Courses of Study

Semester VI

B.Tech Mechanical Engineering

(Batch 2023 Onwards)

Department of Mechanical Engineering

Islamic University of Science and Technology, Kashmir

Table of Contents

Detailed Syllabus for 6th Semester 3
- Discipline Centric Elective - I 3
- Generic Elective - I 4
  - Mechanical Vibrations 5
  - Manufacturing Automation 7
  - Numerical Methods for Engineers 9
  - Data Analytics 11
  - Mechanisms and Vibrations Lab 14
  - Computer Aided Engineering and Analysis Lab 16
  - Internship/Practical Training II 17
  - Design Credits 18
  - Refrigeration and Air Conditioning 19
  - Design of Mechanical Systems 21
  - Advanced Manufacturing Technologies 23
  - Computer Aided Design and Analysis 25
  - Power Plant Engineering 27
  - Introduction to Human Factors Engineering 29
  - Introduction to Flight and its Systems 31

Detailed Syllabus for 6th Semester

Total Credits = 23+X *Total Hours Per Week = 29*

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC352C	Mechanical Vibrations	3	1	0	0	4	4
2	MEC353C	Manufacturing Automation	3	0	0	0	3	3
3	MEC354C	Numerical Methods for Engineers	2	0	2	0	4	3
4	MEC355C	Data Analytics	2	0	2	0	4	3
5	MEC360C	Mechanisms and Vibrations Lab	0	0	2	0	2	1
6	MEC363C	Computer Aided Engineering and Analysis Lab	0	0	2	0	2	1
7	MECXXXE	Discipline Centric Elective - I[1]	3	0	0	0	3	3
8	XXXXXXG	Generic Elective - I[2]	3	0	0	0	3	3
9	MEC364A	Internship/Practical Training II[3]	0	0	2	0	2	0
10	MEC365C	Design Credits	0	0	0	2	0	2
11		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 - I 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.

[3] Contact hours are used for evaluation only.

Discipline Centric Elective - I

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC354E	Refrigeration and Air Conditioning	3	0	0	0	3	3
2	MEC355E	Design of Mechanical Systems	3	0	0	0	3	3
3	MEC356E	Advanced Manufacturing Technologies	3	0	0	0	3	3
4	MEC357E	Computer Aided Design and Analysis	3	0	0	0	3	3

Generic Elective - I

S.No	Course Code	Course Title	L	T	P	S	Hours Per Week	Credits
1	MEC352G	Power Plant Engineering	3	0	0	0	3	3
2	MEC353G	Introduction to Human Factors Engineering	3	0	0	0	3	3
3	MEC354G	Introduction to Flight and its Systems	3	0	0	0	3	3

MEC352C Mechanical Vibrations 3-1-0-0

Course Objectives: This course will enable students to:

1. Understand the basic concepts of vibrations.
2. Understand the working principle of vibration measuring instruments.
3. Acquire the knowledge of numerical methods for multi-degree freedom systems.

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

1. Explain the basic concepts of vibrations and its applications.
2. Apply principles of mechanics and mathematics to obtain governing equations.
3. Obtain the solution of governing equations and interpretation of results using efficient methods.
4. Model and analyze continuous systems and obtain approximate solutions of vibratory systems.
5. Apply the numerical methods to solve complex vibratory multi-degree of freedom system problems.

Module I

Introduction: Types of vibrations, Simple Harmonic Motion (SHM), principle of superposition applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

Module II

Undamped and Damped Free Vibrations: Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, spring and mass elements, effect of mass of spring, Compound Pendulum. Damped Free Vibrations: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

Module III

Forced Vibration: Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio due to harmonic excitation and support motion. Vibration Measuring Instruments & Whirling of Shafts: Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations

Module IV

Systems with Two Degrees of Freedom:IEquations of motion, free vibrations of undamped systems, coordinate coupling, principal coordinates, Eigenvalue problems, natural modes of vibration, orthogonality of natural modes.

Module V

Systems with Multiple Degrees of Freedom: Equations of motion, influence coefficients, stiffness, undamped free vibrations, Eigenvalue problems, modal vectors, modal analysis, determination of natural frequencies and mode shapes, matrix methods, Rayleigh's method, Holzer Method, Dunkerley's Method.

Continuous Systems: Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.

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

Text Books:

1. S. S. Rao, Mechanical Vibrations, Pearson Education Inc., 4th Edition, 2003.
2. W. T. Thomson and M. D. Dahleh, Theory of Vibration with Applications, Pearson Education 5th edition, 2008.

Reference Books:

1. L. Meirovitch, Elements of Vibrations Analysis, Tata McGraw Hill, Special Indian edition, 2007.
2. V. P. Singh, Mechanical Vibrations, Dhanpat Rai & Company Pvt. Ltd., 2016.
3. S. G. Kelly, Mechanical Vibrations- Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
4. J. S. Rao and K. Gupta, Theory & Practice of Mechanical vibrations, New Age International Publications, New Delhi, 2001.

Online Resources:

1. Introduction to Mechanical Vibration by Prof. Anil Kumar (IIT Roorkee), NPTEL Course (https://archive.nptel.ac.in/courses/112/107/112107212/).

MEC353C Manufacturing Automation 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand the importance of automation in the field of machine tool based manufacturing
2. Get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC
3. Understand the basics of product design and the role of manufacturing automation.

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

1. Define the importance of automation in manufacturing value chain
2. Explain the various components of automation tools and techniques
3. Describe an automated assembly system.
4. Design and analyze an automated storage system
5. Define the various tools and techniques employed in Industry 4.0

Module I

Introduction: Definition; Reasons for automating; Strategies; Types of automation; Numerical control (NC, CNC, DNC); Introduction to CNC programming and computer-aided process planning.

