Courses of Study

Semester III

B.Tech Mechanical Engineering

(Batch 2023 Onwards)

Department of Mechanical Engineering

Islamic University of Science and Technology, Kashmir

Table of Contents

Detailed Syllabus for 3rd Semester

Total Credits = 18 *Total Hours Per Week = 22+2*[1]

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC204C	Machine Drawing and Solid Modelling	1	0	4	0	5	3
2	MEC206C	Engineering Thermodynamics	3	0	0	0	3	3
3	MEC207C	Manufacturing Processes I	3	0	0	0	3	3
4	MEC208C	Mechanics of Deformable Solids	3	1	0	0	4	4
5	MEC209C	Complex Variables and Laplace Transform	3	0	0	0	3	3
6	MEC212C	Practicals on Subtractive Manufacturing	0	0	2	0	2	1
7	MEC213C	Experiments on Deformable Solids	0	0	2	0	2	1
8	MEC214A	Bridge Course on Mathematics[1]	2	0	0	0	2	0

Notes:
[1] Mandatory for lateral entry students only.
Students must undergo a practical Training/Internship for duration of four weeks during vacations.

MEC204C Machine Drawing and Solid Modelling 1-0-4-0

Course Objectives: This course will enable students to:

1. Develop understanding of various drawings related to machine components.
2. Develop understanding of assembly of different machine parts.
3. Develop understanding of Solid Modelling in CAD software.

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

1. Comprehend basic production and assembly drawings.
2. Create assembly drawing of machine components from part drawing.
3. Use drawing display tools, sketching tools, geometric relations and dimension the sketch in CAD software.
4. Create base features like extrude, revolve etc. for a solid model.
5. Use advanced modelling tools in creating solid models.

Module I

Introduction to Machine Drawing: Production drawing, assembly drawing. Review of drawing in first angle and third angle projection. Orthographic projections of machine blocks, sectional views. Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners. Reference to handbook for the selection of standard components like bolts, nuts, screws, keys etc.

Module II

Assembly Drawing: Half and Full sectional views, Fasteners & Fixtures: Nut and bolt assembly, Riveted joints, Knuckle joint, Oldham's coupling, Footstep bearing, Plummer block, Screw Jack, Tailstock.

Module III

Introduction to Solid Modelling Sketching: Basic sketching, sketching planes, sketching tools; lines arcs, circle, rectangle, polygon etc, sketching environment, various terms used in the sketching environment, sketching planes, drawing display tools, geometric relations, dimension the sketch, editing/modifying sketching, concept of fully defined sketches, patterns.

Module IV

Base Features: Solid base extrude, thin base extrude, solid base revolve, displaying the model, applying material to the model, changing the appearance of models.

Module V

Advance Modelling Tools: create holes, fillet, chamfer, sweep, loft, introduction to assembly module, introduction to drawing module. Various sub-components/parts of machine elements, to be developed on SolidWorks, Autodesk Inventor.

Pre-requisites: Engineering Visualisation

Text Books:

1. SOLIDWORKS: A Power Guide for Beginners and Intermediate Users by CADArtifex
2. K. L. Narayana, P. Kannaiah and K. Venkata Reddy, Machine Drawing, New Age International

Reference Books:

1. A. Reyes, Beginner's Guide to SOLIDWORKS: Level 1 by MSME, CSWE.
2. D. T. Banach, Autodesk Inventor 2024 Essentials Plus, SDC Publications
3. N. D. Junnarkar, Machine Drawing, Pearson Education India.

Online Resources:

1. Computer Aided Engineering Design by Dr. Anupam Saxena (IIT Kanpur), NPTEL Course (https://nptel.ac.in/courses/112104031).
2. Engineering Drawing and Computer Graphics by Prof. Rajaram Lakkaraju (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/105/112105294/**).**

MEC206C Engineering Thermodynamics 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand the fundamentals of thermodynamics and fluid mechanics.
2. Understand the application of the laws of thermodynamics.
3. Understand various properties of fluids.
4. Understand the application of laws of hydrostatics to different scenarios.

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

1. Comprehend the property diagrams of pure substances.
2. Apply the first law of thermodynamics to open and closed systems.
3. Analyse the problems on heat engines, refrigerators and entropy using the second law of thermodynamics.
4. Explain the different fluid properties and laws governing them.
5. Compute hydrostatic pressure on different surfaces.

