SMTB1101	MATRICES AND CALCULUS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To identify, evaluate and achieve the conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- To provide the students with sufficient knowledge in calculus and matrix algebra, this can be used in their respective fields.
- To Model the Engineering problems and obtaining its solutions mathematically.

UNIT 1 MATRICES 9 Hrs.

Characteristic equation of a square matrix – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen Vectors – Cayley - Hamilton theorem (without proof) – verification, finding inverse and power of a matrix – Diagonalization of a matrix using orthogonal transformation – Quadratic forms – Nature of quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS 9 Hrs.

Definitions – Derivative of standard functions (Results only) - Differentiation of function of function – Logarithmic differentiation – Derivatives of implicit function- Curvature – Centre, Radius and Circle of Curvature in Cartesian co-ordinates – Evolutes.

UNIT 3 FUNCTIONS OF SEVERAL VARIABLES 9 Hrs.

Partial derivatives (Definition) – Total derivative – Jacobian - Taylor's expansion – Maxima and minima of functions of two variables – Constrained maxima and minima using Lagrange's multiplier method.

UNIT 4 INTEGRAL CALCULUS I 9 Hrs.

Beta and Gamma integrals – Relation between Beta and Gamma integrals – Properties of Beta and Gamma integrals with proofs – Evaluation of definite integrals in terms of Beta and Gamma function.

UNIT 5 INTEGRAL CALCULUS II 9 Hrs.

Double integrals in Cartesian and Polar co-ordinates – Change of order of integration – Change of variables from Cartesian to Polar coordinates – Area of plane curves using double integrals. Triple integrals – Volume using triple integrals in Cartesian co-ordinates -Simple Applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Convert the quadratic form to canonical form by orthogonal transformation
CO2 - Construct the Circle of Curvature and Evolute of any curve.
CO3 - Examine the maxima and minima of function of several variables.
CO4 - Analyze the relationship between Beta and Gamma functions and its applications
CO5 - Evaluate double integrals in various coordinate systems
CO6 - Apply the concept of triple integrals in engineering problems

TEXT / REFERENCE BOOKS

1. Bali and Manish Goyal, A Text book of Engineering Mathematics, Laxmi publications, Reprint, 2008
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.
3. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi, 2011.
4. Kandaswamy P & Co., Engineering Mathematics for First Year, IX revised edition, S. Chand & Co Pub., 2010.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill, New Delhi, 11th Reprint, 2010.
6. Veerarajan T., Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, New Delhi, 2008.
7. Venkataraman M.K., Engineering Mathematics – First Year (2nd edition), National Publishing Co., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SPHB1101	PHYSICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concept of crystal structures and symmetry, the physics of scattering and diffraction theory, experimental diffraction from single crystals, instrumentation and powder diffraction.
- To understand, Identify and describe properties of matter, including: flexibility, strength and transparency.
- Able to differentiate various acoustic terms and understand how these apply to different materials and acoustic design solutions and give knowledge about semiconductor physics and discus working and applications of basic devices, including p-n junctions, BJTs and FETs

UNIT 1 QUANTUM MECHANICS 9 Hrs.

Introduction to Quantum Mechanics-Energy distribution function, Wave – particle duality-de Broglie matter waves – Concept of wave function and its physical significance – Heisenberg's Uncertainty Principle – Schrodinger's wave equation – Time independent and Time dependent equations – Particle in a one dimensional rigid box – tunneling (Qualitative) – Scanning Tunneling Microscope (STM).

UNIT 2 PROPERTIES OF MATTER 9 Hrs.

Introduction- Elasticity- Hooke's law - Torsional stress & deformations – Twisting couple – Torsion pendulum - theory and experiment–bending of beams – bending moment–cantilever: -Theory and experiment–uniform and non-uniform bending: theory and experiment- Magnetism - Basic definitions - Magnetic permeability, susceptibility, relation between permeability and susceptibility - Bohr magneton. Classification of magnetic Materials-Hysteresis

UNIT 3 CRYSTAL PHYSICS 9 Hrs.

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter- planar distances – coordination number and packing factor for SC, BCC, FCC, HCP. – crystal imperfections: point defects, line defects –growth of single crystals: solution and melt growth techniques.

