Savitribai Phule Pune University
Faculty of Science & Technology

Curriculum/Syllabus
for
Second Year
Bachelor of Engineering
(Choice Based Credit System)
Mechatronics Engineering (2019 Course)

Board of Studies – Mechatronics Engineering
(With Effect from Academic Year 2020-21)

Savitribai Phule Pune University

Board of Studies – Mechatronics Engineering

Undergraduate Program – Mechatronics Engineering (2019 pattern)

Course Code	Course Name	Teaching Scheme (Hours/ Week)			Examination Scheme and Marks						Credit			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-III														
207002	Engineering Mathematics -III	3	-	1	30	70	25	-	-	125	3	-	1	4
217541	Engineering Material	3	-	-	30	70	25	-	-	125	3	-	-	4
217542	Heat and Mass Transfer	4	2	-	30	70	-	50	-	150	4	1	-	5
217543	Digital Electronics	3	2	-	30	70	-	-	25	125	3	1	-	4
217544	Analysis of Mechanical Structure	3	-	1	30	70	25	-	-	125	3	-	1	4
217545	Modelling of Mechatronics System	-	2	-	-	-	-	25	-	25	-	1	-	1
217546	Object Oriented Programming Lab	-	2	-	-	-	-	25	-	25		1		
202046	Audit Course - III	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**16**	**08**	**02**	**150**	**350**	**75**	**100**	**25**	**700**	**16**	**4**	**2**	**22**
Semester-IV														
217547	Kinematics of Machinery	3	2	-	30	70	-	-	25	125	3	1	-	4
217548	Fluid Mechanics and Machinery	3	2	-	30	70	-	25	-	125	3	1	-	4
217549	Electrical Machines and drive	3	-	1	30	70	25	-		125	3	1	-	4
217550	Sensor and Actator	3	2	-	30	70	-	25	-	125	3	-	1	4
217551	Aplication of Integrated Circuits	3	2	-	30	70	-	50	-	150	3	1	-	4
217552	Project Based Learning - II	-	4	-	-	-	50	-	-	50	-	2		2
202053	Audit Course - IV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**12**	**1**	**150**	**350**	**75**	**100**	**25**	**700**	**15**	**6**	**1**	**22**

Abbreviations: TH: Theory, **PR**: Practical, **TUT**: Tutorial, **ISE**: In-Semester Exam, **ESE**: End-Semester Exam,**TW**: Term Work, **OR**: Oral

Note: Interested students of SE Mechatronics Engineering can opt for any one of the audit course from the list of audit courses prescribed by BoS (Automobile and Mechanical Engineering)

Instructions

- Practical/Tutorial must be conducted in three batches per division only.
- Minimum number of required Experiments/Assignments in PR/ Tutorial shall be carried out as mentioned in the syllabi of respective subjects.
- Assessment of tutorial work has to be carried out as a term-work examination. Term-work Examination at second year of engineering course shall be internal continuous assessment only.
- Project based learning (PBL) requires continuous mentoring by faculty throughout the semester for successful completion of the tasks selected by the students per batch. While assigning the teaching workload of 2 Hrs/week/batch needs to be considered for the faculty involved. The Batch needs to be divided into sub-groups of 3 to 4 students. Assignments / activities / models/ projects etc. under project based learning is carried throughout semester and Credit for PBL has to be awarded on the basis of internal continuous assessment and evaluation at the end of semester.
- Audit course is mandatory but non-credit course. Examination has to be conducted at the end of Semesters for award of grade at institute level. Grade awarded for audit course shall not be calculated for grade point & CGPA.

207002 - Engineering Mathematics - III

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Tutorial : 01Hr/Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Differential & Integral calculus, Differential equations of first order & first degree, Fourier series, Collection, classification and representation of data and Vector algebra.

Course Objectives

1. To make the students familiarize with concepts and techniques in Ordinary & Partial differential equations, Laplace transform & Fourier transform, Statistical methods, Probability theory and Vector calculus.
2. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes

On completion of the course, learner will be able to

CO1. SOLVE higher order linear differential equations and its applications to model and analyze mass spring systems.

CO2. APPLY Integral transform techniques such as Laplace transform and Fourier transform to solve differential equations involved in vibration theory, heat transfer and related mechanical engineering applications.

CO3. APPLY Statistical methods like correlation, regression in analyzing and interpreting experimental data applicable to reliability engineering and probability theory in testing and quality control.

CO4. PERFORM Vector differentiation & integration, analyze the vector fields and APPLY to fluid flow problems.

CO5. SOLVE Partial differential equations such as wave equation, one and two dimensional heat flow equations.

Course Contents

Unit I Linear Differential Equations (LDE) and Applications [08 Hr.]

LDE of nth order with constant coefficients,Complementary Function, Particular Integral,General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modelling of Mass-spring systems, Free &Forced damped and undamped systems.

Unit II Transforms[08 Hr.]

Laplace Transform **(LT):** LT of standard functions, properties and theorems, Inverse LT, Application of LT to solve LDE.

Fourier Transform **(FT):** Fourier integral theorem, Fourier transform, Fourier sine & cosine transforms, Inverse Fourier Transforms.

Unit III Statistics [07 Hr.]

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Curve fitting: fitting of straight line, parabola and related curves, Correlation and Regression, Reliability of Regression Estimates.

Unit IV Probability and Probability Distributions [07Hr.]

Probability, Theorems on Probability, Bayes Theorem, Random variables, Mathematical Expectation, Probability distributions: Binomial, Poisson, Normal, Test of Hypothesis: Chi-Square test, t-test.

UnitV Vector Calculus [08 Hr.]

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal &Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI Applications of Partial Differential Equations (PDE) [08 Hr.]

Basic concepts, modelling of Vibrating String, Solution of Wave equation, One and two dimensional

Heat flow equations, Method of separation of variables, use of Fourier series. Solution of Heat equation by Fourier transforms.

Books & Other Resources

Text Books

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi

Reference Books

1. Erwin Kreyszig, "Advanced Engineering Mathematics', 10e, by Wiley India.
2. M. D. Greenberg, "Advanced Engineering Mathematics", 2e, by Pearson Education.
3. Peter V. O'Neil , "Advanced Engineering Mathematics", 7e, by Cengage Learning
4. S. L. Ross, "Differential Equations", 3e by Wiley India.
5. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 5e, by Elsevier Academic Press

Guidelines for Tutorial and term Work

1. Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
2. Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.The student shall complete the following activity as a Term Work Journal.

217541 - Engineering Materials

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week	**04** Theory : 03	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Higher Secondary Science courses, Engineering Physics, Engineering Chemistry, Systems in Mechanical Engineering

Course Objectives

1. To impart fundamental knowledge of material science and engineering.
2. To establish significance of structure property relationship.
3. To explain various characterization techniques.
4. To indicate the importance of heat treatment on structure and properties of materials.
5. To explain the material selection process.

Course Outcomes

On completion of the course, learner will be able to

CO1. COMPARE crystal structures and ASSESS different lattice parameters.

CO2. CORRELATE crystal structures and imperfections in crystals with mechanical behaviour of materials.

CO3. DIFFERENTIATE and DETERMINE mechanical properties using destructive and non-destructive testing of materials.

CO4. IDENTIFY & ESTIMATE different parameters of the systemviz., phases, variables, component, grains, grain boundary, and degree of freedom. etc.

CO5. ANALYSE effect of alloying element & heat treatment on properties of ferrous & nonferrous alloy.

CO6. SELECT appropriate materials for various applications.

Course Contents

Unit I Crystal Structures and Deformation of Materials [07 Hr.]

Crystal Structures: Study of Crystal structures BCC, FCC, HCP and lattice parameters & properties, Miller indices, Crystal imperfections, and Diffusion Mechanisms

Material Properties: Mechanical (Impact, hardness, etc.), Electrical, optical and Magnetic properties

Deformation of Materials: Elastic deformation, Plastic deformation: slip, twinning, work hardening, baushinger effect, recovery, re-crystallization and grain growth, Fracture: Types of fractures (brittle, ductile), Creep & Fatigue failures

Unit II Material Testing and Characterization Techniques [06 Hr.]

Destructive Testing: Impact test, Cupping test and Hardness test

Non-Destructive Testing: Eddy current test, Sonic & Ultrasonic testing, X-ray Radiography testing (Principle and Applications only)

Microscopic Techniques: Sample Preparation and etching procedure, optical microscopy, Electronic microscopy - only SEM, TEM and X-ray diffraction (Principle and Applications only)

Macroscopy: Sulphur printing, flow line observation, spark test

Unit III Phase Diagrams and Iron-Carbon Diagram [08 Hr.]

Solid solutions: Introduction, Types, Humerothery rule for substitutional solid solutions

Solidification: Nucleation & crystal growth, solidification of pure metals, solidification of alloys.