Module II

Machine and Process Automation: CNC machines, Automated flow lines (types, selection); Work part transport and transfer mechanisms; Feedback systems and control; Modular and reconfigurable machines, adaptive machine controls.

Module III

Automated Assembly Systems: Historical developments; Choice of assembly methods; Design for automated assembly; Transfer systems; Vibratory and non-vibratory feeders; Feed tracks, part orienting and placing mechanisms

Module IV

Factory Automation: Lean manufacturing, Automation scalability (fixed, programmable, flexible and reconfigurable); Design and analysis of automated flow lines; Average production time, production rate, line efficiency; Analysis of transfer lines without storage; Partial and full automation.

Module V

Automation Tools and Techniques: Mechanical, electro-mechanical, pneumatic and hydraulic systems; Sensors integration; Process monitoring, data analysis and control using actuators; Robots (pick, place, assembly, welding, painting, etc.); Automatic Guided Vehicles; Automated inspection and measurement (CMM and 3D Scanning); Machine vision, AI and machine learning; Human-machine interfaces; Examples and case studies. Industry 4.0- Standard, Real-time production monitoring techniques with smart sensors, Configuration of smart shop floor, traceability and call back of defective products.

Pre-requisites: Manufacturing Processes I

Text Books:

1. M. P. Groover, Automation, Production Systems and Computer-integrated Manufacturing, Prentice Hall, 2018.
2. S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, 6th Edition 2013, Publisher: Prentice Hall.

Reference Books:

1. Y Altintas, Manufacturing Automation, 2012, Cambridge University Press, USA.
2. A. K Gupta and S. K Arora, Industrial Automation and Robotics, 2015, Mercury Learning & Information Quicksilver Drive, Dulles VA United States.
3. P. Radhakrishnan, S. Subramanyan and V. Raju, CAD/CAM/CIM, New Age International, 2008,New Delhi.

Online Resources:

1. Introduction to CIM, Dr. Janakarajan Ramkumar (IIT Kanpur), NPTEL Course (https://nptel.ac.in/courses/112/104/112104289/).
2. Automation in Manufacturing by Prof. Shrikrishna N. Joshi, IIT Guwahati, NPTEL Course (https://nptel.ac.in/courses/112/103/112103293/).
3. Mechatronics and Manufacturing Automation, IIT Guwahati, Dr. Shrikrishna N. Joshi, NPTEL Course (https://nptel.ac.in/courses/112/103/112103174/).

MEC354C Numerical Methods for Engineers 2-0-2-0

Course Objectives: This course will enable students to:

1. Comprehend the basic concepts of numerical methods.
2. Acquire the knowledge of interpolation and approximation.
3. Understand the curve fitting, root finding and optimization.

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

1. Apply the basic concepts of numerical methods for the solution of linear systems.
2. Perform interpolation and eigenvalue analysis..
3. Solve equations using numerical differentiation and integration.
4. Apply curve fitting methods for approximation and data inference.
5. Use root finding methods and solve optimization problems.

Module I

Introduction: Need and application of Numerical Methods, Errors: source and types of errors, error propagation. Computer representation of numbers: floating point representation, rounding error and floating point arithmetic. Linear Algebraic Systems: Gauss-Jordan Elimination, Gaussian Elimination, LU Decomposition, Ill Conditioned Systems and Iterative Methods. Solution to the Problems using MATLAB

Module II

Interpolation and Eigen value Analysis: Lagrangian Polynomials - Divided differences interpolating with a cubic spline - Newton's forward and backward difference formulas. The characteristics Polynomial for finding Eigen value and Eigen vectors, Power Methods, Jacobi's Method, Householder Transformation, QR Method, Danilevsky's Method Polynomial Roots. Solution to the Problems using MATLAB.

Module III

Numerical Differentiation and Integration: Derivative from difference tables - Divided differences and finite differences - Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Two and Three point Gaussian quadrature formulas - Double integrals using trapezoidal and Simpson's rules. Solution to the Problems using MATLAB.

Module IV

Curve Fitting: Interpolation, Newton's Difference Formula, Cubic Splines, Least Square, Two-Dimensional Interpolation.

Module V

Root Finding and Optimization: Bracketing methods, Contraction Mapping Method, Secant Method, Muller's Method, Newton's Method, Polynomial Roots, Nonlinear Systems of Equations. Optimization: Local and Global Minima, Line Searches, Steepest Descent Method, Conjugate-Gradient Method, Quasi-Newton Methods, Penalty Functions and Simulated Annealing. Solution to the Problems using MATLAB

Pre-requisites: Calculus for Engineers, Linear Algebra and Differential Equations

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Text Books:

1. R. Schilling and S. Harris, Applied Numerical Methods for Engineers Using Matlab and C-Thomson Learning, 2002.
2. Gerald and Wheatley, Applied Numerical Analysis, Pearson Education, 2002.
3. Reference Books:
4. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall.

Online Resources:

1. Numerical Methods by Prof Sanjeev Kumar IIT Roorkee (https://archive.nptel.ac.in/courses/111/107/111107105/**).**
2. Numerical Methods for Engineers by Prof. Niket Kaisare IIT Madras (https://archive.nptel.ac.in/courses/127/106/127106019/).

MEC355C Data Analytics 2-0-2-0

Course Objectives: This course will enable students to:

1. Understand the basic concepts of data science.
2. Understand and implement various data preprocessing techniques.
3. Understand and use Python based data analytics tools.
4. Understand and implement various data visualization techniques.
5. Understand and implement basic machine learning algorithms.

