KBTCOE

Maratha Vidya Prasarak Samaj's

Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013,

Maharashtra, India

Syllabus of Under-Graduate Program

Third Year B.Tech. Mechanical Engineering (2024 Pattern)

(As per NEP 2020)

Academic Year 2026-27

(Copy for Student Circulation Only)

V1.25.03.2026

Program Specific Outcomes (PSOs).

PSO1: Ability to design, analysis and problem-solving skills using basic principle of mechanical engineering.

PSO2: Ability to impart technical and professional skills through industry institute interaction.

PSO3: Develop practical skills for the benefits of society.

Program Educational Outcomes (PEOs).

PEO1: To prepare technocrats that can satisfy the need of mechanical and allied industries.

PEO2: To develop critical thinking, problem-solving skills, research aptitude, and career and professionalism among the students.

PEO3: To improve and expand technical and professional skills of students through effective teaching-learning and industry interaction.

Program Outcomes (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective

reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) Independent and life-long learning, ii) Adaptability to new and emerging technologies and iii) Critical thinking in the broadest context of technological change. (WK8).

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas is the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Third Year B.Tech. Mechanical Engineering
Curriculum Structure (2024 Pattern) Semester – V

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
101501	**PCC-8**	Heat Transfer	3	2	-	40	60	25	25	**150**	3	1	-	**4**
101502	**PCC-9**	Machine Design – I	2	2	-	40	60	25	25	**150**	2	1	-	**3**
101503	**PCC-10**	Numerical Methods and Optimization	2	2	-	40	60	25	25	**150**	2	1	-	**3**
101504	**PEC-1**	Program Elective Course-1	3	2	-	40	60	25	-	**125**	3	1	-	**4**
170505	**MDM-3**	Multi-Disciplinary Minor-3	3	2	-	40	60	25	-	**125**	3	1	-	**4**
101506	**VSEC-4**	Modeling and Additive Manufacturing Laboratory	-	4	-	-	-	50	-	**50**	-	2	-	**2**
Total			**13**	**14**	**0**	**200**	**300**	**175**	**75**	**750**	**13**	**7**	**0**	**20**

Course Code	PEC Course – 1
101504A	Composite Materials
101504B	Hydraulics and Pneumatics
101504C	Machining Science and Technology

Note: MDM-3 Courses are Listed on Page 6.

Third Year B.Tech. Mechanical Engineering
Curriculum Structure (2024 Pattern) Semester – VI

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
101601	**PCC-11**	Machine Design – II	3	2	-	40	60	25	25	**150**	3	1	-	**4**
101602	**PCC-12**	Computer-Aided Engineering	3	2	-	40	60	25	25	**150**	3	1	-	**4**
101603	**PEC-2**	Program Elective Course-2	3	2	-	40	60	25	25	**150**	3	1	-	**4**
101604	**PEC-3**	Program Elective Course-3	3	2	-	40	60	25	25	**150**	3	1	-	**4**
170605	**MDM-4**	Multi-Disciplinary Minor-4	3	-	1	40	60	50	-	**150**	3	-	1	**4**
Total			**15**	**8**	**1**	**200**	**300**	**150**	**100**	**750**	**15**	**4**	**1**	**20**

Course Code	PEC Course – 2	Course Code	PEC Course – 3
101603A	Mechanical Drives	**101604A**	Piping Design
101603B	Turbomachinery	**101604B**	Modern I.C. Engines
101603C	Metrology and Quality Control	**101604C**	Robotics

Note: MDM-4 Courses are Listed on Page 6.

Third Year B.Tech. Multi-Disciplinary Course – 3 and 4
List of Courses (2024 Pattern) Semester – V and VI

S #	Offered by Department	Streams (Choose One Stream Only)	Semester-V		Semester-VI		Semester-VIII		Eligible Student
			MDM – 3 Code	MDM – 3 Courses	MDM – 4 Code	MDM – 4 Courses	MDM – 5 Code	MDM – 5 Courses	
1.	Mechanical Engineering	Automobile Engineering	**170505A**	Systems in Mechanical Engineering	**170605A**	Automotive Technology	**170805A**	Automotive Control System	All, except Mech. Engg. Dept
2.	Computer Engineering	Software Development	**170505B**	Data Structures and Algorithms	**170605B**	Database Systems	**170805B**	Software System Design	All, except Computer Engg., Information Tech. and AI&DS Dept.
3.	Instru. & Control Engg.	Measurement and Control	**170505C**	Engineering Measurements	**170605C**	Industrial Control Components	**170805C**	Industrial Control Applications	All, except Instru. Control Engg. Dept.
4.	Electronics & Tele. Engg.	Internet of Things	**170505D**	Sensors and Actuators	**170605D**	Embedded System in IoT	**170805D**	Applications of IoT	All, except E&TC Department
5.	Civil Engineering	Infrastructure Planning	**170505E**	Infrastructure and Planning	**170605E**	Governing Policies	**170805E**	Transportation Systems	All, except Civil Engg. Department
6.	Information Technology	Web Technology	**170505F**	Web Development	**170605F**	Application Development	**170805F**	Digital Governance	All, except Info. Tech., Computer and AI&DS Dept.
7.	AI&DS	Data Analytics	**170505G**	Applied Data Science	**170605G**	Data Visualization	**170805G**	Business Analytics	All, except AI&DS, Computer and Information Tech. Dept.
8.	Electrical Engineering	Electrical Machines & Drives	**170505H**	Electrical Machines	**170605H**	Drives and Controls	**170805H**	Industrial Applications	All, except Electrical Engg. Dept

- **Summary of Credits and Total Marks:**

Semester	Credits	Marks
V	20	750
VI	20	750
Total	**40**	**1500**

• Definition of Credit :

The Under Graduate (U.G.) programmes will have credit system. The details of credit will be as follow. 1 Credit = 1 hour/week for lecture = 2 hours/week for practical = 1 hour/week for tutorial

- **Description of Various Courses:**

Type of Course	Description
PCC	Programme Core Course
PEC	Programme Elective Course
MDM	Multidisciplinary Minor Course
VSEC	Vocational and Skill Enhancement Course (Skill Courses)

Semester - V

Course Code: 101501	Course Name: Heat Transfer	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Prerequisite Courses:

- First and Second Law of Thermodynamics, Fluid properties, Continuity equation, Differential and Integral Calculus, Ordinary differential and Partial Differential Equations.

Course Objectives:

- To identify the laws for different modes of heat transfer.
- To understand the properties and economics of thermal insulation and analyze heat transfer through fins and thermal systems with lumped heat capacitance.
- To analyze the natural and forced convective modes of heat transfer in various geometric configurations.
- To understand and realize various laws with their interrelations and analyze radiation heat transfer in black and grey bodies/surfaces with or without radiation shields.
- To analyze various performance parameters for existing heat exchangers and develop methodologies for designing a heat exchanger under prescribed conditions and for a particular application, with references to TEMA standards.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze and apply modes of heat transfer equations for a one-dimensional thermal system.

CO2: Design a thermal system considering fins, thermal insulation and transient heat conduction.

CO3: Evaluate the heat transfer rate in natural and forced convection & validate with experimentation results.

CO4: Interpret heat transfer by radiation between objects with simple geometries, for black and grey surfaces.

CO5: Design and analysis of heat transfer equipment and investigation of its performance.

Course Contents:

Unit-I: Fundamentals of Heat Transfer **08 Hours**

Basic Concepts: Different Modes and Laws of heat transfer, 3-D heat conduction equation in Cartesian coordinates (with derivation), and its simplified equations, simplified equations in cylindrical and spherical coordinates (simplified equations, no derivation), thermal conductivity, boundary conditions.

1-D steady state heat conduction without and with heat generation: heat conduction without heat generation in plane wall, composite wall, composite cylinder, composite sphere. Heat conduction with heat generation in plane wall, cylinder and sphere with different boundary conditions.

Unit-II: Fins and Transient Heat Conduction **08 Hours**

Thermal Insulation: Critical thickness of insulation, types and properties of insulating materials, safety considerations in thermal insulation, Economic and cost considerations, payback period.

Heat transfer through Fins: Types of fins and their applications, governing equation for constant cross-sectional area fins, solution for infinitely long fin (with derivation), adequately long fin with insulated end tip and short fins (no derivation), fin efficiency and effectiveness.

Transient heat conduction: Validity and criteria of lumped system analysis, Biot Number, Fourier Number, time constant and response of thermocouple. Use of Heisler and Grober Charts.

Unit-III: Convection **08 Hours**

Principles of Convection: Local and average heat transfer coefficient, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow.

Forced Convection: local and average heat transfer coefficient, physical significance of non-dimensional numbers, empirical correlations for flat plate, pipe flow, and flow across cylinders, spheres, tube banks.

Free Convection: Physical significance of non-dimensional numbers, Free convection from a vertical, horizontal surface, cylinder and sphere.

Boiling and Condensation: types of boiling, regimes of pool boiling, forced boiling, film wise condensation, drop wise condensation (no numerical treatment), critical heat flux.

Unit-IV: Radiation **08 Hours**

Thermal Radiation, definition of various terms used in radiation mode, Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wein's displacement law. Intensity of radiation and solid

angle; Lambert's cosine law; Radiation heat exchange between two black surfaces, configuration or view factor. Radiation heat exchange between grey surfaces, Electrical analogy for radiation, Radiation shields.

Unit-V: Heat Exchangers **08 Hours**

Classification and applications of heat exchangers, Heat exchanger analysis – LMTD for parallel and counter flow heat exchangers, Effectiveness: NTU method for parallel and counter flow heat exchangers, cross flow heat exchangers, LMTD correction factor, Heat Pipe. Introduction to TEMA standards, design considerations for heat exchangers, materials of construction and corrosion, temperature effects, radiation effects and economic considerations.

Learning Resources:

Text Books:

1. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley.
2. Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw-Hill Education Private Limited.
3. S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press.
4. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science.
5. P.K. Nag, Heat & Mass Transfer, McGraw-Hill Education Private Limited.
6. V. M. Domkundwar, Heat Transfer.

Reference Books:

1. P.K. Nag, Heat & Mass Transfer, McGraw-Hill Education Private Limited.
2. M.M. Rathod, Engineering Heat and Mass Transfer, Third Edition, Laxmi Publications, New Delhi.
3. V. M. Domkundwar, Heat Transfer, Dhanpat Rai & Co Ltd.
4. A.F. Mills, Basic Heat and Mass Transfer, Pearson.
5. S. P. Venkatesan, Heat Transfer, Ane Books Pvt. Ltd.
6. Holman, Fundamentals of Heat and Mass Transfer, McGraw – Hill publication.
7. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, Pearson Education India.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ch12
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ch65
3. https://youtu.be/qa-PQOjS3zA?si=Zt87-pQn-o_6ysmt

List of Practicals:

Complete **eight** experiments (Sr. no.1 to 10) and **two** assignments (Sr. no.11 to 15).

1. Determination of Thermal Conductivity of Insulating Powder.
2. Determination of the thermal conductivity of a metal rod.
3. Determination of the thermal conductivity of the composite wall.
4. Determination of local and average heat transfer coefficient in Natural Convection.
5. Determination of local and average heat transfer coefficient in Forced Convection.
6. Determination of temperature distribution, fin efficiency in Natural / Forced Convection.
7. Determination of the emissivity of a test surface.
8. Determination of Stefan-Boltzmann Constant.
9. Determination of heat transfer, overall heat transfer coefficient and effectiveness of Tube and Tube Heat Exchanger.
10. Study of Pool boiling phenomenon and determination of Critical Heat Flux (CHF).
11. Assignment to solve the transient heat transfer problem using Heisler and Grober Charts.
12. Assignment on heat exchanger/convection/ radiation/conduction using AI.
13. Design of a heat exchanger for any simple application.
14. Industrial visit to the heat treatment industry/ heat exchanger manufacturing industry.
15. Demonstration of dropwise and film-wise condensation.

Course Code: 101502	Course Name: Machine Design – I	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 2 Hours/Week **Practical :** 2 Hours/Week	**2** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Prerequisite Courses:

- Solid Mechanics, Machines and Mechanisms.

Course Objectives:

- To impart the knowledge on materials selection in design
- To familiarize the effects of various types of loading on machine parts.
- To develop the design methodology for mechanical components used in industries.
- To adopt various standards in the design process.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Design the cotter and knuckle Joints, levers and components subjected to eccentric loading.

CO2: Design shafts, keys and couplings as per the international standards.

CO3: Analyze different stresses in power screws.

CO4: Design different types of springs.

CO5: Evaluate the stress developed on the different type of welded and threaded joints.

Course Contents:

Unit-I: Design of Simple Machine Elements **06 Hours**

The meaning of design, engineering design, phases of design, design considerations, stress and strain considerations, factor of safety, standardization, preferred series. Modes of failure, Critical mode of failure, stresses due to bending and torsional load, eccentric loading, design of cotter and knuckle joints. Design of levers, Sustainable material selection for reduced environmental impact.

Unit-II: Design of Shafts, Keys and Couplings **06 Hours**

Overview of power transmission components, shaft, types of shafts and shaft subjected to bending and torsion, shaft design on strength basis and rigidity deflection basis, A.S.M.E code for shaft design, types of keys and their design, design of rigid and flexible couplings.

Unit-III: Power Screw 06 Hours

Terminology of power screw, torque analysis and design of power screws with square and trapezoidal threads, design of C-clamp, screw jack, differential and compound screw and re-circulating ball screw (theoretical treatment only), factors influencing wear in power screws.

Unit-IV: Design of Mechanical Springs 06 Hours

Mechanical spring, types of springs, terminology of helical spring, design of mechanical springs, helical torsion spring, design of multi-leaf spring, nipping and shot peening of spring.

Unit-V: Design of Threaded and welded Joints 06 Hours

Threaded joints, I.S.O metric screw threads profile, coarse and fine threads, designation of metric threads, bolts of uniform strength, design of bolted and threaded joints, eccentrically loaded bolted joints, types of welded joints, stresses in welded joints, strength of welded joints, eccentrically loaded welded joints, and welded joints subjected to bending moment.

Learning Resources:

Text Books:

1. V. B. Bhandari, Design of Machine Elements, 2020, 5th Edition, Tata McGraw-Hill.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw-Hill Publication Co., Ltd.

Reference Books:

1. Richard G. Budynas and Keith Nisbett J, Shigley Mechanical Engineering Design, 2020, 11th Edition (in SI Units), McGraw-Hill
2. Harsha, A. P., Hornberger, L. E., Shoup, T. E., Spotts, M. F., Design of Machine Elements, 2019, Pearson India Education Services Pvt. Limited.
3. Robert L. Norton, Machine Design, 2018, 5th Edition, Pearson.
4. Juvinal R.C and Kurt M. Marshek, Machine Component Design, 2016, Wiley.
5. PSG Design Data: Data Book of Engineers, 2020, Kalaikathir Achchagam.

Web link for MOOC / NPTEL Links:

1. https://www.youtube.com/watch?v=__py5xbKHGA
2. https://www.youtube.com/watch?v=SL21aDqgs8Q
3. https://www.youtube.com/watch?v=PEKfS2Q1WqM&list=PL3D4EECEFAA99D9BE&index=20
4. https://www.youtube.com/watch?v=TPURJnlekeo

List of Practicals:

1. Tutorial on geometric dimensioning and tolerancing.
2. Design project on cotter/knuckle joint or design project on rigid/flexible coupling.

3. Design project on screw jack/C-clamp.

- The design project shall consist of an assembly drawing, with a bill of materials and overall dimensions and drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces.
- A design report giving all necessary calculations of the design of components should be submitted in a separate file.
- Design data book shall be referred to for the selection of materials and standard components for given loading conditions.
- The Project should be assigned to a group of a maximum of four students.

Course Code: 101503	Course Name: Numerical Methods and Optimization	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 2 Hours/Week **Practical :** 2 Hours/Week	**2** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Prerequisite Courses:

- Engineering Mathematics, Basics Mechanical Engineering.

Course Objectives:

- To introduce students to fundamental numerical techniques for solving algebraic equations and systems of simultaneous linear equations.
- To develop the ability to solve ordinary and partial differential equations using numerical methods.
- To enable students to apply numerical integration methods for evaluating single and double integrals in engineering problems.
- To introduce optimization concepts and equip students with the ability to classify optimization problems, formulate linear programming models, and solve them using graphical and Simplex methods for practical industrial decision-making.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply numerical methods to find the roots of equations and solve systems of equations.

CO2: Apply numerical differentiation techniques to solve ODE and PDE.

CO3: Apply numerical integration techniques to solve engineering applications.