Phase Diagrams: Cooling curves, types of phase diagrams, Gibbs phase rules

Iron-Carbon Diagram: Iron-carbon equilibrium diagrams in detail with emphasis in the invariant reactions

Unit IV **Heat Treatments** **[08 Hr.]**

Austenite transformation in steel: Time temperature transformation diagrams, continuous cooling transformation diagrams. Retained austenite and its effect

Steps in Heat treatment and Cooling Medium

Heat Treatment Processes: Introduction, Annealing (Full annealing, Process annealing, Spheroidise annealing, isothermal annealing, stress relief annealing), Normalising, Hardening, Tempering, Austempering, Martempering, Sub-Zero Treatment, Hardenability

Surface Hardening: Classification, Flame hardening, Induction hardening, Carburising, Nitriding, Carbonitriding

Unit V **Ferrous Materials** **[07 Hr.]**

Carbon Steel: Classification, types & their composition, properties and Industrial application

Alloy Steels: Classification of alloy steels & Effect of alloying elements, examples of alloy steels, (Stainless steel, Tool steel) sensitization of stainless steel

Designation of carbon steel and alloy steels as per IS, AISI, SAE Standards

Cast Iron: Classification, types & their composition, properties and Industrial application of (White CI, Gray CI, SG CI, Malleable Cast and alloy Cast Iron)

Microstructure and property relationship of various ferrous Materials

Unit VI **Non-Ferrous Materials** **[07 Hr.]**

Classification of Non-Ferrous Metals: Study of Non-ferrous alloys with Designation, Composition, Microstructure

Mechanical & other properties for Industrial Applications: Copper and its Alloys (Gilding Metal, Cartridge Brass, Muntz Metal, Tin Bronze, Beryllium Bronze), Aluminium and its Alloy (LM5, Duralumin, Y-Alloy, Hinduminum), Nickel and its Alloys (Invar, Inconel), Titanium and its Alloys (α Alloys, α-β Alloys), Cobalt and its Alloys (Stellite Alloys, Alnico), Bearing Alloys (Classification, lead based alloys, tin based alloys), Age Hardening

Microstructure and Property relationship of various Non-ferrous Materials

Recent Material used in Additive Manufacturing: Properties, Composition and Application only

Books & Other Resources

Text Books

1. Dr. V. D. Kodgire& S. V. Kodgire, "Material Science & Metallurgy For Engineers",Everest Publication.
2. William D. Callister, "Materials Science and Engineering an Introduction", Jr, John Wiley & Sons, Inc.

Reference Books

1. A. K. Bhargava, C.P. Sharma, "Mechanical Behaviour & Testing of Materials", P H I Learning Private Ltd.
2. Raghvan V., "Material Science &Engineering",Prentice Hall of India, New Delhi. 2003
3. Avner, S.H., "Introduction to Physical Metallurgy", Tata McGraw-Hill, 1997.
4. Higgins R. A., "Engineering Metallurgy", Viva books Pvt. Ltd.
5. George Ellwood Dieter, "Mechanical Metallurgy", McGraw-Hill 1988
6. Smith, W.F, Hashemi, J., and Prakash, R., "Materials Science and Engineering in SI Units", Tata McGraw Hill Education Pvt. Ltd.

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work Journal

Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments, and Industrial Visits.

Practical*(Any Seven)*

1. Destructive testing - Hardness testing (Rockwell/Vickers) Hardness conversion number
2. Brinell and Poldi hardness Test
3. Impact Test for Steel, Aluminum, Brass and Copper (Charpy/Izod)
4. Non Destructive testing - Dye Penetrant Test/ Magnetic Particle test/ Ultrasonic Test

5. Steps for Specimen Preparation for microscopic examination & Demonstration of Optical Metallurgical microscope
6. Observation and Drawing of Microstructure of Steels, Cast Iron of various compositions
7. Observation and Drawing of Microstructure of Non Ferrous Metals of various compositions
8. Heat Treatment of steels based on relative hardness
9. Jominy End Quench Test for hardenability

Miniature commitment or Assignments *(Any Two)*

1. Exploration of engineering Alloy (Name, composition, properties, microstructure, Heat treatment, Designation & specific applications)- One student one Alloy or material
2. Examine aspects of component form material and manufacturing process point of view (Name, Material, Drawing, Manufacturing Process, properties, microstructure, Heat treatment, & specific applications) - For example spur gear, Needle etc. One student one component
3. Creep and Fatigue Test (Virtual Lab IIT Bombay)
4. Fluorescence Microscope (Virtual Lab IIT Bombay)

Industrial Visits

To provide awareness and understanding of the course, Compulsory Industrial Visit must be arranged for the students.

The Industrial Visit must be preferably to

- Material & Metallurgy related like Engineering Cluster, NDT Lab, and Nearby NABL lab or
- Any manufacturing unit with material orientation

Student must submit a properly documented Industrial Visit Report.

Guidelines for Instructor's Manual

The Instructor's Manual should contain following related to every experiment:

1. Brief theory related to the experiment
2. Apparatus with their detailed specifications
3. Standard ASME/ IS numbers of test procedure
4. Schematic, Layout/diagram
5. Observation table/graphs.
6. Sample calculations for one/two reading
7. Result table, Graph and Conclusions.
8. 3/4 questions related to the experiment
9. Relevance of practical in industry with recent software of image analysis

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment:

1. Theory related to the experiment
2. Apparatus with their detailed specifications
3. Schematic, Layout/diagram
4. Observation table/simulation plots/graphs
5. Sample calculations for one/two reading
6. Result table. Graph and Conclusions
7. 3/4 questions related to the experiment
8. Attach Photo of experiment or image related to Experiment

Guidelines for Lab/TW Assessment

1. There should be continuous assessment for the TW
2. Assessment must be based on understanding of theory, attentiveness during practical, and understanding
3. Session, how efficiently the student is able to do connections and get the results
4. Online evolutions of practical with objective type of Questions
5. Timely submission of journal

217542 – Heat and Mass Transfer

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hr./Week Practical : 02 Hr./Week	**04** Theory : 04 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Practical : 50 Marks

Prerequisite Courses

Higher Secondary Science courses, Engineering Mathematics - I and II, Engineering Physics, Engineering Chemistry

Course Objectives

1. Study of basic concepts and laws ofthermodynamics.
2. Study of modes of heat transfer and governinglaws.
3. Study and analysis of Boilers, turbines and heatexchangers

Course Outcomes

CO1.Demonstrate understanding of basic concepts ofthermodynamics
CO2. Analyze performance of Boilers and steam turbine.
CO3. Analyze the various power cycles
CO4. Identify & explain the three modes of heat transfer (conduction, convection and radiation).
CO5.Interprint heat transfer by convection and radiation between simple geometry for black and gray surface
CO6.Design and analyze different heat exchangers

Course Contents

Unit I **Fundamentals of Thermodynamics** **[08 Hr.]**

Introduction and Basic Concepts: Application areas of thermodynamics, Systems and Control volumes, Properties of system, Continuum, State and equilibrium, Processes and cycles, Temperature and Zeroth law of thermodynamics, Heat and thermodynamic concept of work.

First Law of Thermodynamics:

Statement, Heat and work calculations, Application of first law to non-flow and flow systems, steady flow energy equation as applied to boiler, condenser, and nozzle, compressor and turbine.

Second Law of Thermodynamics:

Statements and their equivalence, thermal energy reservoirs, concept of heat engine, refrigerator, heat pump and perpetual motion machines, Carnot cycle and principles.

Entropy: Concept of entropy, Temperature- entropy plot, Clausius inequality, Principle of Increase of entropy, entropy balance.

Unit II **Boilers and Steam Turbine** **[06 Hr.]**

Boilers

Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Layout of a modern HP boiler, Boiler performance, and Boiler efficiency (No Numerical approach).

Steam Turbines

Impulse turbines, Reaction turbines, velocity diagram, degree of reaction, compounding of steam turbines, Parson's turbine, condition for maximum Efficiency

Unit III **Internal Combustion Engines** **[06 Hr.]**

Internal Combustion Engines

Components and construction details,Terminology, classification, Application,Intake and Exhaust system,Air standard cycles, Carnot, Otto, diesel, dual cycles and their comparison, Two stroke and Four stroke engines, CI and SI engines, Environmental and pollution control issues andremedies

Unit IV **Mode of Heat Transfer Conduction** **[08 Hr.]**

Heat Transfer

Typical heat transfer situations, Modes of heat transfer

Conduction

Fourier's law of heat conduction, thermal conductivity, differential equation of heat conduction with heat generation in unsteady state in the Cartesian coordinate system, Steady heat conduction

in plane walls, composite walls, Concept of thermal resistance and thermal resistance network, Heat conduction in cylinders and spheres, (Derivation NOT INCLUDED for Cylindrical as well as Spherical coordinate systems), Critical thickness/radius of insulation and its importance.

