Courses of Study

Semester VII

B.Tech Mechanical Engineering

(Batch 2023 Onwards)

Department of Mechanical Engineering

Islamic University of Science and Technology, Kashmir

Table of Contents

Detailed Syllabus for 7th Semester

Total Credits = 25+X *Total Hours Per Week = 32*

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC403C	Fluid Machines and Fluid Power	3	0	0	0	3	3
2	MEC404C	Metrology and Instrumentation	3	0	2	0	5	4
3	MEC405C	Production and Operations Management	3	1	0	0	4	4
4	MEC406C	Innovation and Entrepreneurship	2	0	0	0	2	2
5	MEC413C	Industrial Engineering and Ergonomics Lab	0	0	2	0	2	1
6	MEC414C	Experiments on Advanced Energy Systems	0	0	2	0	2	1
7	MEC415C	Minor Project	0	0	8	0	8	4
8	MECXXXE	Discipline Centric Elective - II[1]	3	0	0	0	3	3
9	XXXXXXG	Generic Elective - II[2]	3	0	0	0	3	3
10		Open Elective						X

Notes:

[1] Discipline Centric Electives are offered to the students of the Department of Mechanical Engineering only. The students have to choose Discipline Centric Electives from the list of courses floated by the department only.

[2] Generic Electives are offered to the students of the School of Engineering and Technology including the students of the Department of Mechanical Engineering. The credits corresponding to Generic Elective - II can alternatively be obtained through MOOCs platform, like NPTEL, or from the Minor Degree Course list subject to the approval of the Head of the Department.

Discipline Centric Elective - II

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC407E	Introduction to Acoustics	3	0	0	0	3	3
2	MEC408E	Additive Manufacturing	3	0	0	0	3	3
3	MEC409E	Fundamentals of Composite Materials	3	0	0	0	3	3
4	MEC410E	Propulsion Technology	3	0	0	0	3	3
	MEC411E	Numerical Modelling of Energy Systems	2	0	2	0	4	3

Generic Elective - II

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC404G	Conservation of Energy in Buildings	3	0	0	0	3	3
2	MEC406G	Product Design and Development	3	0	0	0	3	3

MEC403C Fluid Machines and Fluid Power 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand the working of turbines
2. Understand the working of pumps.

Course Outcomes: At the end of this course, a student will be able to:

1. Interpret and explain fundamentals of fluid power.
2. Determine power generated by a turbine and its efficiency.
3. Explain the working of pumps and determine their efficiency.
4. Explain the working of various hydrostatic and hydrokinetic systems..
5. Explain the use of fluids as part of a control system

Module I

Hydraulics: Power plant layout, hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency-angular momentum principle, applications to radial flow turbines.

Module II

Hydraulic Turbines: Classification; energy transfer between rotor and fluid in turbomachines; impulse and reaction turbines-Pelton, Francis, Kaplan and tubular turbines – theory, losses, efficiencies, performance curves; draft tube, cavitation, governing, similarity laws, specific speed, model testing, governing, instrumentation for testing of hydraulic machines.

Module III

Pumps: Classification; centrifugal & axial flow pumps– theory, working principle, heads, losses, efficiencies, performance curves, surging, cavitation, Reciprocating Pump, gear pump, vane pump and screw pump.

Module IV

Hydraulic systems: Hydrostatic systems- pressure accumulator, intensifier, hydraulic lift, hydraulic jack, hydraulic press. Hydrokinetic systems - fluid coupling, fluid torque converter, fluid brakes in automobiles.

Module V

Fluidics: Introduction, terminology, types of fluid logic element, turbulence amplifier, vortex amplifier, logic states, methodology of obtaining input signals and output power, application examples.

Pre-requisites: Fluid Mechanics

Text Books:

1. F. M. White, Fundamentals of Fluid Mechanics, McGraw Hill Education.
2. D. J. Shepherd, Principles of Turbo-Machines, McGraw Hill Education.

Reference Books:

1. B. R. Munson, Fundamental of Fluid Mechanics, John Wiley & Sons.
2. J. Lal, Hydraulic Machines, S Chand Publishers

Online Resources:

1. Fluid Mechanics by Prof John Biddle (California State Polytechnic University, Pomona) (https://www.cpp.edu/meonline/fluid-mechanics.shtml?gclid=CjwKCAjwzo2mBhAUEiwAf7wjkjD8bCq158MT7UmAWp2LvrCbRbI8xPcp1RvCJwAVPoCyV3yprrO3BBoCtMUQAvD_BwE.)

