Courses of Study

B.Tech Robotics and Automation

Batch 2024 Onwards

6th Semester

Department of Mechanical Engineering

Islamic University of Science and Technology Kashmir

Table of Contents

Detailed Course Contents for 6th Semester

Total Credits = 24+X *Total Hours Per Week = 26+3(S)+X*

Course Code	Course Title	L	T	P	S	Credits
MEC352C	Mechanical Vibrations	3	1	0	0	4
ELE363C	Power Electronics and Drives	3	0	2	0	4
MEC353C	Manufacturing Automation	3	0	0	0	3
ECE355C	Industrial Communication Protocols and Networking	2	0	2	0	3
MEC354C	Numerical Methods for Engineers	2	0	2	0	3
MEC355C	Data Analytics	2	0	2	0	3
MEC363C	Computer Aided Engineering and Analysis Lab	0	0	2	0	1
MEC365C	Design Credits	0	0	0	2	2
MEC357C	Internship/Practical Training II[1]	0	0	0	1	1
	Open Elective	-	-	-	-	X

Note(s):

[1] *Contact hours are used for evaluation only. However, the internship or training has to be completed during winter vacations after the fifth semester. The minimum duration of such internship or training has to be four weeks.*

MEC352C Mechanical Vibrations 3-1-0-0

Course Objectives: This course provides students with a foundational understanding of vibration theory, covering the principles of oscillatory motion and dynamic systems. Students will learn the working mechanisms of vibration measuring instruments, such as accelerometers and vibrometers, and their applications in real-world scenarios. Additionally, the course introduces numerical methods for analyzing multi-degree-of-freedom systems, equipping learners with computational techniques to model and solve complex vibration problems. By combining theory and practical applications, students will develop the skills to assess and mitigate vibrations in mechanical and structural systems

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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.

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/).

ELE363C Power Electronics and Drives 3-0-2-0

Course Objectives: This course equips students with a comprehensive understanding of power electronics and electric drives, covering the operation, design, and synthesis of various power converter circuits and their industrial applications. Students will learn the fundamental principles of electric drives and actuators, including their key components and control mechanisms. The course emphasizes hands-on experience with power electronic converters, enabling learners to analyze, design, and implement these systems in real-world scenarios. By integrating theory with practical exercises, students will develop the skills to optimize power conversion and drive systems for diverse engineering applications.

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

1. Understand the fundamental principles involved in the operation of power electronic switches and the different methods to control them
2. Design and analyze DC-DC converters
3. Understand and apply Analyze the performance of inverters and control techniques
4. Explain the key concepts and components of electric drives.
5. Apply various speed control techniques for DC and AC motors.

Module I

Introduction to Semiconductor Devices: Characteristics and specifications of semiconductor power devices: Power Diode, Thyristors, Triac, BJT, MOSFET, IGBT, Characteristics of SCR UJT firing circuits, di/dt& dv/dt protection of switches, Snubber circuits, SIC based switches and their drivers.

Module II

D-DC Converters: Basics of DC Motors: Construction, Types (Shunt, Series, separately excited), and Working Principles. Characteristics and Performance of DC Motors. Speed Control Techniques: Armature Voltage Control, Field Flux Control. Introduction to Chopper-Controlled DC Drives.

Module III

Rectifier, Inverter and Regulators: AC-DC Converters: Single-phase full-wave uncontrolled rectifiers, Single-phase full wave thyristor rectifier, DC-AC converters: Introduction, Principle of operation of voltage source inverters, Single phase inverters, pulse width modulation (PWM), AC-AC converters: phase control, Principle of operation of cycloconverters, matrix converter.

Module IV

Fundamentals of Electrical Drives and Applications: Basics of Brushless DC (BLDC) Motors: Construction, Operation, and Applications. Introduction to Stepper Motors: Types, Operation, and Control. Overview of Servo Motors: Characteristics and Applications.

Module V

Special Machines Drives and Implementations: Induction motor drives: Variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) V/f control of induction

motor. Variable frequency control, self-control, Voltage source inverter fed synchronous motor drive, Brushless DC Motor drive, DSP Based electric drives system.

List of Experiments:

1. To study V-I characteristics of Power MOSFET and IGBT
2. To study V-I characteristics of SCR and measure latching and holding currents
3. To study the bridge type and centre tapped uncontrolled rectifier with and without filter
4. To study step-down DC-DC converter
5. To study step-up DC-DC converter
6. To study SCR based controlled rectifier
7. Operation of single-phase full bridge inverter with PWM Techniques
8. Operation of single-phase AC voltage controller and waveform analysis.
9. Study of thyristor-controlled and Chopper fed DC motor Drive
10. To Study the operation of 3 phase inverter fed induction motor drives

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Text Books:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd edition, 2001.
3. Electric Motors and Drives: Fundamentals, Types and Applications" by Austin Hughes and Bill Drury.

Reference Books:

1. P.S. Bimbhra , "Power Electronics", 4th edition, Khanna Publisher, India, 2018.
2. Vedam Subramanyam, Electric Drives Concepts and Applications, Tata McGraw Hill Education Private Limited, 2nd edition, 2011
3. S.R. Deb and Shanka Deb Robotics Technology and Flexible Automation, 2nd Edition, McGraw Hill Education (India) Private Limited, 2010.

Online Resources:

1. Fundamental of Electric Drives by Prof. S.P Das (IIT Kanpur), NPTEL Course (https://archive.nptel.ac.in/courses/108/104/108104140/).