CO4: Apply curve fitting techniques using the least squares method to obtain the best fit for experimental data.

CO5: Formulate and solve linear programming problems using graphical and simplex methods for engineering optimization and industrial decision-making.

Course Contents:

Unit-I: Roots of Equations and Simultaneous Equations 06 Hours

Roots of Equation: Bracketing method- Bisection method, Open end method- Newton-Raphson Method

Simultaneous Equations: Gauss elimination Method, Partial pivoting, Gauss-Seidel method, Thomas algorithm for tri-diagonal matrix. (Cover application-based problems)

Unit-II: Numerical Differentiation **06 Hours**

Ordinary Differential Equations (ODE): Euler method, Runge - Kutta second order method, Runge - Kutta fourth order method.

Partial Differential Equations (PDE): Finite difference method, Simple Laplace method, PDE's parabolic explicit solution.

Unit-III: Numerical Integration **06 Hours**

Numerical Integration (1D): Trapezoidal rule, Simpson's 1/3rd rule, Gauss Quadrature 2-point and 3-point method. **Double Integration:** Trapezoidal rule, Simpson's 1/3rd rule.

Unit-IV: Curve Fitting and Interpolation **06 Hours**

Curve fitting-least square technique, straight line, power equation, exponential equation. Interpolation - Lagrange's interpolation, inverse interpolation.

Unit-V: Optimization Techniques **06 Hours**

Introduction to optimization, classification, and industrial application, methods to solve linear programming problems: graphical method, simplex method. Modern optimization techniques: genetic algorithm, simulated annealing.

Learning Resources:

Text Books:

1. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw-Hill Publishing Co. Ltd.
2. B. S. Grewal, Numerical Methods in Engineering and Science", Khanna Publication.

Reference Books:

1. Joe D. Hoffman, Numerical Methods for Engineers and Scientists", CRC Press.
2. S. S. Rao, Engineering Optimization, Theory and Practice, Wiley-Interscience Publication.

Web link for MOOC / NPTEL Links:

1. http://nptel.ac.in/courses/111101003/
2. http://nptel.ac.in/courses/111105038/
3. http://nptel.ac.in/courses/111105041/

List of Practicals:

- Tutorial for the subject shall be conducted in a minimum of three batches per division.
- Term work shall be awarded on the basis of the performance of students during tutorials as a continuous internal assessment.

1. Program on roots of equation.

2. Program on simultaneous equations.
3. Program on ODE.
4. Program on numerical integration.
5. Program on curve fitting using least square technique.
6. Program on interpolation.
7. Case study on mechanical system optimization using MATLAB.

Note: Validate answer with suitable solver.

Course Code: 101504A	Course Name: Composite Materials	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Prerequisite Courses:

- Material Science, Manufacturing Processes, Engineering Mechanics.

Course Objectives:

- To impart fundamental knowledge in composite materials.
- To understand the manufacturing and design requirements of composite materials.
- To interpret the testing and application selection process.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the fundamentals of composite materials.

CO2: Demonstrate basics and progressive techniques of composite materials.

CO3: Analyze the macro and micro mechanical behavior of the lamina.

CO4: Select appropriate testing and inspection methods for composite materials.

CO5: Select composite materials for various applications.

Course Contents:

Unit-I: Introduction to Composites **08 Hours**

Classification and characteristics of composite materials, function of the matrix and reinforcement in composite, terminology of laminated composite materials, hybrid composites, advantages and disadvantages of composites.

Unit-II: Manufacturing of Composites **08 Hours**

Polymer matrix composite manufacturing, metal matrix composite manufacturing, ceramic matrix composite manufacturing and selection of manufacturing method.

Unit-III: Mechanics of Composite Materials **08 Hours**

Basic Terminologies: Volume fraction and weight fraction, rule of mixture, macro-mechanical behavior of a lamina, micro-mechanical behavior of a lamina, failure theories for composite materials.

Unit-IV: Standards in Composites **08 Hours**

Mechanical tests, bond strength, testing techniques for composite double cantilever beam, nondestructive inspection of composites and standards for composite materials.

Unit-V: Application of composite Materials **08 Hours**

Applications of composite materials for aerospace and transportation applications, the automobile industry, energy and marine applications and the sports industry, including protective equipment.

Learning Resources:

Text Books:

1. Composite Materials: Science and Engineering by K. K. Chawla, Springer, 2016.
2. Fiber-Reinforced Composites: Materials, Manufacturing, and Design by P.K. Mallick, CRC Press, Edition 3, 2007.

Reference Books:

1. Engineering Composite Materials by Bryan Harris, The Institute of Materials, Landon.
2. Fundamentals of Composites Manufacturing-Materials, Methods and Applications by A Bent Strong, Society of Manufacturing Engineers, 2008.
3. Mechanics of composite materials by R. M. Jones., Ed.2., Taylor and Fransis, 2018
4. Composite Materials Handbook, SAE International, 2017.

Web link for MOOC / NPTEL Links:

1. Introduction of Composite https://nptel.ac.in/courses/112/104/112104229/
2. Manufacturing of composite https://nptel.ac.in/courses/112/104/112104221/
3. Mechanics of laminated composite https://nptel.ac.in/courses/112/104/112104161/
4. Advanced Composite https://nptel.ac.in/courses/112/104/112104249/

List of Practicals:

1. Study of composite materials and their classification.
2. Fabrication of GFRP composite using hand lay-up method.
3. Preparation of composite specimens using compression molding technique.
4. Determination of volume fraction and weight fraction of composites.
5. Tensile testing of composite materials.
6. Impact testing of composite materials.
7. Study of hybrid composites and their applications.
8. Case studies on industrial applications of composites.

Course Code: 101504B	Course Name: Hydraulics and Pneumatics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Prerequisite Courses:

- Engineering Mechanics, Manufacturing Processes and Machines.

Course Objectives:

- To study governing laws used in fluid power systems.
- To study fluid power applications.
- To study working principles of various components.
- To study selection of different components.
- To study how to design fluid power systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand working principle of components used in hydraulic & pneumatic systems.

CO2: Analyze various actuators and fluid power controllers in hydraulic systems.

CO3: Selection of appropriate components required for hydraulic and pneumatic systems.

CO4: Analyze hydraulic and pneumatic systems for industrial applications.

CO5: Design a system according to the requirements.

Course Contents:

Unit-I: Basics of Fluid Power and Pumps **08 Hours**

Fluid power basics, advantages and limitations, Types of fluids - Properties of fluids and selection, standard symbols. **Pumps** - types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves.

Unit-II: Hydraulic Actuators and Fluid Power Control **08 Hours**

Actuators: Linear and rotary actuators, types, construction and characteristics. Cylinder mountings, cushioning of cylinders. Hydraulic motors.

Fluid Power Control: Direction control, flow control and pressure control valves, types, construction, and operation, servo and proportional valves.

Unit-III: Hydraulic Circuits and Contamination Control 08 Hours

Hydraulic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail-safe circuit, counterbalance circuit, actuator locking, unloading circuit, motor breaking circuit, etc.

Contamination control: Contamination, sources of contamination, suction strainer, filters, filtration, filter ratings.

Unit-IV: Pneumatics – Components, Control Valves and Circuit 08 Hours

Compressors: Types, principle of working and constructional details. Comparison of pneumatic with hydraulic power transmissions. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two-pressure valve, quick exhaust valve and time delay valves and electro-pneumatics. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low-cost automation and in industrial automation.

Unit-V: System Analysis and Design 08 Hours

Calculation of piston velocity and thrust under static and dynamic applications, considering friction and inertia loads; design considerations for cylinders; design of hydraulic/pneumatic circuits for practical applications; selection of components such as reservoirs, control elements, actuators, accumulators, intensifiers, filters and pumps.

Learning Resources:

Text Books:

1. Esposito A, Fluid Power with Application, Prentice Hall.
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance, Tata McGraw-Hill.
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw-Hill.
4. Stewart H. L, Hydraulics and Pneumatics, Taraporewala Publication.
5. Jagadeesha T, Hydraulics and Pneumatics, Wiley - Dreamtech Press.

Reference Books:

1. Pipenger J.J, Industrial Hydraulics, McGraw-Hill.
2. Pinches, Industrial Fluid Power, Prentice Hall.
3. Sundaram K. Shanmuga, “Hydraulic and Pneumatic Controls”. Chand & Co.
4. Yeaple, Fluid Power Design Handbook.
5. Vickers-Industrial-Hydraulics-Manual.
6. Pneumatic Standard Manufacturer’s Catalogues FESTO.
7. Md. Abdus Salam, Fundamentals of Pneumatics and Hydraulics- Springer.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc24_me55/preview
2. https://www.festo.com/media/catalog/204256_documentation.pdf
3. https://www.noelle-nordhorn.de/fileadmin/user_upload/pdf/Festo-Catalogue_2022_EN-compressed.pdf
4. https://www.scribd.com/document/289203703/Vickers-Industrial-Hydraulics-Manual

List of Practicals:

1. Test on Gear/Vane/Piston pump and plot performance characteristics
2. Following experiments to be done on the hydraulic trainer.
    a. Regenerative circuit.
    b. Speed control circuit.
    c. Sequencing circuit.
3. Following experiments to be done on pneumatic trainer.
    a. Automatic reciprocating circuit.
    b. Speed control circuit.
    c. Pneumatic circuit involving Shuttle /Quick exhaust / Two pressure valve.
4. Test on pressure relief valve/flow control valve.
5. Test on linear /rotary actuator.
6. Design and Simulation of simple hydraulic systems used in practice using manufacturers' catalogue and analysis using software such as Festo-FluidSim /Automation Studio.
7. Design and Simulation of Simple Pneumatic Systems Using Manufacturer's Catalogue and FESTO FluidSIM Software / Automation Studio.
8. Industrial visit to study Hydraulic / Pneumatic based Automation systems
9. Assignments:
    a. Hydraulic and pneumatic symbols for different components as per standards
    b. To study techniques of condition monitoring and fault diagnosis in industrial systems by analyzing parameters: vibration, temperature, pressure, and noise to detect early faults and ensure reliable and efficient operation of machinery.
    c. Standard specifications of hydraulic/ pneumatic components using the manufacturer's catalogues.

Course Code: 101504C		Course Name: Machining Science and Technology
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Prerequisite Courses:

- Manufacturing Processes, Materials Science and Metallurgy.

Course Objectives:

- To know about fundamentals of metal cutting process, tool wear and tool life.
- To select, describe and perform finishing of parts using standard tools.
- To understand the basic concepts, importance and functions of jigs and fixtures.
- To select appropriate non-conventional machining process depending upon desired output characteristics.
- Prepare list of operations, tools, and set of manufacturing instructions and selection of quality assurance method.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the fundamentals of metal cutting, during machining processes.

CO2: Apply grinding concepts to select suitable grinding wheels for manufacturing applications.

CO3: Select Jigs and fixtures for industrial applications.

CO4: Classify different advanced machining processes.

CO5: Evaluate various parameters of process planning.

Course Contents:

Unit-I: Mechanics of Metal Cutting **08 Hours**

Introduction to metal cutting, geometry of single-point cutting tool, orthogonal and oblique cutting processes, chip formation, types of chips, chip thickness ratio, chip breakers, merchant's circle of forces, numerical, concepts of machinability, factors affecting machinability, machinability index, tool life, factors affecting on tool life, tool life equation of Taylor, tool wear and its types.

Unit-II: Grinding and Finishing Processes 08 Hours

Types of grinding machines, grinding wheel shapes, designation, abrasives, bond, grit, grade, and structure of wheels, mounting of wheels, balancing of wheels, glazing and loading of wheels, dressing and truing of wheels.

Super-Finishing Processes: Introduction, principles, working, process parameters, advantages, limitations, and applications for processes like honing, lapping, buffing and burnishing, etc.

Unit-III: Jigs and Fixtures 08 Hours

Significance and purpose of jigs and fixtures, concept of degree of freedom, 3-2-1 principle of location, jigs- definition, location guidelines, principles of clamping, principles of guiding, types of jigs.

Fixtures: Definition, location guidelines, principles of clamping, principles of setting elements, types of fixtures, selection of jigs and fixtures.

Unit-IV: Advanced Machining Processes 08 Hours

Introduction, Principles, Working, Process Parameters, Advantages, Limitations and application for processes: Electro Chemical Machining (ECM), Electric Discharge Machining (EDM), Wire Cut EDM, Abrasive Jet Machining (AJM), Ultra Sonic Machining (USM), LASER Beam Machining (LBM), Plasma Arc Machining (PAM) and additive manufacturing.

Unit-V: Process Planning 08 Hours

Introduction- methods of process planning, drawing interpretation, material evaluation, process selection, production equipment selection, process parameters calculation, Selection of jigs and fixtures, selection of quality assurance methods, Economics of process planning, operation sheet and inspection plan, documents for process planning.

Learning Resources:

Text Books:

1. A Text Book of Manufacturing Technology, R. K. Rajput, Laxmi Publications (p) LTD
2. A Text Book of Production Technology, P. C. Sharma, S. Chand Publications
3. Elements of Workshop Technology, Vol-II, S. K. HajraChaudhary, Media Promoters & Publications Pvt. Ltd.

Reference Books:

1. Production Technology Manufacturing Systems VOL-I & II, R. K. Jain, Khanna Publishers.

2. Manufacturing Science, Amitabh Ghosh and Ashok Kumar Mallik, Affiliated East-West Press, 2010.
3. Jigs & Fixtures, P.H. Joshi, Third edition, McGraw-Hill, 2017.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/112104290
2. https://nptel.ac.in/courses/112105212
3. https://nptel.ac.in/courses/112103248
4. https://nptel.ac.in/courses/112103250

List of Practicals:

1. Demonstration of cutting tool geometry and nomenclature of the tools used in conventional machines.
2. To perform surface grinding operation and measure surface finish.
3. To identify various jigs and fixtures and their applications.
4. Demonstration of Additive Manufacturing technology (from modelling to printing).
5. To study route sheets, process sheets, and inspection documents.
6. To study cost estimation and economic considerations in process planning.
7. Preparation of process plan and a case study for any given component.
8. Visit to any manufacturing industry.

Course Code: 170505A	Course Name: Systems in Mechanical Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry.

Course Objectives:

- To identify the sources of energy and their conversions.
- To explain the basic concept of engineering thermodynamics and its application.
- To introduce proper manufacturing process applicable to produce components.
- To understand the basic concepts of mechanical engineering.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply knowledge of thermodynamics concepts.

CO2: Explain basic laws of thermodynamics, heat transfer and their applications.

CO3: Select different materials for different applications.

CO4: Explain the basics of engineering components.

CO5: Describe and get exposure to the latest trends in manufacturing processes.

Course Contents:

Unit-I: Thermodynamic Concepts **08 Hours**

Introduction to thermodynamics, introduction to various thermodynamic properties, heat and work, thermodynamic laws. Power plant engineering and sources of energy : conventional thermal, nuclear, hydraulic power plant. Nonconventional- wind, solar, tidal, geothermal.

Unit-II: Heat Transfer **08 Hours**

Modes of heat transfer: conduction, convection and radiation. Fourier's law, Newton's law of cooling and Stefan-Boltzmann's law. Domestic appliances, viz., refrigerator, air-conditioner.

Unit-III: Material Science **08 Hours**

Classification of materials, their properties and applications, phase change material (PCM), composite material.

Unit-IV: Introduction to Transmission Devices 08 Hours

Study of shafts, belt drive, chain drive, gear and gear trains and clutches.

Unit-V: Manufacturing Processes 08 Hours

Metal casting, forging, sheet metal working, machining and machine tools, and metal joining processes.

Learning Resources:

Text Books:

1. Nag, P. K., “Engineering Thermodynamics" Tata McGraw-Hill Publisher Co. Ltd.
2. Chaudhari and Hajra, “Elements of Workshop Technology”, Volume I and II, Media Promoters and Publishers, Mumbai.
3. Rajput, R.K., “Basic Mechanical Engineering”, Laxmi Publications Pvt. Ltd.
4. Raghavan V.,“Materials Science And Engineering: A First Course”,Hall of India.

Reference Books:

1. Khan, B. H., “Non-Conventional Energy Sources, Tata McGraw-Hill Publisher Co Ltd.
2. Khurmi, R.S, and Gupta, J. K., “A Textbook of Thermal Engineering”, S. Chand & Sons.
3. Incropera, F. P.and Dewitt, D.P., “Fundamentals of Heat and Mass Transfer, John Wileyand Sons, USA.
4. Juvinal, R. C., Fundamentals of Machine Component Design, John Wiley & Sons, USA.
5. Kripal Sing, “Automobile Engineering”, Vol.1 and Vol.2.