MEC404C Metrology and Instrumentation 3-0-2-0

Course Objectives: This course aims to provide students with comprehensive knowledge of metrology and measurement systems in mechanical engineering, including principles of measurement, system components, and errors and uncertainties. Students will learn various measurement techniques for length, angle, surface, and non-destructive testing, as well as measurement of thermal and fluid properties, forces, stress, and strain. The course also aims to equip students with comprehensive knowledge and practical skills in metrology and instrumentation, enabling accurate measurement of dimensional parameters using basic and advanced measurement techniques.

Course Outcomes: At the end of this course, a student will be able to:

1. Acquire comprehensive knowledge about metrology, measurement systems, accuracy, and uncertainties.
2. Comprehend various measurement techniques used for length, angle, surface, and non-destructive testing.
3. Demonstrate proficiency in performing thermal and fluid properties measurements, forces, stress, and strain measurements.
4. Explain the optical and laser-based techniques, digital metrology setups, and their applications in Industry 4.0.
5. Demonstrate accurate measurement skills, perform calibration procedures, measure the mechanical properties like flow, pressure, temperature, force, etc. and make use of modern sensors for measurements.

Module I

Introduction to Metrology and Instrumentation: Definition, importance, and applications of metrology in mechanical engineering, Basic principles of measurement: accuracy, precision, resolution, and repeatability, Measurement system components: sensors, transducers, signal conditioning, and data acquisition, Errors and uncertainties in measurements: systematic and random errors, calibration.

Module II

Measurement Techniques and Instruments: Limits Fits and Tolerances, Length measurement techniques: vernier callipers, micrometres, and gauge blocks, Angle measurement: protractors, sine bars, and autocollimators. Measurement of surface roughness, flatness, and roundness: profilometers, Non-destructive testing techniques: ultrasonic testing.

Module III

Measurement of Thermal and Fluid Properties: Temperature measurement: thermocouples, resistance temperature detectors (RTDs), and thermistors. Pressure measurement: manometers, Bourdon gauges, and pressure transducers. Flow measurement: venturimeter, orifice plate, and flowmeters. Recent advances in development of sensors for thermal, fluid, and pressure sensing applications.

Module IV

Measurement of Forces, Torque, Stress, and Strain: Measurement of forces: load cells, strain gauges, and force transducers, Stress and strain measurement: strain gauges, rosette analysis, and stress concentration factors, Strain measurement for structural health monitoring and material characterization. Recent advances in development of sensors for force, torque, stress and strain

measurement.

Module V

Optical and laser-based measurement techniques: interferometry, laser doppler velocimetry (LDV), and laser scanning, Metrology of Gears and Screw Threads, Digital Metrology Setups and Industry Revolution 4.0, Thermal Measurement and Data-Acquisition Considerations.

Pre-requisites: Basic Mechanical Engineering, Mechanics of Materials, Manufacturing Processes

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List of Experiments:

1. Measurement of Dimensional Parameters:
    i. Vernier Caliper: Measurement of length, diameter, and thickness.
    ii. Micrometer Screw Gauge: Measurement of external and internal dimensions.
    iii. Measurement of small linear displacements and runout using dial indicator
2. Measurement of Flatness, Roughness, and Roundness:
    i. Measurement of flatness using a Granite Surface Plate and Dial Indicators.
    ii. Measurement of roughness using a surface roughness tester.
    iii. Measurement of roundness using a roundness tester.
3. Calibration of Bourdon Tube Pressure Gauge using a Deadweight Tester.
4. Calibration of Digital Pressure Gauge with a known reference.
5. Calibration of Thermocouples using a thermo setted temperature bath.
6. Calibration of Resistance Temperature Detectors (RTDs) using a Wheatstone bridge.
7. Calibration of flowmeters (orifice, venturi, or magnetic) using a volumetric tank and measurement of flow rate.
8. Strain Measurement: Introduction to Strain Gauges and Wheatstone Bridge, Measurement of strain on a cantilever beam subjected to loads.
9. Measurement of vibrations using accelerometers and data acquisition systems.
10. Analysis of vibration data using Fast Fourier Transform (FFT).
11. Measurement of Force and Torque and calibration of load cells and torque transducers using standard weights.

