Courses of Study

Semester V

B.Tech Mechanical Engineering

(Batch 2023 Onwards)

Department of Mechanical Engineering

Islamic University of Science and Technology, Kashmir

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Detailed Syllabus for 5th Semester

Total Credits = 21+X *Total Hours Per Week = 26*

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC302C	Design of Machine Elements	3	0	0	0	3	3
2	MEC305C	Manufacturing Processes II	3	0	0	0	3	3
3	MEC306C	Heat Transfer	3	1	0	0	4	4
4	MEC307C	Control Systems Engineering	3	0	0	0	3	3
5	MEC308C	Probability and Statistics	3	0	0	0	3	3
6	MEC309C	Economics and Financial Management	2	0	0	0	2	2
7	MEC313C	Experiments on Heat Transfer	0	0	2	0	2	1
8	MEC314C	Practicals on Control Systems	0	0	2	0	2	1
9	MEC315C	Practicals on Manufacturing Processes II	0	0	2	0	2	1
10	MEC316A	Colloquium[1]	0	0	2	0	2	0
11		Open Elective						X

Notes:

[1] Contact hours are used for evaluation only.

Students must undergo a practical Training/Internship for duration of four weeks during vacations.

MEC302C Design of Machine Elements 3-0-0-0

Course Objectives: This course will enable students to:

1. Acquire the knowledge of the origin, nature and applicability of empirical design principles, relevant codes, standards and design guidelines for different machine elements.
2. Understand safety-critical design of machine components using failure criteria based on mechanics of materials.
3. Understand the deflection and twisting considerations in shafts under static and fatigue loading conditions.
4. Understand and design the different types of springs and their applications.
5. Acquire knowledge of permanent and temporary joints and their failure criterion.

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

1. Apply knowledge of basic machine elements used in machine design.
2. Understand the stress and strain on machine components and identify and quantify failure modes of machine parts.
3. Design a shaft for static and fatigue loading.
4. Explain the various types of springs and design the same
5. Design temporary and permanent joints to withstand loads and deformations.

Module I

Introduction to Design: Various stages of the design process, design tools and resources, standards and codes, safety, reliability and product liability, uncertainties in design, introduction to behavior of mechanical systems.

Module II

Failure prevention in mechanical components: Failures resulting from static loads, static strength, factor of safety, theories of failure for static loads, selection of failure theories, Introduction to fatigue in materials, various approaches to fatigue failure analysis and design, endurance limit and modifying factors, stress concentration and notch sensitivity, failure criteria for fluctuating loads.

Module III

Design of shafts: Shaft design for static and fatigue loads, shafts subjected to twisting and bending moments, deflection considerations, shaft materials, design of shaft components.

Module IV

Design of springs: Types of springs, stresses induced in helical springs, spring materials, design for static and fatigue loads, extension springs, torsion springs, spiral springs, leaf springs.

Module V

Design of permanent and temporary joints : Riveted joints, failures of riveted joints, design of riveted joints for boilers and pressure vessels, welded joints, welding symbols, butt and fillet welds, screwed joints, designation of screw threads, stresses induced in screw threads, bolt strength, design of cotter and knuckle joints.

Pre-requisites: Mechanics of Deformable Solids

Text Books:

1. R. G. Budynas and J. K. Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill Education, 10th Edition, 2014 .

Reference Books:

1. R. L. Mott, Machine Elements in Mechanical Design, Pearson Ed Asia, 4th Edition, 2005.
2. M. F. Spotts, T. E. Shoup and L. E. Hornberge, Design of Machine Elements, Pearson Education, 8th Edition, 2019.
3. V. B. Bhandari, Design of Machine Elements, McGraw Hill Education, 4th Edition, 2017.
4. P. C. Sharma and D. K. Aggarwal, A Textbook of Machine Design, S. K. Kataria & Sons, 2013.