Module I

Introduction: Historical development, microscopic and macroscopic views of matter, Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

Module I

Pure Substance: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Module III

Concept of Energy: Mechanical concept of energy, internal energy, conservation of energy, energy transfer as work, various modes, energy transfer as heat, First law for closed system, first law for cyclic processes,. Applications of first law for cycles. Enthalpy, Enthalpy of ideal gases, First law for open systems and applications**.**

Module IV

Second Law of Thermodynamics: Statement and applications of second law, thermodynamic reservoirs and their equivalence, reversible cycle, Carnot cycle, efficiencies of reversible cycle, Carnot's theorem, reversed Carnot cycle and coefficient of performance. Thermodynamic temperature scale. Clausius' theorem, concept of entropy, principle of increase of entropy and its applications, basic concepts of available and unavailable energy. T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Module V

Heat and Work Transfer: Calculations involving heat transfer, work transfer and change in thermodynamic properties with various processes, internal energy, enthalpy, specific heat and entropy of an ideal gas mixture, air water vapour mixture. Complete and incomplete combustion analysis, heating value of fuels, A/F Ratios, analysis of products of combustion, Orsat apparatus.

Pre-requisites: NA

Text Books:

1. Y. A. Cengel, Thermodynamics: An Engineering Approach, McGraw Hill Education (India).

Reference Books:

1. M. J. Moran and Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons.
2. R. E. Sonntag , C. Borgnakke and G. J. Van Wylen , Fundamentals of Thermodynamics, John Wiley & Sons.
3. K. Wark , Thermodynamics, McGraw Hill Education (India). 4. Nag P. K., Engineering Thermodynamics, McGraw Hill Education (India).

Online Resources:

1. Engineering Thermodynamics by Prof. D.P. Mishra (IIT Kanpur), NPTEL Course (https://onlinecourses.nptel.ac.in/noc20_ae09/preview**).**

MEC207C Manufacturing Processes I 3-0-0-0

Course Objectives: This course will enable students to:

1. Create awareness on the basic concepts of machining processes.
2. Get an insight on conventional and non-conventional machining principles and operations.
3. Impart knowledge about the significance of controlling process parameters for the optimal performance for newly developed engineering materials used in industries and research organisations.

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

1. Explain the mechanism of chip formation in machining processes.
2. Explain various machining processes such as turning, drilling, boring, shaping, slotting, milling and grinding.
3. Define the principle of gear generation by traditional and advanced machining processes.
4. Identify and suggest finishing and super finishing operations for particular applications.
5. Comprehend the mechanism of non-traditional machining processes such as EDM, ECM, USM, AJM etc.

Module I

Introduction to Manufacturing: Manufacturing needs and Concepts, broad classification of engineering manufacturing processes. Introduction to Machining: Purpose, Principle and Definition. Mechanics of metal cutting - cutting tool materials, temperature, wear, geometry and chip formation, Force and tool life calculations, surface finish and machinability.

Module II

General Purpose Machine Tools: Lathe and its types - Constructional details including accessories and attachments, operations, types of lathe, CNC Lathe., Constructional and operational details of Shaping - Planing - Slotting – Drilling - Boring – Reaming – Tapping – Broaching.

Module III

Milling Machine and Gear Generation: Cutters - Milling operations - Indexing. Gear generating principles - Gear Hobber - Gear finishing methods - Bevel gear generator, CNC Milling machine.

Module IV

Grinding and Finishing Processes: Operations and applications of surface, cylindrical and centreless grinding processes, dressing, truing and balancing of grinding wheels, grading and selection of grinding wheels, micro-finishing (honing, lapping, super-finishing).

Module V

Advanced Machining Processes/Non- Conventional Machining Processes: EDM, ECM, ECG, CM, AJM, Wire cut EDM, USM, LBM process principle, process parameters and their applications. Process capabilities and their applications

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Pre-requisites: Product Realisation through Manufacturing

Text Books:

1. A. Ghosh and A.K. Mallick, Manufacturing Science, Affiliated East-West Press Pvt. Ltd. 2010.
2. S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, 6th Edition 2013, Publisher: Prentice Hall.
3. R. K. Rajput, A Textbook of Manufacturing Technology, Laxmi publications, New Delhi, 2019.

Reference Books:

1. P. N. Rao, Manufacturing Technology Volume-II, McGraw Hill Education, New Delhi, 2013.
2. P. C. Pandey and H. S. Shan, Modern Machining Processes, McGraw Hill Education, 2017.
3. E. P. DeGarmo, J. T. Black, R. A. Kohser, Materials and Processes in Manufacturing, 9th Edition, 2003, Wiley.
4. W. A. Knight and G. Boothroyd, Fundamentals of Metal Machining and Machine Tools, 3rd Edition, 2005, CRC Press.