Text Books:

1. N. V. Raghvendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press.
2. S. Mekid, Metrology and Instrumentation: Practical Applications for Engineering and Manufacturing, Wiley-ASME Press.
3. T. G. Beckwith, R. D. Marangoni, and J. H. Lienhard, Mechanical Measurements, Pearson

Reference Books:

1. K. J. Hume, T. G. Hume, Metrology for Engineers, Butterworth-Heinemann

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Online Resources:

1. Engineering Metrology, By Prof. Janakranjan Ramkumar & Prof. Amandeep Singh (IIT Kanpur), NPTEL Course (https://onlinecourses.nptel.ac.in/noc19_me70).

MEC405C Production and Operations Management 3-1-0-0

Course Objectives: This course will enable students to get knowledge on production and operation management techniques that develop relationships between market demand and production capability with due consideration to quality assurance of the products and the optimality of the process in terms of resources and time management.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the scope and basics of production management.
2. Describe the various scientific approaches, tools, and techniques used in project management.
3. Apply production planning and control techniques and inventory management models.
4. Apply the tools and techniques for factory management.
5. Make decisions, and obtain optimal solutions for various situations/problems in production planning and management through the use of operation research tools.

Module I

Introduction: Scope of production management. Production system and resources (machines, tooling, etc.); Types of production, Roles of line supervisors and production managers.

Module II

Project Management: Project life cycle: concept phase, Project initiations, DPR preparation; Project planning: Project team, producing quality outputs, handling risk, acceptance criteria; Project execution; Project Monitoring and control: Project networks, progress review, CPM and PERT, critical path, re-scheduling; Project closure: acceptance of project deliverables; Analytics: Performance, capability aggregation, cost benefit analysis, variability analysis, Output-outcome analysis, project documentation, best practices, and depository.

Module III

Production Planning and Control: Production planning, Process planning, Resource planning, demand-utility mapping (production capability index, forecasting models, aggregate production planning, materials requirement planning); Inventory Management: Economic order Quantity, discount models, stochastic inventory models, practical inventory control models, JIT; Supply chain and management.

Module IV

Factory Management: Factory layout: line balancing, material flow and handling, Lean and green manufacturing, Human resource management, Training need analysis, Advantage and opportunities for Digitalization, Advanced factory systems: TQM; Important acts, regularities and safety norms, Reliability assessment of processes, Process capability, lean manufacturing.

Module V

Operations Management: Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment; Simple queuing theory models; Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model.

Pre-requisites: NA

Text Books:

1. R. Panneerselvam, Production and Operations Management, Prentice Hall India, 2012.
2. L. J. Krajewski and L. P. Ritzmen, Operations Management: Strategy and Analysis, Pearson, 2001.
3. W. J. Hopp and M. L. Spearman, Factory Physics: Foundations of Manufacturing Management, McGraw Hill, 2000.
4. H. A. Taha, Operations Research: An Introduction, Prentice Hall India, 1997.

Reference Books:

1. R. B. Chase, F. R. Jacobs and N. J. Aquilano, Operations Management for Competitive Advantage, Tata McGraw Hill, 2003.
2. B. Mahadevan, Operations Management: Theory and Practice, Pearson, 2015.
3. M. P. Poonia and S. C. Sharma, Total Quality Management, Khanna Publishing House, 2020.

Online Resources:

1. Production and Operations Management by Prof. Rajat Agarwal (IIT Roorkee), SWAYAM/NPTEL Course (https://onlinecourses.nptel.ac.in/noc20_mg06/preview).

MEC406C Innovation and Entrepreneurship 2-0-0-0

Course Objectives: This course aims to expose aspiring student entrepreneurs to various elements of a technology venture, from market need identification to innovative solution development and its commercialization through business planning and start-up company incubation.

Course Outcomes: At the end of this course, a student will be able to:

1. To understand the essential concepts of entrepreneurship.
2. Develop innovative ideas and demonstrate an understanding of the entrepreneurial process, including opportunity recognition, feasibility analysis, and market validation.
3. Apply relevant tools and techniques for marketing, financing, and scaling a startup.

Module I

Entrepreneurship: concept, characteristics, and prerequisites. Classification of entrepreneurship. Factors underlying the success and reasons for the failure of entrepreneurship. Role of entrepreneurship in economic development. Challenges in starting a new venture.

Module II

New product development: New product development lifecycle, Product-market fit validation. Creativity and innovation, Understanding the creative process. Developing ideas and business opportunities—methods of generating new ideas, Opportunity scanning,

Module III

Product Innovation: Definition and Significance of Product Innovation The role of innovation in business strategy. Market analysis and feasibility planning. Writing and presentation of a business plan.