Online Resources:

1. Design of Machine Elements – I by Prof. B. Maiti (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/105/112105124/)

MEC305C Manufacturing Processes II 3-0-0-0

Course Objectives: This course will enable students to:

1. Identify and explain basic manufacturing processes.
2. Acquire knowledge on fundamental concepts in metal casting, welding, and forming processes.
3. Define basics of digital printing, powder metallurgy process and fabrication methods for polymer products and glass products.

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

1. Explain casting processes for various materials and components.
2. Identify a suitable welding process & process parameters for an application.
3. Design a suitable metal forming system for making an industrial product.
4. Analyse the influence of Process Parameters on the powder metallurgy process.
5. Explain and summarise the principles and key characteristics of additive manufacturing technologies.

Module I

Introduction: Role of Manufacturing in the development of a country – classification of manufacturing processes. Casting Processes: Casting: Fundamentals of metal casting .Types and design of patterns. Molding materials. Pressure dies casting, centrifugal casting, continuous casting; Casting analysis; Casting defects and their remedies.

Module II

Metal Joining processes: Introduction to joining processes. Fusion and solid state welding; resistance welding; principle of arc welding and arc welding processes-power sources and consumables ; gas welding; brazing, soldering.– Weld joint design, cooling rate, and joint properties. Welding defects- Testing and inspection of welded joints.

Module III

Metal forming processes: Metal working, Elastic and plastic deformation, Concept of strain hardening, Hot and cold working– Bulk metal forming- Sheet metal forming- Forging principle and types, principle of rolling and its types , extrusion-types of extrusion, wire drawing. Sheet metal working operations. Metal forming defects.

Module IV

Powder metal processes and equipment: Powder metallurgy and its applications -production of metal powders-stages in powder metallurgy – fabrication and characterization of powders, powder packing and compaction, sintering. Design considerations .Processing and characterization of powder metallurgy products.

Module V

Additive manufacturing and rapid prototyping: Introduction: subtractive and additive processes Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping. Liquid based and powder based systems. Fused deposition modeling (FDM), 3D printing -working principle and applications.

Pre-requisites: Manufacturing Processes I

Text Books:

1. S. Kalpakjian; S. R. Schmid, Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall.
2. A. Ghosh and A. K. Mallik, Manufacturing Science, Wiley Eastern, 2010.
3. P. N. Rao, Manufacturing Technology: Foundry, Forming And Welding, Tata McGraw Hill, 2017

Reference Books:

1. J. S. Campbell, Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1995.
2. M.C.Flemings, Solidification Processing, Tata McGraw Hill, 1982.
3. P. C. Pandey and C. K. Singh, Production Engineering Sciences, Standard Publishers Ltd., 2013

Online Resources:

1. Fundamentals of Manufacturing Processes, Prof. D. K. Divewdi IIT Roorkee (https://archive.nptel.ac.in/courses/112/107/112107219/)
2. Manufacturing Process Technology -Part I, IIT Kanpur (https://nptel.ac.in/courses/112104195).

MEC306C Heat Transfer 3-1-0-0

Course Objectives: This course will enable students to:

1. Learn the basic modes of heat transfer with emphasis on understanding the 1-D steady state heat conduction.
2. Determine heat transfer coefficients by applying empirical correlations in external forced convection.
3. Determine heat transfer coefficients in internal forced convection and free convection heat transfer.
4. Acquire knowledge of heat exchangers for engineering applications.
5. Learn the basic principles of radiation heat transfer for solving problems on black and grey surfaces.

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

1. Explain the conduction heat transfer for different systems.
2. Explain the different dimensionless parameters in external forced convection and calculate the heat transfer coefficient.
3. Calculate the average heat transfer coefficient in internal forced convection and natural convection problems.
4. Design the different types of heat exchangers and calculate their effectiveness.
5. Justify and explain the radiation effect on different surfaces.