UNIT 4 SEMICONDUCTOR PHYSICS 9 Hrs.

Classification of Materials-Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors - Fermi level in intrinsic and extrinsic semiconductors. Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, V-I characteristics, junction capacitance and voltage breakdown. Zener diode and its characterization- Avalanche breakdown- JEFT- I-V characteristics- amplifying and switching.

UNIT 5 LASER AND ITS APPLICATIONS 9 Hrs.

Absorption and Emission of Radiation by atoms, ions and molecules. Laser medium Phenomenon of population inversion. Laser cavity (fiber laser, and other cavities), generation of coherent beam, Q-switching, short pulse generation, power amplification. Basic Laser Principles: Theory of Laser, Properties of Laser, Fundamental Optical properties, Modified Optical properties, Laser output – its characteristics.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Solve the time independent Schrodinger wave equation for a particle in a box to obtain the Eigen values and functions.

CO2 - Understand the dual nature of radiation and matter

CO3 - Estimate the atomic packing factor for SC, BCC & FCC structures.

CO4 - Recognize sound level descriptors and how they are used in architectural acoustics and analyse acoustic properties of typically used materials for design consideration.

CO5 - Understanding the working, design considerations and applications of various semi conducting devices including p-n junctions, BJTs and FETs

CO6 - Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.

TEXT / REFERENCE BOOKS

1. Pillai S.O., Solid state Physics, New age International Publishers, 7th Edition.
2. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill Publications.
3. M.N.Avadhanulu&P.G.Kshirasagar. A text book of Engineering Physics, S.Ch.Publishing.
4. B. B.Laud,Lasers and nonlinear optics, New age International Publishers, II-Edition.
5. R. Murugesan, Modern Physics, S. Chand Publishing, 15th Edition (2015).
6. D. S. Mathur, Elements of Properties of Matter, S. Chand Publishing (2014).
7. K. Bandyopadhyay, Nanomaterials, New age International Publishers,
8. K. K. Chattopadhyay, Introduction to nano science and nano technology, PHI publisher,
9. Sulabha Kulkarni, Introduction to Nanoscience and Nanotechnology 2nd Edition
10. David Griffiths, Introduction to electrodynamics, Addison-Wesley publishing 3rd Edition

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1101	DIGITAL ELECTRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the fundamentals of digital logic
- To understand the various number systems and codes
- To design various combinational and sequential circuits

UNIT 1 LOGIC GATES AND MINIMIZATION CIRCUITS 9 Hrs.

Basic digital circuits AND - OR - NAND - NOR - EX-OR - EX-NOR operations - universal building block construction using logic gates - Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions – min term (SOP) – max term (POS) - K Map representation of logic functions - simplification of logic functions using K Map - Don't care conditions, Quine-Mc Cluskey method of minimization.

UNIT 2 COMBINATIONAL CIRCUITS 9 Hrs.

Half and Full Adders - Half and Full Subtractors - Code Converters Encoder - Decoder – Multiplexer Demultiplexer - Binary/ BCD adders, subtractors - Carry look ahead adder - parity checker - parity generators - Magnitude comparator

UNIT 3 SEQUENTIAL CIRCUITS 9 Hrs.

General model of sequential circuits - flip-flops - latches - level triggering, edge triggering – master slave configuration - Mealy/Moore models - state diagram - state table - State minimization - State assignment - Excitation table and maps - shift registers - Ring counter

UNIT 4 MEMORY DEVICES 9 Hrs.

Memory types and terminology - static and dynamic RAM - ECL RAM - Non-Volatile RAM - Sequential Memories: Recirculation shift Registers-First in first out memories - Magnetic core memories - magnetic disk memories - Programmable Logic Devices (PLD) - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) - Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using ROM, PLA, PAL

UNIT 5 SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS AND VHDL 9 Hrs.

Design of synchronous sequential circuits – parity checker – sequence detector – Asynchronous sequential logic: Race conditions and Cycles – Hazards in combinational circuits. Introduction to VHDL -Behavioral, Data Flow and Structural Model – Operators – Data objects – Data types, Attributes – Test Benches – Simple programs FOR.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply Boolean algebra principles and different types of number systems to design the digital circuits.