Module IV

Design & prototyping: Importance of design and prototyping. Design thinking and the design process. Introduction to prototyping tools and materials. Functionality and manufacturability. Intellectual property rights. Intellectual property infringement.

Module V

Marketing & Finance: Marketing and Sales for Entrepreneurs, Product positioning and branding, Sales strategies, and customer acquisition. Financing the venture-early-stage financing, and growth funding. Source of funding for startup ventures; financial projections and accounting; Startup to scale up financing. Entrepreneurial support system in India Social impact & responsibility.

Pre-requisites: NA

Text Books:

1. J. Bessant and J. Tidd, Innovation and Entrepreneurship, Wiley,(2015).
2. D. F. Kuratko and R. M. Hodgetts, Entrepreneurship: Theory, Process, and Practice, Cengage Learning, (2018).
3. D. Byers, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill,
4. B. R. Barringer and R. D. Ireland, Entrepreneurship: Successfully Launching New Ventures, Pearson, (2019).

Reference Books: NA

Online Resources:

1. https://archive.nptel.ac.in/courses/110/106/110106141/

MEC413C Industrial Engineering and Ergonomics Lab 0-0-2-0

Course Objectives: This course will enable students to develop skills in production planning simulation and to apply the concepts of human factors considerations and work study tools in industrial practice.

Course Outcomes: At the end of this course, a student will be able to:

1. Conduct modelling and simulation exercises on production planning using software.
2. Use ergonomic and human factors in the design of various products.
3. Apply work study tools to enhance productivity in industrial units.

List of Exercises and Experiments

1. Introduction to Witness simulation software: Modelling overview, conducting a simulation project, witness rules. Exercises on witness simulation software on the following:
    i. Manufacturing modelling
    ii. Warehouse modelling
    iii. Multi-cycle machine and labour modelling
    iv. Supply chain and logistics modelling
2. Experiment on the effect of background noise/music on cognitive task performance.
3. Experiment on body movement ranges with special emphasis on head, leg, arm and hip.
4. Experiment on anthropometric considerations for seating.
5. Exercise-cum-mini project on ergonomic considerations in the design specifications of a product.
6. Exercise on the application of method study approach to analyse the motions involved in machining operation of a given job.
7. Exercise on application of work measurement technique to analyse the time components involved in machining operation of a given job.
8. Study suitable movements/travel of man, material or equipment, and draw string diagrams, travel charts and flow diagrams.
9. Introduction to softwares for project managers like Lucidchart, Microsoft Project, Smartdraw etc.
10. Exercises on PERT/CPM charts using software packages.

Pre-requisites: NA

Online Resources:

1. https://www.lanner.com/en-gb/technology/witness-simulation-software.html

MEC414C Experiments on Advanced Energy Systems 0-0-2-0

Course Objectives: This course aims to provide practical knowledge in calculating different parameters involved in a psychrometric process and design the air conditioning system for human comfort. The students will learn the methods of estimating cooling and heating loads on rooms/ buildings. Students learn about the working of solar panels in different conditions and the functions of components for the effective design of solar panels. The course will also introduce the students to non-conventional energy devices.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the fundamental principles and applications of the air conditioning system.
2. Explain the procedure and estimation of cooling and heating load
3. Design a duct network for air conditioning systems.
4. Describe the working of solar panels in different conditions and the functions of components used to generate electricity from solar panels.
5. Explain the principles of different energy storage systems.

List of Experiments:

1. Study of psychrometry of air conditioning processes using an air conditioning test rig.
2. Determination of relation between temperature, time and input power of underfloor heating system.
3. Estimation of cooling load for a laboratory.
4. Performance analysis of a Peltier based cooling system.
5. Design and analysis of air distribution ducting systems.
6. Plot a wind rose at a particular location.
7. Plot PV characteristic curve of a solar panel.
8. Study, sizing, simulation and data analysis of complete PV systems.
9. Performance analysis of a solar thermal system.
10. Performance analysis of a Hydrogen FC System.
11. Comparative study of various automotive battery technologies.

Pre-requisites: Refrigeration and Air Conditioning, Renewable Energy Engineering.

Text Books:

1. C. P. Arora, Refrigeration and Air Conditioning, McGraw Hill Education (India), 3rd edition, 2017.
2. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education (India). 2nd edition, 2017.

Reference Books:

1. S. P. Sukhatme and J. K. Nayak, Solar Energy, McGraw Hill Education (India). 4th edition, 2017.
2. J. Twidell and T. Weir, Renewable Energy Resources, Routledge, 3rd edition, 2015.