Transient Heat Conduction

Lumped system analysis, One dimensional transient problems analytical solutions

Unit V **Convection and Radiation** **[08 Hr.]**

Convection

Mechanism of convection of Natural and Forced convection, Laminar flow heat transfer in circular pipe, constant heat flux and constant wall temperature, Turbulent flow heat transfer in circular pipes, Heat transfer in laminar and turbulent flow over a flat plate, Physical significance of various dimensionless numbers useful in natural and forcedconvection

Radiation

Basic laws of radiation (Plank's law, Kirchoff's law, Stefan-Boltzman law, Wien's displacement law, Lambert's cosine law), Radiation exchange between black surfaces, Shape factor, Radiation exchange between gray surfaces, Radiation shield and the radiation effect

Unit VI **Heat Exchanger** **[06 Hr.]**

Boiling and Condensation

Pool boiling, Flow boiling, Film condensation, Drop wise condensation

Heat Exchangers

Types of heat exchangers, Overall heat transfer coefficient, Analysis of heat exchangers, LMTD method, Effectiveness-NTU method

Books & Other Resources

Text Books

1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications
2. R. K. Rajput, "Engineering Thermodynamics", EVSS Thermo, Laxmi Publications
3. P. L Ballaney, "Thermal Engineering", Khanna Publishers
4. C.P. Arora, "Thermodynamics", Tata McGraw Hill
5. Domkundwar, Kothandaraman andDomkundwar,"Thermal Engineering",Dhanpat Rai Publishers
6. M MRathore, "Thermal Engineering", Tata McGraw-Hill

Reference Books

1. Rayner Joel, "Basic Engineering Thermodynamics", AWL-Addison Wesley
2. Cengel and Boles, "Thermodynamics an Engineering Approach", McGraw Hill
3. G.VanWylen, R.Sonntag and C.Borgnakke, "Fundamentals of Classical Thermodynamics", John Wiley & Sons
4. Holman J.P, "Thermodynamics", McGraw Hill
5. Heat Transfer, 9thed., J P Holman, McGrawHill
6. lntroduction to Thermodynamics and Heat Transfer, YunusCengel, 2nded,McGraw-Hill

Guidelines for Laboratory Conduction

The student shall complete the following activity as Term Work

The Term work shall consist of successful completion of Practicals, and Industrial Visits. Oral Examination shall be based on the term work.

Practical

1. Joule's experiment to validate, first law of thermodynamics.
2. Survey of temperature sensors used in various thermal systems.
3. Determination Thermal conductivity of insulating powder.
4. Determination Thermal conductivity of Metal rod.
5. Determination of local and avereage heat transfer coeffient in Natural Convection.
6. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
7. Thermodynamic Analysis of any System / Model by using any Computer Software.
8. Determination of Emisivity of Test Surface.
9. Virtual Laboratoty : Study of performance of heat exchanger

Link for V Lab:-https://www.vlab.co.in/

Industrial Visits

Visit to any Process Industry/Plant having Boiler equipped with Accessories.
The visit report consists of

- Details about the Industry/Process Plant.
- Operational description of the Equipment with specification, its use, capacity, application etc.

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217543 – Digital Electronics

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Oral : 25 Marks

Prerequisite Courses

Basic Electrical & Electronics Engineering; Logic Gates, Basic of Computer configuration

Course Objectives

1.To study number systems and develop skills for design and implementation of combinational logic circuits and sequential circuits
2. To understand the functionalities, properties and applicability of Logic Families.
3. To introduce programmable logic devices and ASM chart and synchronous state machines.
4.To basics of microprocessor.

Course Outcomes

CO1: Simplify Boolean Expressions using K Map.
CO2: Design and implement combinational circuits.
CO3: Design and implement sequential circuits.
CO4: Develop simple real-world application using ASM and PLD.
CO5: Choose appropriate logic families IC packages as per the given design specifications.
CO6: Explain organization and architecture of computer system

Course Contents

Unit I **Minimization Technique** **[08 Hr.]**

Logic Design Minimization Technique -: Minimization of Boolean function using K-map(up to 4 variables) and Quine Mc-Clusky Method, Representation of signed number- sign magnitude representation ,1's complement and 2's complement form (red marked can be removed), Sum of product and Product of sum form, Minimization of SOP and POS using K-map.

Unit II **Combinational logic Design** **[06 Hr.]**

Code converter -: BCD, Excess-3, Gray code, Binary Code. Half- Adder, Full Adder, Half Subtractor, Full Subtractor, Binary Adder (IC 7483), BCD adder, Look ahead carry generator, Multiplexers (MUX): MUX (IC 74153, 74151), Cascading multiplexers, Demultiplexers (DEMUX)-Decoder (IC 74138, IC 74154), Implementation of SOP and POS using MUX, DMUX, Comparators (2 bit), Parity generators and Checker

Unit III **Sequential logic Design** **[07 Hr.]**

Flip-Flop: SR, JK,D,T; Preset &Clear, Master Slave JK Flip Flops, Truth Tables and Excitation tables, Conversion from one type to another type of Flop Flop. Registers: SISO, SIPO, PISO, PIPO, Shift Registers, Bidirectional Shift Register, Ring Counter , Universal Shift Register Counters: Asynchronous Counter, Synchronous Counter, BCD Counter, Johnson Counter, Modulus of the counter (IC 7490),Synchronous Sequential Circuit Design :Models- Moore and Mealy, State diagram and State Table ,Design Procedure, Sequence Generator and detector.

Unit IV **Algorithmic State Machines and Programmable Devices** **[06 Hr.]**

Algorithmic State Machines: Finite State Machines (FSM) and ASM, ASM charts, notations, construction of ASM chart and realization for sequential circuits. PLDS:PLD, ROM as PLD, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Designing combinational circuits using PLDs

Unit V **Logic Families** **[06 Hr.]**

Classification of logic families: Unipolar and Bipolar Logic Families, Characteristics of Digital ICs: Fan-in, Fan-out, Current and voltage parameters, Noise immunity, Propagation Delay, Power Dissipation, Figure of Merits, Operating Temperature Range, power supply requirements. Transistor-Transistor Logic: Operation of TTL NAND Gate (Two input), TTL with active pull up, TTL with open collector output, Wired AND Connection, Tristate TTL Devices, TTL characteristics. CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs

Unit VI **Introduction to Computer Architecture** **[06 Hr.]**

Introduction to Ideal Microprocessor – Data Bus, Address Bus, Control Bus. Microprocessor based Systems – Basic Operation, Microprocessor operation, Block Diagram of Microprocessor. Functional Units of Microprocessor – ALU using IC 74181, Basic Arithmetic operations using ALU IC 74181, 4-bit Multiplier circuit using ALU and shift registers. Memory Organization and Operations, digital circuit using decoder and registers for memory operations

Books & Other Resources

Text Books:

1. Modern Digital Electronics by R.P.Jain, 4th Edition, ISBN 978-0-07-06691-16 Tata McGraw Hill
2. Digital Logic and Computer Design by Moris Mano, Pearson , ISBN 978-93-325-4252-5

Reference Books

1.John Yarbrough, ―Digital Logic applications and Design, Cengage Learning, ISBN – 13: 978-81- 315-0058-3

2. D. Leach, Malvino, Saha, ―Digital Principles and Applications‖, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4.

3. Anil Maini, ―Digital Electronics: Principles and Integrated Circuits‖, Wiley India Ltd, ISBN:978- 81-265-1466-3.

4. Norman B & Bradley, ―Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258

MOOC Courses:

1. Digital Circuits, by Prof. Santanu Chattopadhyay , https://swayam.gov.in/nd1_noc19_ee51/preview

2. Digital Circuits and Systems , Prof. S. Srinivasan https://nptel.ac.in/courses/117/106/117106086/

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. **Student should perform at least 12 experiments with all experiments from group A and any 5 assignments from group Band one from group C assignments.**

Suggested List of Laboratory Experiments/Assignments

Group A

1 To Realize Full Adder/ Subtractor using a) Basic Gates and b) Universal Gates

2 Design and implement Code Converters-Binary to Gray and BCD to Excess-3

3 Design and Realization of BCD Adder using 4-bit Binary Adder (IC 7483).

4 Realization of Boolean Expression for suitable combination logic using MUX 74151 /74153, DMUX 74154/74138

5 To Verify the truth table of two bit comparators using logic gates.

6 Design & Implement Parity Generator and checker using EX-OR.

Group B

7 Design and Realization: Flip Flop conversion

8 Design of 2 bit and 3 bit Ripple Counter using MS JK flip-flop.

9 Design of Synchrous 3 bit Up and Down Counter using MSJK Flip Flop / D Flip Flop10 Realization of Mod -N counter using (Decade Counter IC 7490) .