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

1. Understand the fundamental concepts of data analytics.
2. Perform data preprocessing tasks, including data cleaning, transformation, and visualization,using Python and relevant libraries.
3. Create effective graphical representations of data using various charts and plots.
4. Understand basic concepts of machine learning, including regression and classification.
5. Understand and implement basic machine learning algorithms.

Module I

Introduction to Data Analytics: Descriptive, Predictive, and Prescriptive Analytics, Data Types, Analytics Types, Data Analytics Steps: Data Pre-Processing, Data Cleaning, Data Transformation, and Data Visualization.

Data Analytics Tools: Data Analytics using Python: Statistical Procedures, NumPy, Pandas, SciPy, Matplotlib.

Module II

Data Pre-Processing: Understanding data, Handling Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python, Turning categorical variables into quantitative variables in Python, Accessing Databases with Python.

Module III

Data Visualization: Graphical representation of data, Characteristics and charts for effective graphical displays, Chart types - Single var: Dot plot, Jitter plot, Error bar plot, Box-and-whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, More than two variables: Stacked plots, Parallel coordinate plot.

Module IV

Machine Learning Concepts I: Regression: Linear regression and Logistic regression, Classification – Bayes' classifier, Decision Tree, K Nearest Neighbor Algorithm, Support Vector Machines.

Module V

Machine Learning Concepts II: Clustering – k-Means Algorithm, Frequent pattern mining – Apriori algorithm.

List of Programs

1. Write a NumPy program to generate an array of 15 random numbers from a standard normal distribution.
2. Write a NumPy program to create a two-dimensional array with shape (8,5) of random numbers. Select random numbers from a normal distribution (200,7).

3. Write a Pandas program to add, subtract, multiple and divide two Pandas Series. Sample Series: [2, 4, 6, 8, 10], [1, 3, 5, 7, 9]
4. Write a Pandas program to convert a NumPy array to a Pandas series.
5. Write a Pandas program to create the mean and standard deviation of the data of a given Series.
6. Write a Pandas program to compute the minimum, 25th percentile, median, 75th, and maximum of a given series.
7. Write a Pandas program to get the day of month, day of year, week number and day of week from a given series of date strings.
8. Consider Iris Dataset, load the iris data into a dataframe and perform following basic operations on it:
    i. print the shape of the data, type of the data and first 10 rows and get the number of observations, missing values and nan values.
    ii. Use Scikit-learn to print the keys, number of rows-columns, feature names and the description of the Iris data.
    iii. create a 2-D array with ones on the diagonal and zeros elsewhere. Now convert the NumPy array to a SciPy sparse matrix in CSR format
    iv. basic statistical details like percentile, mean, std etc. of iris data.
    v. Write a Python program to drop Id column from a given Dataframe and print the modified part. Call iris.csv to create the Dataframe.
    vi. create a plot to get a general Statistics of Iris data
9. Consider the same Iris Dataset and perform visualization on the same:
    i. Write a Python program to create a Bar plot and pie plot to get the frequency of the three species of the Iris data.
    ii. Write a Python program to create a graph to see how the length and width of SepalLength, SepalWidth, PetalLength, PetalWidth are distributed.
    iii. Write a Python program to create a joinplot to describe individual distributions on the same plot between Sepal length and Sepal width. Note: joinplot - Draw a plot of two variables with bivariate and univariate graphs.
    iv. Write a Python program to draw a scatterplot, then add a joint density estimate to describe individual distributions on the same plot between Sepal length and Sepal width.
    v. Write a Python program using seaborn to Create a kde (Kernel Density Estimate) plot of sepal_length versus sepal width for setosa species of flower.
    vi. Write a Python program to create a box plot (or box-and-whisker plot) which shows the distribution of quantitative data in a way that facilitates comparisons between variables or across levels of a categorical variable of iris dataset. Use seaborn.
    vii. Write a Python program to create a Principal component analysis (PCA) of iris dataset.
10. Write a Python program using Scikit-learn to split the iris dataset into 80% train data and 20% test data. Train or fit the data into the model and using the K Nearest Neighbor Algorithm and create a plot of k values vs accuracy.
11. Build a decision tree model that predicts the species of iris from the petal and sepal width and length. Perform model evaluation.
12. Implementing Support Vector Machine (SVM) classifier in Python using the iris features from iris dataset and train an SVM classifier and use the trained SVM model to predict the iris species type.

Text Books:

1. T. Mitchell, Machine Learning, McGraw Hill
2. A. Géron, O'Reilly Media, Hands-On Machine Learning with Scikit-Learn and TensorFlow.

Reference Books:

1. G. J. Myatt and W. P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, Wiley 2009.
2. T. H. Davenport, J. G. Harris and R. Morison, Analytics at Work: Smarter Decisions, Better Results, Harvard Business Press, 2010
3. R. Schutt and C. O"Neil, Doing Data Science, O"REILLY, 2006.
4. S. Kumar, F. Morstatter and H. Liu, Twitter Data Analytics, Springer-Verlag, 2014

Online Resources:

1. Machine Leaning, Andrew Ng, Coursera.

MEC360C Mechanisms and Vibrations Lab 0-0-2-0

Course Objectives: This course will enable students to:

1. Experience various mechanisms and draw the velocity and acceleration diagrams by graphical method
2. Get in-hand training on the significance and determination of vibration characteristics of vibrating systems.
3. Supplement the theoretical knowledge with experimentation to validate the frequency response of discrete and continuous systems.

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

1. Draw the velocity and acceleration diagrams of various mechanism by graphical methods
2. Explain the functioning of gears, gear trains and governors
3. Model, design and determine free vibration characteristics of single degree/multiple degree of freedom systems.
4. Carry out the response analysis of free/forced vibrations.
5. Analyze the torsional vibrations of rotating systems.

