7. Bansal Keemann, Meliss, Renewable energy sources and conversion technology, Tata Mc Graw Hill.
8. Kothari D.P., Renewable energy resources and emerging technologies, Prentice Hall of India Pvt. Ltd.

OEC-ME 202	Operations Research	3L:0T:0P	3 credits

Pre-requisite: NIL

Objective: To enable students to understand and apply operations research techniques in industrial operations for obtaining optimized solutions.

Outcome: Determination of optimal or near optimal solution to complex decision making problems.

Module:1

Introduction: Features of Operations Research (OR), Methodology of OR, Scopes and Objectives of OR, models in OR. (**Lectures 4)**

Module:2

Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis

Introduction and assumptions of LPP, Mathematical formulation of LPP, Graphical Method, Simplex Method. (**Lectures 9)**

Module :3

Transportation Problems: Introduction, North – West Corner Method, Least Cost Method, Vogel's Approximation Method, Test for Optimality. Assignment Problems: Introduction, Hungarian Assignment Method, Unbalanced Assignment Problems. (**Lectures 8)**

Module :4

Sequencing: Introduction, Formulation of Sequencing Problem, Johnson's Rule. Network Analysis: Introduction, PERT and CPM, Time – Cost Trade-off (Project Crashing), Resource Leveling. (**Lectures 7)**

Module :5

Dynamic Programming: Introduction, Deterministic Dynamic Programming, Probabilistic Dynamic Programming. Simulation: Introduction, Monte Carlo Simulation, Simulation of Inventory and Queuing System. (**Lectures 7)**

Module :6

Queuing Theory: Introduction, General Structure of Queuing System, Operating Characteristics of Queuing System, Queuing Models. Replacement Theory: Introduction, Replacement Policies: Gradually Deteriorating Equipments, Items that Fail Suddenly. (**Lectures 7)**

Text/Reference Books:

1. Operations research – An Introduction, Hamdy A Taha, 8th Edition, Pearson Education.
2. Introduction to Operations Research, Hillier and Lieberman, 8th Edition, TMH.
3. Operations Research, R Panneerselvan, 2nd Edition, PHI.
4. Quantitative Techniques in Management, N D Vohra, 4th Edition, McGraw Hill.

OEC-ME 203	Computational Fluid Dynamics	3L:0T:0P	3 credits

Pre-requisite: Heat Transfer and Numerical Analysis Techniques.

Objective: To introduce the CFD techniques and tools for modelling, simulating and analysing practical engineering problems with hands on experience using commercial software packages used in industry.

Outcome: Students are able to understand the use of different CFD techniques and tools for modelling, simulation and analysis of complex engineering problems.

Module :1

Introduction: Philosophy of Computational Fluid Dynamics, Computational Fluid Dynamics as a research tool, Computational Fluid Dynamics as a design tool, the impact of Computational Fluid Dynamics on automobile and engine applications, Industrial manufacturing applications, environmental engineering applications. (**Lectures 9)**

Module : 2

Governing equations of Computational Fluid Dynamics: Models of the flow, the substantial derivative, divergence of velocity, continuity equation, momentum equation, energy equation, Physical boundary conditions. (**Lectures8)**

Module : 3

Partial differential equations: General method of determining the classification of partial differential equations, The impact of different equation on Computational Fluid Dynamics: Hyperbolic equations, Parabolic equations and Elliptic equations . (**Lectures 6)**

Module : 4

Basic aspects of Discretization: Introduction to finite differences, Difference equations, Explicit and implicit approaches. (**Lectures 6)**

Module : 5

Grids with appropriate transformation: General transformation of the equations, Matrices and Jacobians, Stretched (compressed) grids. (**Lectures 5)**

Module : 6

Some Simple Computational Fluid Dynamics Techniques: Lax-Wendroff Technique, Mac Cormack's Technique, Relaxation Technique, Pressure Correction Technique, etc. (**Lectures 8)**

Text/Reference Books:

1. John D. Anderson, Jr. "Computational Fluid Dynamics", McGraw-Hill, Inc.

2. Date, A. W., "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005.

3. Sengupta, T. P. "Fundamental of Computational Fluid Dynamics", Orient Longman, Hyderabad, India, 2004.

OEC-ME 204	Safety Management	3L:0T:0P	3 credits

Objectives: This course is directed towards creating safety awareness, identifying hazards and mitigation of accidents along with introduction of legal requirements and following up action.
Outcome: After reading the course an engineer may develop confidence of over safe operations.

Module :1
Need, Modern safety concepts, OSHA norms. (**Lectures 3)**

Module :2
Safety Management function, Cost analysis of accidents, system safety analysis. (**Lectures 6)**

Module : 3
Hazards identification and control. Pressure hazard, fire hazard and Electrical hazard. **(Lectures 12)**

Module : 4
Hazard in construction industry, Hazard due to acceleration and fall, Mechanical hazard, Hazard due to heat and temperature. (**Lectures 11)**

Module : 5
Safe practices rules, Personal protective equipment. (**Lectures 4)**

Module :6
Ergonomics. (**Lectures 6)**

Text/Reference Books:

1. Safety Management - John V. Grimaldi& Rollin H Simmands.

2. Ergonomics at work - Osborne, D. J, John wiley&Sons.s
3. Industrial safety Handbook - Handey, W, Mcgraw Hill.
4. Designer's Guide to OSHA - Mcgraw Hill.
5. Handbook of occupational safety and Health - Johnwiley& Sons.
6. Industrial Accident Prevention – Heinrich, Hetal, Mcgraw Hill.