Web link for MOOC / NPTEL Links:

1. Energy resources. https://www.youtube.com/watch?v=Zgp86PVXXuQ
2. Thermodynamic Concepts. https://nptel.ac.in/courses/112103275
3. https://www.youtube.com/playlist?list=PLbRMhDVUMngeVrxtbBzn8HvP8KAWBpI5

List of Practicals: (Any 5)

1. Study of non-conventional or renewable sources of energy.
2. Study of laws of thermodynamics.
3. Study of laws of heat transfer.
4. Study of domestic appliances like the refrigerator and the air conditioner.
5. Study of materials used for different applications.
6. Study of power transmission devices.
7. Study of manufacturing processes.

Course Code: 170505B	Course Name: Data Structures and Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Programming, Programming and Problem Solving.

Course Objectives:

- To learn the fundamentals of data structures.
- To understand how data can be logically organized using data structures.
- To illustrate the types of data structures and their use in engineering.
- To choose suitable data structures for real engineering problems.
- To learn system efficiency, such as time and memory usage, without mathematics or programming.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand basic concepts of data structures.

CO2: Apply the concepts of stacks and queues.

CO3: Implement appropriate non-linear data structures.

CO4: Demonstrate searching and sorting techniques in engineering data handling.

CO5: Illustrate real-world engineering case studies using data structures.

Course Contents:

Unit-I: Introduction to Data Structures **08 Hours**

Need for data organization, Overview of Data structures: Types of data structures, **Abstract Data Types (ADT):** Concept and significance, **Arrays:** Characteristics and representation, types of arrays: 1D and 2D, Use in storing engineering measurements and parameters.

Case Study: Engineering Data Management in a Weather Monitoring System.

Unit-II: Linear Data Structures **08 Hours**

Introduction to linear data structures, **Stack**: Concept, operations, and behavior (LIFO), Applications: undo operations and automation systems. **Queue**: Concept, operations, and behavior (FIFO), Applications: scheduling, buffering, and resource management, Conceptual

comparison between stack and queue, **Linked Lists:** Introduction, need, types and applications.

Case Study: Smart Office Management System.

Unit-III: Non-Linear Data Structures **08 Hours**

Need for non-linear data representation, Trees: Terminology: root, node, parent, child, and level, Types of trees: Binary tree, Binary search tree, Tree traversal, Applications of Non-linear Data Structures, Graphs: Basic concepts, Concept of directed and undirected graphs, graph representation. Case Study: College Campus Management System.

Unit-IV: Searching and Sorting **08 Hours**

Importance of searching and sorting, **Searching techniques:** Concept of linear and binary search, Use cases in engineering, **Sorting techniques:** Concept of ordering and prioritization, Examples such as sorting by size, cost and priority using bubble sort, selection sort, merge sort, Time and Space Complexity Concepts. **Case Study:** Engineering Inventory and Component Management System.

Unit-V: Engineering Case Studies **08 Hours**

Data structures used in real time applications, Identification of case studies from Mechanical / Civil / Electrical systems etc., Selection of appropriate data structures for given engineering problems, and discussion on the benefits of proper data structuring.

Learning Resources:

Text Books:

1. Y. Kanetkar and A. Kanetkar, Let Us C++, New Delhi, India: BPB Publications.
2. E. Horowitz and S. Sahni, Fundamentals of Data Structures in C++, New York, NY, USA: W. H. Freeman, ISBN: 978-0716782926.

Reference Books:

1. M. A. Weiss, Data Structures and Algorithm Analysis in C++, 2nd ed., New Delhi, India: Pearson Education, ISBN: 81-7808-670-0.

Web link for MOOC / NPTEL Links:

1. Data Structures And Algorithms By Prof. Naveen Garg, IIT Delhi. https://nptel.ac.in/courses/106102064

List of Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications, and current trends related to the subject.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment or mini-project that goes beyond the syllabus but aligns with the course.

List of Suggested Assignments:

1. Implementation of an array.
2. Implementation of stack.
3. Implementation of queue.
4. Implementation of trees.
5. Implementation of graphs.
6. Implementation of searching techniques.
7. Implementation of sorting techniques.
8. Mini project.

List of Suggested Activity-based Learning:

1. Flipped Classroom.
2. Gamification.
3. Online Interactive Tool.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignments.
6. VLab.

Course Code: 170505C	Course Name: Engineering Measurements	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry, Basic Electronics and Electrical Engineering.

Course Objectives:

- To explain the static/dynamic characteristics of measurement systems and the working principles of displacement, speed, vibration, and force/torque transducers.
- To impart knowledge on industrial pressure and vacuum measurement techniques along with standard calibration methods.
- To explain the construction, signal compensation, and operational characteristics of contact and non-contact temperature sensors.
- To introduce the mechanics, and selection criteria of various fluid level and flow monitoring instruments.
- To familiarize students with the principles of viscosity, density, humidity, and chemical sensors, alongside an introduction to intelligent SMART sensing systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Evaluate the performance of transducers used for mechanical parameters like displacement, speed, vibration, force, and torque.

CO2: Calibrate pressure and vacuum measuring devices using standard dead-weight or vacuum testing rigs.

CO3: Select appropriate temperature sensors for precise thermal monitoring.

CO4: Evaluate the operational dynamics of industrial fluid flow and level sensors based on principles.

CO5: Demonstrate miscellaneous sensors according to their working principles.

Course Contents:

Unit-I: Fundamentals of Engineering Measurements **08 Hours**

Measurement system elements, static and dynamic characteristics.

Need for sensors and transducers, definition and classification of transducers.

Displacement Measurement: Resistive-potentiometers, inductive-LVDT, capacitive, piezoelectric, ultrasonic, and proximity sensors.

Speed measurement, vibration measurement, force and torque measurement.

Unit-II: Pressure Measurement **08 Hours**

Units and their relations, manometers, elastic sensors, piezoelectric secondary transducers, differential pressure sensors, capacitive (delta cell), vacuum gauges, dead weight tester.

Unit-III: Temperature Measurement **08 Hours**

Temperature scales, units and their relations, classification of temperature sensors, bimetallic thermometer, Resistance temperature detectors (RTD), types of RTD, lead wire compensation,

thermistors, Thermocouples, thermopiles, thermos-well, cold junction compensation techniques, pyrometers, temperature IC sensor LM35.

Unit-IV: Flow Measurement **08 Hours**

Bernoulli's equation for incompressible flow, head type flow meters (orifice, venture meter and pitot tube), variable area type (Rotameter), turbine, electromagnetic, ultrasonic, mass flow meter: Coriolis flow meter.

Unit-V: Level and Miscellaneous Measurement **08 Hours**

Level Measurement: Float, DP cell, ultrasonic, capacitive.

Viscosity: Saybolt, Searle's rotating cylinder, rotameter. Density: Hydrometers. Humidity: Resistive and capacitive type sensors. PH sensors, conductivity sensors.

Learning Resources:

Text Books:

1. Instrumentation Measurement and Analysis – B.C. Nakra, K.K. Chaudhry, 4th Edition, McGraw Hill, 2010, ISBN: 978-0070709868
2. Principles of Industrial Instrumentation" — D. Patranabis, ISBN (latest editions): 978 0070605502 (approximate for recent editions)
3. Transducers and Instrumentation – D.V.S. Murty, 3rd Edition, PHI Learning, 2011, ISBN: 978-8120346876.

Reference Books:

1. Industrial Instrumentation – A.K. Sawhney, 4th Edition, Dhanpat Rai & Co., 2010, ISBN: 978-8177000311
2. Measurement Systems: Application and Design – Ernst O. Doebelin, 5th Edition, McGraw Hill, 2003, ISBN: 978-0071223122.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee32

List of Practicals (Any 8):

1. Measure linear displacement using a Linear Variable Differential Transformer (LVDT).
2. Determine the characteristics of different proximity sensors.
3. Calibrate a load cell and determine its sensitivity for weight measurement.
4. Measure angular displacement using a shaft angle encoder.
5. Calibrate a Bourdon tube pressure gauge using a dead-weight tester.
6. Calibrate a vacuum gauge using a vacuum gauge tester.
7. Calibrate a Resistance Temperature Detector (RTD) and determine the temperature of an unknown liquid.
8. Determine temperature using LM35.
9. Flow measurement using DP transmitter.
10. Measure pH sensor output and calibrate it using standard buffer solutions.
11. Flow measurement using Orifice / Venturi flowmeter.

Course Code: 170505D	Course Name: Sensors and Actuators	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Electronic Engineering, Programming Language C.

Course Objectives:

- To enable students to apply IoT concepts, architectures (3-layer and 5-layer), and system components (sensors, actuators, devices) in designing basic IoT-based solutions for real-world applications.
- To analyse different types of sensors (such as temperature, pressure, proximity, and optical sensors) and their applications in real-world systems.
- To study various actuators (electrical, mechanical, hydraulic, and pneumatic) and understand their role in control systems.
- To develop the ability to interface sensors and actuators with microcontrollers and embedded systems for data acquisition and control.
- To apply knowledge of sensors and actuators in designing and implementing practical systems used in automation, robotics, and industrial applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply knowledge of IoT building blocks, architectures, and components to develop and implement simple IoT applications for real-world applications.

CO2: Analyze sensor/transducer performance, signal conditioning, and data acquisition to assess measurement accuracy and errors.

CO3: Apply principles of temperature, pressure, force, flow, and level sensors to select and use appropriate sensors for measurement applications.

CO4: Examine the operating principles and performance characteristics of position, proximity, and motion sensors to compare and select appropriate sensors for specific measurement and control applications.

CO5: Evaluate performance, working principles and control mechanisms of electrical, fluid power, and specialized actuators for various automation and control system applications.

Course Contents:

Unit-I: Introduction to IoT and Architecture **08 Hours**

Definition, Need & Scope of IoT, Evolution of IoT, Industry 4.0, Basic Components of IoT: Sensors, Actuators, Devices, IoT System Building Blocks, IoT Architecture: 3-Layer, 5-Layer models (simple explanation), IoT Applications across various sectors, (healthcare, manufacturing, smart homes, agriculture, transport).

Unit-II: Introduction to Signal Conditioning **08 Hours**

Concepts: Sensors vs. Transducers, Sensor Classification (Active/Passive, Digital/Analog), Performance Characteristics (Static and Dynamic: Sensitivity, Linearity, Hysteresis, Response Time). **Signal Conditioning:** Bridge circuits, Amplifiers (Op-Amp), Filtering (Low-pass, High-pass), Data Acquisition (ADC/DAC). **Error Analysis:** Calibration, Sensitivity Analysis, and Uncertainty.

Unit-III: Thermal and Mechanical Sensors **08 Hours**

Temperature Sensors: Thermocouples (Seebeck effect), Resistance Temperature Detectors (RTDs), Thermistors (NTC/PTC), Bimetallic strips, Pyrometers.

Pressure Sensors: Manometer, Bourdon Tube, Diaphragm, Bellows, Piezoelectric and Strain Gauge.

Force & Weight Sensors: Strain Gauges (Bridge circuits, gauge factor), Load Cells.

Flow & Level Sensors: Ultrasonic, Capacitive, Float Sensors, Turbine Flowmeters, Venturi Tubes.

Unit-IV: Position, Proximity and Motion Sensors **08 Hours**

Position and Displacement Sensors: Potentiometers (Linear/Rotary), Linear Variable Differential Transformers (LVDT), Eddy current probes.

Proximity Sensors: Inductive (metallic), Capacitive (non-metallic), Optical/Photoelectric, Magnetic (Reed switches), Light Dependent Resistors (LDR), Fiber-optic sensors.

Motion & Acceleration Sensors: Accelerometers (1-3 axis), Gyroscopes, MEMS inertial sensors, Velocity sensors.

Unit-V: Actuation Systems **08 Hours**

Electric Actuators: DC Motors, AC Motors, Stepper Motors, Servo Motors, Solenoids, Relays.

Fluid Power Actuators: Hydraulic and Pneumatic Cylinders, Valves, Pumps.

Specialized Actuators: Piezoelectric actuators, Shape Memory Alloys.

Control Methods: PWM (Pulse Width Modulation) speed control.

Learning Resources:

Text Books:

1. Milan Milenkovic, "Internet of Things: Concepts and System Design", Springer, 2020.
2. D. V. S. Murthy, "Transducers and Instrumentation" Prentice Hall of India, 2nd Edition, 2012.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2014
4. Rolando Herrero, "Fundamentals of IoT Communication Technologies", Springer, 2022.

Reference Books:

1. Ian Sinclair & John Dunton, "Sensors and Transducers", Newnes (Elsevier) 3rd Edition, 2016.
2. Samayveer Singh, Manju, Aruna Malik, Pradeep Kumar Singh, "IoT-enabled Sensor Networks: Architecture, Methodologies, Security, and Futuristic Applications", Bentham Science Publishers, 2024.
3. C.S. Rangarajan, "Instrumentation Devices and Systems", Tata McGraw-Hill, 1st Edition, 2010.
4. Mohan Lal Kolhe, Kailash J. Karande, Sampat G. Deshmukh, "Artificial Intelligence, Internet of Things (IoT) and Smart Materials for Energy Applications", CRC Press (Taylor & Francis), 2023.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc25_ee76/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee82/preview
3. https://onlinecourses.nptel.ac.in/noc26_ee41/preview

List of Practicals: (Any 8)

1. Interfacing of an LED with Arduino board.
2. Display real-time temperature & humidity values on serial monitor using DHT11.
3. IoT-Based Motion Detection / Security System (Interface PIR Motion Sensor. Send alert notification (app pop-up, buzzer or LED indicator).
4. IoT-Based Gas/Smoke Detection System. (Interface MQ-2 Gas sensor (or simulator). Trigger buzzer/alert message when gas level exceeds a threshold. Send alert notification to mobile using cloud app (Blynk/MQTT).
5. IoT-Controlled Servo Motor / Door Lock System. (Interface a servo motor. Control angle/position remotely using a cloud dashboard or mobile app.)
6. Heartbeat / Pulse Monitoring System (IoT-Based). (Interface pulse sensor or simulated heartbeat data. Send health parameters to cloud for real-time monitoring.)

7. Water Level Monitoring & Alert System. (Use ultrasonic sensor to measure water tank level. Send water-level data to cloud and generate alerts when level is low or high.)
8. Fire Detection and Alert System. (Flame sensor or temperature sensor combination. Trigger instant alerts and send real-time fire detection signals to mobile/cloud.)
9. Voice-Controlled IoT Device (Google Assistant/Alexa Integration). Control LED/Fan simulation using voice commands through Google Assistant + IFTTT or Alexa IoT skills.
10. IoT-Based Smart Street Lighting System. Automatically control a street light (LED) using an LDR sensor and send status (ON/OFF) to an IoT dashboard.
11. Smart Energy Monitoring System. Measuring and visualizing electrical parameters (current/voltage simulation allowed) and uploading data to cloud.
12. IoT-Based Weather Station (Multi-Sensor System). Interfacing two or more sensors (temperature, humidity, light, pressure) and publishing combined data to cloud.

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Course Code: 170505E	Course Name: Infrastructure and Planning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Building Technology and Architectural Planning.

Course Objectives:

- To understand and analyze urban infrastructure systems, including their types, planning data, standards, and the roles of stakeholders in urban development.
- To apply concepts of water supply, sanitation, stormwater, solid waste, and transport planning to propose sustainable and efficient urban infrastructure solutions.
- To develop knowledge of rural planning principles and government schemes to improve village infrastructure, housing, livelihoods, and social services.
- To use modern planning tools and technologies (GIS, remote sensing, drones) for the implementation, monitoring, management of urban and rural infrastructure projects.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the role and types of urban infrastructure, key planning data and standards, and the planning process with stakeholder roles.

CO2: Apply concepts of water supply, sanitation, stormwater, and solid waste management to plan and propose basic urban infrastructure improvements.

CO3: Apply transport and land-use planning concepts to improve urban mobility, accessibility, and sustainability

CO4: Develop rural planning strategies using government schemes to improve village infrastructure, housing, and livelihoods.

CO5: Implement rural infrastructure and connectivity solutions using GIS and other planning tools.

Course Contents:

Unit-I: Introduction to Urban Planning and Infrastructure **08 Hours**

Role of infrastructure in urban development, Types of infrastructure: physical (water, power, transport), social (education, health), utilities Planning data, resource analysis, norms and

standards Infrastructure planning process and stakeholder roles layouts.