List of Experiments (Mechanisms)

1. To study various types of links and mechanisms and draw the inversions and velocity diagrams of different mechanisms by Graphical Method.
2. To study the operation of various types of brakes and clutches.
3. To study and conduct experiments on different types of governors: Watt Governor, Proell Governor, Porter Governor, and Hartnell Governor.
4. To study the basic fundamentals and operation of different types of gears and gear trains.
5. To study and perform experiments on the operation of a gyroscope.
6. To conduct experiments on the balancing of rotating and reciprocating masses.

List of Experiments (Vibrations)

1. To study undamped free oscillations of a simple pendulum and determine the natural frequency of oscillations.
2. To study undamped free vibrations of a spring mass system and to determine the natural frequency of vibrations.
3. To study the vibrations of a compound pendulum and determine its radius of gyration.
4. To study the torsional vibration of a single rotor shaft system and to determine the natural frequency.
5. To study the forced vibration of damped second order systems and draw load magnification factor v/s frequency and phase angle v/s frequency curves.
6. To determine the radius of gyration of a given bar / Disc using bifilar / trifilar suspension.
7. To study the vibrations of different types of beams.

Pre-requisites: Kinematics and Dynamics of Machines, Mechanical Vibrations

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Text Books:

1. J. E. Shigley, Theory of Machines and Mechanisms, McGraw Hill Education (India).
2. S. S. Rao, Mechanical Vibrations, Pearson Education Inc., 4th Edition, 2003.

Reference Books:

1. S. S. Rattan, Theory of Machines, McGraw Hill Education (India).
2. V. P. Singh, Mechanical Vibrations, Dhanpat Rai & Company Pvt. Ltd., 2016.

Online Resources:

1. Machine Dynamics and Mechanical Vibrations Lab, Virtual Labs at NIT Surathkal (https://mdmv-nitk.vlabs.ac.in/Introduction.html).
2. Kinematics and Dynamics of Mechanisms Laboratory, Virtual Labs at IIT Kharagpur (http://vlabs.iitkgp.ac.in/kdm/).

MEC363C Computer Aided Engineering and Analysis Lab 0-0-2-0

Course Objectives: This course will enable students to:

1. Acquire basic understanding of Modelling and Analysis software.
2. Understand 3D modeling techniques using state of the art commercial CAD software with the creation of parts and assemblies.
3. Understand basic functioning of commercial finite element analysis (FEA) packages with application to mechanical members subjected to different loading and boundary conditions.

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

1. Explain the need and application of modern CAD and CAE software.
2. Develop 3D models of solids using standard CAD approaches.
3. Comprehend and develop mechanical assemblies using standard CAD approaches.
4. Provide FEA solutions to structural components along with analytical validation.

List of Practicals:

1. General Introduction of solid modeling and analysis, Types of Modeling techniques, Basic 3D CAD principles.
2. Concept of Protrusion and Cuts. Extrusion and Extrusion Cut,
3. Concept of Revolution and Revolution Cut.
4. Concept of Sweep and Helical Sweep and cuts.
5. Mechanical Assembly: Part modeling and assembly of Oldham Couplings, Knuckle Joint.
6. Mechanical Assembly: Part modeling and assembly of Plummer Block, Footstep bearing.
7. Mechanical Assembly: Part modeling and assembly of Gear Trains.
8. Basic FEA Principles, Concept of analysis, Types of analysis, Axial loading in tension and compression.
9. Analysis and comparison of a bar under axial load.
10. Analysis and comparison of a truss and beam bar under various loading conditions.
11. Analysis and comparison involving 1-D heat transfer problems.
12. Analysis and comparison of a plane stress and strain problems.

Reference Books:

1. SOLIDWORKS: A Power Guide for Beginners and Intermediate Users by CADArtifex
2. A. Reyes, Beginner's Guide to SOLIDWORKS: Level 1 MSME, CSWE.
3. D. L. Logan, A First Course in the Finite Element Method, Cengage Learning.
4. K. Lawrence, ANSYS Tutorial Release 2020, SDC Publications, 2020

Online Resources:

1. Engineering drawing and computer graphics, by Prof. Rajaram Lakkaraju, IIT Kharagpur, https://nptel.ac.in/courses/112105294
2. Ansys learning resources, https://www.ansys.com/en-in/academic/learning-resources

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MEC364A Internship/Practical Training II 0-0-2-0

Course Objectives: The objective of internship/practical training is to make sure that the students receive hands-on, real-world experience in an industrial setting or a research institution. It would also provide them exposure to industry-specific challenges, research problems undertaken at institutes of national importance, and develop essential skills in problem-solving, teamwork, and project management.

Course Outcomes: At the end of the internship/practical training, a student will be able to explain some of the industrial processes, briefly define a specific industrial environment and develop a deeper understanding of mechanical engineering principles and practices. A student will also develop a heightened awareness of the professional demands and expectations within the industry, preparing them for successful careers in the field. A student will also develop an interest in pursuing higher education in the frontier areas of mechanical engineering.

Few guidelines for the internship/practical training:
The department expects students to do such internships or practical training at some established industrial setups or research institutes like CSIR/CMERI/DRDO/ISRO/IITs/NITs. In particular, the students in the third year shall preferably visit an industry/research institute, etc. In no case, shall this internship/training be replaced by a training on some software at a private institute. All internships/training shall have to be approved by the Head of the Department beforehand. The internships/training should be focussed with few objectives rather than just a visit to the industry/research institution.

Duration:
Minimum four weeks training or internship only, shall qualify for the evaluation later on, and the award of audit complete.