Module I

Conduction: Thermal conductivity of solids, liquids and gases. General heat conduction equation in Cartesian, cylindrical and spherical coordinate systems; One dimensional steady state heat conduction through composite walls. Critical thickness of insulation. 1-D heat conduction with internal heat generation. Extended surfaces, generalized equation for fins: heat transfer rate, temperature distribution; fin efficiency for different conditions at fin tip. 1-D unsteady heat conduction; lumped heat capacity method.

Module II

External forced convection: Introduction to convective flow - forced and free. Conservation equations for mass, momentum and energy for 2-dimensional forced convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. General expression for local heat transfer coefficient; Average heat transfer Coefficient; Empirical equations for laminar and turbulent flows over surfaces of plates and cylinders.

Module III

Internal forced convection: Flow inside a duct - velocity boundary layer, hydrodynamic entrance length and hydrodynamically developed flow. Use of empirical relations for solving laminar and turbulent conditions for internal flow.

Free convection: mechanism of heat transfer during natural convection, empirical heat transfer correlations for natural convection, boiling phenomena.

Module IV

Heat Exchangers: Classification of heat exchangers and their temperature distributions; overall heat transfer coefficient and fouling factors; Log mean temperature difference (LMTD). Heat exchanger effectiveness, NTU-method. Heat exchangers design considerations, Heat Pipe.

Introduction to mass transfer: Analogy between heat and mass transfer; Mass diffusion; Fick's law.

Module V

Radiation: Introduction to thermal radiation, Plank's distribution law. Monochromatic and total emissive power, Emissivity, Stefan-Boltzmann law, Weins displacement law. Kirchoff's law; Solid angle, Intensity of radiation, Radiative heat exchange between two black surfaces, shape factor for simple geometries. Radiative heat exchange between non- black surfaces, Radiation shields.

Pre-requisites: NA

Text Books:

1. F. P. Incropera, D. P. Dewitt, T.L. Bergman and A.S. Lavine, Principles of Heat & Mass Transfer, Wiley (India), 8th Edition.

Reference Books:

1. Y. A. Cengel and A. J. Ghajar, Heat and Mass transfer: Fundamentals and applications, McGraw Hill Education (India), 5th edition.
2. J. P. Holman and S. Bhattacharyya, Heat Transfer, McGraw Hill Education (India), 10th edition.

Online Resources:

1. Introduction to Heat and Mass Transfer by Prof. S. P. Sukhatme and Prof. U.N. Gaitonde (IIT Bombay), NPTEL Course (https://nptel.ac.in/courses/112101097).

MEC307C Control Systems Engineering 3-0-0-0

Course Objectives: The objective of this course is to provide students with a comprehensive understanding of control systems, and their analysis and applications. Students will learn to mathematically model physical systems, gain insights into the time response analysis, examine steady-state and transient behaviour and perform stability analysis.

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

1. Explain the significance of control systems and develop mathematical models of electro-mechanical systems and their transfer functions.
2. Analyse time domain performance, steady-state errors, and transient responses of first and second-order control systems.
3. Apply stability criteria such as Routh-Hurwitz, and Root Locus methods for control system analysis and design.
4. Evaluate frequency domain specifications using Bode and Nyquist diagrams to determine stability and margins.
5. Synthesise control systems to meet specified design requirements and performance criteria.

Module I

Introduction: History, applications, and classification; Mathematical modelling of physical systems; Mathematical preliminaries – Complex Variables, Laplace Transform, Transfer function; Block diagram representation; Signal flow graphs - Reduction using Mason's gain formula; Models of some Industrial Control Systems.

Module II

Time Response Analysis and Design Specifications; Standard test signals; Time domain performance of first and second order control systems; Steady state and transient response; Steady state errors and error constants.

Module III

The concept of stability, Asymptotic and BIBO stability, Relation between characteristic equation roots and BIBO stability, Routh-Hurwitz stability criterion, Relative stability analysis.

Module IV

Root Locus Technique and its Construction Principles; Angle and Magnitude Criterion, Properties of Root Loci, Construction of Root Locus Diagram, Determination of Damping ratio, Gain Margin and Phase Margin from Root Locus.