Unit-II: Water, Sanitation and Stormwater Systems 08 Hours

Water supply sources, treatment, storage, distribution, Water demand forecasting, leakage, reuse, rainwater harvesting, Sanitation systems: sewage generation, collection, treatment, greywater management, Stormwater drainage, natural drainage, stormwater harvesting Institutional and management issues, Municipal solid waste: generation, collection, treatment, recycling.

Unit-III: Transport and Mobility Planning 08 Hours

Importance of transport infrastructure in urban form transport modes (public, private, non-motorized), and mobility demand land use–transport integration, accessibility, TOD (Transit-Oriented Development) transport modeling basics, pricing, congestion and sustainable mobility.

Unit-IV: Principles and Strategies of Rural Planning 08 Hours

Introduction to rural planning: need, scope, and objectives, rural settlement patterns and typologies, planning strategies for rural development central and State government schemes: MGNREGA, PMAY-G, Swachh Bharat Mission, PMGSY, Jal Jeevan Mission, role of planning in livelihood, housing, and social infrastructure.

Unit-V: Rural Infrastructure Management 08 Hours

Physical infrastructure: water supply, sanitation, drainage, roads, energy, solid waste management, social infrastructure: schools, healthcare, community centers, Transport and connectivity: rural road hierarchy, public transport, traffic management, Tools and technology: GIS, remote sensing, drones for rural planning, Implementation, monitoring, and governance of rural projects.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications.
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives - Vivek Saurath & Manoj Agarwal).

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.

3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.
4. MRTP Act 1966 : The director, government printing, stationary and publications, Maharashtra state, Mumbai.
5. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
6. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
7. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
8. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
2. https://www.edx.org/certificates/professional-certificate/delftx-inclusive-and-sustainable-cities?index=product&queryId=2d5f1360201b4959787e19d485c4178e&position=3
3. https://www.coursera.org/learn/smart-cities
4. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
5. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
6. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
7. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals:

1. Prepare a case study for any infrastructure project of India and give presentation. (Group Activity).
2. Design a practical rainwater harvesting solution for any building. (Individual work).
3. Prepare a land-use map for a neighborhood with classification (residential, commercial, industrial, etc.) by calculation. (Group Activity)
4. Identify the major causes of congestion on any busy road in the city and suggest practical improvements to reduce traffic delays. Present your findings with brief observations and supporting photos or sketches. (Group work)
5. Draw a simple O–D diagram of your route from home to college, marking key points like home, major junctions, bus stops, and the college gate. Include the approximate distance and travel time with neat sketch map with brief travel details. (Individual work)

6. Select one rural development scheme (MGNREGA, PMAY-G, SBM, PMGSY, or JJM) and prepare a brief report covering its objectives, beneficiaries, key components, impact on rural livelihood or infrastructure, and a simple implementation flowchart (Individual work)
7. Prepare a village infrastructure improvement proposal for a hypothetical village of 1,000–1,500 people, listing existing issues, suggesting improvements in water supply, sanitation, housing, livelihood, and roads, and identifying relevant government schemes for implementation. (Group work)
8. Site visit to any urban infrastructure or rural infrastructure management project.

Course Code: 170505F	Course Name: Web Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Computer Networks.

Course Objectives:

- To familiarize students with Web Programming basic concepts.
- To learn and understand Web scripting languages.
- To introduce students to responsive web design frameworks and modern UI components.
- To provide knowledge of web page styling and layout design for effective user interfaces.
- To familiarize students with website development using no-code platforms.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand a basic of web application.

CO2: Develop structured web pages using HTML.

CO3: Apply styling and layout design principles to create visually appealing web interfaces.

CO4: Develop responsive and user-friendly web pages using modern design frameworks and layout approaches.

CO5: Create and publish functional websites using modern website development tools.

Course Contents:

Unit-I: Introduction to Web Applications **08 Hours**

Internet, Basic internet protocols, World Wide Web, HTTP Request message, HTTP response message, Client–Server Architecture, Frontend vs Backend, World Wide Web, Role of browsers and web servers, Introduction to W3C and web standards.

Unit-II: Web Essentials and Mark-up Language- HTML **08 Hours**

HTML: Introduction, history and versions. Tags, elements, and attributes, HTML elements: headings, paragraphs, line break, links, frames, lists, tables, images and forms, Input elements and basic validation, difference between HTML and HTML5.

Unit-III: CSS Styling and Layout Design 08 Hours

CSS: Introduction to Style Sheet, CSS features, Types of CSS, CSS core: Properties, Classes, Child-Class (Nested CSS), Colors, Text, Background, Border, Margin, Padding, Positioning (flex, grid, inline, block), Animation, Transition.

Unit-IV: Bootstrap for Responsive Web 08 Hours

Bootstrap vs plain CSS, Installing and using Bootstrap, Bootstrap grid system, Responsive design using Bootstrap, **Common Bootstrap Classes:** Buttons, Tables, Forms, Cards, Navigation bar, Alerts and Models.

Unit-V: Website Design Using No-Code Platforms 08 Hours

Introduction to no-code and low-code web development and Advantages, Website design using **Wix Studio:** Page structure and layout, Responsive design tools, Customization of UI components, **Website design using WordPress:** Themes and templates, Page builders, Content management basics, Publishing and maintaining websites.

Learning Resources:

Text Books:

1. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Robert W. Sebesta, “Programming the World Wide Web”, 4th Edition, Pearson Education.
3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley Publications.

Reference Books:

1. Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. HTML5 & CSS3 Complete Reference”, McGraw-Hill.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed79

List of Practicals:

1. Create a simple HTML webpage that displays basic information about yourself including name, photo, educational details, hobbies, and contact information using headings, paragraphs, images, and hyperlinks, ordered and unordered list.
2. Develop a webpage that displays a student marksheet using HTML tables including subjects, marks, and total percentage.

3. Create an HTML form for student registration including fields such as name, email, gender, date of birth, course selection, and submit/reset buttons. Apply basic input validation.
4. Design a webpage using external CSS to demonstrate styling of text, background colors, borders, and fonts also make use CSS Flexbox to arrange elements such as header, navigation bar, content section, and footer.
5. Design a webpage demonstrating CSS animation and transition effects on buttons, images, or text elements.
6. Create a responsive webpage using Bootstrap that includes navigation bar, image banner, cards, alerts, buttons, and tables and content sections.
7. Design a responsive webpage using Bootstrap Grid System that adjusts layout for mobile, tablet, and desktop screens.
8. Develop and publish a basic website using a No-Code platform such as WordPress or Wix Studio that includes at least three pages (Home, About, Contact).
9. Mini Project: Design and develop a complete responsive website for a small business, institute, or portfolio using HTML, CSS, and Bootstrap or a No-Code platform. The website should include navigation, forms, images and a responsive layout.

Course Code: 170505G	Course Name: Applied Data Science	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamentals of Data Science.
- To apply Data Science in different domain.
- To do exploratory analysis on a given data.
- To understand the concept of regression models.
- To facilitate learning of data pre-processing using R Programming.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply statistics and probability methods to solve real-life problems.

CO2: Demonstrate the Data Science Process and how its components interact.

CO3: Apply basic tools (plots, graphs, summary statistics) to carry out EDA.

CO4: Solve real life problems using regression techniques.

CO5: Apply machine learning algorithms for real world applications.

Course Contents:

Unit-I: Probability and Statistics **08 Hours**

Basics: sample space, outcomes, probability. Events: mutually exclusive, Conditional probability, Bayes' rule. Describing a Single Set of Data, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Random Variables, Continuous Distributions, The Normal Distribution. **Case Study:** Probability Analysis of Credit Card Fraud Detection.

Unit-II: Introduction to Data Science and Data Preprocessing **08 Hours**

Defining data science and big data, Recognizing the different types of data, Machine Learning Definition and relation with Data Science, Data Science Process: Data collection; Data preparation; Training a model on the data, evaluation of the model performance, Data visualization techniques and inferences. **Case Study:** Data Preprocessing for Online

Shopping Recommendation System.

Unit-III: Exploratory Data Analysis (EDA) 08 Hours

Statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery Developing Initial Hypotheses, Identifying Potential Data Sources, EDA case study, testing hypotheses on means, proportions and variances. **Case Study:** Analysis of Food Delivery Trends.

Unit-IV: Regression models 08 Hours

Simple linear regression, least-squares principle, MLR, logistic regression, Multiple correlation, Partial correlation, Cross Validation, Overfitting, Under Fitting and Model Selection, Prediction by using Ridge Regression. **Case Study:** House Price Prediction Using Real Estate Data.

Unit-V: Introduction to Machine Learning & R Programming 08 Hours

Supervised learning, Unsupervised learning, Association Rule mining, Naive Bayes Classifier, k-means clustering, Introduction to R, R packages, Tidy data, Tabular data and data import, Strings and regular expressions. **Case Study:** Customer Segmentation in Retail Business.

Learning Resources:

Text Books:

1. Data Science from Scratch: Joel Grus, O'Reilly Media Inc. 2015, ISBN: 9781491901427.
2. R for data science: import, tidy, transform, visualize, and model data", Wickham, Hadley, and Garrett Grolemund. O'Reilly Media, Inc.", 2016.
3. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015, ISBN: 9781449358655.

Reference Books:

1. Introduction to Probability and Statistics for and Engineers and Scientists, S. Ross, 3rd Edition, Elsevier, 2004.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer.
3. Hadley Wickham,Garrett Grolemund, " R for Data Science" , O'Reilly Media, 12 December 2016, ISBN:9781491910344, 1491910348.

Web link for MOOC / NPTEL Links:

1. Python for Data Science
   https://onlinecourses.nptel.ac.in/noc20_cs36/preview

List of Practicals:

1. Download any standard dataset from Kaggle. Using a programming language such as Python /R, perform statistical analysis to understand the structure, distribution, and relationships within the data.
2. Write python code that loads any standard dataset downloaded from Kaggle and plot the graph.
3. Perform some basic data cleaning operations on standard dataset using Python / R (Dataset should contain minimum 1000 records)
4. Perform data preprocessing, exploratory analysis on any standard dataset (dataset should contain minimum 1000 records) Using Python /R.
5. Perform correlation and regression analysis for any standard dataset downloaded from Kaggle, Government databases etc using Python / R.
6. Perform Simple Linear regression on for any standard data set downloaded from Kaggle, UCI, Government databases Using Python / R
7. Perform data analysis using Python / R / Weka for readily available data set using any one machine learning algorithm.

Course Code: 170505H	Course Name: Electrical Machines	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Basic Electrical Engineering.

Course Objectives:

- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of various motors.
- To test & analyze the performance of single phase and three phase motors.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the principles of electromechanical energy conversion, torque equation, and constructional features of electric motors.

CO2: Apply characteristics and speed control methods of DC motors to select suitable drives for applications.

CO3: Examine performance characteristics of three-phase induction motors for selection and control in mechanical loads.

CO4: Compare single-phase motors to select appropriate types for domestic and light-industrial use.

CO5: Apply operating principles and control methods of synchronous, BLDC, stepper, and servo motors in engineering applications.

Course Contents:

Unit-I: Fundamentals of Electric Motors **08 Hours**

Basic concepts of electromechanical energy conversion, Fleming's rules, torque and EMF equations. Constructional features: Stator, rotor, windings, bearings, cooling systems, Comparison of AC vs DC motors and their industrial relevance, Safety considerations & motor nameplate data interpretation.

Unit-II: DC Motors **08 Hours**

Construction: Lap and wave windings, commutator, field excitation, Working principle and back EMF, Types: shunt, series, compound motors, Torque-speed characteristics and performance curves, Speed control techniques (armature and field control), Applications in traction, lifts, rolling mills, robotics. Brushless DC motors: construction, electronic commutation, uses in EV and drones.

Unit-III: Three-Phase Induction Motors **08 Hours**

Construction and working: squirrel cage vs slip-ring, Rotating magnetic field concept, slip, torque production, Torque-speed characteristics: starting torque, breakdown torque, Starting methods: DOL, star-delta, auto-transformer, Speed control: V/f control, rotor resistance, slip power recovery, Selection criteria for mechanical drives (load type, duty cycle), Use in pumps, compressors, crushers, conveyors, HVAC systems.

Unit-IV: Single-Phase Induction Motors & Auxiliary Motors **08 Hours**

Limitations of single-phase supply, double-revolving field theory, Types: split-phase, capacitor-start, capacitor-run, shaded pole, Universal motor: working and uses, Applications in domestic & light-industrial mechanical equipment (fans, washing machines, small tools).

Unit-V: Synchronous & Special Motors **08 Hours**

Synchronous Motors: excitation, torque-angle characteristics, Starting methods, V-curves, power factor improvement. **PMSM:** Construction, electronic controller, uses in EV. **Stepper Motors:** Variable reluctance & PM types, step angle, control, Servo motors for automatic control systems & CNC automation, Application focus in robotics, precision positioning and aerospace actuators.

Learning Resources:

Text Books:

1. Edward Hughes “Electrical Technology”, ELBS, Pearson Education.
2. Ashfaq Husain, “Electrical Machines”, Dhanpat Rai & Sons.
3. S. K. Bhattacharya, “Electrical Machine”, Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4. Nagrath & Kothari, “Electrical Machines”, Tata McGraw Hill.
5. Bhag S Guru, Husein R. Hiziroglu, “Electrical Machines”, Oxford University Press.
6. K Krishna Reddy, “Electrical Machines- I and II”, SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and distributors, Delhi, 1983.
3. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw Hill, New Delhi, 2003
4. S. K. Sen, Electrical Machinery, Khanna Pub., Delhi, 2012.
5. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee69/preview
2. https://archive.nptel.ac.in/courses/108/102/108102146/

List of Practicals (Any 8):

1. Load test on DC shunt motor to obtain torque-speed, efficiency and performance characteristics.
2. Speed control of DC motor using armature voltage and field control methods.
3. No-load and blocked-rotor tests on 3-phase induction motor to determine equivalent circuit parameters.
4. Load test on 3-phase induction motor to obtain performance characteristics.
5. Study and comparison of DOL, star-delta & auto-transformer starters for induction motor.
6. V/f (open-loop) speed control of induction motor using inverter (simulation or hardware).
7. Load test on synchronous motor to plot V-curves and study power-factor control.
8. Performance characterization of BLDC motor (simulation or hardware kit).
9. Stepper motor stepping and micro-stepping experiment to determine step angle and positioning accuracy.
10. Servo motor position control using PID controller and performance analysis.
11. Thermal/run-down and insulation resistance test (theoretical analysis for motor selection).
12. Motor selection and design mini-project based on given mechanical load (simulation/theoretical).

Course Code: 101506	Course Name: Modeling and Additive Manufacturing Laboratory	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**PR + OR : 50 Marks**

Expected Prerequisite Courses:

- Engineering Mathematics, Engineering Graphics, Solid Mechanics.

Course Objectives:

- To develop skill in 2D sketching, 3D modeling, assembly creation, and production drawing using modern CAD software
- To enable students to generate G-code, perform slicing, and understand the operational parameters required for producing components through 3D printing technologies.
- To design and 3D print a simple mechanical component as a mini project.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Develop fully constrained 2D sketches of mechanical components using CAD tools.

CO2: Create 3D models and assemblies of mechanical components using appropriate constraints.

CO3: Prepare detailed production drawings for parts and assemblies with standard annotations.

CO4: Generate G-code and slice 3D models using suitable printing parameters.

CO5: Fabricate and evaluate mechanical components using 3D printing technology.

List of Practicals:

1. Develop a 2D sketch incorporating geometric and dimensional constraints using any commercially available solid modeling software.
2. Model a machine component using various commands and features available in a 3D CAD software.
3. Perform assembly modelling of the components created in Assignment 2, applying appropriate mating conditions and generating an exploded view of the assembly.
4. Generate production drawings for the individual parts and assembly, incorporating appropriate tolerances and annotations.
5. Create a 3D model using suitable modeling software.
6. Generate G code and slice the model using suitable software.

7. Mini Project-Each student/group must design and print a mechanical component.

Learning Resources:

Text Books:

1. Zeid, I and Sivasubramania, R., (2009), "CAD/CAM: Theory and Practice", 2nd edition, McGraw-Hill Education, ISBN-13: 978-0070151345
2. Rao, P. N., (2017), "CAD/CAM: Principles and Applications", 3rd edition, McGraw-Hill Education, ISBN-13: 978-0070681934
3. Chang, Kuang-Hua, (2015), "e-Design: Computer-Aided Engineering Design", Academic Press, ISBN-13: 978-0123820389.