Evaluation Mode and Rubrics:
The internship or the practical training shall be evaluated in the sixth semester and the students would be awarded the audit complete grade based on the internship/practical training report, attendance during the same, presentation before the departmental committee, and the original certificate submission.

MEC365C Design Credits 0-0-0-2

Course Objectives: The objective of earning design credits is to enable students to undertake at least one activity during the whole undergraduate programme that involves fabrication of a prototype with some social relevance. This activity would thereby connect a student to the society in terms of application of mechanical engineering.

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

1. Explain the various instances where mechanical engineering has greatly contributed to solve some of the problems faced by human society.
2. Apply the basic concepts of mechanical engineering to solve some of the existing problems in the society.

Few guidelines for earning design credits:

1. The department expects a group of students to get into various teams and register the same with the course coordinator at the beginning of the sixth semester.
2. The students would select a particular topic and start working upon the same after approval of the coordinator/committee.
3. The students shall in no case select a research topic for this course as it is a pure fabrication activity leading to a prototype/working model.
4. The students shall avoid heavy expenditure on this activity, rather a basic use of some material/tools/machines available in the department/workshop is only expected. Use of CAD/3D printing/CNC/other machinery in the workshop is desirable.
5. The students shall finish the activity by the end of this semester only.
6. No report is expected from this activity, rather a prototype or working model is required for evaluation.
7. There shall be no designated slots in the timetable for this activity, rather students at their free time or beyond the academic schedule are expected to work on this project and finish it on time.

Evaluation Mode and Rubrics:
The students shall be awarded grades based on the concept/working model/application/details of the design/presentation. A mid-term review of the same would also be taken as part of continuous assessment.

Pre-requisites: NA

Text Books:

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

Reference Books:

1. TimJones, New Product Development, Butterworth-Heinemann Ltd, Oxford. UCI -1997.

Online Resources: NA

MEC354E Refrigeration and Air Conditioning 3-0-0-0

Course Objectives: This course will enable students to:

1. Understand the fundamentals of refrigeration and air conditioning.
2. Study various refrigeration cycles and evaluate their performance.
3. Acquire knowledge of refrigerants.

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

1. Describe the fundamental principles and applications of vapour compression and air refrigeration systems.
2. Present the properties, applications and environmental issues of different refrigerants.
3. Describe equipment operating principles employed in refrigeration systems.
4. Describe different methods of refrigeration, vapour absorption refrigeration system, non-conventional refrigeration systems and air refrigeration cycle.
5. Calculate cooling load for air conditioning systems used for various applications, operate and analyze the air conditioning systems.

Module I

Vapour Compression and Air Refrigeration Systems: Analysis of Vapour Compression (VC) System, Multipressure System, Cascading V.C. Systems, Gas refrigeration system. Bell-Coleman cycle, Steam Jet Refrigeration, Cold preservation of food, cold storage.

Module II

Refrigerants: Primary & secondary refrigerants, properties and selection of refrigerants. Impact of Chloro Fluoro Carbons (CFC) on Ozone layer and global warming, Alternatives of CFC's. Cryogenics, liquification of gases.

Module III

Components of Refrigeration Systems: Compressors: Positive Displacement (Reciprocating and Rotary); Dynamic (Centrifugal and Axial) Compressors; Condensers and Evaporators (Both Natural and Forced Convection type); Expansion Devices and other components of the system.

Module IV

Vapour Absorption Refrigeration System: Properties of binary mixture, processes executed by binary mixture, processes executed by binary mixtures, Aqua-Ammonia and Li-Br Absorption systems; rectification. Non-conventional refrigeration systems: vortex tube, thermo electric, pulse-tube, thermo-acoustic refrigeration

Module V

Air-conditioning: Psychrometry of A.C. processes, Thermal comfort and Comfort chart, A.C. Systems, Cooling and heating loads. A.C. duct sizing, air distribution, fans, air cleaning, pipe sizing and layout. A.C. controls: elements of basic control systems, thermostats, humidistats dampers, sequencing of control operations. Mathematical Analysis of Air-Conditioning Systems: Cooling and Heating Load Estimation.

Pre-requisites: Engineering Thermodynamics and Applied Thermodynamics

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Text Books:

1. C. P. Arora, Refrigeration and Air Conditioning, McGraw Hill Education, 3rd edition, 2017.
2. W. F. Stoecker and J.W. Jones, Refrigeration and Air conditioning, McGraw Hill Education, 1982.
3. R. K. Rajput, Refrigeration and Air Conditioning, S.K. Kataria and sons, 2013.
4. Reference Books:
5. R. J. Dossat, Principles of Refrigeration, John Wiley & Sons, 5th edition, 2001.
6. M. Prasad, Refrigeration and Air Conditioning, New Age Publishers, 3rd edition, 2015.

Online Resources:

1. Refrigeration and Air Conditioning by Prof. Ravi Kumar (IIT Roorkee), NPTEL Course, (https://onlinecourses.nptel.ac.in/noc19_me58/preview).

MEC355E Design of Mechanical Systems 3-0-0-0

Course Objectives: This course will enable students to:

1. Attain the basic knowledge required to understand, analyze, design and select machine elements required in transmission systems
2. Impart design skills and to apply those skills for the problems in real life industrial applications
3. Inculcate an attitude of team work, critical thinking, communication, planning and scheduling through design projects.
4. Create awareness amongst students about safety, ethical, legal, and other societal constraints in execution of their design projects.
5. Develop a holistic design approach to find out pragmatic solutions to realistic domestic and industrial problems

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

1. Understand and apply principles of brake and clutch design.
2. Inculcate an ability to design belt drives and selection of belt, rope and chain drives.
3. Become proficient in Design of Super Gear, Helical and Bevel Gear.
4. Develop capability to analyze Rolling contact bearing and its selection from manufacturer's catalogue.
5. Achieve an expertise in design of Sliding contact bearing in industrial applications.