OEC-ME 205	Non-Conventional Manufacturing	3L:0T:0P	3 credits

Objective: To understand how the material removal by using various energy and to know how the new materials and complex parts are produced with high accuracy by using new technology.

Module:1

Introduction: Historical background of non-conventional machining processes, Classification, Basic fundamentals of various process and related comparison. (**Lectures 4)**

Module: 2

Mechanical Machining Process: Principle and working and applications of mechanical machining processes such as ultrasonic machining, water jet cutting. (**Lectures 7)**

Module: 3

Thermal and Chemical Machining Process: Principle and working and applications of thermal and chemical machining processes such as electro-discharge machining, electro-chemical machining. (**Lectures 7)**

Module: 4

Non-conventional welding process: Principle and working and application of non-conventional welding processes such as laser beam welding, electron beam welding, ultrasonic welding, plasma arc welding. explosive welding, cladding. under water welding, metallising. (**Lectures 10)**

Module: 5

Non-conventional forming process: Principle, working and applications of high energy forming processes such as explosive forming, electro-magnetic forming, electro-discharge forming, water hammer forming, explosive compaction. (**Lectures 10)**

Module :6

Introduction to Micro Manufacturing: Micro manufacturing fundamentals, significance, application of NCMPs for micro manufacturing, Micro to Nano finishing processing information. (**Lectures 4)**

Text Books/ References Books:

1. P.C. Pandey and H.S. Shah, *Modern Machining Processes*, Tata Mcgraw-Hill Publishing Co. Ltd, New Delhi, 1980.
2. A. Ghosh and A.K. Mallik, *Manufacturing Science*, 2nd edition, Affiliated East West Press, New Delhi.
3. G.F. Benedict, *Nontraditional Manufacturing Processes*, Marcel Dekker Inc., New York (ISBN 0-8247-7352-7), 1987.
4. V.K. Jain, *Advanced Machining Processes*, Allied Publishers, 2009.
5. J. A. Mc Geough, *Micromachining of Engineering Materials*, Taylor & Francis, 2001.

Outcome: Students will be able to understand the fundamentals of various non-conventional machining processes and their influence on performance and their applications.

INTERNSHIP AND SUMMER TRAINING							
Major Head of Activity	**Credits (Max.)**	**Period (Max.)**	**Total Duration**	**Sub Activity Head**	**Proposed Document As Evidence**	**Evaluated by**	**Performance**
INST-ME 203 Inter/Intra Institutional Activities	4	During summer vacation after 2d sem.	4 **Week**	Inter/ Intra Institutional Workshop/ Training	Certificate	Programme Head	Satisfactory/ Good/Excellent
				Working for consultancy/ research project	Certificate	Programme Head	Satisfactory/ Good/Excellent
				Festival Events (Technical/Business/ Others)	Certificate	Programme Head	Satisfactory/ Good/Excellent
				Contribution in Incubation/ Innovation/Entrepreneurship Cell/Institutional Innovation Council	Certificate	Cell In-charge	Satisfactory/ Good/Excellent
				Learning at Departmental Lab/Tinkering Lab/Institutional workshop	Certificate	Cell In-charge	Satisfactory/ Good/Excellent
INST-ME 305 Innovation / IPR / entrepreneurship	6	During summer vacation after 4th/sem	6 **Week**	Participation in innovation related competition for eg. Hackathons etc.	Certificate	Faculty Mentor	Satisfactory/ Good/Excellent
				Development of new product/ Business Plan/ registration of start-up Participation in all the activities of Institute's Innovation Council for IPR workshop/ Leadership Talks/ Idea/Design/ Innovation/ Business Completion/ Technical Expos etc.	Certificate	Programme Head	Satisfactory/ Good/Excellent
				Work experience at family business	Certificate	President/ Convener of ICC	Satisfactory/ Good/Excellent
INST-ME 402 Internship	6	During summer vacation after 4th/ 6th sem.	6 **Week**	Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ Online Internship	Certificate	TPO	Satisfactory/ Good/Excellent

MOOCs

A massive open online course (MOOCs) is an online course aimed at unlimited participation and open access via the web. In addition to traditional course materials, such as filmed lectures, readings, and problem sets, many MOOCs provide interactive courses with user forums to support community interactions among students, professors, and teaching assistants, as well as immediate feedback to quick quizzes and assignments. MOOCs are a recent and widely researched development in distance education, first introduced in 2006 and emerged as a popular mode of learning.

Links:

1. http://mooc.org/
2. https://www.edx.org/course

SWAYAM

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM are in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, nine National Coordinators have been appointed: They are AICTE for self-paced and international courses, NPTEL for engineering, UGC for non-technical post-graduation education, CEC for under-graduate education, NCERT & NIOS for school education, IGNOU for out of the school students, IIMB for management studies and NITTTR

for Teacher Training programme.

Links:

1. https://swayam.gov.in/