Online Resources: NA

MEC407E Introduction to Acoustics 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand the basic concept of acoustic waves and their interaction with discontinuities.
2. Acquire the knowledge of design problems related to acoustics.

Course Outcomes: At the end of this course, a student will be able to:

1. Analyse linear acoustic wave problems and explain hearing and sound perception.
2. Predict reflection and transmission of design partitions.
3. Model and analyse problems related to radiation, scattering and diffraction.
4. Evaluate the losses during the transmission of sound wave.
5. Analyse and design solutions for practical problems related to acoustics of large and small enclosures.

Module I

Introduction to Acoustic Wave and its Solution: 1D acoustic wave equation, acoustic intensity and energy, units of sound, hearing and perception, analysis methods of linear acoustic wave equation.

Module II

Reflection and Transmission: Normal incidence from one fluid to another, Mass law, transmission loss at a partition, oblique incidence (Snell's law), transmission and reflection from an infinite and finite structure.

Module III

Radiation of Acoustic Wave: Radiation from a breathing and trembling sphere, Kirchoff-Helmholtz Integral equation, baffled piston, finite vibrating plate, diffraction, scattering.

Module IV

Absorption and Attenuation of Sound: Absorption from viscosity and thermal conduction, absorption coefficient, viscous losses at walls, Sound in enclosures, Sabine's theory, direct and reverberant field, characteristics of sound in small space, duct acoustics.

Module V

Acoustics of Enclosed Spaces: Sound Field in a Room, Acoustics of a Partition Wall, Design of Acoustic Enclosures, Noise Reduction of a Partition Wall and Enclosure, Acoustics of Barriers. Simple Expansion Chamber, Plug Muffler, Absorptive Ducts and Mufflers, Acoustic Source Characteristics of I.C. Engines, Design of Muffler Shell and Plates, Helmholtz Resonators, Active Noise Control in a Duct.

Pre-requisites: Mechanical Vibrations

Text Books:

1. Y. Kim, Sound Propagation, An impedance based approach, John Wiley and Sons Inc 1st edition, 2010.
2. D. T. Blackstock, Fundamentals of Physical Acoustics, John Wiley and Sons Inc 1st edition, 2000.
3. L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, Fundamentals of Acoustics, John Wiley and Sons Inc 4th edition, 2000.

Reference Books:

1. M. Bruneau, Fundamentals of Acoustics, John Wiley and Sons 1st edition, 2006.

Online Resources:

1. Acoustics, by Prof. N. Tiwari (IIT Kanpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/104/112104026/)

MEC408E Additive Manufacturing 3-0-0-0

Course Objectives: This course will enable students to:

1. Develop understanding of additive manufacturing (AM) technologies.
2. Provide an overview of how computers can be utilised in additive manufacturing.
3. Develop the ability to use the AM techniques appropriate for mechanical engineering applications.
4. Apply knowledge of additive manufacturing in a wide variety of applications.

Course Outcomes: At the end of this course, a student will be able to:

1. Understand the overall principle and various processes for additive manufacturing.
2. Select a particular additive manufacturing process based on the application.
3. Plan the steps in fabricating a given part using additive manufacturing.
4. Understand various equipment and specifications of Additive Manufacturing technology.
5. Apply additive manufacturing technologies in product development life cycle.

Module I:

Introduction to Additive Manufacturing (AM): Evolution of AM/3D printing; Comparison with subtractive and forming processes; Advantages of AM; Classification of AM processes; Key steps in AM. Preparation of cad models – the STL file, problems with STL files, STL file manipulation

Module II:

Liquid State-based AM Processes: Stereolithography – Process and working principle; Photopolymers; Photo polymerization, layering technology, Laser and Laser scanning; Micro-stereo lithography; Equipment and specifications; Applications, advantages, disadvantages, examples; Solid ground curing: Process, Working principle; Equipment and specifications; Applications, advantages, disadvantages, examples.

Module III:

Solid State-based AM Processes: Fused Deposition Modeling – Process, working principle and materials; Equipment and specifications; Laminated object manufacturing – Process and working principle; Equipment and specifications; Applications, advantages, disadvantages, examples; Other solid-state processes – Ultrasonic consolidation, Gluing, Thermal bonding; Demonstration of equipment.

Module IV:

Powder Based AM Processes: Powder Bed Fusion Processes – Working principle and materials; Powder fusion mechanism and powder handling; Various LBF processes (principle, materials, applications and examples) – Selective laser Sintering, Electron Beam Melting, Laser Engineered Net Shaping, Binder Jetting and Direct Metal Deposition; Comparison between LBF processes; Materials-process-structure-property relationships; relative advantages and limitations.