Module I

Design of Brakes and Clutches: Design of friction elements, various types of brakes, design equations for various types of brakes, design analysis of all types of brakes, e.g., band brake, long shoe brake, etc. design analysis of all types of clutches.

Module II

Design of Belt drives: Design and analysis of flat and V-belt, equations for power, slip, etc. V-belt drives and rope drives, wire ropes, designation of wire ropes, stresses induces in wire ropes, design of chain drives.

Module III

Design of Gear Drives: Introduction to gear design, design of spur gear, equation for σ_b and σ_c for spur gear, design analysis for bending, force analysis for Helical gear, design analysis for helical gear, design of bevel gear, determination of bearing forces, horizontal and vertical shafts, design analysis for bevel gear , design analysis for worm gear.

Module IV

Design of Plain Bearings: Introduction to Plain bearings, Bearing surface at Micro level, Derivation of Energy equation and PV factor , PV graph, Values of PV , Derivation of Wear coefficient equation, Step-by-step procedure for Plain bearing design, Self-lubricating bearings and use of clearance for life of bearing, Design of Hydrodynamic bearings, Derivation of Reynolds equation for three dimensional case, Journal bearing geometry, Variation of viscosity with pressure and temperature, Viscosity index, Sommerfeld number.

Module V

Design of Roller Bearings: Introduction to Rolling element bearings, Design of AFB , Equations for L10 life, Static and dynamic loadings, Use of AFB catalogue, Determination of Load based on radial and thrust load for ball bearings, Derivation of Load equation for Tapered AF bearings.

Pre-requisites: Mechanics of Deformable Solids and Design of Machine Elements

Text Books:

1. R. G. Budynas and J. K. Nisbett , Shigley's Mechanical Engineering Design, McGraw Hill Education (India).
2. R. L. Mott , Machine Elements in Mechanical design, Prentice-Hall Inc, New Jersey.

Reference Books:

1. M. F. Spotts , Design of Machine Elements, Prentice-Hall Inc, New Jersey.
2. V. B. Bhandari , Design of Machine Elements, McGraw Hill Education (India).
3. P. C. Sharma and D. K. Aggarwal , A Textbook of Machine Design, S. K. Kataria and Sons New Delhi India.

Online Resources:

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

MEC356E Advanced Manufacturing Technologies 3-0-0-0

Course Objectives: This course will enable students to:

1. Acquire knowledge on the advancements of metal casting processes.
2. Define the advanced welding processes and their applications.
3. Understand the processing and fabrication techniques of composites and polymers

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

1. Classify various manufacturing systems and explain the need for advanced manufacturing.
2. Identify the basic difference between various casting processes and the need for advanced casting techniques.
3. Discuss various advanced metal forming processes with industrial applications.
4. Select the appropriate joining process based on material and its end use application.
5. Compare the materials such as composites and polymers along with their fabrication and processing techniques.

Module I

Introduction to Advanced Manufacturing: Manufacturing and manufacturing systems, manufacturing aspects selection and classification. Need for advanced manufacturing. Materials and selection.

Module II

Advanced Casting Process: Metal mould casting basics, continuous casting, permanent mould casting, pressure die casting, Vacuum mould casting, Evaporative pattern casting (EPC) - Hybrid and vacuum, Ceramic shell investment casting, process and applications.

Module III

Advanced Metal forming Process: Unconventional Forming Methods: Classification, Process Principle, Applications, High energy rate forming (HERF) process, Electromagnetic forming, explosive forming, Electro-hydraulic forming, stretch forming, contour roll forming

Module IV

Advanced Welding Processes: Atomic hydrogen, ultrasonic welding (USW), Plasma arc welding (PAW), laser beam welding (LBW), and Electron beam welding (EBW). Wire-feed based WAM.

Module V

Processing of polymers and composites: Introduction to polymers and composites-Polymer fabrication methods viz., Injection moulding, Compression moulding, Transfer moulding, Thermoforming .Ultrasonic Molding Technology: Recent Advances and Potential Applications in the Medical Industry. Types of composites, Composite fabrication methods viz., Compression moulding, Vacuum moulding, Prepreg fabrication, Filament winding.. Thermoplastics and Thermosets, Elastomers and composites.

Pre-requisites: Manufacturing Processes I, Manufacturing Processes II

Text Books:

1. S. Kalpakjian and Schmid, Manufacturing Processes for Engineering Materials, 2017, 5th edition, Prentice Hall.
2. H. Abdel-Gawad El Hofy, Fundamentals of Machining Processes (Conventional and Nonconventional Processes), 2018, 3rd Edition, CRC press.
3. A. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd. New Delhi.
4. V. K. Jain, Micro manufacturing processes, 2013, CRC Press

Reference Books:

1. H. R. W., Loper C. R., and Rosenthal P. C. Principles of Metal Castings, 1997, 2nd Edition, Tata McGraw Hill, New Delhi.
2. Mark J. Jackson, Micro and Nano fabrication, 2010, CRC Press, Taylor & Francis Group
3. Yi Qin, Micro-Manufacturing Engineering and Technology, 2010, Elsevier Publisher, ISBN: 978-0-8155-1545-6

Online Resources:

1. Advanced manufacturing processes by Prof. A. K. Sharma (IIT Roorkee) NPTEL course (https://archive.nptel.ac.in/courses/112/107/112107078/)

MEC357E Computer Aided Design and Analysis 3-0-0-0

Course Objectives: This course will enable students to:

1. Develop understanding of CAD in engineering design and analysis.
2. Provide an overview of how computers can be utilized in mechanical component design.
3. Develop the ability to use the CAD techniques appropriate for mechanical engineering applications.
4. Apply knowledge of the interdisciplinary nature of computer graphics, geometric modeling and engineering design in the wide variety of applications.
5. Provide an overview of finite element methods and its application in mechanical component design.