Module V

Frequency response and Frequency domain specifications; Bode diagrams and Nyquist Methods; Determination of Stability, Phase Margin and Gain Margin from the Bode Diagrams and Nyquist Methods.

Pre-requisites: Engineering Mechanics, Complex Variables and Laplace Transforms

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Text Books:

1. N. S. Nise, Control Systems Engineering, John Wiley and Sons.
2. M. Gopal, Control Systems–Principles and Design, Tata McGraw-Hill Ltd.
3. K. Ogata, Modern Control Engineering, Prentice Hall of India Pvt. Ltd.

Reference Books:

1. B. C. Kuo, Automatic Control Systems, John Wiley & Sons.

Online Resources:

1. Control Systems, By Prof. C. S. Shankar Ram (IIT Madras), NPTEL Course (https://archive.nptel.ac.in/courses/107/106/107106081/).
2. Control Engineering, By Prof. M. Gopal (IIT Delhi), NPTEL Course, (https://nptel.ac.in/courses/108102043).

MEC308C Probability and Statistics 3-0-0-0

Course Objectives: The objective of this course is to provide a fundamental understanding of the principles of probability theory, appreciate the interplay between probability theory and statistical analysis, and interpret the significance of statistical findings in practical terms.

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

1. Explain fundamental statistical concepts and probability theories.
2. Create meaningful solutions by applying conditional probability and random variable concepts to practical scenarios
3. Comprehend and interpret various probability distributions and their real-world applications.
4. Apply data analysis techniques, regression, and correlation to solve problems
5. Critically analyse and derive probability theorems, fostering strong problem-solving skills.

Module I

Statistics: Measures of central tendency and Measures of variations (Dispersions), Moments, Measures of Skewness and Kurtosis. Moment generating functions, problems.

Module II

Standard Distributions: Binomial, Poisson and Normal Distributions, Beta and Gamma Distribution, t Distribution, F-Distribution, Chi-square Distribution and their applications.

Module III

Method of Least Squares & Correlation: Methods of least squares, fitting of straight line and parabola of degree 'p'. Regression and Correlation. Multiple and Partial Correlation.

Module IV

Probability: Random experiment, sample space, events, classical, statistical and axiomatic definitions of probability. Statements and proof of theorems on addition and multiplication of probabilities, problems.

Module V

Conditional Probability: Bayes theorem on conditional probability. Random variables, Derivation of formulae for mean, variance and moments of random variables for discrete and continuous cases. Laws of expectation problems.

Pre-requisites: NA

Text Books:

1. S. C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons.
2. Brownlee, Statistical Theory and Methodology in Science & Engineering, John Wiley & Sons.

Reference Books:

1. R. E. Walpole, Introduction to Mathematical Statistics, Macmillan publications.
2. Meyer, Data Analysis for Scientists & Engineers, John Wiley & Sons.

Online Resources:

1. Probability and Statistics by Prof. Somesh Kumar (IIT Kharagpur), NPTEL Course (https://archive.nptel.ac.in/courses/111/105/111105090/).

MEC309C Economics and Financial Management 2-0-0-0

Course Objectives: This course will enable students to:

1. To analyse the fundamental economic concepts and principles
2. Understand the role of economics and financial management in engineering projects.
3. Apply financial analysis techniques to evaluate and make informed investment decisions for engineering projects.

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

1. Understand the basic concepts of microeconomics, macroeconomics, and financial management.
2. Understand the macroeconomic variables and their impact on engineering projects.
3. Comprehend basics of accounting, cost concepts, and financial statement analysis.
4. Establish the relationship between Risk & return, Time value of money, sources of finance and capital budgeting decisions.

Module I

Introduction: Economics and Financial Management, Importance of economics and financial management in engineering, Basic economic concepts and principles.