Reference Books:

1. Machining Simulation Using SOLIDWORKS CAM 2025 By Kuang-Hua Chang, ISBN: 978-1-63057-724-7
1. Parametric Modeling with Pro/ENGINEER Wildfire 5.0 By Randy H. Shih, ISBN: 978-1-58503-539-7
2. Technical Drawing 101 with AutoCAD 2025 By Ashleigh Congdon-Fuller, Antonio Ramirez, Douglas Smith, ISBN: 978-1-63057-656-1
3. An Introduction to CATIA V6 Release 2012By Kirstie Plantenberg, ISBN: 978-1-58503-663-9
4. Parametric Modeling with Creo Parametric 11.0 An Introduction to Creo Parametric 11.0 By Randy H. Shih, ISBN: 978-1-63057-690-5.

Web link for MOOC / NPTEL Links:

1. https://www.youtube.com/watch?v=8nzsWCk3tt8&list=PLTLBPX248C5naVD3bsgMrPkdTc2iOLhU2
2. https://www.youtube.com/watch?v=sVWsUS_7V6s&list=PLrOFa8sDv6jfVMccV28fssFut0EG0NNb6
3. https://www.youtube.com/watch?v=Co9FF_ZaD8&list=PLrOFa8sDv6jcZHbxvT1QVjpiFEEwfW5C1
4. https://www.youtube.com/watch?v=XXAcgtF5sBE&list=PLAELa0kqRz65ctxT4eDmlF6kz4BENZbDS
5. https://www.youtube.com/watch?v=Ulttc_2p4DY&list=PLrOFa8sDv6jcp8E3ayUFZ4iNI8uuPjXHe
6. https://www.youtube.com/watch?v=2XI6vPDATQ0&list=PLROUP1bV8REQNj5I6vyydhaAUO6IdgfXU

Semester - VI

Course Code: 101601	Course Name: Machine Design – II	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Solid Mechanics, Machine Design – I.

Course Objectives:

- To familiarize the effects of various types of loading on machine parts.
- To apply fundamentals for the design and/or selection of elements in transmission systems.
- To understand the philosophy that real engineering design problems are open-ended and challenging.
- To demonstrate design skills for the problems in real life industrial applications.
- To develop an attitude of team work, critical thinking, communication, planning and scheduling through design projects.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Design of mechanical components subjected to fluctuating loads.

CO2: Design of Spur & Helical gear for industrial applications.

CO3: Design of Bevel and Worm gear for industrial applications.

CO4: Selection of bearings from the manufacturer's catalogue for a typical application, considering design parameters.

CO5: Design a machine tool gearbox for different applications.

Course Contents:

Unit-I: Design for Fluctuating Loads **08 Hours**

Stress concentration, fatigue failure, endurance limit, notch sensitivity, Design of components subjected to completely reversed stresses, Goodman and Soderberg diagrams, and modified Goodman diagram.

Unit-II: Spur and Helical gears 08 Hours

Spur gears: Material selection for gears, modes of gear-tooth failure, and gear lubrication methods. Force analysis, beam strength (Lewis) equation, velocity factor, service factor, load concentration factor, effective load on gear, wear strength (Buckingham's) equation, estimation of module based on beam and wear strength, estimation of dynamic tooth load by velocity factor and Buckingham's equation. Introduction to AGMA (American Gear Manufacturing Association) approach of gear design.

Helical gears: Force analysis of helical gear, beam strength of helical gear, wear strength and estimation of effective load based on velocity factor (Barth factor) and Buckingham's equation.

Unit-III: Bevel and Worm Gears 08 Hours

Bevel gears: Force analysis of a straight bevel gear. Design of a straight bevel gear based on beam strength, wear strength, and estimation of effective load based on velocity factor (Barth factor) and Buckingham's equation.

Worm gears: Force analysis of worm gear drives, friction in worm gears, efficiency of worm gears, worm and worm gear material, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor) IS 1443-1974, Thermal consideration in worm gear drive.

Unit-IV: Bearings 08 Hours

Working principle of hydrodynamic, hydrostatic bearing and rolling contact bearing. Classification of bearings. selection of bearings from the manufacturer's catalogue. Comparison of sliding contact and rolling contact bearings.

Unit-V: Design of Machine Tool Gear Box 08 Hours

Introduction to machine tool gearboxes, classification, basic considerations in design of drives and it's applications, determination of variable speed range, graphical representation of speed and structure diagram, Ray diagram, selection of optimum ray diagram, kinematic /gearing diagram, deviation diagram, difference between numbers of teeth of successive gears in a change gear box.

Learning Resources:

Text Books:

1. V. B. Bhandari, Design of Machine Elements, 2020, 5th Edition, Tata McGraw-Hill.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw-Hill Publication Co., Ltd.

3. N. K. Mehta, Machine Tool Design and Numerical Control, 3rd Edition, Tata McGraw-Hill.

Reference Books:

1. Richard G. Budynas and Keith Nisbett J, Shigley Mechanical Engineering Design, 2020, 11th Edition (in SI Units), McGraw-Hill
2. Harsha, A. P., Hornberger, L. E., Shoup, T. E., Spotts, M. F., Design of Machine Elements, 2019, Pearson India Education Services Pvt. Limited.
3. Robert L. Norton, Machine Design, 2018, 5th Edition, Pearson.
4. Juvinal, R.C and Kurt M. Marshek, Fundamentals of Machine Component Design, 2016, Wiley.
5. Design Data - P.S.G. College of Technology, Coimbatore.

Web link for MOOC / NPTEL Links:

1. https://www.youtube.com/watch?v=AS0zQhMfJUw&list=PLXBo4hMCwFtpNKupFOrR0xUkuDdwpMIR4
2. https://www.youtube.com/watch?v=i9xbJTIGJlE&list=PLXBo4hMCwFtpNKupFOrR0xUkuDdwpMIR4&index=8
3. https://www.youtube.com/watch?v=NnBZZAZEG4s

List of Practicals:

1. Assignments on fluctuating loads, selection of bearings.
2. Design a project on a two-stage gearbox having a combination of spur/helical, spur/bevel, or helical bevel gears for industrial application **or** a single-stage worm gearbox for industrial application.
3. Design Project on machine tool gearbox.

- The design project shall consist of an assembly drawing, with a bill of materials and overall dimensions and drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A design report giving all necessary calculations of the design of components should be submitted in a separate file. Design data book shall be referred to for the selection of materials and standard components for given loading conditions.
- Excel Based Design Sheet can be prepared.
- The Project should be assigned to a group of a maximum of four students.

Course Code: 101602		Course Name: Computer-Aided Engineering
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Solid Mechanics, Numerical and Statistical Methods, Engineering Mathematics, Manufacturing Processes, Material Science.

Course Objectives:

- To understand the fundamentals and applications of Finite Element Analysis (FEA).
- To nurture students about the discretization process and the criteria for quality mesh.
- To understand the approaches of Computer Aided Engineering and to find displacement and stresses over 1D problem.
- To understand the approaches of Computer Aided Engineering and to find displacement and stresses over 2D and 3D problems.
- To understand the fundamentals of nonlinear analysis and the role of AI in CAE for efficient simulation and improved engineering design.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply FEA concepts and methods to analyze engineering problems.

CO2: Apply the various meshing techniques for better evaluation of approximate results.

CO3: Evaluate the structural response of bar and truss elements under mechanical and thermal loading to determine stresses, displacements, and reaction forces.

CO4: Evaluate the effectiveness of 2D and 3D finite element models in solving engineering structural problems.

CO5: Apply the principles of nonlinear analysis and AI in CAE to analyze engineering systems and enhance design performance.

Course Contents:

Unit-I: Introduction to Finite Element Method **08 Hours**

History of FEA, industrial applications, problem classification, element, node, degree of freedom, discretization, interpolation, coordinate system used in FEA, Constraints. Basic

steps use in FEA, types of analysis, methods used in FEA: potential energy method, Rayleigh-Ritz method and Galerkin method, commercial packages, advantages, limitations.

Unit-II: Meshing Techniques **08 Hours**

Classification of elements, 1D, 2D and 3D element meshing, element selection criteria, refining mesh, effect of mesh density in critical region, use of symmetry.

Element Quality Criterion: Jacobian, aspect ratio, warpage, average element size, minimum length, skewness, tetra collapse etc., mesh refinement technique (h and p method), geometry associate mesh, mesh quality, mesh independent test, element selection criteria, refining mesh, effect of mesh density in critical region, Use of symmetry, shape function, difference between mapped mesh and free mesh.

Unit-III: 1D Elements **08 Hours**

Bar and Truss Element: Element stiffness matrix, Assembling stiffness Equation, Load vector, stress and reaction forces calculations.

Temperature Effect on Bar Element: Calculation due to uniform temperature change, Stress and reaction forces calculations.

Unit-IV: 2D Elements and 3D Elements **08 Hours**

Types of 2D Elements: Formulation of elemental stiffness matrix and load vector for Plane stress/strain, such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Assembly of global stiffness matrix and load vector, boundary conditions, solving for primary variables (displacement).

Types of 3D Elements: Primary and secondary variables, properties of 3D shape functions. Assembly of global stiffness matrix and load vector, boundary conditions and solving for primary variables (nodal displacements).

Unit-V: Nonlinear Analysis and CAE with AI **08 Hours**

Nonlinear Analysis: Introduction to nonlinear problems, comparison of linear and nonlinear analysis, types of nonlinearities, solution techniques for nonlinear analysis,

Impact of AI on Computer Aided Engineering: Overview of AI in CAE, AI-based acceleration of simulation workflows, automation of pre-processing, AI-assisted generative design for optimized geometries and AI-supported post-processing.

Learning Resources:

Text Books:

1. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite.

2. S. S. Bhavikatti, Finite Element Analysis, New Age International Publishers, Third Edition, 2015.
3. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India.
4. G Lakshmi Narasaiah, Finite Element Analysis, BS Publications / BSP Books.
5. J. N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill Series in Mechanical.
6. P. Seshu, Textbook of Finite Element Analysis, PHI Learning Private Limited, New Delhi.

Reference Books:

1. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India (P) Ltd., New Delhi.
2. Cook R. D., Finite Element Modeling for Stress Analysis, John Wiley and Sons Inc.
3. Fagan M. J., Finite Element Analysis Theory and Practice, Prentice Hall.
4. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw-Hill.
5. Daryl L. Logan, A First Course in the Finite Element Method, Fourth Edition, Thomson Canada Limited.

Web link for MOOC / NPTEL Links:

1. Basics of Finite Element Analysis by Prof.NachiketaTiwari, IIT Kanpur. https://nptel.ac.in/courses/112/104/112104116/
2. Advanced Finite Element Analysis by Dr. R. Krishnakumar, Department of Mechanical Engineering, IIT Madras. https://nptel.ac.in/courses/112/106/112106130/
3. Finite Element Analysis for Welding Analysis by Prof. Swarup Bag, Department of Mechanical Engineering, IIT Guwahati. https://nptel.ac.in/courses/112/103/112103299/
4. Tutorial/ for ANSYS Tutorials. https://sites.ualberta.ca/~wmoussa/Ansys

List of Practicals:

1. Structural analysis of Bar using 1D element.
2. Structural analysis truss using 1D element.
3. Structural Analysis of any mechanical component using 2D element.
4. Thermal analysis of any mechanical component using 1D/2D/3D elements.
5. Structural analysis of a mechanical component using 3D elements and comparison of results obtained using tetrahedral (Tet) and hexahedral (Hex) meshes.
6. Nonlinear analysis of a beam under buckling load.
7. Modal Analysis of simply supported/Cantilever beam.
8. Coupled Analysis: (Structural + Thermal) of any mechanical component.

Course Code: 101603A	Course Name: Mechanical Drives	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Engineering Mechanics, Solid Mechanics, Machines and Mechanisms.

Course Objectives:

- To understand the working principles of mechanical drives, clutches, brakes, flywheels, and Step-Less-Regulation systems.
- To analyze forces, torque, power transmission, and stability in mechanical components.
- To apply these concepts to evaluate and improve mechanical and automotive system performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze the performance parameters of belt and chain drive systems.

CO2: Compare different types of clutches and evaluate their working principles.

CO3: Analyze various braking systems and their mechanisms.

CO4: Analyze turning moment diagrams.

CO5: Analyze the geometry, velocity ratio, and torque characteristics of various Continuous Variable Transmission systems.

Course Contents:

Unit-I: Belt and Chain Drives **08 Hours**

Belt Drives: Velocity ratio, slip, creep, length of open & cross belts, power transmission, tensions, centrifugal & initial tension, V-belt drive, advantages & limitations.

Chain Drives: Basics, advantages, pitch and speed relations, chain terminology, classification of chains, hoisting chains, conveyor chains, power-transmitting chains, chain length.

Unit-II: Clutches and Power Transmission Elements **08 Hours**

Introduction to clutches; purpose and requirements; friction materials; types of clutches; single plate clutch- construction, working, torque transmission; multiplate clutch-need,

construction, applications; cone clutch: principle, advantages, limitations; centrifugal clutch, working based on centrifugal force, construction, applications in vehicles and machines.

Unit-III: Braking Systems **08 Hours**

Introduction, classification of brakes, block/shoe brakes: single, pivoted, double, band brakes: simple and differential, band and block brake, internal expanding shoe brake, braking of vehicles, hydraulic brakes: construction, working, advantages and disadvantages, disc brakes, pneumatic (air) brakes: working principle, vacuum brakes.

Unit-IV: Turning Moment Diagrams and Flywheels **08 Hours**

Turning moment diagrams, single-cylinder double-acting steam engine, four-stroke IC engine, multicylinder engines, fluctuation of energy, maximum fluctuation of energy, coefficient of fluctuation of energy, flywheel, coefficient of fluctuation of speed, energy stored in a flywheel, flywheel rim dimensions, flywheel in punching press.

Unit-V: Step-Less-Regulation **08 Hours**

Continuous Variable Transmissions: Geometry, velocity and torque analysis of faceplate variators, conical variators, spheroidal and cone variators, variators with axially displaceable cones, PIV drives.

Learning Resources:

Text Books:

1. Rattan, S. S. (2014). Theory of machines (4th ed.) McGraw-Hill Education.
2. Singh, S. (2005). Theory of machines. Pearson Education.

Reference Books:

1. Bhandari, V. B. (2010). Design of machine elements (3rd ed.). Tata McGraw-Hill.
2. PSG College of Technology. (2018). PSG design data book (3rd ed.).
3. Ghosh, A., and Mallik, A. K. (1988). Theory of mechanisms and machines. East-West Press.
4. Budynas, R. G., and Nisbett, J. K. (2015). Shigley's mechanical engineering design (10th ed.). McGraw-Hill Education.
5. Pandya, N. C., and Shah, C. S. (1980). Elements of machine design. Charotar Publishing House.
6. Crouse, W. H., & Anglin, D. L. (2006). Automotive mechanics (10th ed.). McGraw-Hill Education.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/116102012
2. https://youtu.be/Cq3ipvjuicM?si=1xy5LF1OpkoSNrme

3. https://youtu.be/FydJu1A1oeM?si=MmQqBclD7hsnMPyA
4. https://youtu.be/wZ-mX1wSWXg?si=rccIcxxXqFKTnYv8

List of Practicals:

1. Investigation of slip, velocity ratio, and power transmission characteristics in a flat belt drive system
2. To determine the torque transmitting capacity of a friction clutch experimentally.
3. To evaluate the performance of a brake by measuring the power absorbed during operation.
4. Study and plotting of the turning moment diagram for an I.C. engine model.
5. Study of continuous variable transmission and infinite variable transmission.
6. Assignments/tutorial: The following two assignments shall be completed and the record shall be submitted in the form of a journal.
    a. Minimum one problem on belt and chain drives, friction clutches, brakes, and flywheel.
    b. Mini project/presentations/case study/seminar.

Course Code: 101603B		Course Name: Turbomachinery
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Fluid Mechanics, Engineering Thermodynamics, Heat Transfer.

Course Objectives:

- To provide the knowledge of basic principles, governing equations and applications of turbomachines.
- To provide the students with opportunities to apply basic thermos-fluid dynamics flow equations to turbomachines.
- To explain construction and working principles of turbomachines.
- To evaluate the performance characteristics of turbomachines.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Validate impulse moment principle using flat, inclined and curved surfaces and analyze performance characteristics of impulse hydraulic turbines.

CO2: Analyze performance characteristics of reaction hydraulic turbines.

CO3: Analyze performance parameters of single & multistage centrifugal pumps along with discussion of cavitation and selection.

CO4: Analyze performance parameters of impulse and reaction steam turbine.

CO5: Analyze performance parameters of centrifugal compressors along with a discussion of the theoretical aspects of axial compressors.