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

1. Select and use appropriate geometric modeling techniques for mechanical engineering applications.
2. Formulate problems involving concatenated transformations of geometric entities.
3. Represent and model geometric entities like curves, splines and surfaces.
4. Explain different solid modeling techniques and approaches used in CAD packages.
5. Formulate and solve basic engineering problems using FEM involving spring, bar and heat transfer problems.

Module I:

Introduction: Role of computers in design process; Computer aided design, analysis and manufacturing; Popular CAD software used in industry, wireframe modeling, surface modeling, solid modeling, feature based solid modeling, solid modeling functions, Boolean functions,; Input and output devices.

Module II:

Transformations: Matrix representation of points, lines and planes; 2D transformation for translation, scaling, rotation and reflection; Homogeneous representation & concatenation; 3D transformations.

Module III:

Curves and Surfaces: Representation of curves; Hermite curves, Bezier curves, B- spline curves, Surface modeling – parametric representation, planar surface, surface of revolution, Bezier and B-spline surfaces

Module IV:

Solid Modeling: Solid modeling techniques – sweep (linear and curved), Boolean (constructive solid geometry) and other techniques; Solid model representation (Boundary and Constructive Solid Geometry)

Module V:

Engineering Analysis: Introduction to finite element method; FE analysis of 1D element problems (spring, bar elements, heat transfer problems); Development of element stiffness equation and their assembly; Popular CAE software used in industry and its application for Plain strain and plane stress problems; Domain discretization, pre-processing and post-processing; Verification and validation.

Pre-requisites: NA

Text Books:

1. I. Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. D. L. Logan, A First Course in the Finite Element Method, Cengage Learning.

Reference Books:

1. M. E. Mortenson, Geometric Modeling, Tata McGraw Hill, 2013.
2. D. Hearn and M. P. Baker, Computer Graphics, Prentice Hall Inc., 1992.
3. D. F. Rogers and J. A. Adam, Mathematical Elements for Computer Graphics, McGraw Hills.
4. A. Tizzar, Computer Aided Engineering, McGraw Hills.
5. J. N. Reddy , An Introduction to the Finite Element Method, McGraw Hill, International Edition, 1993.

Online Resources:

1. Computer Aided Design and Manufacturing, by Prof. Anoop Chawla, Prof. P.V. Madhusudan Rao, IIT Delhi (https://nptel.ac.in/courses/112/102/112102101/).
2. Computer Aided Engineering Design, by Dr. Anupam Saxena, IIT Kanpur, (https://nptel.ac.in/courses/112/104/112104031/).

MEC352G Power Plant Engineering 3-0-0-0

Course Objectives: This course will enable students to:

1. Explore different aspects of power plant engineering and the associated energy conversions.
2. Understand the working of power plants based on different fuels and the criteria for site selection.
3. Understand the basic working principle of turbines and steam generators.
4. Appreciate the principles of safety and environmental issues.

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

1. Explain the economics involved in Power Plants and identify the sources for power generation.Differentiate between various fuels and analyze the air fuel ratio.
2. Describe the thermodynamic cycles used in thermal power plants and the different components comprising the power plant.
3. Discuss the working principle and basic components of the hydroelectric power plants and the governing of turbines.
4. Describe the working principle and basic components of the diesel and nuclear power plant and identify the factors for the selection of power plant.
5. Analyze the economic considerations of power plants and calculate load distribution and various tariffs.

Module I

Introduction: Concepts and classification of power plants, resources for power generation, Global and national status of power generation.

Fuels and Combustion: Classification of fuels, calorific value and its determination. Combustion equation, stoichiometric air fuel ratio, excess air requirement, actual air fuel ratio, Flue gas analysis.

Module II

Thermal Power Plants: Essentials of steam power plant equipment, Thermodynamic cycle of steam flow: Carnot cycle, Rankine cycle, Actual Rankine cycle, Reheat cycle, Rankine cycle with Regeneration, Power plant design, characteristics of steam power plant, Fuel handling, Methods of fuel firing, Types of boilers, Steam turbines and alternators, Feed water and its treatment.

Module III

Hydroelectric Power Plants: General layout and arrangement of Hydroelectric power plants, Types of turbines, description and principles of impulse and reaction turbines, turbine characteristics, selection of turbines, governing of turbines.

Module IV

Diesel Power Plants: Characteristics and selection of diesel power plant., Main components and its working, heat balance and plant efficiency.

Nuclear Power Plants: Basics of Nuclear engineering, Layout and subsystems of Nuclear power plants, Working of Nuclear reactors, safety measures for Nuclear power plants.

Module V

Energy Economics and Environment: Economic and environmental issues; Power tariffs; Load distribution parameters; Load curve; Capital and operating cost of different power plants; Pollution control technologies including waste disposal options for coal and nuclear plants.

Pre-requisites: NA

Text Books:

1. P. K. Nag, Power Plant Engineering, McGraw Hill Education, 4th edition, 2014.
2. R. K. Hedge, Power Plant Engineering, Pearson Education India, 1st edition, 2006.
3. S. C. Arora, & S. Domkundwar, A Course in Power Plant Engineering, Dhanpat Rai & Sons, 8th edition, 2016.