Online Resources:

1. Manufacturing processes by A.B Chattopadhyay (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/105/112105126/).

MEC208C Mechanics of Deformable Solids 3-1-0-0

Course Objectives: This course will enable students to:

1. Utilise concepts of stress and strain.
2. Analyse bending and shear stresses in structural members.
3. Utilise concepts to design columns and cylinders.

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

1. Explain concepts of stress and strain.
2. Analyse bending and shear stresses developed in beams.
3. Compute shear stresses developed in shafts.
4. Evaluate the slope and deflection in beams.
5. Design and analyse columns and pressure vessels.

Module I

Concept of Stress and Strain: Concept of stress and strain, Hooke's law, Tensile, compressive and shear stresses, Poisson's ratio, Stress-strain diagram, Elastic constants and their relationships, Volumetric strain, Bars of uniform and varying sections subjected to single and multiple loads, Analysis of bars of composite sections, Concept of thermal stress, Principal plane and principal stress, Transformation of plane stress, Mohr's circle.

Module II

Mechanics of Beams: Shear force, bending moment diagram for cantilever, simply supported, overhanging beam due to point load, uniformly distributed load and uniformly varying load, Theory of pure bending, Bending stress in beams of regular sections, I-section, T-section, Derivation of shear stress distribution in beams of simple sections, Shear stress distribution in beams having I and T sections, shear center and shear flow.

Module III

Deflection of Beams: Relation between deflection, slope, radius of curvature, shear force, bending moment, Slope and deflection of cantilever, and simply supported beams subjected to point load and uniformly distributed load using double integration method, Macaulay's method, and moment-area method, Slope and deflection of propped cantilever and continuous beams using double integration method, Macaulay's method, and moment-area method.

Module IV

Theory of Pure Torsion: Shear stress in terms of torque in a circular shaft, Strength, Stiffness, Torsional rigidity and power transmitted, Torque expression for solid and hollow circular shafts subjected to torsion, Shafts of varying sections subjected to single and multiple torques, Circular shafts in series and parallel, Solid and hollow circular shafts subjected to combined bending and torsion, Composite solid and hollow circular shafts.

Module V

Columns and Pressure Vessels: Members subjected to combined bending and axial loads, Expression for crippling load with different end conditions based on Euler's and Rankine's theories, column subjected to eccentric load. Thin cylindrical and spherical shells subjected to internal pressure, Change in dimensions of thin cylindrical and spherical shells due to internal pressure, Lame's theory on stresses in thick cylinders.

Pre-requisites: Engineering Mechanics

Text Books:

1. I. H. Shames, J. M. Pitarresi, Introduction to Solid Mechanics, Prentice Hall India, 3rd Edition, 2000.
2. S. Timoshenko, Strength of Materials, Part 1: Elementary Theory and Problems, CBS, 3rd Edition, 2021.
3. S. Timoshenko, Strength of Materials, Part 2: Advanced Theory and Problems, CBS, 3rd Edition, 2021.

Reference Books:

1. F. P. Beer, E. R. Johnston, J. T. DeWolf, D. F. Mazurek, Mechanics of Materials, McGraw Hill, 7th Edition, 2014.
2. R. C. Hibbeler, Mechanics of Materials, Pearson, 9th Edition, 2013.
3. E. P. Popov, Mechanics of Materials, Pearson Education India, 2nd Edition, 2015.

Online Resources:

1. Mechanics of Solids by Dr. Priyanka Ghosh (IIT Kanpur), NPTEL Course (https://nptel.ac.in/courses/105104160).

MEC209C Complex Variables and Laplace Transform 3-0-0-0

Course Objectives: This course will enable students to:

1. Demonstrate ability to apply integral calculus techniques, including definite and indefinite integration, in various engineering applications.
2. Have a deep understanding of the theory and principles of Fourier analysis, including Fourier series and Fourier transforms.
3. Apply Fourier analysis techniques to solve real-world problems in engineering
4. Grasp of the theory and properties of Laplace transforms, including the Laplace domain and inverse Laplace transforms
5. Utilise Laplace transforms to solve engineering problems involving dynamic systems.

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

1. Develop a strong foundation in integral calculus, including the ability to perform various types of integrations and apply them to solve engineering problems.
2. Gain a comprehensive understanding of the theory and principles of Fourier analysis.
3. Achieve proficiency in Laplace transforms, understanding their properties and applications.
4. Apply integral calculus, Fourier analysis, and Laplace transforms to analyze and solve engineering problems.
5. Develop the ability to recognize opportunities to apply integral calculus, Fourier analysis, and Laplace transforms in interdisciplinary engineering contexts.