Course Contents:

Unit-I: Impact of Jet and Hydraulic Impulse Turbines **08 Hours**

Impact of Jet: Introduction to turbomachines (hydraulic and thermal), classification of turbo machines, and applications of turbomachines. Impulse momentum principle and its application to fixed and moving flat, inclined and curved plates/vanes. Velocity triangles and their analysis, work done equations.

Hydraulic Impulse Turbines: Introduction to hydro power plant, classification of hydraulic turbines, concept of impulse turbines. Construction, principle of working, design aspects,

velocity diagrams and their analysis of the Pelton wheel.

Unit-II: Hydraulic Reaction Turbines **08 Hours**

Concept of reaction turbines. Construction, working principles, design aspects, velocity diagrams, and their analysis of Francis and Kaplan turbines, degree of reaction.

Draft Tubes: types and efficiencies, governing of hydraulic turbines, Cavitation in turbines.

Unit-III: Centrifugal Pumps **08 Hours**

Introduction & classification of rotodynamic pumps, main components of centrifugal pump, construction and working of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, work done and efficiency, series and parallel operation of pumps, priming of pumps, specific speed.

Unit-IV: Steam Turbines **08 Hours**

Steam Nozzles: Equations for velocity and mass flow rate (No derivation, no numerical).

Steam Turbines: Construction and working of Impulse and Reaction steam turbine, velocity diagram, work done efficiencies, multi-staging, compounding, Degree of reaction, losses in steam turbine, governing of steam turbines.

Unit-V: Rotary Compressors **08 Hours**

Centrifugal Compressors: Classification, construction and working, velocity diagram, flow process on T-s diagram, Euler's work, actual work input, various losses.

Axial Flow Compressors: Construction and working, stage velocity triangle and its analysis, enthalpy entropy diagram, stage losses and various efficiencies. (No numerical)

Learning Resources:

Text Books:

1. Fluid mechanics and hydraulic machines, Dr. R.K. Bansal, Laxmi Publication.
2. Hydraulics & Fluid Mechanics and Machinery, Modi P N & Seth S N, Standard Book House.
3. Turbines, Compressors & Fans, S.M. Yahya, Tata-McGraw Hill.
4. Turbomachines, B. U. Pai, Wiley India.
5. Steam and Gas Turbines and Power Plant Engineering, R. Yadav, Central Publication.

Reference Books:

1. Bhandari, V. B. (2010). Design of machine elements (3rd ed.). Tata McGraw-Hill.
2. PSG College of Technology. (2018). PSG design data book (3rd ed.).

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112105182
3. https://nptel.ac.in/courses/112104117

List of Practicals:

1. Verification of impulse momentum principle
2. Study and trial on impulse water turbine and plot the main and operating characteristics
3. Study and trial on any one hydraulic reaction turbine and plot the main and operating characteristics.
4. Study and trial on the centrifugal pump and plot the operating characteristics.
5. Study on convergent-divergent air/steam nozzle.
6. Study of surging, stalling and choking phenomenon in compressors, performance characteristics of centrifugal and axial flow compressors.
7. Visit to the hydropower plant.
8. Visit to the pumping station.

Course Code: 101603C		Course Name: Metrology and Quality Control
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks **PR + OR** : 25 Marks

Expected Prerequisite Courses:

- Engineering Mathematics, Manufacturing Processes.

Course Objectives:

- To select suitable instrument / gauge / method of inspection for determining geometrical and dimensional measurements and understand the advances in Metrology such as use of CMM, Laser, and Machine Vision System for Metrology etc.
- To design inspection gauges for metrology.
- To select and apply appropriate quality control Technique for given application.
- To select and apply appropriate quality management tools and suggest an appropriate Quality Management System (QMS).

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain principles and standards used in engineering metrology.

CO2: Apply surface roughness measuring instruments, comparators for precision inspection and design gauges.

CO3: Apply quality control tools for problem-solving.

CO4: Analyze TQM principles in manufacturing systems.

CO5: Analyze statistical concepts and techniques used in quality control and process improvement.

Course Contents:

Unit I: Introduction to Metrology and Advancements **08 Hours**

Introduction, principles of engineering metrology, **Measurement Standards:** Line, end and wavelength standards, Types and sources of errors, Accuracy and Precision, calibration, Coordinate Measuring Machine (CMM), Laser Metrology, Machine Vision Systems, profile projector, digital metrology.

Unit-II: Comparators, Surface Roughness and Gauges **08 Hours**

Different types of comparators, surface roughness measurement: introduction to surface texture, parameters for measuring surface roughness, surface roughness measuring instrument, concepts related to tolerances, limits and fits [IS 919-1993], Taylor's principle, types of gauges, wear allowance on gauges, considerations of gauge design (numerical).

Unit-III: Quality and Tools **08 Hours**

Concept of quality, cost of quality and value of quality, quality of design, quality of conformance, quality of performance, Deming's cycles and 14 points, Juran trilogy approach, old and new quality control tools, quality circle, control plan.

Unit-IV: Total Quality Management **08 Hours**

Introduction, quality function deployment, 5S, Kaizen, Kanban, JIT, Poka yoke, FMECA, TPM, zero defects, introduction to lean manufacturing, Six Sigma: Concept and applications, quality management system requirements: ISO 9001, TS-16949, ISO-14000, Introduction to Industry 4.0.

Unit-V: Statistical Quality Control **08 Hours**

Statistical concepts and techniques in quality control and improvement, control charts for attributes and variables, concepts and procedures of process capability, acceptance sampling: sampling inspection, sampling methods, OC curve and its characteristics.

Learning Resources:

Text Books:

1. I. C. Gupta, Engineering Metrology, Dhanpat and Rai Publications, New Delhi, India.
2. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw-Hill Publication.
3. M. S. Mahajan, Statistical Quality Control, Dhanpat and Rai Publications.

Reference Books:

1. R. K. Jain, Engineering Metrology, Khanna Publications.
2. Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.

Web link for MOOC / NPTEL Links:

1. https://nptel.ac.in/courses/112106138
2. https://nptel.ac.in/courses/112104250
3. https://nptel.ac.in/courses/112107259
4. https://nptel.ac.in/courses/112106179

List of Practicals:

1. Demonstrate and compute linear and angular measurements.
2. Determine the geometry and dimensions of a given composite object or a single-point tool using an optical projector.
3. Measurement of gear parameters using gear tooth vernier caliper
4. Limit gauges: concepts, uses, and applications of go/no-go gauges, Taylor's principle, and design of gauges (numerical and student activity).
5. Demonstration of surface roughness measurement using the surface roughness tester.
6. Case study on various tools in total quality management (TQM).
7. Determination of process capability from given components and plot variable control chart/ attribute chart using software.
8. Visit to the QA/QC unit of the automotive industry/engineering industry.

Course Code: 101604A	Course Name: Piping Design	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Engineering Drawing, Strength of Materials, Fluid Mechanics and Engineering Thermodynamics.

Course Objectives:

- To introduce fundamentals of industrial piping systems and components.
- To develop understanding of piping materials, codes and standards.
- To enable students to analyze piping flexibility, stress and support systems.
- To familiarize students with piping layout, isometrics and fabrication drawings.
- To provide exposure to practical piping design used in process industries.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the function and classification of piping systems.

CO2: Select appropriate piping materials based on service conditions.

CO3: Apply piping codes and standards in design.

CO4: Perform basic piping stress and flexibility analysis.

CO5: Prepare piping layouts, isometric drawings, and support schemes.

Course Contents:

Unit I: Introduction to Piping Engineering 08 Hours

Role of piping in process industries (oil & gas, chemical, power, pharma), Types of piping systems: process piping, utility piping, transmission piping, Pipe sizes, schedules, pressure ratings, Pipe fittings: elbows, tees, reducers, flanges, Valves: gate, globe, ball, butterfly, check valves, Pipe joints: welded, threaded, flanged.

Unit-II: Piping Materials and Standards 08 Hours

Metallic piping materials: carbon steel, alloy steel, stainless steel, Non-metallic piping: PVC, CPVC, HDPE, FRP, Material selection criteria: pressure, temperature, corrosion, cost, Introduction to piping codes and standards: ASME B31 series, ASTM material standards, ANSI, ISO, API standards. Pipe wall thickness calculation (basic approach).

Unit-III: Piping Layout and Design Considerations 08 Hours

Piping layout principles for plants and equipment, Equipment piping: pumps, compressors, heat exchangers, vessels, Thermal expansion and its effects, Expansion loops, bends, and offsets, Introduction to piping isometric drawings, Bill of Materials (BOM) for piping.

Unit-IV: Piping Stress Analysis and Supports 08 Hours

Types of stresses in piping systems, Flexibility and stress concepts, Sustained, expansion, and occasional loads, Types of piping supports: Rigid supports, springs, hangers, Anchors, guides, stops, Basics of piping support span calculations, Introduction to piping stress analysis software (CAESAR II – overview only).

Unit-V: Fabrication, Erection and Inspection 08 Hours

Pipe fabrication methods, welding processes used in piping, Non-Destructive Testing (NDT): RT, UT, PT, MT, Hydrostatic and pneumatic testing, Piping erection sequence, Introduction to piping drawings: GA drawings, Isometric drawings, Spool drawings, Safety practices in piping systems.

Learning Resources:

Text Books:

1. Process Piping Design Handbook – Ed. B. J. Basu / Bicheno.
2. Piping Handbook – Mohinder L. Nayyar, McGraw-Hill.
3. Piping Design & Engineering – G. P. Rai.
4. Plant Design and Economics for Chemical Engineers – Pipkin.

Reference Books:

1. Industrial Piping – K. L. Narayana Rao.
2. Piping and Pipeline Engineering – George A. Antaki.
3. Process Plant Layout and Piping Design – Edgar A. Tuner & R. Dennis Tarday.
4. Process Equipment and Plant Design – S. D. Dawande / N. K. Jain.
5. American Society of Mechanical Engineers (ASME) B31.3 – Process Piping.
6. ASME B16 Series (Fittings, Valves, Flanges) (Various B16 standards) API Standards (e.g., API 5L, API-610) (As needed for specific industries).
7. Caesar II Piping Stress Analysis Handbook – Autodesk / COADE.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc21_ch52/preview
2. https://onlinecourses.nptel.ac.in/noc25_ch25/preview
3. https://www.coursera.org/specializations/design-of-industrial-piping-systems
4. https://www.udemy.com/course/piping-design-engineering/

5. https://www.udemy.com/course/piping-system-drafting-design-fabrication-with-isometrics/
6. https://www.udemy.com/course/designing-piping-systems-pipe-fittings-flanges-valves/

List of Practicals:

1. Study of industrial piping components.
2. Selection of pipe size, schedule, and pressure rating.
3. Material selection for piping systems.
4. Study of piping codes and standards.
5. Basic pipe wall thickness calculation.
6. Preparation of piping layout for simple equipment.
7. Equipment piping drawing – pump connection.
8. Preparation of BOM from isometric drawing.
9. Study of fabrication, welding, NDT and hydrotesting procedures.

Course Code: 101604B	Course Name: Modern I. C. Engines	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Engineering Thermodynamics, Machines and Mechanisms.

Course Objectives:

- To provide fundamental understanding of construction and working of I C (Internal Combustion) engines.
- To equip learners with tools and methods to measure performance and emissions of I C engines.
- To acquaint learners with contemporary I C engine technologies.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Describe the construction and working of I C Engines.

CO2: Compare various fuels used in I C engines and describe modern fuel supply systems.

CO3: Measure performance and emissions of I C Engine.

CO4: Analyze the combustion process in I C engines.

CO5: Compare cooling, lubrication and ignition system of I C Engines.

Course Contents:

Unit I: Introduction to I C Engine **08 Hours**

I C engine: Components and Construction details, Terminology, Classification, Applications and selection of engine, Engine development process, Intake and exhaust system, Valve actuating mechanisms, Valve timing diagram.

Fuel, air, and actual cycle: Air-standard cycles, fuel-air cycles, and actual cycles. Effects of variables on performance, various losses and comparison of the Air standard with the Fuel and Actual cycle.

Unit-II: Fuels and Supply Systems 08 Hours

Basic requirements of engine fuels, Properties of petrol and diesel fuels, non-conventional fuels for IC engines: LPG, CNG, methanol, ethanol, bio-diesel and hydrogen.

Fuel Supply Systems for SI and CI engines: Electronic control systems such as - Multi-Point Fuel Injection (MPFI), Gasoline Direct Injection (GDI) and Common Rail Direct Injection (CRDI) system, Sensor, ECU and actuators used in Electronic Fuel Injection systems, Introduction to On-Board Diagnostics (OBD).

Unit-III: Engine Testing and Emissions 08 Hours

Engine Testing: Engine testing procedure, measurement of indicated power, brake power, fuel consumption, air consumption, measurement of friction power by willan's line method and morse test, calculation of mean effective pressure, various efficiencies, specific fuel consumption, heat balance sheet of ic engines and performance characteristic curves.

Emission and Control: Introduction to Indian Driving Cycle (IDC), European Driving Cycle (EDC), SI and CI Engines emission and controlling methods, methods to measure emission such as Non-Dispersive Infrared Red (NDIR), Flame Ionization Detector (FID), Chemiluminescent Analyzer, Smoke meter, Euro Norms and Bharat Stage norms, historical evolution of emission regulations.

Unit-IV: Combustion in SI and CI Engines 08 Hours

SI engines: Air-fuel ratio and related concepts, Adiabatic Flame Temperature, combustion stages in SI engines, abnormal combustion, theory of detonation and parameters affecting detonations, rating of fuels in SI engines, combustion chambers used in SI engines.

CI engines: Combustion stages in CI engines, theory of knocking and parameters affecting knocking, rating of fuels in CI engines and combustion chambers used in CI engines.

Unit-V: Engine Systems 08 Hours

Cooling system: Air cooling, oil cooling, liquid cooling.

Lubrication system: Objectives of lubrication system, properties of lubricant, Methods of lubrication.

Ignition system: Battery coil ignition system, Electronics Ignition (CDI, TCI), Maximum Brake Torque (MBT) & spark advance. Supercharging and turbo-charging.

Learning Resources:

Text Books:

1. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill.

2. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co.

Reference Books:

1. J. B. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill.
2. W. W. Pulkrabek, “Engineering Fundamentals of the Internal Combustion Engine”, PHI.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc21_ch52/preview
2. https://onlinecourses.nptel.ac.in/noc24_me38/preview
3. https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/
4. https://tinyurl.com/UdemyICEngine

List of Practicals:

1. Assembly and disassembly of the IC Engine.
2. Morse test to measure the frictional power of the engine.
3. Trial on petrol engine to measure performance parameters and heat balance sheet.
4. Trial on a variable compression ratio diesel engine to measure performance parameters and heat balance sheet.
5. Visit to the PUC center for emission measurement.
6. Visit to Automobile Service Station / Manufacturing Facility.
7. Presentation on advances in I C Engines pertaining to material, design, combustion, manufacturing technology, etc.

Course Code: 101604C	Course Name: Robotics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Engineering Mechanics, Basics of Electrical and Electronics Engineering, Control system.

Course Objectives:

- To develop foundational knowledge of the essential components used in robotic systems.
- To study various gripper mechanisms and sensors and understand role of suitable control system.
- To understand statistics & kinematics of robots.
- To develop understanding of motion planning techniques in joint and Cartesian spaces for robotic systems
- To provide foundational knowledge of machine learning techniques and smart industrial automation systems.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain different types of robot configurations with relevant terminology.

CO2: Select suitable sensors, actuators and drives for robotic systems.

CO3: Apply the principles of kinematics to determine the motion and positioning of robotic systems.

CO4: Explain the fundamentals of robot dynamics and manipulator mechanism design.

CO5: Demonstrate the use of sampling, quantization, and machine learning concepts in intelligent robotic and automation applications.

Course Contents:

Unit I: Introduction to Robotics **08 Hours**

Introduction: Basic Concepts, laws of Robotics, Robot anatomy, Classification, structure of robots, point to point and continuous path robotic systems. Robot performance- resolution, accuracy, repeatability, dexterity, compliance, RCC device, Applications.

Unit-II: Gripper and Sensors 08 Hours

Robot Grippers: Types of grippers, design of gripper, force analysis for various basic gripper systems including mechanical, hydraulic and pneumatic systems.

Robotic Sensors: Characteristics of sensing devices, classification, selection and applications of sensors. Types of sensors, need for sensors and vision system in the working

Drives and Control Systems: Types and selection of drives, actuators and transmission systems, types of controllers, closed loop control.

Unit-III: Kinematics of Robotics 08 Hours

Transformation matrices and their arithmetic, link and joint description, Denavit–Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics of two joints, solvability, algebraic and geometrical methods. Velocities and static forces in manipulators: motion of the manipulator links, singularities, static forces.