Reference Books:

1. M. M. El-Wakil, Power Plant Technology, McGraw Hill, 1st edition, 2002.
2. J. H. Rust, Nuclear Power Plant Engineering, Haralson Pub Co., 1999.
3. P. J. Potter, Power Plant Theory and Design, Kreiger Pub. Co., 2nd edition, 1988.
4. E. B. Norris and E. Therkelsen, Heat Power, McGraw Hill, 2nd edition,1939.

Online Resources:

1. Power Plant engineering by Prof. Ravi Kumar (IIT Roorkee), NPTEL Course (https://onlinecourses.nptel.ac.in/noc22_me73/preview).

MEC353G Introduction to Human Factors Engineering 3-0-0-0

Course Objectives: This course will enable students to develop an awareness of the major perspectives underlying the field of Ergonomics and an understanding of the potential that Human Factors Engineering has for society and organizations now and in the future.

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

1. Interpret the scope and importance of Human Factors Engineering/Ergonomics.
2. Explain the physical aspects of human factors.
3. Analyze the problems present in the work environment and design a job analysis method.
4. Create better work methods considering human factors for better performance.
5. Apply the key concepts of work and equipment design for reducing accidents.

Module I

Introduction: Definition, History, and Scope of Human Factors/Ergonomics; Man-machine-environment interaction system: A design perspective; Human compatibility, comfort, and adaptability.

Module II

Physical aspects of human factors: Anthropometrics, How does anthropometrics help in design? Body and activity systems; posture, joint movement and biomechanics; Occupational stress and musculoskeletal disorders; Safety and health issues.

Module III

Design of Work Environments: Environmental factors influencing human performance. Varieties of work environments, Everyday environment, and risks, Social environment: Group dynamics, Selection, training, placement, promotion, counseling, job motivations, and job satisfaction. Safety-critical environments, Techniques of job analysis.

Module IV

Work Methods: Efficiency at work, the concept of efficiency, the work curve, its characteristics, the work methods; hours of work, nature of work, fatigue and boredom, rest pauses. The personal factors; age abilities, interest, job satisfaction, the working environment, noise, illumination, atmospheric conditions, increasing efficiency at work; improving the work methods, Time and motion study, its contribution, need for allowances in time and motion study.

Module V

Work and Equipment Design: Criteria in evaluation of job-related factors, job design, methods design, workspace and its arrangement; Accident and Safety: The human and economic costs of accidents, accident record, and statistics, the causes of accidents, situational and individual factors related to accident reduction.

Pre-requisites: NA

Text Books:

1. R. Bridger, Introduction to Ergonomics, CRC Press, 2008.
2. C. Wicknes, J. Lee, Y. Liu & S. Gordon Becker, An Introduction to Human Factors Engineering, Pearson New International Edition, 2013.

3. M. S. Sanders & E. J. McCormic, Human Factors Engineering and Design, McGraw Hill Inc., 1993.
4. B. Vikram & Priya, Industrial Psychology, New Age International Publishers, 2010.

Reference Books:

1. N. R. F. Mair, Principles of Human relations, Applications to Management, John Wiley & Sons Inc., 1952.
2. D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997.
3. G. Salvendy, Handbook of Human Factors and Ergonomics, John Wiley & Sons Inc., 2021.
4. J. Dul & B. Weerdmeester, Ergonomics for beginners, a quick reference guide, CRC Press, 2001.

Online Resources:

1. Ergonomics for beginners: Industrial Design Perspective by Prof. Debkumar Chakrabati (IIT Guwahati), NPTEL Course (https://archive.nptel.ac.in/courses/107/103/107103004/).
2. Applied Ergonomics by Prof. Shantanu Bhattacharya (IIT Kanpur), NPTEL Course (https://archive.nptel.ac.in/courses/112/104/112104222/).

MEC354G Introduction to Flight and its Systems 3-0-0-0

Course Objectives: This course will enable students to:

1. Know the history and basic principle of flight.
2. Understand the foundation of flight, aircraft structures, materials and propulsion.
3. Develop an understanding of stability for an aircraft along with its different systems.

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

1. Appreciate and apply the basic principle of aviation.
2. Apply the concepts of fundamentals of flight and explain the basics of aircraft structures and materials.
3. Explain the power generation in flight vehicles.
4. Comprehend the complexities involved during the course of flight.
5. Identify the various systems in an aircraft.

Module I

History and Basic principles of flight – History of aviation; Classification of aircrafts; Basic components of an aircraft, control surfaces and high lift devices; ; Helicopters, their parts and functions airspeed and groundspeed; forces over wing section, aerofoil nomenclature; generation of lift and drag, Mach number and supersonic flight effects.

Module II

Aircraft Structures and Materials: Introduction; general types of construction; monocoque, semi monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.

Module III

Aircraft Propulsion: Aircraft power plants, Turboprop, turbojet and turbofan engines; ramjets and scramjets; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation.

Module IV

Aircraft Stability: Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning, aircraft maneuvers; Performance of aircraft, maximum and minimum speeds for horizontal flight at a given altitude; correct and incorrect angles of bank; aerobatics, inverted maneuver, maneuverability.

Module V

Aircraft Systems: Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system.

Pre-requisites: NA

Books:

1. J. D. Anderson, Introduction to Flight, McGraw-Hill Education, 2011.
2. A. C. Kermode, Flight without formulae, Pearson Education India, 1989.

Reference Books:

1. R. C. Nelson, Flight stability and automatic control, McGraw-Hill International Editions, 1998..
2. I. Moir and A. Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, John Wiley & Sons, 2011.

Online Resources:

1. Introduction to Flight by Prof. Rajkumar Pant, IIT Bombay (https://archive.nptel.ac.in/courses/101/101/101101079/)