11 Design and implement Sequence generator (for Prime Number/odd and even) using MS JK flip-flop

12 Design and implement Sequence detector using MS JK flip-flop

Group C

13 Study of Shift Registers (SISO,SIPO, PISO, PIPO)

14 Design of ASM chart using MUX controller Metho

217544 – Analysis of Mechanical Structure

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Tutorial : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Engineering Mathematics- I and II, Systems in Mechanical Engineering, Engineering Mechanics

Course Objectives

1. To acquire basic knowledge of stress, strain due to various types of loading.
2. To draw Shear Force and Bending Moment Diagram for transverse loading.
3. To determine Bending, Shear stress, Slope and Deflection on Beam.
4. To solve problems of Torsional shear stress for shaft and Buckling for the column.
5. To apply the concept of Principal Stresses and Theories of Failure.
6. To utilize the concepts of Solid Mechanics on application based combined mode of loading.

Course Outcomes

On completion of the course, learner will be able to

CO1. DEFINE various types of stresses and strain developed on determinate and indeterminate members.

CO2. DRAW Shear force and bending moment diagram for various types of transverse loading and support.

CO3. COMPUTE the slope & deflection, bending stresses and shear stresses on a beam.

CO4. CALCULATE torsional shear stress in shaft and buckling on the column.

CO5. APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element.

CO6. UTILIZE the concepts of SFD & BMD, torsion and principal stresses to solve combined loading application based problems.

Course Contents

Unit I **Simple stresses & strains** **[08 Hr.]**

Simple Stress & Strain: Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram for ductile and brittle materials, factor of safety, Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads and self-weight, Thermal stresses in plain and composite members

Unit II **Shear Force & Bending Moment Diagrams** **[07 Hr.]**

SFD & BMD: Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure

Unit III **Stresses, Slope & Deflection on Beams** **[08 Hr.]**

Bending Stress on a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section

Shear Stress on a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section

Slope & Deflection on a Beam: Introduction to slope & deflection on a beam with application, slope, deflection and Radius of Curvature, Macaulay's Method, Slope and Deflection for all standard beams

Unit IV **Torsion, Buckling** **[08 Hr.]**

Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience

Torsion on Thin-Walled Tubes: Introduction of Torsion on Thin-Walled Tubes Shaft and its application

Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory

Unit V **Principal Stresses, Theories of Failure** **[08 Hr.]**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses

Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory

Unit VI **Application based combined loading & stresses** **[08 Hr.]**

(Based on load and stress condition studied in Unit I to Unit V)

Introduction to the Combined Loading and various stresses with application, Free Body Diagram and condition of Equilibrium for determining internal reaction forces, couples for 2-D system, Combined stresses at any cross-section or at any particular point for Industrial and Real life example for the following cases: Combined problem of Normal type of Stresses (Tensile, Compressive and Bending stress), Combined problem of Shear type of stresses (Direct and Torsional Shear stresses), Combined problem of Normal and Shear type of Stresses

Books & Other Resources

Text Books

1. R. K. Bansal, "Strength of Materials", Laxmi Publication
2. S. Ramamurtham, "Strength of material", Dhanpat Rai Publication
3. S.S. Rattan, "Strength of Material", Tata McGraw Hill Publication Co. Ltd.
4. B.K. Sarkar, "Strength of Material", McGraw Hill New Delhi
5. Singer and Pytel, "Strength of materials", Harper and row Publication
6. R. C. Hibbeler, "Mechanics of Materials", Prentice Hall Publication

Reference Books

1. Egor. P. Popov, "Introduction to Mechanics of Solids",Prentice Hall Publication
2. G. H. Ryder, "Strength of Materials", Macmillan Publication
3. Beer and Johnston, "Strength of materials", CBS Publication
4. James M. Gere, "Mechanics of Materials", CL Engineering
5. Timoshenko and Young, "Strength of Materials", CBS Publication, Singapore
6. Prof. S.K. Bhattacharyya, IIT Kharagpur , "NPTEL Web course material" https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Guidelines for Tutorial Conduction

The student shall complete the following activity as a Term Work

The Termwork shall consist of completion of Practicals, Self-learning Study Assignments and Presentations.

Practical *(Any 6 experiments out of experiment no 1 to 8 from the following list whereas experiment no. 9 and 10 are mandatory. Minimum One experiment must be performed on IoT platform- Virtual Lab)*:

1. Tension test for Ductile material using extensometer on Universal Testing Machine.
2. Compression test for Brittle material on Universal Testing Machine.
3. Shear test of ductile material on Universal Testing Machine.
4. Tension test of Plastic/Composite material on low load capacity Tensile Testing Machine.
5. Measurement of stresses and strains using strain gauges.

6. Experimental verification of flexural formula in bending for cantilever, Simple supported beam.
7. Study and interpretations of stress distribution pattern using Polariscope for Plastic/Acrylic.
8. Experimental verification of torsion formula for circular bar.
9. Verification of results of any two from experiments no 1-8 using any FEA software tools.
10. **Self-learning study practical**: *Following topics are distributed among the group of 3-5 Students and groups need to present and also submit the slides/poster on TW file.*
    a. Experimental stress analysis, Strain Gauges rosette with case study.
    b. Residual stresses and Fatigue life with case study.
    c. Effect of heat treatment on the mechanical properties of a metal with case study.
    d. Mechanical properties of materials, Stresses and Design of components with case study.
    e. Failure Mode Analysis and Stresses with case study.

217545 - Modeling of Mechatronics System		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hr./Week	**01** Practical : 01	Practical : 25 Marks

Prerequisite Courses

Systems in Mechanical Engineering, Engineering Graphics, Engineering Mathematics - I and II

Course Objectives

1. To visualize an object and convert it into adrawing.
2. To gain knowledge of conventional representation of various machining and mechanical details as perIS.
3. To become conversant with 2-D and 3-Ddrafting.

Course Outcomes

1. Visualize and prepare detail drawing of a given object.
2. Draw details and assembly of mechatronics systems.
3. Read and interpret a given machinedrawing.
4. Create 2-D and 3-D models using any standard CAD software with manufacturing considerations.

Course Contents

Practical

The student shall complete the following Practical in laboratory using suitable CAD modeling software. Learner will demonstrate skills to communicate drawings as per industry standards.

1. 2-D sketching with geometrical and dimensional constraints
2. Solid & Surface modeling for simple mechanical components (Output file as Production drawing and Model Based Definition (MBD) (a) Sheet-Metal (b) Machining (c) Fabrication (d) Casting (e) Forgings (f) Plastic Molding
3. Assembly modeling (Output file as Assembly drawing and detailing) of the parts modeled in Practical assignment-2 using proper assembly constraint conditions and generation of exploded view for assemblies like Couplings, Electrical actuator, Gear Assemblies, Automated system Components (Pick and Place Robot ,Automated bottle filling etc.), Valves, Machine Tools, Gear-Box, 3D printer, etc.
4. Reverse Engineering of surface/solid modeling using Point Cloud Data.
5. Assembly Modeling by importing parts/components from free online resources like CAD and Product development software websites, forums, blogs, etc.
6. Demonstration on CAD Customization (with introduction to programming languages, interfacing)

217546 - Object Oriented Programming Laborotary

Teaching Scheme	Credits	Examination Scheme
Practical : 02 Hr./Week	**01** Practical : 01	Practical : 25 Marks

Prerequisite Courses

Course Objectives

1. To explore & understand the principles of Object Oriented Programming (OOP).
2. To use the object-oriented paradigm in program design.
3. To provide object-oriented programming insight using C++
4. To lay a foundation for advanced programming.

Course Outcomes

On completion of the course, learner will be able to

1. CO1: Analyze the strengths of object oriented programming
2. CO2: Design and apply OOP principles for effective programming
3. CO3: Develop the application using object oriented programming language(C++)
4. CO4: Apply object-oriented concepts for advanced programming.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. Use of open source software is encouraged. Based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus. Operating System recommended: - 64-bit Open source Linux or its derivative Programming tools recommended: - Open Source C++ Programming tool like G++/GCC, OPENGL.

Suggested List of Laboratory Experiments/Assignments

Any 8 Experiments /Assignment need to perform

1 Implement a class Complex which represents the Complex Number data type. Implement the following
i. Constructor (including a default constructor which creates the complex number 0+0i).
ii. Overloaded operator+ to add two complex numbers.
iii. Overloaded operator* to multiply two complex numbers.
iv. Overloaded << and >> to print and read Complex Numbers.

2 .Write a C++ program create a calculator for an arithmetic operator (+, -, *, /). The program should take two operands from user and performs the operation on those two operands depending upon the operator entered by user. Use a switch statement to select the operation. Finally, display the result.

3. Develop an object oriented program in C++ to create a database of student information system containing the following information: Name, Roll number, Class, division, Date of Birth, Blood group, Contact address, telephone number, driving license no. and other. Construct the database with suitable member functions for initializing and destroying the data viz constructor, default constructor, Copy constructor, destructor, static member functions, friend class, this pointer, inline code and dynamic memory allocation operators-new and delete.