Module V:

Applications of AM: Product development lifecycle applications – Rapid prototyping, concept models, visualisation aids, replacement parts, tooling, jigs and fixtures, moulds and casting; Application sectors – aerospace, automobile, medical, jewellery, sports, electronics, food, architecture, construction and others.

Pre-requisites: NA

Text Books:

1. S. Soloman, 3D Printing & Design, Khanna Book Publishing Company, New Delhi,2020.C.
2. I. Gibson, D. W. Rosen and B. Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015.

Reference Books:

1. V. K. Patri and M. Weiyin, Rapid prototyping: laser-based and other technologies. Springer Science & Business Media, 2013.
2. I. Gibson, D. Rosen, and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, New York, NY, 2015.
3. Kumar, L. Jyothish, P. M. Pandey, and D. I. Wimpenny, eds. 3D printing and additive manufacturing technologies. Singapore: Springer, 2019.
4. Jacobs, F. Paul. "Fundamentals of stereolithography." In 1992 International Solid Freeform Fabrication Symposium. 1992.
5. C. K. Chua, L. K. Fai, "3D Printing and Additive Manufacturing: Principles & Applications," World Scientific, 2015.
6. C. P. Paul, A. N. Junoop, "Additive Manufacturing: Principles, Technologies and Applications," McGrawHill, 2021.

Online Resources:

1. Fundamentals of Additive Manufacturing Technologies By Prof. Sajan Kapil, IIT Guwahati, (https://onlinecourses.nptel.ac.in/noc22_me122/preview)

MEC409E Fundamentals of Composite Materials 3-0-0-0

Course Objectives: This course will enable students to:

1. Identify and explain the need for composite materials.
2. Acquire knowledge on classification of composite materials.
3. Know the fundamentals of composite materials.

Course Outcomes: At the end of this course, a student will be able to:

1. Explain the advantages of using composite materials as an alternative to conventional materials for specific applications
2. Describe the advanced fabrication and processing for producing composite parts.
3. Explain the significance of Metal matrix composites with reference to various applications.
4. Discuss the fabrication and processing of ceramic based composites.
5. Analyse and comprehend the mechanics behind the properties of composite materials.

Module I

Introduction to Composites: Fundamentals of Composites, Need For Composites, Classification Of Composites, Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Particle Reinforced Composites, Fibre Reinforced Composites.

Module II

Polymer Matrix Composites: Polymer Resins, Thermosetting Resins, Thermoplastic Resins, Reinforcement Fibres, Various Types Of Fibres, PMC Processes, Hand Lay Up Processes, Spray Up Processes, Compression Moulding, Reinforced Reaction Injection Moulding, Resin Transfer Moulding, Filament Winding, Injection Moulding, Fibre Reinforced Plastics, Glass Fibre Reinforced Plastics, Laminates.

Module III

Metal Matrix Composites: Characteristics Of metal matrix composites, Types Of Metal Matrix Composites, Reinforcements, Rule Of Mixtures, Processing Of metal matrix composites, Powder Metallurgy Process, Diffusion Bonding, Stir Casting, Squeeze Casting, Interface Properties.

Module IV

Ceramic Matrix Composites: Ceramic Materials, Types Of Ceramic Matrix Composites, Oxide Ceramics, Non Oxide Ceramics, Reinforcements, Sintering, Hot Pressing, Cold and hot Isostatic Pressing, Processing Of Ceramic Matrix Composites.

Module V

Mechanics Of Composites: Lamina Constitutive Equations, Lamina Assumptions, Homogeneous Orthotropic Lamina, Isotropic Limit Case, Orthotropic Stiffness Matrix, Stress and Strain Displacement Relations, Basic Assumptions Of Laminated Anisotropic Plates, Laminate Constitutive Equations.

Pre-requisites: NA

Text Books:

1. F. L. Mathews and R. D. Rawlings, Composite Materials: Engineering and Science, Chapman & Hall Publications

Reference Books:

1. K. K. Chawla, Composite Materials, Springer Publications.
2. T. W. Clyne and P. J. Withers, Introduction to Metal Matrix Composites, Cambridge University Press.
3. S. C. Sharma , Composite Materials, Narosa Publications.
4. L. J. Broutman and R. M. Krock , Modern Composite Materials, Addison-Wesley Publications.