Unit-IV: Dynamics of Robotics 08 Hours

Introduction to dynamics, trajectory generations, motion planning, and control: joint and Cartesian space trajectory planning and generation, potential field method for motion planning, manipulator mechanism design, force control and hybrid position/force control.

Unit-V: Machine Vision System and AI of Robotics 08 Hours

Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. **Artificial Intelligence:** Introduction, Need and Application, Introduction to Internet of Things (Industrial control, Smart Social Network), Industry 4.0, Machine learning.

Learning Resources:

Text Books:

1. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.

Reference Books:

2. Groover M.P, Automation, production systems, and computer-integrated manufacturing, PHI.
3. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
4. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
5. Mathia, Robotics for Electronics Manufacturing, Cambridge Uni. Press, India

6. A Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2013.
7. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015.Advanced Engineering Mathematics by Erwin Kreyszig, Ed. I, 2020(Wiley Eastern Ltd.).

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/specializations/introduction-robotics
2. https://nptel.ac.in/courses/107106090?utm
3. https://www.nptel.ac.in/courses/112107289?utm

List of Practicals:

1. Study of Cartesian / Cylindrical / Spherical robot.
2. Study of articulated / SCARA robot.
3. Virtual modeling for kinematic and dynamic verification of any robotic structure using suitable software.
4. Design, modeling and analysis of two different types of grippers.
5. Report on industrial application of robot /Industrial visit.

Course Code: 170605A	Course Name: Automotive Technology	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Mechanics.

Course Objectives:

- To provide fundamental understanding of construction and working of automobile subsystems.
- To equip students with tools and methods to measure and analyze performance of automobiles.
- To acquaint students with contemporary automotive technologies.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Compare the various chassis and drive-trains of an automobile.

CO2: Analyze axles, wheels, tyres and the steering system of an automobile.

CO3: Select suspension and braking systems of an automobile.

CO4: Measure and analyze the performance of an automobile and describe the safety aspects.

CO5: Discuss electrical systems and assess modern propulsion technologies of an automobile.

Course Contents:

Unit-I: Introduction to Chassis and Drive Train 08 Hours

Introduction: Current scenario in Indian auto/ancillary industries, vehicle specifications and classification.

Chassis and Frames: Types of chassis layout with reference to power plant locations and drive, various types of frames and constructional details.

Drive Trains: Necessity and selection of clutch, necessity of gearbox and different types, overdrive, torque convertor, continuous variable transmission, dual clutch transmission, automated manual transmission, propeller shaft, final drive, and differential.

Unit-II: Axles, Wheels, Tyres and Steering System 08 Hours

Axles: Purpose, requirement and types of front and rear axle, loads acting on rear axles.

Wheels and Tyres: Wheel construction, alloy wheel, wheel balancing and rotation, type of

tyres, tyre construction, tyre materials, factors affecting tyre life.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristics, steering linkages and gearbox, power steering, collapsible steering, reversibility of steering, four-wheel steering, wheel alignment.

Unit-III: Suspension and Brake Systems **08 Hours**

Suspension: Types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydrogas, interconnected suspension, self-leveling suspension (active suspension), shock absorbers (hydraulic and air). **Brake Systems:** Drum, disc, mechanical, hydraulic, air brakes, power-assisted brakes, hand brake, ABS, EBD, BA.

Unit-IV: Vehicle Performance and Safety **08 Hours**

Vehicle performance: parameters; vehicle resistances; traction and tractive effort; power requirements for propulsion; road performance curves (numerical examples); vehicle stability; vehicle testing on a chassis dynamometer; NVH in automobiles. **Vehicle safety:** Types of active and passive safety, vehicle interior and ergonomics.

Unit-V: Electrical Systems and Modern Propulsion Technologies **08 Hours**

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, introduction to lithium batteries.

Electrical System and Accessories: Basic electric layout of the vehicle, automotive sensors and actuators, electronic control unit/module.

Modern Propulsion Technologies: Concept and environmental importance of EVs and HEVs, Layout, construction and working, Challenges and future scope of EVs and HEV.

Learning Resources:

Text Books:

1. William H. Crouse., “Automotive Mechanics”, Tata McGraw Hill Publishing House.
2. Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd.

Reference Books:

1. Kirpal Singh, “Automobile Engineering”, Volume 1, Standard Publishers distributors.
2. R. K. Rajput, “Automobile Engineering”, Laxmi Publications.

Web link for MOOC / NPTEL Links:

1. Fundamentals of Automotive Systems: https://onlinecourses.nptel.ac.in/noc20_de06/preview
2. Autotronics: https://onlinecourses.nptel.ac.in/noc26_me101/preview

3. Vocational: Automotive Services Technician (Four-Wheeler): https://onlinecourses.swayam2.ac.in/nos24_ge28/preview
4. Automotive Industrial Engineering: https://www.coursera.org/learn/automotive-industrial-engineering
5. Automotive Engineering: Automobile Fundamentals: https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/

List of Practicals: (Any 6)

1. Identify four vehicles having different chassis layout and compare their performance.
2. Identify four vehicles equipped with different types of automatic transmission and compare their performance.
3. Visit an automobile service centre for demonstration of wheel alignment and write a detailed report on axle, wheels, tyres and wheel alignment of one car.
4. Experimental study of shock absorber.
5. Measurement of noise and vibration in an automobile.
6. Study of requirements of BNCAP test.
7. Demonstration on basic maintenance and checks of an automobile such as doors etting, consumable checking and replacing, brake pad checking &replacing, checking tyre wear etc.

Course Code: 170605B	Course Name: Database Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Fundamentals of Programming.

Course Objectives:

- To understand the fundamental concepts of database management.
- To identify and classify entities, attributes, and relationships in real-world problem domains.
- To understand the principles and structure of the relational data model.
- To demonstrate the use of SQL for secure and efficient database querying and management.
- To understand the basic concepts of transaction processing and concurrency control.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the basic concepts, architecture, and components of database systems.

CO2: Convert ER diagrams into equivalent relational database schemas.

CO3: Normalize relational schemas using functional dependencies.

CO4: Explain the purpose and components of SQL in relational database systems.

CO5: Identify various transaction states and common transaction operations.

Course Contents:

Unit-I: Introduction to Database Systems **08 Hours**

Need of database system, Types of Data, Database System Applications, Database System VS File System, View of Data, Data Abstraction, data independence, Data Models, Structure of Database Management Systems. **Case Study:** Study of Architecture of any Database Management System (DBMS) like Oracle or MySQL.

Unit-II: Entity Relationship Modeling **08 Hours**

Conceptual data modeling: entities, entity types, attributes and its types, relationships, cardinalities on relationship, Entity Relationship diagram extended Features: Specialisation and Generalization on the ER Model. **Case Study:** ER Diagram conversion into Tables for

College Management Systems.

Unit-III: Relational Data Model **08 Hours**

Concept of relations, schema-instance distinction, keys and their types, Codd's Rules, Concept of Anomalies, Normalization, functional dependencies and Normal forms, 1NF, 2NF, 3NF and BCNF decompositions and desirable properties of them. **Case Study:** Library management system to identify different types of keys.

Unit-IV: Structured Query Language (SQL) **08 Hours**

Querying in SQL, DDL to create database and tables, table constraints, update database-update behaviors, DML, aggregation functions group by and having clauses, retrieve data from the database, generate and query views. Different types of Joins. **Case Study:** Design and implementation of Student Course Management System using SQL for effective management of students, courses, and faculty members.

Unit-V: Overview of Transaction Management **08 Hours**

The ACID Properties, Transactions and Schedules, Concurrency Control–The Need for Concurrency Control, Serializability, Locking Methods, Deadlock, Time Stamping Methods, Concurrency Control Protocols. Database Recovery: Need for Recovery, Recovery Techniques. **Case Study:** Design Online Shopping Cart Transaction Management In an e-commerce platform, multiple users simultaneously add, update, and purchase products.

Learning Resources:

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition
2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Sixth Edition, ISBN-13: 978-0-136-08620-8.

Reference Books:

1. Shio Kumar Singh, Database Systems Concepts Design and Applications, Pearson
2. Mario Piattini, Oscar Diaz - Advanced Database Technology and Design- online book.

Web link for MOOC / NPTEL Links:

1. Introduction to Database Systems By Prof. Sreenivasa Kumar, IIT Madras. https://onlinecourses.nptel.ac.in/noc20_cs03/preview

List of Practicals:

1. Study of installation of various database software like MySQL, MariaDB & Oracle, etc.
2. Draw an ER diagram for any database system with various entities and their attributes on ERWin/ERDPLUS Software.
3. Implement SQL queries to provide students with hands-on experience for studying various commands of DDL.
4. Implement SQL queries to provide students with hands-on experience for studying various commands of DML.
5. Implement SQL queries to provide students with hands-on experience for studying various Logical Operators of SQL.
6. Implement SQL queries to provide students with hands-on experience in implementing various data constraints using SQL commands in MySQL/MariaDB.
7. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing all types of joins.
8. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing sub-queries and views.
9. Write at least 10 SQL queries for suitable database applications using SQL DML statements for studying various aggregation functions.
10. ER Modeling and Normalization: a. Consider case studies and formulate.
    a. Problem statement for any application to be developed.
    b. Propose a conceptual design using ER.
    c. Convert ER diagram into relational tables and normalize relational data model.
11. Mini- Project.

Course Code: 170605C	Course Name: Industrial Control Components	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Fundamentals Electronics Engineering.

Course Objectives:

- To understand the basics of process control, including variables, system types, and real-world applications of control loops.
- to learn about transmitters, signal standardization, communication protocols, and converters used for accurate measurement in process control.
- To explore control actions and tuning methods to optimize controller performance and prevent issues like reset windup.
- To understand control valve design, terminology, types, and sizing using Cv calculations in line with industry standards.
- To learn about valve accessories and actuators, focusing on their design and function for optimal control system performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Analyze process variables, control system types, and process characteristics, and evaluate examples of process control loops in industry.

CO2: Apply knowledge of transmitters, signal standards, protocols, and converters to evaluate their role in process control systems.

CO3: Design and apply control actions and tuning methods to optimize controller performance and system stability.

CO4: Evaluate control valve selection, sizing, and design based on key characteristics and industry standards.

CO5: Analyze and evaluate valve accessories and actuators for optimal performance in process control systems.

Course Contents:

Unit-I: Introduction to Process Control 08 Hours

Key Concepts in Process Control: Process Variables: Definition and differentiation of manipulated, disturbance, and output variables.

Control System Types: Understanding Open-Loop vs. Closed-Loop systems.

Block Diagram Representation: Structure and components of control loops. Examples of Process Control Loops: Application examples of control loops in industries—temperature, flow, level, and pressure.

Unit-II: Transmitters and Converters 08 Hours

Transmitters and Signal Standardization: Importance of transmitters in process control systems. Standardization of signals: current (4-20 mA), voltage (0-10 V), and pressure signal standards. **Types of Transmitters:** Live zero vs. dead zero, and concept of two-wire. SMART Transmitters. **Differential Pressure Transmitters (DPT):** Types, installation, and calibration of DPTs. Application in level and flow measurement. Zero elevation, suppression.

Converters: Understanding the difference between converters and transmitters. Types: Current-to-pressure and pressure-to-current converters.

Unit-III: Control Actions and Tuning Techniques 08 Hours

Discontinuous Control: On-Off, multi-position, floating control modes. **Continuous Control:** Proportional (P), Integral (I), Derivative (D), PI, PD, and PID control modes.

Reset Windup: Techniques to prevent reset windup, rate before reset, and bumpless transfer.

Controller Tuning Methods: Introduction to process reaction curve. Tuning techniques: Ziegler-Nichols.

Unit-IV: Control Valve: Design, Sizing, and Selection 08 Hours

Control Valve Fundamentals: Key terminology: Rangeability, turndown ratio, cavitation, flashing, noise, viscosity index, valve capacity, AO, AC, and fail-safe actions. **Valve Characteristics:** Linear, equal percentage, and quick-opening characteristics.

Valve Types and Applications: Overview of different valve types: Globe, Ball, Butterfly, Diaphragm, and specialty valves for high-temperature and high-pressure applications.

Valve Sizing and Selection: Cv Calculation.

Unit-V: Control Valve Accessories and Actuator Design 08 Hours

Valve Accessories: Detailed discussion on accessories such as petitioners (pneumatic, electro-pneumatic, and digital), I/P converters, volume boosters, air lock, limit switches, solenoid valves, and hand wheels.

Actuator Types and Design: Understanding different actuator types: Spring and diaphragm, piston cylinder, and smart actuator.

Learning Resources:

Text Books:

1. C. D. Johnson, Process Control and Instrument Technology, Tata McGraw Hill, Publications, 8th Edition.
2. N. A. Anderson, Instrumentation for Process Measurement and Control, CRC Press.

Reference Books:

1. G. Liptak, "Process Control", Instrument Engineering Handbook CRC Press,

Web link for MOOC / NPTEL Links:

1. Industrial Automation and Control, By Prof. Siddhartha Mukhopadhyay, IIT Kharagpur.
   https://nptel.ac.in/courses/108105062
2. Process Control and Instrumentation, by Dr. P.K. Saha, IIT Guwahati.
   https://nptel.ac.in/courses/103103037

List of Practicals: (Any 8)

1. Identification of industrial control components.
2. Block diagram of an industrial automation system.
3. Comparison of open-loop and closed-loop systems.
4. Direction control valve applications.
5. Control valve sizing basics.
6. Actuator selection.
7. Valve characteristic comparison.
8. PID control exercises.
9. Tuning of PID controller for level/flow control loop.
10. Controller tuning problems.
11. Process reaction curve analysis.
12. Study of the control valve & plot the installed characteristics of the control valve.

Course Code: 170605D	Course Name: Embedded System in IoT	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Basic Electronics Fundamentals, Sensors and Actuators, Basic C Programming.

Course Objectives:

- To understand the fundamentals of embedded systems, IoT architecture, and the role of hardware–software co-design in connected devices.
- To develop the ability to interface sensors, actuators, and communication modules with microcontrollers for IoT applications.
- To analyze and implement embedded programming concepts using platforms such as Arduino, Raspberry Pi, or ARM-based controllers.
- To design and develop IoT-based systems using networking protocols (e.g., MQTT, HTTP) and cloud integration techniques.
- To evaluate security, power management, and real-time constraints in embedded IoT systems for efficient and reliable performance.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain fundamentals of embedded systems, including components, classifications, design metrics, and the role of microcontrollers.

CO2: Apply IoT hardware design concepts using microcontroller platforms, interfaces, and communication modules with effective power management.

CO3: Apply IoT communication models, protocols, data transmission, and basic cloud integration concepts.

CO4: Analyze Embedded C programming, real-time processing, RTOS concepts, and low-power design techniques in IoT-based embedded systems.

CO5: Evaluate end-to-end IoT system design, security mechanisms, and real-world IoT applications across domains.

Course Contents:

Unit-I: Introduction to Embedded Systems 08 Hours

Definition, characteristics, and requirements of embedded systems, Embedded system components: hardware, software, processors, peripherals, Classification of embedded systems, Embedded system design metrics: cost, power, performance, memory, reliability, Applications of embedded systems in various domains, Overview of microprocessors vs microcontrollers, Role of 8-bit microcontrollers in embedded development.

Unit-II: IoT Hardware Platforms and Interfacing 08 Hours

Design Considerations for IoT Hardware, Microcontroller Platforms: Arduino, ESP32, NodeMCU, Nucleo (STM32 Overview), ADC, DAC, GPIO Programming, Communication Interfaces: UART, SPI, I2C, Wireless Communication Modules (Wi-Fi, BLE, GSM, LoRa – Basics), Power Management in IoT Devices.

Unit-III: IoT Communication Protocols and Networking 08 Hours

IoT Communication Models, IP Addressing Basics, Application Layer Protocols: MQTT, HTTP, CoAP (Overview), Client-Server vs Publish-Subscribe Model, Data Acquisition and Transmission, Introduction to Cloud Platforms (ThingsBoard / AWS IoT – Conceptual), REST API Basics.

Unit-IV: Embedded Software and Real-Time Concepts for IoT 08 Hours

Embedded C for IoT Applications, Interrupt Handling and Timer-Based Programming, Real-Time Data Monitoring, Introduction to RTOS for IoT Devices, Task Scheduling Basics, Data Logging and Local Storage, Edge Computing Concept, Low Power IoT Design Techniques.