4. Imagine a publishing company which does marketing for book and audio cassette versions. Create a class publication that stores the title (a string) and price (type float) of a publication. From this class derive two classes: book, which adds a page count (type int), and tape, which adds a playing time in minutes (type float). Write a program that instantiates the book and tape classes, allows user to enter data and displays the data members. If an exception is caught, replace all the data member values with zero values.

5. A book shop maintains the inventory of books that are being sold at the shop. The list includes details such as author, title, price, publisher and stock position. Whenever a customer wants a book, the sales person inputs the title and author and the system searches the list and displays whether it is available or not. If it is not, an appropriate message is displayed. If it is, then the system displays the book details and requests for the number of copies required. If the requested copies book details and requests for the number of copies required. If the requested copies are available, the total cost of the requested copies is displayed; otherwise the message Required copies not in stock is displayed. Design a system using a class called books with suitable member functions and Constructors. Use new operator in constructors to allocate memory space required. Implement C++ program for the system.

6. Create employee bio-data using following classes i) Personal record ii))Professional record iii)Academic record Assume appropriate data members and member function to accept required data & print bio-data. Create bio-data using multiple inheritances using C++.

7. Crete User defined exception to check the following conditions and throw the exception if the criterion does not meet. a. User has age between 18 and 55 b. User stays has income between Rs. 50,000 – Rs. 1,00,000 per month c. User stays in Pune/ Mumbai/ Bangalore / Chennai d. User has 4-wheeler Accept age, Income, City, Vehicle from the user and check for the conditions mentioned

8**.** Write a C++ program that creates an output file, writes information to it, closes the file andopen it again as an input file and read the information from the file.

9. Write C++ program using STL for sorting and searching with user defined records such as person record(Name, DOB, Telephone number), Item record (Item code, name, cost,quantity) using vector container

10. Write a program in C++ to use map associative container. The keys will be the names of states, and the values will be the populations of the states. When the program runs, the user is prompted to type the name of a state. The program then looks in the map, using the state name as an index, and returns the population of the state.

202046 - Audit Course - III		
Teaching Scheme	**Credits**	**Examination Scheme**
-	-	-

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from second year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course III

- Technical English For Engineers
- Entrepreneurship Development
- Developing soft skills and personality
- Design Thinking
- Foreign Language (preferably German/ Japanese)
- Science, Technology and Society

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with a certificate.

Assessment of an Audit Course

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the marksheet.

217547 - Kinematics of Machinery

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Oral : 25 Marks

Prerequisite Courses

Systems in Mechanical Engineering, Engineering Mathematics - I and II, Engineering Physics, Engineering Mechanics, Geometric Modeling & Drafting

Course Objectives

1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications.
2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approach.
3. To develop the skill to propose and synthesize the mechanisms using graphical and analytical technique.
4. To develop the competency to understand & apply the principles of gear theory to design various applications.
5. To develop the competency to design a cam profile for various follower motions.

Course Outcomes

On completion of the course, learner will be able to

CO1. APPLY kinematic analysis to simple mechanisms
CO2. ANALYZE velocity and acceleration in mechanisms by vector and graphical method
CO3. SYNTHESIZE a four bar mechanism with analytical and graphical methods
CO4. APPLY fundamentals of gear theory as a prerequisite for gear design
CO5. CONSTRUCT cam profile for given follower motion

Course Contents

Unit I **Fundamentals of Mechanism** **[07 Hr.]**

Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom, Mobility of Mechanism, Inversion, Grashoff's law, Four-Bar Chain and its Inversions, Slider crank Chain and its Inversions, Double slider crank Chain and its Conversions, Mechanisms with Higher pairs, Equivalent Linkages and its Cases - Sliding Pairs in Place of Turning Pairs, Spring in Place of Turning Pairs, Cam Pair in Place of Turning Pairs

Unit II **Kinematic Analysis of Mechanisms: Analytical Method** **[07 Hr.]**

Analytical methods for displacement, velocity and acceleration analysis of slider crank Mechanism, Velocity and acceleration analysis of Four-Bar and Slider crank mechanisms using Vector and Complex Algebra Methods. Computer-aided Kinematic Analysis of Mechanism like Slider crank and Four-Bar mechanism, Analysis of Single and Double Hook's joint

Unit III **Kinematic Analysis of Mechanisms: Graphical Method** **[08 Hr.]**

Displacement, velocity and acceleration analysis mechanisms by Relative Velocity Method (Mechanisms up to 6 Links), Instantaneous Centre of Velocity, Kennedy's Theorem, Angular Velocity ratio Theorem, Analysis of mechanism by ICR method (Mechanisms up to 6 Links), Coriolis component of Acceleration (Theoretical treatment only)

Unit IV **Synthesis of Mechanisms** **[07 Hr.]**

Steps in Synthesis: Type synthesis, Number Synthesis, Dimensional synthesis, Tasks of Kinematic synthesis - Path, function and motion generation (Body guidance), Precision Positions, Chebychev spacing, Mechanical and structural errors

Graphical Synthesis: Inversion and relative pole method for three position synthesis of Four-Bar and Single Slider Crank Mechanisms

Analytical Synthesis: Three position synthesis of Four-Bar mechanism using Freudenstein's

equation, Blotch synthesis

Unit V **Kinematics of Gears** **[08 Hr.]**

Gear: Classification

Spur Gear: Terminology, law of gearing, Involute and cycloidal tooth profile, path of contact, arc of contact, sliding velocity, Interference and undercutting, Minimum number of teeth to avoid interference, Force Analysis (theoretical treatment only)

Helical and Spiral Gears: Terminology, Geometrical Relationships, virtual number of teeth for helical gears

Bevel Gear & Worm and Worm Wheel: Terminology, Geometrical Relationships

Gear Train: Types, Analysis of Epicyclic gear Trains, Holding torque - simple, compound and Epicyclic gear Trains, Torque on Sun and Planetary gear Train, compound Epicyclic gear Train

Unit VI **Mechanisms in Automation Systems** **[08 Hr.]**

Cams & Followers: Introduction, Classification of Followers and Cams, Terminology of Cam Displacement diagram for the Motion of follower as Uniform velocity, Simple Harmonic Motion (SHM), Uniform Acceleration and Retardation Motion (UARM), Cycloid motion, Cam Profile construction for Knife-edge Follower and Roller Follower, Cam jump Phenomenon

Automation: Introductions, Types of Automation

Method of Work Part Transport: Continuous transfer, Intermittent or Synchronous Transfer, Asynchronous transfer, Different type of transfer mechanisms - Linear transfer mechanisms and Rotary transfer mechanisms

Automated Assembly-Line: Types, Assembly line balancing Buffer Storages, Automated assembly line for car manufacturing, Artificial intelligence in automation

Books & Other Resources

Text Books

1. S. S. Rattan, "Theory of Machines", Third Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi.
2. Bevan T, "Theory of Machines", Third Edition, Longman Publication
3. G. Ambekar, "Mechanism and Machine Theory", PHI
4. J. J. Uicker, G. R. Pennock, J. E. Shigley, "Theory of Machines and Mechanisms", Fifth Edition, International Student Edition, Oxford

Reference Books

1. Paul E. Sandin, "Robot Mechanisms and Mechanical Devices Illustrated", Tata McGraw Hill Publication
2. Stephen J. Derby, "Design of Automatic Machinery", 2005, Marcel Dekker, New York
3. Neil Sclater, "Mechanisms and Mechanical Devices Sourcebook", Fifth Edition, Tata McGraw Hill Publication
4. Ghosh Malik, "Theory of Mechanism and Machines", East-West Pvt. Ltd.
5. Hannah and Stephans, "Mechanics of Machines", Edward Arnolde Publication
6. R. L. Norton, "Kinematics and Dynamics of Machinery", First Edition, McGraw Hill Education (India) P Ltd. New Delhi
7. Sadhu Singh, "Theory of Machines", Pearson
8. Dr. V. P. Singh, "Theory of Machine", Dhanpatrai and Sons
9. C. S. Sharma &KamleshPurohit, "Theory of Machine and Mechanism", PHI
10. M.P. Groover, "Automation, production systems and computer-integrated manufacturing", Prentice-Hall of India Pvt. Ltd, New Delhi

Web References

1. https://nptel.ac.in/courses/112104121/ (NPTEL1, Kinematics of Machines, Prof. Ashok K Mallik, IIT Kanpur)
2. https://nptel.ac.in/courses/112/106/112106270/ (NPTEL2, Theory of Mechanism, Prof. Sujatha Srinivasan, IIT Madras)
3. https://nptel.ac.in/courses/112/105/112105268/ (NPTEL3, Kinematics of Mechanisms and

Machines, Prof. AnirvanDasGupta, IIT Kharagpur)
4. https://nptel.ac.in/courses/112/105/112105236/ (NPTEL4, Mechanism and Robot Kinematics, Prof.AnirvanDasGupta, IIT Kharagpur)
5. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Mechanical/Robotics Course/Course_home_lect1.html (NPTEL5, Introduction to Robotics and Automation, IIT Bombay)

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignmentsusing Drawing Aids, Assignmentsusing Software & Programming Languages, Assignmentsusing Virtual Laboratory and Detailed Industrial Visit Report.