MEC353C Manufacturing Automation 3-0-0-0

Course Objectives: This course introduces students to the critical role of automation in machine tool-based manufacturing, highlighting its impact on productivity, precision, and efficiency. Students will explore key elements of manufacturing automation, including CAD/CAM systems, sensors, pneumatics, hydraulics, and CNC technology. Additionally, the course covers the fundamentals of product design and how automation enhances the design-to-production workflow. Through a blend of theory and practical insights, learners will gain a comprehensive understanding of how automated systems transform modern manufacturing processes.

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.

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/).

ECE355C Industrial Communication Protocols and Networking 2-0-2-0

Course Objectives: To introduce students to the principles and protocols of industrial and wireless communication systems, enabling them to design and evaluate reliable communication interfaces for robotic and automation applications.

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

1. Describe communication protocols like UART, SPI, and I2C essential for robotic hardware integration.
2. Evaluate fieldbus and industrial Ethernet protocols for real-time robotic and automation applications.
3. Analyze the suitability of wireless communication technologies for robotic networks and control systems.

Module I

Basics of Industrial Communication & Communication Protocols: Overview of communication systems OSI model basics; asynchronous and synchronous communication; serial and parallel communication; signal encoding. bus arbitration and protocol comparison.Fundamentals of UART RS-232, RS-485, SPI, and I2C, timing and framing concepts;

Module II

Fieldbus and Industrial Ethernet Protocols: Introduction to Modbus (RTU & TCP), Profibus, CAN, DeviceNet; Industrial Ethernet: EtherCAT, PROFINET, Ethernet/IP; network topologies, master-slave and peer-to-peer architectures, latency, and reliability considerations.

Module III

Wireless Communication in Industrial and Robotic Systems: Wi-Fi, Bluetooth, BLE, ZigBee, LoRa, NRF module; GSM, wireless sensor networks; mesh topology; challenges in wireless systems: noise, interference, bandwidth, power.

List of Practicals (indicative):

1. Configure and test serial data exchange using UART and validate using a terminal.
2. Establish a basic connection between your smartphone and Arduino via Bluetooth, allowing you to send and receive data using the serial monitor.
3. Displaying various forms of data on serial monitor and serial plotter.
4. Use a Bluetooth connection to toggle an LED on and off, demonstrating basic control over an output.
5. Interface a sensor (e.g., temperature sensor, distance sensor) with the Arduino and send the sensor readings to your smartphone via Bluetooth.
6. Use I2C to control an LCD or read/write data to an EEPROM module.
7. USB/raspberry Camera: Capturing images and videos using a USB/raspberry camera.
8. Controlling motor (DC or servo) using bluetooth.
9. Write a program for Interfacing of GSM module
10. Write a program to collect data of various sensors and display it on the console.

11. Write a program to Display data on (LED MATRIX/LCD/OLED) (Serial/parallel)

Textbooks:

1. A. Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress Publications.
2. Thas John Robert, Arduino Data Communications, Packt Publishing Limited.

Reference Books:

1. C. Bartodziej, The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics, Springer.
2. R. Kamal, Embedded System: Architecture, Programming and Design, McGraw Hill Education
3. O. Vermesan and P Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers

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Online Resources: NA

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

Course Objectives: This course introduces students to the fundamental concepts of numerical methods, equipping them with essential mathematical tools for solving complex engineering problems. Students will learn interpolation and approximation techniques to estimate values between data points and represent functions efficiently. The course also covers curve fitting, root-finding algorithms, and optimization methods, enabling learners to analyze data, solve nonlinear equations, and identify optimal solutions. Through practical examples and computational exercises, students will develop the skills to apply these numerical techniques to real-world engineering and scientific challenges.

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.

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.

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.

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.

List of Practicals

1. Floating Point Error and Propagation
2. Gauss-Jordan and Gaussian Elimination
3. LU Decomposition and Ill-Conditioned Systems
4. Lagrange and Newton's Interpolation
5. Cubic Spline Interpolation
6. Eigenvalue Estimation using Power and Jacobi Methods
7. Numerical Differentiation and Integration
8. Gaussian Quadrature for Double Integrals
9. Root Finding Using Bracketing and Open Methods
10. Optimization Using Gradient-Based and Metaheuristic Methods

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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 provides students with a foundational understanding of data science, covering essential concepts and practical skills. Students will learn to preprocess data using various techniques to ensure quality and consistency for analysis. The course introduces Python-based data analytics tools, enabling learners to manipulate and analyze datasets efficiently. Additionally, students will explore data visualization techniques to effectively communicate insights and patterns. Finally, the course covers basic machine learning algorithms, equipping students with the skills to implement predictive models. Through hands-on projects, students will gain practical experience in the entire data science workflow, from preprocessing to visualization and machine learning.

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.

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

Course Objectives: This course introduces students to Modeling and Analysis software, providing foundational skills in 3D modeling using industry-standard CAD tools to create parts and assemblies. Students will also learn the basics of Finite Element Analysis (FEA), applying commercial FEA packages to analyze mechanical components under various loads and boundary conditions. Through hands-on practice, learners will gain proficiency in design simulation and validation for engineering applications.

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

MEC357C Internship/Practical Training II 0-0-0-1

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:
Only training or internship of a minimum duration of four weeks shall be considered valid for evaluation and award of credits.

Evaluation Mode and Rubrics:
The internship or practical training shall be evaluated in the fourth semester. Students will be awarded credits based on their internship/practical training report, attendance, presentation before the departmental committee, and submission of the original certificate.

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/3Dprinting/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.

TextBooks:

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.