Module II

Microeconomics for Engineers: Supply and Demand Analysis, Market Structures and Competition, Cost Analysis and Production Decisions, Pricing Strategies, and Revenue Maximization.

Module III

Macroeconomics: Macroeconomics and Engineering Projects, National income and output, Unemployment and Economic growth, Inflation, Monetary and fiscal policy, Implications for engineering projects.

Module IV

Financial Management: Source of Finance: Retained Earnings, Share Capital, Term Loans, Debt: Debentures, bonds, Working Capital; Capital Budgeting: Meaning and Techniques.

Module V

Financial Statement Analysis: Ratio Analysis; Funds Flow Statement & Cash Flow Analysis.

Pre-requisites: NA

Text Books:

1. Managerial Economics: Economic Tools for Today's Decision Makers: by Paul Keat (Author), Philip Young (Author) 2013.
2. Principles Of Macro Economics: Misra and Puri.2009, Himalaya publishing house, New Delhi.
3. Modern Microeconomics, A. koutsoyiannis , Macmillan, London.
4. Microeconomics Robert S. Pindyck and daniel L. rubinfeld:,pearson education Inc. New Delhi
5. "Financial Management: Theory and Practice" by Prasanna Chandra.

6. "Financial Management: Principles and Applications" by S. N. Maheshwari and S. K. Maheshwari.
7. "Financial Management: Text, Problems, and Cases" by M. Y. Khan and P. K. Jain.

Online Resources: NA

MEC313C Experiments on Heat Transfer 0-0-2-0

Course Objectives: This course aims to equip students with practical knowledge for applying different heat transfer principles in engineering applications. The students will learn to calculate the parameters governing the various modes of heat transfer (Conduction, Convection and Radiation). The students will also learn the thermal analysis and sizing of heat exchangers for designing various types of heat exchangers.

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

1. Determine thermal conductivity of different engineering substances.
2. Determine the heat transfer coefficient for free and forced convection.
3. Apply the principles of heat conduction for determining fin efficiency.
4. Compute the effectiveness for parallel flow and counter flow heat exchangers
5. Calculate different parameters involved in radiation heat transfer

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List of Experiments:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulation powder.
3. Determination of thermal conductivity of a liquid by the guarded hot plate method.
4. Determination of overall resistance of a composite wall.
5. Determination of heat transfer coefficient in forced convection through a horizontal tube.
6. Determination of Fin efficiency and effectiveness of a pin fin in forced convection.
7. Determination of heat transfer coefficient in a vertical cylinder in natural convection.
8. Determination of LMTD and NTU in parallel flow and counter flow heat exchanger.
9. Determination of Stefan Boltzmann's constant.
10. Determination of Emissivity.
11. Demonstration of heat pipe.
12. Study of Film wise condensation.
13. Study of drop wise condensation.
14. Study of different phases of boiling.

Pre-requisites: NA

Text Books:

1. F. P. Incropera, D. P. Dewitt, T.L. Bergman and A.S. Lavine, Principles of Heat & Mass Transfer, Wiley (India), 8th Edition.

Reference Books:

1. Y. A. Cengel and A. J. Ghajar, Heat and Mass transfer: Fundamentals and applications, McGraw Hill Education (India), 5th edition.
2. J. P. Holman and S. Bhattacharyya, Heat Transfer, McGraw Hill Education, 10th edition.

Online Resources:

1. Heat and Thermodynamics lab - (Heat & Thermodynamics Virtual Lab : Physical Sciences).
2. Practical - Heat Transfer (https://www.youtube.com/watch?v=yfd_pkcLZhQ&list=PL-Oy7nhqIWzuCJ2OYiPEF3AsTTf8-LFCD)

MEC314C Practicals on Control Systems 0-0-2-0

Course Objectives: This course aims to provide practical knowledge in designing and implementing various control systems. Students will learn to build feedback control systems using sensors and actuators, and gain hands-on experience in MATLAB and Simulink to analyse system stability, design controllers, and simulate control algorithms for motors, mechanical systems, etc.