Practical*(Experiment # 1 is compulsory and Select any Two from Experiment # 2 to 4)*

1. To make a model of any mechanism by using waste material by the group of 4 to 6 students and to give a presentation using PPTs.
2. Speed and torque analysis of epicyclic gear train to determine holding torque.
3. To study and verify cam jump phenomenon.
4. To study manufacturing of gear using gear generation withrack as a cutter and to generate an involute profile.

Assignments using Drawing Aids *(Experiment #1 to 3 and 6 are compulsory and Select any One from Experiment #4-5)*

Do following graphical assignments on Half Imperial drawing sheet:

1. Identify mechanisms in real life and Analyze for types and number of links, pairs, obtain degrees of freedom. Submit the sheet and working video of the mechanism.
2. To solve two problems on velocity and acceleration analysis using relative velocity and acceleration method.
3. To solve two problems on velocity analysis using the ICR method.
4. To draw conjugate profile for any general type of gear tooth.
5. To study various types of gearboxes.
6. To draw cam profile for any two problems with combination of various follower motion with radial and off-set cam.

Assignments using Software *(Any Three Assignments - Minimum one computer programming based and Minimum one based on use of software)*

Do following assignments by using Software or by using Coding/Programming Languages:

1. To design a simple Planer Mechanism by using any software (Geogebra, SAM, Working Model, any 3D Modelling Software, etc.)
2. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Slider Crank Mechanism using Analytical Method
3. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Hooke's joint Mechanism using Analytical Method
4. To generate a Cam Profile using any Modelling Software (MechAnalyser, any 3D Modelling Software)
5. To synthesize the Four-Bar and Slider Crank Mechanism (Geogebra, SAM, any 2D/3D Modelling Software)
6. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for the Synthesis of Mechanism using Chebychevs spacing, Freudensteins equation and function generation

Assignments using Virtual Laboratory *(minimum Two experiments)*

Please visit the links given below for exploring experiments on Kinematics of Machinery using Virtual Laboratory. Write a Brief Reports of using Virtual Laboratory to perform following assignment:

1. Mechanics-of-Machines Lab (All Experiments), http://mm-nitk.vlabs.ac.in/index.html
2. Mechanisms and Robotics - Oldham Coupling Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html

3. Mechanisms and Robotics - Quick Return Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html
4. Mechanisms and Robotics - CAM Follower Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html

Industrial Visits

A Compulsory industrial visit must be arranged to industries/ establishments consisting automation and mechanization during semesterto provide awareness and understanding of the course.

The Industrial Visit must be preferably to

- Manufacturing industries with Assembly-line Automation
- Sugar factory
- Bottle filling plants

Student must submit properly documented Detailed Industrial Visit Report in his/her own words.

Assignments on Content beyond syllabus

Following assignments can be attempted:

1. Forward and Inverse Kinematics of 2R/2P/RP/PR Manipulators using Software (Geogebra, RoboAnalyser, Vlab, etc.)
2. Kinematic Analysis of 6 DOF Industrial Robot using Software (RoboAnalyzer, Vlab, etc.)

217548 - Fluid Mechanics and Machinery

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Practical : 25 Marks

Prerequisite Courses

Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Course Objectives

1. To study the properties of thefluids.
2. To study the dynamics offluids.
3. To study the transport of mass, momentum andenergy.
4. To study the applications of the conservation laws to flow though pipes and hydraulics machines.

Course Outcomes

1. Illustrate the physical properties and characteristic behavior offluids.
2. Illustrate the principle and applications of continuityequation.
3. Learn about the Euler's equations along thestreamlines.
4. Apply the principles of turbulent Vs laminar flow to flowsystems
5. Apply the concepts of friction and determine frictionfactors.
6. Illustrate dimensional analysis for model and similitude of hydraulicmachines.
7. Illustrate the working principle of hydraulicturbines.
8. Illustrate the working principle of hydraulicpump.

Course Contents

Unit I **Properties of Fluid** **[06 Hr.]**

Units & Dimensions. Properties of fluids – Specific gravity, specific weight, viscosity, compressibility, vapour pressure and gas laws–capillarity and surface tension.Flow characteristics: concepts of system and control volume. Classification of fluids - Properties of fluids. Centre of pressure - Plane and curved surfaces. Buoyancy and stability of floating bodies.

Unit II **Fluid Kinematic and Fluid Dynamic** **[07 Hr.]**

Fluid kinematics: stream line, path line and streak lines and stream tube, classification of flows-steady & unsteady, uniform, non uniform, laminar, turbulent, rotational, and irrotational flows-equation of continuity for one dimensional flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, Bernoulli's equation - applications - Venturi meter – Orifice meter Pitot tube. Momentum equation and its application on force on pipe bend. Applications of momentum equations.

Unit III **Incompressible Fluid Flow** **[08 Hr.]**

Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow though circular conduits and circular annuli. Boundary layer concepts. Boundary layer thickness. Hydraulic and energy gradient. Darcy –Weibach equation. Friction factor and Moody diagram. Commercial pipes. Minor losses. Flow though pipes in series and in parallel.

Unit IV **Dimensional Analysis** **[10 Hr.]**

Dimension and units: Buckingham's Π theorem. Discussion on dimensionless parameters. Models and similitude. Applications of dimensionless parameters. Model analysis Dimensionless number and their significance, model laws, Reynolod's model law, Fraude's model law, Euler's model law, Weber's model law, Mach's Model law, Typeof models, scale effect in model, limitation of hydraulic similitude

Unit V **Hydraulics Turbine** **[09 Hr.]**

Hydro turbines: Definition and classification, turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine - working proportions, work done, efficiencies,

hydraulic design –draft tube- theory- functions and efficiency.

Unit VI **Hydraulic Pump** **[08 Hr.]**

Pumps: definition and classifications - Centrifugal pump; classifications, working principle, velocity triangles, Work done - Reciprocating pump: classification, working principle, Basic principles of indicator diagram. Performance parameters and characteristics of pumps and turbines; Positive displacement pumps.

Books & Other Resources

Text Books

1. SukumarPati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill.
2. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", Wiley India
3. Potter Wiggert, "Fluid Mechanics", Cengage Learning
4. Fox, Pichard, "Introduction to Fluid Mechanics", McDonald- Wiley
5. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics",Standard Book House.
6. Cengel&Cimbla, "Fluid Mechanics",TATA McGraw-Hill
7. F. M. White, "Fluid Mechanics", TATA McGraw-Hill
8. R. K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publication

Reference Books

1. Frank M. White, 1999, Fluid Mechanics, 4e,McGraw-Hill.
2. Streeter V.L., and Wylie, E.B., "Fluid Mechanics",4thEdtion, McGraw-Hill,1983.
3. Babu.V "Fundamentals of Incompressible Flow", CRC press, First Edition, 2010.
4. White F.M., "Fluid Mechanics", 5th Edition, Tata McGraw-Hill, New Delhi,2003.
5. Som S.K., and Biswas, G., "Introduction to Fluid Mechanics and Fluid Machines", 2nd Edition, Tata McGraw-Hill,2004.
6. Vijay Gupta, Santhosh Kumar Gupta, "Fluid Mechanics and it applications", New

Web References

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/104/112104118/
3. https://nptel.ac.in/courses/112/105/112105269/
4. http://www.efluids.com/efluids/books/efluids_books.htm
5. http://web.mit.edu/hml/ncfmf.html
6. http://www.efluids.com/efluids/pages/edu_tools.htm
7. https://spoken-tutorial.org/tutorial-search/?search_foss=OpenFOAM&search_language=

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Total 10 experiments from the following list must be performed. During Oral, theStudent is evaluated based on the completion of Practical, Assignments using Virtual Laband Detailed Mini project / Industrial Visit Report/Simulation of fluid flow / Programming using any suitable software.

Practical*(Experiment # 3 & 9 are compulsory; Select any OneSimulation of Experiments from Experiment # 4 & 6;Perform any Eight experiments)*

1. Determination of pressure using manometers (minimum two)
2. Determination of fluid viscosity and its variation with temperature.
3. Determination of Metacentric height of floating object.
4. Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus.
5. Draw flow net using electrical analogy apparatus to calculate discharge for rectangular / enlargement / contraction channel.
6. Trail on Francies Turbine
7. Trial on Gear Pump/ Vane /Piston Pump
8. Determination of minor/major losses through metal/non-metal pipes.
9. Mini project/Industrial visit/Simulation of fluid flow/Programming using any suitable software

Assignments using Virtual Laboratory *(Any Two Virtual Lab experiments from experiment # 1,2,5,7,8 mentioned above)*

Please visit the links given below for exploring and performing experiments on Fluid Mechanics

using Virtual Laboratory. Write brief Reports using Virtual Laboratories:

1. https://eerc03-iiith.vlabs.ac.in/
2. http://fm-nitk.vlabs.ac.in/

217549 – Electrical Machines and Drive

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Tutorial : 02 Hr./Week	**04** Theory : 03 Tutorial :01	In-Semester : 30 Marks End-Semester : 70 Marks TW : 25Marks

Prerequisite Courses :
Basic of Electrical Motor, Engg Mathematics, Electrical Circuits

Course Objectives

1. To teach basic of electrical machines and its characteristic.
2. To teach different electrical drives.

Course Outcome:

1. Evaluate the steady state behavior and basic operating characteristics of A.C Machine
2. Demonstrate analytical skills to assess machine performance in steady state
3. Understand the basics of electric drives and fundamentals of drive dynamics
4. Analyze DC drive, Induction and Synchronous Motors Drives.