Online Resources:

1. Introduction to Composites by Prof. N. Tiwari (IIT Kanpur), NPTEL Course (**https://archive.nptel.ac.in/courses/112/104/112104229/**).

MEC410E Propulsion Technology 3-0-0-0

Course Objectives: This course will enable students to:

1. Learn about the fundamentals of propulsion technology.
2. Describe flow through the diffuser and nozzle of a jet engine.
3. Classify different types of compressors used in jet engines.
4. Learn about combustion processes in a jet engine

Course Outcomes: At the end of this course, a student will be able to:

1. Explain different types of jet engines and parameters affecting the performance.
2. Analyse the various parameters governing flow through diffusers.
3. Explain the principles of axial and centrifugal compressors used in jet engines and factors affecting the performance of these compressors.
4. Explain the combustion phenomena occurring in a jet engine and factors affecting the combustion performance.
5. Explain the flow through nozzles and various parameters affecting its performance.

Module I

Introduction to Aircraft propulsion: Introduction to propulsion and thermodynamic cycles, Types of aircraft engines Performance parameters, fundamental equations, factors affecting thrust and efficiencies.

Module II

Diffusers: Subsonic inlet and Internal flow, Major features of external flow: stagnation conditions, Relation between minimum area ratio and external deceleration ratio, Supersonic inlets, Shock swallowing by area variation, External deceleration, Modes of inlet operation.

Module III

Axial compressors: Working principle of axial compressor of jet engines, Degree of reaction, Compressor blade design & stage performance calculation, , Axial compressor performance characteristics.

Centrifugal compressors: Working principle of centrifugal compressor of jet engines, Work input and pressure rise, Inducer and impeller, Compressor stage design, Concept of pre-whirl rotation, stall, Performance characteristics.

Module IV

Combustion chambers: Classification of combustion chambers, Important factors affecting combustion chamber design, Combustion process, Combustion chamber performance, Effect of operating variables on performance, Flame tube cooling, Flame stabilisation, Use of flame holders.

Module V

Nozzles: Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions, Nozzle efficiency, Losses in nozzles, Over expanded, under expanded nozzles, Ejector and variable area nozzles, Shock waves.

Pre-requisites: Applied Thermodynamics

Text Books:

1. V. Babu, Fundamentals of Propulsion, ANE Books.
2. S.M. Yahya, Fundamentals of Compressible Flow with aircraft and rocket propulsion, New Age International publishers, 3rd edition.
3. H. Cohen, H.I.H. Saravanamuttoo, G.F.C. Rogers, P. Straznicky and A.C .Nix, Gas turbine Theory, Pearson.
4. E. Rathakrishnan, Gas Dynamics, PHI learning.

Reference Books:

1. P. G Hill and C. R. Peterson, Mechanics & Thermodynamics of Propulsion, Pearson Education, 2nd edition.
2. H. S. Mukunda, Understanding Aerospace Chemical Propulsion, I K International Publishing House Pvt. Ltd.

Online Resources:

1. Introduction to Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay, NPTEL course, (https://www.youtube.com/playlist?list=PLbMVogVj5nJS7srFCd_hJwdgHRd27YMgF).

MEC411E Numerical Modelling of Energy Systems 2-0-2-0

Course Objectives: This course will enable students to:

1. Correlate physical phenomena and mathematical models.
2. Model simple fluid flows.
3. Model heat transfer problems

Course Outcomes: At the end of this course, a student will be able to:

1. Interpret mathematical models for physical phenomena.
2. Apply numerical methods to solve fluid flow problems.
3. Apply numerical methods to solve heat conduction problems.
4. Apply numerical methods to solve convection problems.
5. Analyse the behaviour of energy systems using simulation software.

Module I

Introduction: Methods of performance prediction: theoretical calculation, numerical simulation and experimental investigation; mathematical description of physical phenomena, governing differential equations: energy, momentum, Boundary conditions, Discretization: methods of discretization.

Module II

Calculation of Flow Field: momentum equations for a source-sink, flow around blunt bodies, boundary layer flow, and airfoils, modelling of pipe flows, modelling of compressible flows

Module III

Heat Conduction: numerical analysis of steady 1-D heat conduction, heat conduction equation with heat generation, linearization of source term, solution of algebraic equations, unsteady one-dimensional conduction, explicit and implicit schemes.