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

1. Explain the principles of feedback control systems and the functioning of various sensors and sources in maintaining constant reference input.
2. Describe the components and operation of basic control systems using water level sensors and pumps, temperature sensors, DC motors, etc.
3. Apply knowledge of control systems to design, simulate, and implement speed regulation for a toy car, and level control for a tank.
4. Perform stability analysis, steady-state error calculations, and root locus plots to assess system behaviour and response.
5. Build customised control algorithms in MATLAB and Simulink for specific applications.

List of Practicals

1. Light Sensor Control: Build a simple feedback control system using a light sensor and a light source to maintain a constant light intensity despite varying distances between the sensor and the source.
2. Water Level Control: Create a basic control system using a water level sensor and a water pump to maintain a constant water level in a container.
3. Temperature Controller with On/Off Control: Develop an On/Off temperature control system using a temperature sensor and a heater/cooler to regulate the temperature of a small chamber.
4. Speed Control of a Toy Car: Design a control system to regulate the speed of a toy car using a simple DC motor and a potentiometer as a speed control input.
5. Water Flow Control with a Valve: Use a flow sensor and a servo-controlled valve to maintain a constant water flow rate through a pipe.
6. Introduction to MATLAB and Simulink as a tool for analysis and design of control systems.
7. Using MATLAB for analysis of the roots of the first order systems and plot the response to different parametric variations.
8. Using MATLAB for analysis of the roots of a second order system and plot the response to different parametric variations.
9. Stability Analysis of a Control System: Use MATLAB to determine the stability of the system by analysing the poles. Simulate the system in Simulink and observe the response to step and impulse inputs.
10. Steady-State Error Analysis: Use MATLAB to calculate the steady-state error for different reference inputs. Verify the results in Simulink by simulating the closed-loop system.
11. Root Locus Design: Create a transfer function for a control system with an adjustable parameter (e.g., gain). Plot the root locus using MATLAB to observe the effect of the parameter on system stability.
12. Level Control in a Tank using MATLAB and Simulink: Design a level control system for a tank in MATLAB, and implement the control algorithm in Simulink to control the liquid level.

Pre-requisites: Engineering Mechanics, Complex Variables and Laplace Transforms

Text Books:

1. K. Ogata, Control System Design Using MATLAB and Simulink. Pearson, 2010.

Reference Books:

1. K. R. C. Dorf and R. H. Bishop, Modern Control Systems. Pearson, 2016.

Online Resources: NA

MEC315C Practicals on Manufacturing Processes II 0-0-2-0

Course Objectives: This course will enable students to:

1. Acquire hands-on practice of various basic manufacturing processes.
2. Familiarize with the real challenges of the manufacturing industry.
3. Develop practical knowledge regarding conventional and advanced manufacturing processes.

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

1. Design and make simple castings independently.
2. Compare the components manufactured using 3d printing and conventional techniques
3. Differentiate the various welding processes.
4. Inspect the weld joint defects and causes behind them.
5. Analyze the effect of varying parameters in welded joints.

List of Practicals:

1. Preparation of sand mould for the given engineering part and investigating the mould properties.
2. Estimation of molding sand properties.
3. Fabrication of Pattern for sand moulding through conventional and digital manufacturing method.
4. Evaluation of 3D printed pattern over conventional pattern for complex profiles.
5. Study of SMAW/ MMAW welding equipment and process.
6. Study of TIG / MIG welding equipment and process.
7. Making of Lap joints / T- Joints at different welding parameters.
8. To observe the effect of varying current on the butt joint made through the SMAW process and calculate the heat input.
9. Welding practice on T/Butt joints using SMAW.
10. Welding practice on T/Butt joint using MIG/GTAW welding and comparison thereof.

Pre-requisites: NA

Online Resource:

1. List of Virtual labs in Mechanical Engineering (NITTTR Kolkata), (http://www.nitttrkol.ac.in/virlab.php#top).