Course Contents

Unit I **DC Motors** **[06 Hr.]**

Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine tests.

Unit II **Three Phase Induction (Asynchronous) Motor** **[08 Hr.]**

Types of induction motor, flux and mmf waves, development of circuit model, power across air gap, torque and power output, starting methods, speed control, induction generator, induction machine dynamics, high efficiency induction motors, Single phase IM, Modeling of induction machine.

Unit III **Synchronous Machine** **[08 Hr.]**

Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor operation, dynamics, modeling of synchronous machine, PM synchronous machines.

Unit IV **Electrical Drives ,Dynamic and Control** **[07 Hr.]**

Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, speed control and drive classifications, Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load Torques, Constant Torque and Constant Power operation of a Drive, Steady state stability, Load epilation and selection motors.

Unit V **DC Motor Drives** **[06 Hr.]**

Dc motors and their performance starting, transient analysis, speed control, ward Leonard drives, Controlled rectifier fed drives, [full controlled3 phase rectifier control of dc separately excited motor], multi-quadrant operation, Chopper controlled drives Closed loop speed control of DC motor.

Unit VI **AC Drives** **[07 Hr.]**

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. Synchronous motor operation with fixed frequency, variable speed drives, PMAC and BLDC motor drives, Stepper motor drives, switch reluctance motor drives

Books & Other Resources

Text Books:-

1. D. P. Kothari, I. J. Nagrath, "Electric Machines ", Tata McGraw Hill Publication, Fourth edition, reprint 2012.
2. A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans ,"Electric Machinery", Tata McGraw Hill Publication, sixth edition 2002. 44
3. G. K. Dubey, "Fundamentals of Electrical Drives", Second edition (sixth reprint), Narosa Publishing house, 2001

Reference Books

1. M. G. Say," Alternating current machines", fifth edition, E.L.B.S. Publication.
2. P. C. Sen, "Principles of Electric Machines and Power Electronics ", John Wiley and Sons Publication, second edition 1997
3. M. H. Rashid, "Power Electronics -Circuits, devices and Applications", 3rdEdition, PHI Pub. 2004.
4. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
5. A. F. Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley and Sons, New York 1954

Guideline for Tutorial

Following Experiment need to be conducted as part of tutorial and Term Work Submission

1. Evaluate a performance of a dc motor by load test.
2. Determination of equivalent circuit parameters of an induction motor by no load and blocked rotor test
3. Practical realization of the behavior of a synchronous motor by excitation variation and control of power factor
4. Perform a load test on a synchronous motor to estimate its efficiency.
5. Study of load test on a synchronous generator to evaluate its voltage regulation.
6. Parallel operation of two synchronous generators and control of load sharing among them.
7. Load test on a single phase transformer to evaluate efficiency.
8. Study of commercial AC and DC drives.

217550 – Sensors and Actuator

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical :01	In-Semester : 30 Marks End-Semester : 70 Marks PR : 25 Marks

Prerequisite Courses

Course Objectives

1. Study of means of measuring various physicalvariables.
2. Study of different types ofactuators.

Course Outcomes

1. Understand how different physical variables are measured and illustrate their working principles
2. Identify and select proper sensors for specificapplications
3. Understand issues of implementation of different sensors including calibration and error analysis
4. Understand different types of actuators and theirimplementation

Course Contents

Unit I Measurement Characteristic and Signal conditioning [6Hrs]

Significance of Sensor Measurements, Classification of Sensors, Analog vs Digital Sensors

Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.

Dynamic Characteristics: Sensor bandwidth and frequency response

Signal conditioning: Signal Communication: Serial, Parallel; Synchronous, Asynchronous Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action) Amplifier, Conversion, Filtering, Impedance Buffering ,Selection criteria of sensors for mechatronic systems

Unit II Displacement Sensors [6Hrs]

Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder),

Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Wheatstone Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors

Measurement of Angular Velocity: Tachometers, Digital tachometers and Stroboscopic Methods.

Acceleration Measurement, theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectricaccelerometers

Unit III Pressure ,Flow,Tempreture sensors [6Hrs]

Pressure Measurement: Microphones, Elastic pressure transducers, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement,

Flow Measurement: Bernoullis flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter.

Temperature Measurement: Electrical methods of temperature measurement, Resistance thermometers, Thermistors and thermocouples, Pyrometers, thermal cameras

Special Sensors: Chemical Sensors, Hall Effect Sensors, Optical Light sensors, Tactile/Touch sensors, Cameras and image analysis

Unit IV Electrical Actuation System [6Hrs]

DC motors: Review of DC motor, Modeling of DC motor behavior, Heat dissipation in DC motor, Velocity Profile Optimization, Inertia matching, Servo Amplifier, DC motor drive.

Stepper Motors: Characteristics of a Stepper motor, Classification of a Stepper motor, Principle of Operation, Step Angle, Electrical model of energized coil, Drive method, Stepper motor performance **Induction motors:** Three phase motor, induction motor characteristics

Linear Actuators: Voice Coil Actuators, solenoids

Unit V Pneumatic and Hydraulic actuating systems [6Hrs]

Pneumatic and Hydraulic actuating systems

Components of pneumatic and hydraulic systems, pumps, compressor, filter, control valves, pressure regulation, relief valves, accumulator.

Harmonic drive, Comb drive.

Smart Material Actuators: Piezoelectric transducers, Electroactive polymers, Shape Memory alloys, Artificial Muscle materials

Unit VI Consideration during with actuator selection [6Hrs]

Actuator bandwidth and frequency response, actuator range, power and energy considerations, tradeoffs between force/displacement or torque/speed, control systems and electronics,industrial considerations

Books & Other Resources

References:

1. Sensors and Actuators: Control System Instrumentation -Clarence W Silva, CRC PressUSA
2. Sensors and Actuators in Mechatronics: Design and Applications: Andrzej M Pawlak, CRC PressUSA
3. Measurement Systems (Applications and Design) 5th ed.- E.O. Doebelin - *McGrawHill.*
4. Mechanical Engineering Measurement - Thomas Beckwith, N.Lewis Buck, Roy Marangoni-
   Narosa Publishing House, Bombay.
5. Mechanical Engineering Measurements - A. K. Sawhney – *DhanpatRai& Sons, NewDelhi.*
6. Instrumentation Devices & Systems - C.S. Rangan&G.R.Sarrna - *Tata McGrawHill.*
7. Instrumentation & Mechanical Measurements - A.K.Thayal.
8. Optomechatronics: Fusion of Optical and Mechatronics Engineering By HyungsuckCho
9. Smart Structures: Analysis and Design, AV Shrinivasan and D MichealMacfarland. Cambridge UniversityPress

Guidelines for Laboratory Conduction

Following Experiment need to conducted in Lab as part of Tutorial

Expt. No.	List of the Experiment
01	Design of virtual instrumentation set up for measurement of any mechanical characteristics using any software platform
02	Design of virtual instrumentation set up for actuating mechanical system using any software platform
03	Experiment on measurement of load using suitable sensor.
04	Development of a data acquisition / mechatronics system using low cost open source hardware and software.
05	Experiment on interfacing of suitable sensor and actuator with DAQ
06	Experimental characterization of DC motor
07	Study of smart material actuators
08	Development of hydraulic/pneumatic circuit for an industrial application
09	Design based experiment aiming selection of actuator for industrial application.
10	Industrial visit to understand integration and application of sensors and actuators

217551 –Applications of Integrated Circuits

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical :01	In-Semester : 30 Marks End-Semester : 70 Marks Practical : 50 Marks

Prerequisite Courses

Course Objectives

1. To teach fundamental principles of standard linear integrated circuits.
2. To develop a overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practicalapplications

Course Outcomes

1. Demonstrate an understanding of fundamentals of integratedcircuits.
2. Analyze the various applications and circuits based on particular linear integrated circuit.
3. CO on converters and Voltage Regulator
4. Design applications using integrated circuit

Course Contents

Unit I Fundamentals of Operational Amplifier [6Hrs]

Ideal Op Amp, characteristics of op-amp, op-amp parameters, high frequency effects on op-amp gain and phase, slew rate limitation, practical determination of op-amp parameters, single supply versus dual supply op- amp

Operational amplifier open loop and closed loop configurations,Inverting and non-invertingamplifier

Unit II Linear Applications of Operational Amplifier [7Hrs]

Amplifiers: Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier and application of Op-Amp in Transducer Measurement System with detail designProcedure.