Module IV

Convection and Diffusion: Steady 1-D convection and diffusion: derivation, discretization, upwind scheme, hybrid scheme; reaction of species and mass transfer

Module V

Thermal Systems Modelling: Modelling of composite wall, heat exchangers, extended surfaces, modelling of energy storage systems- solar thermal, hydrogen, phase change materials using COMSOL/open source software

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Pre-requisites: Fluid Mechanics and Machines, Heat and Mass Transfer

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Text Books:

1. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis
2. G. Biswas and S. Mukherjee , Computational Fluid Dynamics, Narosa

Reference Books:

1. F. M. White, Fundamentals of Fluid Mechanics, McGraw Hill Education
2. F. P. Incropera and D. P. Dewitt, Fundamentals of Heat & Mass Transfer, McGraw Hill.
3. W. F. Stoecker, Design of Thermal Systems, McGraw Hill Education

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Online Resources:

1. Design and Optimization of Energy Systems by Prof. C Balaji (IIT Madras), NPTEL Course (https://nptel.ac.in/courses/112106064).

MEC404G Conservation of Energy in Buildings 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand energy efficient buildings and thermal comfort.
2. Acquire the knowledge of heating and cooling of buildings using renewable energy.
3. Learn to estimate the building load.

Course Outcomes: At the end of this course, a student will be able to:

1. Analyse energy efficient buildings.
2. Explain different methods to maintain comfort in a building.
3. Describe heating and cooling of a building using renewable sources of energy.
4. Estimate building load using various methods

Module I

Climates and Buildings: Thermal properties and energy content of building materials, Building envelope, Insulation, Energy efficient roofing & Wall systems, Energy efficient fenestrations & Glazing technology. Lighting (Daylighting and Electric lighting).

Module II

Comfort Systems: Mechanical systems and equipment, Psychrometry, heating, ventilation, and air conditioning, Energy conservation techniques in air conditioning systems, service hot water heating. Passive and active methods of heating and cooling.

Module III

Renewable Energy Systems: Renewable Energy use in Buildings, Solar collectors, Photovoltaic cells, Active and passive Solar heating and cooling of buildings, use of wind energy in buildings.

Module IV

Estimation of Building Loads: Steady state method, Network method, Numerical methods, Computer packages for carrying out thermal design of buildings and predicting performance.

Pre-requisites: NA

Text Books:

1. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.
2. J. R. Williams, Passive Solar Heating, Ann Arbar Science, 1983.

Reference Books:

1. R.W. Jones, J. D. Balcomb, C. E. Kosiewiez, G. S. Lazarus, R. D. McFarland and W. O. Wray, Passive Solar Design Handbook, Vol. 3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.
2. J. L. Threlkeld, Thermal Environmental Engineering, Prentice Hall, 1970.

Online Resources:

1. Energy Efficiency, Acoustics and Daylighting in Building by Dr. B. Bhattacharjee (IIT Delhi), NPTEL Course, (https://nptel.ac.in/courses/105102175).
2. Sustainable Materials and Green Buildings by Dr. B. Bhattacharjee (IIT Delhi), NPTEL Course (https://archive.nptel.ac.in/courses/105/102/105102195/).

MEC406G Product Design and Development 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand and describe the product development process and its various tools.
2. Give an overview about the importance of DFM (Design for Manufacturing) and DFE (Design for the Environment) in product development.

Course Outcomes: At the end of this course, a student will be able to:

1. Identify and analyse the product design and development processes in the manufacturing industry.
2. Select an appropriate product design and development process for a given application.
3. Analyse, evaluate and apply the methodologies for product design, development and management.
4. Undertake a methodical approach to the management of product development to satisfy customer needs.
5. Carry out cost and benefit analysis through various cost models

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Module I

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. **Development Processes and Organizations:** A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization. **Product Planning:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process

Module II

Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process**.**

Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

Concept Generation: The activity of concept generation, clarifies the problem, search externally, search internally, explore systematically, and reflect on the results and the process.

Module III

Concept Selection: Overview of methodology, concept screening, and concept scoring,

Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process.

Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Module IV

Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

Module V

Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes.

Product Development Economics: Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

Pre-requisites: NA

Text Books:

1. K. T. Ulrich, Product Design and Development - Steven D Eppinger - Irwin McGraw Hill.

Reference Books:

1. A. C. Chitale and R. C. Gupta, Product Design and Manufacturing, PH1, - 3rd Edition, 2003.
2. T. B Heinmann, New Product Development, Oxford. UCI -1997.

Online Resources:

1. Product Design and Development by By Prof. Inderdeep Singh (IIT Roorkee), NPTEL Course (Product Design and Development - Course (nptel.ac.in)