Module I

Laplace transform: shifting theorem, Laplace transforms of derivatives and integrals, Heaviside's unit function. Dirac Delta function and its Laplace transforms. Laplace transforms of periodic functions, Heaviside's expansion theorem.

Module II

Inverse Laplace transforms: initial and final value theorems. Convolution theorem and its applications, use of Laplace transforms in the solution of linear differential equations.

Module III

Complex analysis: Complex variables, analytic functions, Cauchy Riemann equations. Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's inequality and Liouville's theorem on integral function.

Module IV

Expansions and Series in calculus: Taylor's & Laurent's expansions, Zeros & poles of analytic functions, Residues. Fourier series, Harmonic analysis.

Module V

Fourier transform: Fourier sine and cosine transform. Fourier integral formula and its applications to the solution of boundary value problems.

Pre-requisites: NA

Text Books:

1. E. B Saff., and A. D Snider., Fundamentals of Complex Analysis for Mathematics, Science, and Engineering, Prentice Hall India, New Delhi.

2. R. V. Churchill, Complex variables and applications, McGraw Hill Education (India).
3. N. Snedden, The use of Integral Transforms, McGraw Hill Education (India).

Reference Books: NA

Online Resources:

1. Engineering Mathematics II by Prof. Jitendra Kumar (IIT Kharagpur) NPTEL Course (https://nptel.ac.in/courses/111105134).

MEC212C Practicals on Subtractive Manufacturing 0-0-2-0

Course Objectives: This course will enable students to:

1. Acquire the knowledge of process parameters during metal cutting operations.
2. Identify and use specific machine tools.

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

1. Identify cutting parameters and various types of cutting tools.
2. Employ various machine tools: conventional and CNC equipment.
3. Develop and measure the dimensions of a component according to the measurement standards.

List of Practicals:

1. Study of Machine Tools (Lathe, Shaper, Slotter, and Planner) – study the types of cutting tools available and relative motions between cutting tool and workpiece on each machine tool.
2. Prepare a single point cutting tool from wood/foam as per given specifications (to check the tool angles).
3. Prepare a job from a mild steel/aluminium rod on a conventional Lathe machine.
4. Prepare a job from a mild steel/aluminium rod on a CNC Lathe.
5. Machining a keyway by using a slotting machine.
6. Machining a V-block by using a shaper.
7. Job making on drilling machine
8. Gear cutting using milling machines.
9. Prepare and check the dimensions of the sample by Surface Grinding.
10. Prepare a part from a mild steel billet on a VMC.
11. Grinding of single point cutting tool as per given specifications (to check the tool angles) in a Tool and Cutter Grinder.

Pre-requisites: Product Realisation through Manufacturing

Text Books:

1. H. Choudhury, Elements of Workshop Technology Vol 1 & 2, Media Promoters & Publishers, 1971.

Reference Books:

1. Z. Huda, Machining Processes and Machines Fundamentals, Analysis, and Calculations, 2020.

Online Resources:

1. Virtual Lab on Manufacturing processes (Virtual Lab on Manufacturing Processes (iitkgp.ac.in))
2. Lab Manual by IIT Kanpur (TA202A-Lab manual_updated.pdf (iitk.ac.in)

MEC213C Experiments on Deformable Solids 0-0-2-0

Course Objectives: This course will enable students to:

1. Identify the procedures for conducting various destructive tests.
2. Understand the concept of hardness.
3. Utilise mechanical properties of various materials under different loading.

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

1. Understand the procedures for conducting tensile, compressive and impact tests.
2. Identify the procedures to measure the hardness of materials.
3. Determine the Young's modulus using tensile test on rods.
4. Compare the fatigue behaviour of a notched and unnotched specimen.
5. Identify the aspects of testing the strength of various materials under different loading conditions.

List of Practicals:

1. To determine the mechanical properties of mild steel and cast iron specimens under tension load.
2. To determine the mechanical properties of mild steel and cast iron specimens under compression load.
3. To determine the ultimate shear strength in double shear of mild steel rod.
4. To find the impact strength of mild steel and cast iron using Izod and Charpy tests.
5. To determine the mechanical properties of mild steel specimens under torsion.
6. To determine the flexural properties of mild steel specimens subjected to gradual increasing loads.
7. To determine the pressure inside thin walled cylinders using strain gauge.
8. To determine the fatigue properties of different materials under notched and un-notched conditions.
9. To determine the hardness of various metallic materials using Rockwell and Brinell and Vickers hardness tests.
10. To determine the critical load for columns undergoing buckling for various end conditions.