Converters: Current to voltage converters, voltage to currentconverters

Active Filters: First order filters, Second order active finite and infinite gain low pass, high pass, band pass and band rejectfilters.

Sine Wave Oscillators: RC phase shift oscillator and Wien bridge oscillator

Unit III Non-Linear Applications of Operational Amplifier [8Hrs]

Comparators: Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector.

Schmitt Triggers: Inverting and non-inverting Schmitt trigger

Waveform Generators: Square wave generator and triangular wave generator with duty cycle modulation

Precision Rectifiers: Half wave and full wave precision rectifiers andtheir applications.

Peak Detectors, Sample & Hold Circuits, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters

Unit IV Data Converter [6Hrs]

Analog to Digital: Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC, ADC0808/0809 and itsinterfacing

Digital to Analog: Performance parameters of DAC, Binaryweighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC, DAC0808 and its interfacing

Unit V **Special Purpose Integrated Circuit** **[6Hrs]**

Functional block diagram, working, design and applications of Timer 555.

Functional block diagram, working and applications of VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380.

Unit VI **Voltage Regulator** **[7Hrs]**

Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM337) voltage regulators.

Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold- back protection, Switching regulator topologies,

Functional block diagram and working of LT1070 monolithic switching regulator.

Books & Other Resources

References:

1. Sergio Franco, "*Design with operational amplifiers and analog integrated circuits*", Tata McGraw Hill, 3rdEdition.
2. William D. Stanley, "*Operational Amplifiers with Linear Integrated Circuits* ", Pearson, 4thEdition
3. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4thEdition.
4. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition.
5. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4thEdition.
6. R. P. Jain, "*Modern Digital Electronics*," Tata McGraw Hill, 3rdEdition.
7. Ron Mancini, "*Op Amps for Everyone*", Newnes, 2ndEdition.
8. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2ndEdition.
9. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6thEdition.
10. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", NewYork: McGraw-Hill, Burr-Brown ResearchCorporation.

Guidelines for Laboratory Conduction

Out of Following Experiment Any 8 Experiment need to conducted in Lab as part of Practical Examination

1. Development of OP-AMP Circuit to measure performance characteristic
2. Demonstrate the use of op-amp as (1) summing amplifier (2) substractor (3) zero crossing detector and (4) voltage comparator.
3. Design and obtain frequency response of second order of Active filter
4. Design a Schmitt trigger a wien bridge oscillator and to study their operation.
5. Construct and study 4 Bit digital to analog converter circuit.
6. Design of Astable Multivibrator Circuit using 555 Timer.
7. Schmitt Trigger Circuits- using IC 741 & IC 555
8. Design a low voltage variable regulator of 2 to 7V using IC 723
9. Obtain the regulation characteristics of three terminal voltage regulators 7805,7809,7912

217552 - Project Based Learning - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hr./Week	**02** Practical : 02	Term Work : 50 Marks

Preamble

Currently, engineering education is undergoing significant structural changes worldwide. The rapidly evolving technological landscape forces educators to constantly reassess the content of engineering curricula in the context of emerging fields and with a multidisciplinary focus. In this process, it is necessary to devise, implement and evaluate innovative pedagogical approaches for the incorporation of these novel subjects into the educational programs without compromising the cultivation of the traditional skills. In this context, the educational community is showing rapidly rising interest in project-based learning approaches.

The mainstream engineering education follows traditional classroom teaching, in which the major focus is mainly on the lecture and the student has very little (if any) choice on the learning process. However rapid development in engineering and technology requires adopting a teaching approach that would assist students not only in developing a core set of industry relevant skills, but also enable them to adapt to changes in their professional career.

Course Objectives

1. To emphasize project based learning activities that are long-term, interdisciplinary and student-centric.
2. To inculcate independent and group learning by solving real world problems with the help of available resources.
3. To be able to develop applications based on the fundamentals of mechanical engineering by possibly applying previously acquired knowledge.
4. To get practical experience in all steps in the life cycle of the development of mechanical systems: specification, design, implementation, and testing.
5. To be able to select and utilize appropriate concepts of mechanical engineering to design and analyze selected mechanical system.

Course Outcomes

On completion of the course, learner will be able to

CO1. IDENTIFY the real-world problem (possibly of interdisciplinary nature) through a rigorous literature survey and formulate / set relevant aims and objectives.
CO2. ANALYZE the results and arrive at valid conclusions.
CO3. PROPOSE a suitable solution based on the fundamentals of mechanical engineering by possibly integration of previously acquired knowledge.
CO4. CONTRIBUTE to society through proposed solutions by strictly following professional ethics and safety measures.
CO5. USE of technology in proposed work and demonstrate learning in oral and written form.
CO6. DEVELOP ability to work as an individual and as a team member.

Group Structure

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 3 (Three) to 4 (Four) students in each class
2. A supervisor/mentor teacher is assigned to 3-4 groups or one batch

Project Selection

The project can be selected by undertaking a survey of journal papers, patents or field visit (A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific). The problem shall consist of following facets: feasibility of arriving at a solution, analyzing the problem, design and development of the system (hardware or virtual).

There are no commonly shared criteria/ guidelines for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the

content and structure of the activity undertaken.

Solution to problem-based projects through ***"learning by doing"*** is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students" wandering within different disciplines and professional environments. As stated in the preamble as the world has adapted and propagated multidisciplinary approach, hence the proposed project activity preferably should be restricted to only mechatronics domain specific projects and should be Interdisciplinary in nature. However the chosen problem should be integration of other streams of engineering with Mechatronics engineering.

Although in a genuine case 100% software/ virtual project topic may be allowed.

Ethical Practices, teamwork and project management:
Use Indian standards or any relevant standards for project manufacturing, respect the time of others, attend the reviews, poster presentation and model exhibitions, strictly follow the deadline of project completion, comply with all legislation requirements that govern workplace health and safety practices.

Effective Documentation
In order to make our engineering graduates capable of preparing effective documentation, it is required for the students to learn the effective writing skills. The PBL final report is expected to consist of the Literature Survey, Problem Statement, Aim and Objectives, System Block Diagram, System Implementation Details, Discussion and Analysis of Results, Conclusion, System Limitations and Future Scope. Many freely available software tools (for instance Mendley (Elsevier), Grammarly) are expected to be used during the preparation of PBL synopsis and final report. It is expected that the PBL guides/mentors shall teach students about utilizing valid sources of information (such as reference papers, books, magazines, etc) related to their PBL topic.

Evaluation & Continuous Assessment
The institution/head shall be committed to ensuring the effective and rigorous implementation of the idea of project based learning. Progress of PBL shall be monitored regularly on a weekly basis. Weekly review of the work shall be necessary. During the process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

The effectiveness of the concept PBL lies in rigorous and continuous assessment and evaluation of the student performance. It is recommended that all activities are required to be recorded regularly. A regular assessment of PBL work is required to be maintained at the department in PBL log book by students. It is expected that the PBL log book must include following:

1. Information of students and guide
2. Weekly monitoring by the PBL guide,
3. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC).

The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department.

Recommended parameters for assessment, evaluation and weightage

1. Idea Inception (kind of survey). (10%)
2. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
3. Attended reviews, poster presentation and model exhibition. (10%)

4. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
5. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)
6. Outcome (physical model/prototype/ virtual model/ product development/ assembly & disassembly and analysis of standard mechanism or system, design and development of small applications using Arduino, design of control systems, development of various systems/ subsystems of BAJA/SUPRA/Robots/GoKart/ Sunrisers/Hackathon/ application development and similar activities/ System performance and analysis) (40%)
7. Participation in various competitions/ publication/ copyright/ patent) (10%)

Learning Resources

Reference Books / Research Articles

1. John Larmer, John R. Mergendoller, and Suzie Boss, "Setting the Standard for Project Based Learning"
2. John Larmer and Suzie Boss, "Project Based Teaching: How to Create Rigorous and Engaging Learning Experiences"
3. Erin M. Murphy and Ross Cooper, "Hacking Project Based Learning: 10 Easy Steps to PBL and Inquiry"

Web resources

1. https://www.edutopia.org/project-based-learning
2. www.howstuffworks.com
3. https://www.pblworks.org/
4. www.wikipedia.org

202053 - Audit Course - IV		
Teaching Scheme	**Credits**	**Examination Scheme**
-	-	-

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from second year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course IV

- Language & Mind Emotional Intelligence
- Advanced Foreign Language (preferably German/ Japanese)
- Human Behaviour
- Speaking Effectively
- Business Ethics
- Technical writing/ Research writing

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with a certificate.

Assessment of an Audit Course

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the mark sheet.