Unit-V: IoT System Design, Security and Applications 08 Hours

End-to-End IoT System Design Methodology, IoT Security: Authentication, Encryption Basics, Secure Communication (TLS Concept), Data Analytics Basics for IoT, Industrial IoT (IIoT) Overview, Smart City Applications, Smart Energy Monitoring System, IoT-Based Environmental Monitoring, Smart Irrigation System, Remote Health Monitoring System.

Learning Resources:

Text Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi & Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education.
2. Zdravko Karakehayov, “Embedded Systems Design with 8051 Microcontrollers: Hardware and Software”, CRC Press / Taylor & Francis.
3. Raj Kamal, “Embedded Systems: Architecture, Programming & Design”, Tata McGraw-Hill.

4. David E. Simon, “An Embedded Software Primer”, Pearson Education.

Reference Books:

1. Daniel D. Gajski, Samar Abdi, “Embedded System Design: Modeling, Synthesis and Verification”, Springer, 2021.
2. Peter Marwedel, “Embedded System Design: Foundations of Cyber-Physical Systems and the Internet of Things”, Springer
3. Qing Li & Caroline Yao, “Real-Time Concepts for Embedded Systems”, CRC Press (Taylor & Francis)
4. Marilyn Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Elsevier
5. Catherine H. Gebotys, “Security in Embedded Devices”, Springer.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc24_ee68/preview
2. https://onlinecourses-archive.nptel.ac.in/noc19_cs32/course
3. https://www.coursera.org/learn/iot

List of Practicals: (Any 8)

1. Draw and explain 3-layer and 5-layer IoT architecture. Map real-world application to architecture layers.
2. Comparison of IoT Development Boards. Compare Arduino, ESP32, Raspberry Pi based on: Processing speed, Memory, Connectivity, Power consumption, Application suitability.
3. Sensor & Actuator Selection. Select appropriate sensors for:
    a. Smart irrigation system
    b. Health monitoring system
    c. Smart energy meter

    Justify selection with technical reasoning.
4. Protocol Comparison. Compare MQTT, HTTP, CoAP. Identify best protocol for given IoT scenario.
5. IoT Communication Model Analysis. Device-to-Device. Device-to-Cloud. Device-to-Gateway. Draw block diagrams and explain.
6. Embedded C Programming Problems. Write logic for:
    a. Sensor threshold detection
    b. PWM-based motor control
    c. Interrupt-based event detection.
7. IoT Security Case Study. Identify security threats in smart home system. Suggest countermeasures.

8. Design complete IoT solution for Smart parking.
9. Design complete IoT solution for Weather monitoring.
10. Industrial IIoT Monitoring Plan. Design a predictive maintenance node with: Vibration analysis, Data transmission, Dashboard planning.
11. Smart Campus IoT Design. Complete architecture including: Sensors, Networking, Cloud, Security, Cost estimation.
12. Sensor Signal Conditioning Design. Design amplifier gain for low-voltage sensor. Select filter type for noise removal.

Course Code: 170605E	Course Name: Governing Policies	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Business Economics.

Course Objectives:

- To explain the principles of infrastructure systems, governance frameworks, and policy implementation in urban and rural contexts.
- To examine economic evaluation tools, including demand forecasting, cost–benefit analysis, financing options, and PPP models.
- To interpret national infrastructure programs, policies, and regulations for effective development planning.
- To apply sustainable, inclusive, and technology-driven approaches to plan and manage urban and rural infrastructure.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand infrastructure, governance, and policy implementation in urban and rural development.

CO2: Analyze economic aspects of infrastructure, apply demand forecasting, cost–benefit analysis, financing mechanisms, and PPP models.

CO3: Apply national infrastructure programs, policies, and regulations to plan and assess urban and rural development projects.

CO4: Implement planning and management tools for urban and rural infrastructure projects.

CO5: Apply concepts of sustainable and inclusive infrastructure by integrating climate resilience, risk reduction, resource efficiency, digital governance, and global case insights.

Course Contents:

Unit-I: Infrastructure Governance **08 Hours**

Concept, scope, and components of urban & rural infrastructure, Infrastructure lifecycle and asset management, Principles of good governance, Role of central, state, and local governments, Urban Local Bodies (ULBs), Panchayati Raj Institutions (PRIs), National

policies on housing, transport, water, sanitation, energy, rural development, Policy formulation, implementation, monitoring.

Unit-II: Economics of Urban and Rural Infrastructure 08 Hours

Economic characteristics of infrastructure (public goods, externalities, natural monopoly), Demand forecasting & cost–benefit analysis (CBA), Budgetary allocations, grants, and intergovernmental transfers, Municipal finance and rural development financing, PPP models, Case studies, Life-cycle costing, Economic impact assessment, social cost–benefit analysis.

Unit-III: Policies, Acts and Regulatory Frameworks 08 Hours

AMRUT, Smart Cities Mission, Swachh Bharat Mission, National Urban Housing Policy, PMAY, National Transport Policies, PMGSY, NRLM, MGNREGA, Rural drinking water, sanitation, electrification programs, Environmental regulations (EIA, Water/Air Acts, Waste Management Rules), Land acquisition and R&R policies, Infrastructure concession frameworks.

Unit-IV: Planning, Implementation and Monitoring of Infra. Projects 08 Hours

Master planning, regional planning, Integrated urban/rural planning approaches, GIS-based infrastructure planning, DPR preparation, feasibility studies, Procurement methods, contract management, Risk management, KPIs for urban and rural services, Service level benchmarks (SLBs), Digital governance & monitoring systems.

Unit-V: Sustainable, Inclusive and Resilient Infrastructure Governance 08 Hours

Green and climate-resilient infrastructure, Disaster risk reduction, Energy efficiency, circular economy, Infrastructure for marginalized groups, Rural–urban linkages for balanced development, E-governance tools IoT, AI, and data analytics, UN SDGs and infrastructure governance, international case studies.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives — Vivek Saurath & Manoj Agarwal.

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.

3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.
4. Swachh Bharat Mission Guidelines.
5. MRTP Act 1966: The director, government printing, stationary and publications, Maharashtra state, Mumbai
6. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
7. Natural Infrastructure and Resilient Cities: Role of Green Infrastructure in Urban Planning for Adaptation to Climate Change in India (2025, by National Institute of Disaster Management, Delhi).
8. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
9. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
10. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/imb21_mg02/preview
2. https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview
3. https://onl inecourses.nptel.ac.in/noc23_ce52/preview
4. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
5. https://www.coursera.org/learn/smart-cities
6. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
7. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
8. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
9. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals (Any 8):

1. Presentation on any national policy for housing and transport. (Group Activity)
2. Analyze the latest central/state government budget allocations for infrastructure sectors. (Individual Activity)
3. Comparison of Public-Private Partnership (PPP) models in infrastructure project (Individual Activity)
4. Conduct a sanitation or waste management study under Swachh Bharat guidelines with case study. (Individual Activity)

5. Prepare a compliance checklist for industries under Water Act, Air Act, and Waste Management Rules. (Group Activity)
6. Prepare a land use map and zoning proposal for a neighborhood. (Group work)
7. Conduct a basic energy audit of a building (college, hostel, home) and propose energy-saving measures. (Group Activity)
8. Suggest a small-scale circular economy project for rural or urban ward. (Group Activity)
9. Map how infrastructure projects (roads, water supply, housing, digital systems) contribute to SDGs 6, 7, 9, 11, and 13. (Individual Activity)
10. Identify and explain components of a tender document by referring to any online tender document related to infrastructure project.

Course Code: 170605F	Course Name: Application Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Web Development, Database Management Systems.

Course Objectives:

- To familiarize students with client-side scripting concepts.
- To provide knowledge of server-side development and backend processing in web applications.
- To enable students to understand basic database concepts.
- To understand and learn Web application deployment.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply the client-side technologies for web development.

CO2: Develop user interfaces using component-based design approaches.

CO3: Apply the server-side technologies for web development.

CO4: Create effective web applications for business functionalities using the latest web development platforms.

CO5: Deploy web applications in collaborative environments.

Course Contents:

Unit-I: Basics of Web Application Interactivity 08 Hours

Introduction to JavaScript, JS Variables and Constants, JS Variable Scopes, JS Data Types, JS Functions, JS Array, JS Object, JS Events.

Unit-II: ReactJS 08 Hours

Introduction to ReactJS, ReactJS Components Styling, Routing, Redux- Architecture, Hooks-Basic hooks, useState() hook, useEffect() hook, useContext() hook.

Unit-III: Backend Development Using NodeJS 08 Hours

Role of backend in web applications, Introduction to NodeJS, Environment Setup, Node.JS Events, Node.JS Functions, Node.JS Built-in Modules, File System, Handling Data I/O in

Node.JS, Create HTTP Server, Create Socket Server.

Unit-IV: Database Integration Using MongoDB 08 Hours

Introduction to databases, Need for databases in web applications, Types of databases: SQL vs NoSQL, MongoDB fundamentals, Data models and schemas, Basic CRUD operations.

Unit-V: Managing and Deploying Web Applications: GitHub 08 Hours

Deployment strategies, Overview of Git, Git Repositories: Public vs private repositories, Basic Git Workflow & commands, collaboration using GitHub.

Learning Resources:

Text Books:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Kogent Learning Solutions Inc, Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, XML and AJAX, Blackbook, Dreamtech Press, ISBN: 9788177228496.

Reference Books:

1. Shama Hoque, Full-Stack React Projects: Learn MERN Stack Development by Building Modern Web Apps, Packt Publishing.
2. Dr. Hiren Joshi, Web Technology and Application Development, DreamTech, 1st Ed.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/programming-with-javascript
2. https://www.coursera.org/specializations/build-dynamic-website

List of Practicals:

1. Design responsive user registration and login which will do the following actions: Register user, login user functionality.
2. Create a To-Do List application where users can add tasks, mark tasks as completed, and delete tasks.
3. Develop a frontend using React JS which includes forms and navigation.
4. Create a Node.JS Application which serves a static website.
5. Develop a Node.js application with MongoDB to perform CRUD Operations.
6. Create version control account on GitHub and implement basic git commands and repository handling.
7. Mini Project: Develop a web application using front end and backend technologies in any of the domains: Social Media, E-commerce, Finance, Education, Any other.

Course Code: 170605G	Course Name: Data Visualization	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamental concepts and importance of data visualization.
- To develop the ability to create basic graphical representations such as bar charts, line charts, etc.
- To enable students to explore and summarize datasets using filtering, aggregation, and basic statistical measures.
- To apply visualization techniques to analyze time-series and geospatial data commonly used in engineering applications.
- To develop skills for creating dashboards and communicating insights through visual storytelling and business analytics tools.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the importance, principles, and techniques of data visualization and perform basic data exploration using filtering and aggregation methods.

CO2: Apply appropriate visualization techniques to create basic and advanced charts.

CO3: Analyze time-series datasets to identify trends, seasonality, and noise using suitable visualization techniques.

CO4: Analyze geospatial data using mapping techniques to derive meaningful insights.

CO5: Develop interactive dashboards and visual reports using visualization tools to communicate data insights effectively.

Course Contents:

Unit-I: Overview of Data Visualization **08 Hours**

Importance and benefits of good data visualization– Design principles. Visualization ethics, misleading visualizations, accessibility considerations, and best practices for effective visual communication. Statistical Measures, Introduction to Python libraries for visualization,

Exploring Data – Reduce Items and Attributes: Filter and Aggregate.

Unit-II: Creation of Basic Visualization 08 Hours

Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts. Creation of Advanced Visualization: Heat Map– Facet Grid – Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees.

Unit-III: Visualization of Time Series Data 08 Hours

Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data such as Power load variation, Machine temperature monitoring, Rainfall and water level data, Signal variation in electronics.

Unit-IV: Visualization of Geospatial Data 08 Hours

Spatial join - overlapping geospatial data to maps and adding special cues – Case Study-Visualization of multimodal data and analysis-case study sensor data and health care, genome and biomedical data.

Unit-V: Business Analytics and Visualization Tools 08 Hours

Creation of interactive dashboards, charts, and visual reports using data visualization tools, applying visualization principles and data storytelling techniques.

Learning Resources:

Text Books:

1. Python Data Visualization: An Easy Introduction to Data Visualization in Python, ISBN: 9780070087705, Tata McGraw-Hill Education, 2009.
2. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.

Reference Books:

1. Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code Jack Dougherty and Ilya Ilyankou 1st Edition, O'Reilly Media, 2021.
2. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/advanced-data-visualization-with-tableau-public

List of Practicals:

1. Load a dataset and perform basic data exploration by identifying attributes, data types, and displaying summary statistics.
2. Using a dataset, compute statistical measures (mean, median, standard deviation) and perform filtering and aggregation
3. Create Histogram, Bar Chart (vertical and horizontal), and Line Chart using a suitable dataset.
4. Using a dataset, create Box Plot and Scatter Plot to analyze data distribution and relationships between variables.
5. Using a dataset, generate advanced visualizations such as Heat Map and Facet Grid with appropriate color palettes.
6. Using a time-series dataset, create visualizations to identify trends, seasonality, and patterns.
7. Using a geospatial dataset, plot location-based data on a map and analyze spatial distribution.
8. Create an interactive dashboard using data visualization tools and present insights using data storytelling.

Course Code: 170605H	Course Name: Drives and Controls	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Power Electronics, Electric Machines.

Course Objectives:

- To understand the fundamentals, components, and control principles of electric drive systems.
- To analyze thermal models and select appropriate motor power ratings for different duty cycles.
- To study performance, speed control, and braking methods of DC motor drives.
- To understand operation, control techniques, and speed control methods of induction motor drives
- To understand the types, operation, and control of synchronous and special motor drives for fixed and variable speed applications.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the fundamentals, components, selection criteria, and control techniques of electric drives, including closed-loop and PLL control.

CO2: Analyze the thermal characteristics of motors to determine suitable motor power ratings under different duty cycles and load conditions.

CO3: Analyze performance, speed control, multi-quadrant operation, and closed-loop control of DC motor drives.

CO4: Explain starting, speed control methods, slip power recovery techniques, and closed-loop control of induction motor drives.

CO5: Analyze the operation and control of synchronous, Permanent Magnet Synchronous Motor, BLDC, stepper, and switched reluctance motor drives.

Course Contents:

Unit-I: Basics of Electric Drives and Control 08 Hours

Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, status of Electrical Drives (DC & AC), speed control and drive classifications, close loop control of drives, phase locked loop (PLL) control.

Unit-II: Selection of Motor Power Rating 08 Hours

Thermal model of motor for heating and cooling-Relationship between temperature rise and time, Heating time constant, Cooling time constant. classes of motor duty- continuous duty, short time duty, intermittent periodic duty, intermittent periodic duty with starting, intermittent periodic duty with starting & braking, continuous duty with intermittent periodic loading, continuous duty with starting & braking, Continuous duty with periodic speed changes. Determination of motor ratings, Selection of power ratings of motor -continuous duty and constant load, continuous duty and variable load, Short time rating of motor.

Unit-III: DC Motor Drives 08 Hours

DC motors and their performance starting, transient analysis, speed control, Controlled rectifier fed drives, full controlled 3 phase rectifier control of dc separately excited motor, Multi quadrant operation, Chopper controlled drives closed loop speed control of DC motor.

Unit-IV: Induction Motor Drives 08 Hours

Induction motor analysis, starting and speed control methods- voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery: Static Kramer and Scherbius Drive, Single phase induction motor starting, braking and speed control.

Unit-V: Special Purpose Motor Drives 08 Hours

Synchronous motor types, operation with fixed frequency, variable speed drives, Permanent Magnet Synchronous Motor and BLDC motor drives, Stepper motor drives, switch reluctance motor drives.

Learning Resources:

Text Books:

1. G. K. Dubey, Fundamentals of Electrical Drives, 2nd Edition (sixth reprint), Narosa Publishing House, 2001.
2. M. L. Soni, P.V. Gupta, U. S. Bhatnagar, “A course in Electrical Power”, 1999, Dhanpat Rai & Sons.

Reference Books:

1. M. H. Rashid, Power Electronics -Circuits, devices and Applications, 3rd Edition, PHI Pub. 2004.
2. B. K. Bose, Modern Power Electronics and AC Drives, Pearson Education, Asia, 2003.

Web link for MOOC / NPTEL Links:

1. http://nptel.ac.in/courses/108104140

List of Practicals:

1. Based on Basics of Electric Drives and Control.
2. Based on Selection of Motor Power Rating.
3. Based on DC Motor Drives.
4. Based on Induction Motor Drives.
5. Based on Special Purpose Motor Drives.
6. Mini project/case study on Electrical drives.
7. Seminar on Electrical drives.
8. Industrial Visit to electrical drive and control industry and prepare report.

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