Pre-requisites: NA

Text Books:

1. A. A. Jayakumar, Strength of Materials Lab Manual, Notion Press, 2020.

Reference Books:

1. F. P. Beer, E. R. Johnston, J. T. DeWolf and D. F. Mazurek, Mechanics of Materials, McGraw Hill, 7th Edition, 2014.
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill Education, 2nd Edition, 2017.

Online Resources:

1. Strength of Materials Lab, Virtual Labs at NIT Surathkal (https://sm-nitk.vlabs.ac.in/)

MEC214A Bridge Course on Mathematics 2-0-0-0

Course Objectives: This course aims to provide students with a strong foundation in fundamental mathematical concepts, encompassing topics such as Basic Coordinate Geometry, Matrices/Determinants, Differential Calculus, Integration, and Differential Equations. By the course's conclusion, students will be proficient in applying these principles to solve real-world problems, enhancing their analytical and problem-solving abilities.

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

1. Acquire fundamental knowledge and comprehension of key geometric principles and matrix operations, forming a solid foundation for subsequent learning.
2. Demonstrate their ability to apply derivative and integral concepts to real-world situations, fostering analytical thinking and the capacity to dissect complex problems.
3. Evaluate and synthesise solutions, employing diverse methods to solve differential equations of varying orders, thereby developing advanced problem-solving skills.
4. Follow a progressive trajectory, guiding from foundational knowledge and comprehension to practical application, critical analysis, and creative synthesis, empowering them to tackle progressively intricate mathematical challenges.
5. Master a comprehensive array of mathematical skills, encompassing topics such as lines, matrices, calculus, integration, and differential equations, demonstrating proficiency across a spectrum

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Module I

Basic Coordinate Geometry: Straight Line: Equations, direction ratios and direction cosines, angle between two lines, distance of a point from a line. Plane : General form, intercept and normal form, Condition of coplanarity of two lines, equation of a plane passing through the intersection of two planes, angle between two intersecting planes.

Module II

Matrices and Determinants: Types of Matrices, Operations on Matrices, Determinants and Cofactors, Inverse of a Square Matrix, Rank of Matrix, Elementary row/column operations, System of Linear Equations.

Module III

Differential Calculus: Derivatives: definition and basic rules: Average vs. instantaneous rate of change, Estimating derivatives, Differentiability, Power rule, Derivatives of trigonometric functions, Product and Quotient rules, chain rule Implicit differentiation, Differentiating inverse functions, Second derivatives, Logarithmic differentiation. Applications of Differential Calculus: Straight-line motion. Approximation with local linearity, L'Hôpital's rule. Analysing functions. Mean value theorem, Extreme value theorem and critical points.

Module IV

Integration: Integrals as accumulations of change, Approximation with Riemann sums, Summation notation review, Riemann sums in summation notation, Defining integrals with Riemann sums, Fundamental theorem of calculus and accumulation functions, Definite integral, Properties of definite integrals, Reverse power rule, Indefinite integrals of common functions, Definite integrals of common functions, Integrating using different methods.

Module V

Differential Equations: First order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors - Existence and uniqueness of solution, General solutions of second order differential equation - Homogeneous and non-homogeneous differential equations with constant coefficients - Method of variation of parameters - Method of undetermined coefficients, higher order differential equations with constant coefficients.

Pre-requisites: NA

Text Books:

1. James Stewart, Essential Calculus: Early Transcendentals, Cengage Learning.
2. Hall and Knight, HigherAlgebra, S.Chand & Co. Ltd.
3. S. L. Loney, Coordinate Geometry, Arihant Publications.

Reference Books:

1. Fred Safier and Agnes A. Herzberg, Schaum's Outline of Precalculus, McGraw-Hill Education
2. Frank Ayres Jr. and Elliott Mendelson, Schaum's Outline of Calculus, McGraw-Hill Education.
3. John H. Hubbard and Barbara Burke Hubbard, Vector Calculus, Linear Algebra, and Differential Forms: A Unified Approach, Pearson
4. Morris Kline, Calculus: An Intuitive and Physical Approach, Dover Publications.
5. Dennis G. Zill, A First Course in Differential Equations with Modeling Applications, Cengage Learning.

Online Resources: NA