CO2 - Design and realize the combinational circuits using logic gates

CO3 - Design and construct synchronous sequential circuits using basic flip flops

CO4 - Analyze the various memory devices, Programmable Logic Devices and logic families

CO5 - Design and analyze the synchronous, asynchronous logic families & Hazards and mapping of data path elements using VHDL

CO6 - Analysis and Design of Various Digital Electronic Circuits.

TEXT / REFERENCE BOOKS

1. M. Morris Mano, Michel D. Ciletti, Digital Design, Pearson Education, New Delhi, 6th edition,2018
2. Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hall of India, New Delhi, 12th Edition, 2018
3. A. Anand Kumar, Fundamentals of Digital Circuits, PHI Learning Pvt. Ltd. 2014.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Education Inc, New Delhi,10th Edition, 2006
5. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, Tata McGrawHill, Delhi, 8th Edition 2015
6. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 7th Edition,2013

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMEB1102	**ENGINEERING GRAPHICS AND DESIGN (Common to Aeronautical, automobile, Mechanical and Mechatronics)**	**L**	**T**	**P**	**EL**	**Credits**	**Total Marks**
		3	**0**	**0**	**0**	**3**	**100**

COURSE OBJECTIVES

- To Understand the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products and to expose them to existing national standards related to technical drawings.
- To make the student to visualize and read the drawings.
- To make the students to understand the importance of sectioning and development of surfaces, orthographic and pictorial projections

UNIT 1 PLANE CURVES 9 Hrs.

Concepts and Conventions - Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — Drawing of tangents and normal to the above curves.

UNIT 2 PROJECTION OF POINTS AND LINES 9 Hrs.

Projection - Types of projection - Projection of points lying in four quadrants - Projection of lines (First angle projection only) -Projection of lines parallel and inclined to one or both the planes

UNIT 3 PROJECTION OF SOLIDS 9 Hrs.

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

UNIT 4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 9 Hrs.

Purpose of sectioning - Sectional views - Hatching - Section plane perpendicular to one plane and parallel to other plane -Section plane inclined to HP-True shape of the section. Need for development of surfaces - Types of development of surfaces - Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids, cylinders and cones.

Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

UNIT 5 ISOMETRIC PROJECTION AND FREEHAND SKETCHING 9 Hrs.

Principles of isometric projection — isometric scale - isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones.

Orthographic Projection-: Visualization concepts and Free Hand sketching: Visualization principles — Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify the national standards related to the Engineering drawing based on BIS and construct conic sections and polygons.

CO2 - Solve practical problems involving projection of lines.

CO3 - Draw orthographic projections of solids.

CO4 - Draw orthographic section of solids and improve the Students visualization skill to develop New products and development of surfaces and its applications in manufacturing industry.

CO5 - Draw the isometric projections of simple solids.

CO6 - Draw the orthographic view of solids and learn to convert pictorial into orthographic projection.

TEXT / REFERENCE BOOKS

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House,53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3. Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited,2018.
4. Engineering drawing practice for schools and colleges, SP 46 – 1988 (http:// web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf).

PUBLICATION OF BUREAU OF INDIAN STANDARDS

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

S11BLH11	PROBLEM SOLVING TECHNIQUES USING C	L	T	P	EL	Credits	Total Marks
		2	0	2	0	3	100

COURSE OBJECTIVES

- Devise programs using Loops, Control structures and Array in C.
- Construct modules for real time applications using Functions in C.
- Compare and Contrast Structure and Union for implementing coding in data management using C.

UNIT 1 BITS AND BYTES IN COMPUTING 12 Hrs.

Computers: Hardware – Software – Processor – Memory – I/O devices – Interface – Programming Languages – Evolution from COBOL, FORTRAN to C, Python – Need

Algorithms: Role in problem solving – Analysis – Design – Flowcharts: Role in problem solving – Symbols – Design – Pseudocode: Role in problem solving – Design - Program: Role in problem solving – Design

Practice Problems:

1. Describe a simple real world problem in your domain/department and describe it in the form of problem statement, input, output and provide its solution in terms of algorithm, flowchart, pseudo code and program.

UNIT 2 C: MATH BEHIND CODING 12 Hrs.

C: Structure of program – Character set – Tokens – Keywords – Identifiers – Constants – Variables – Datatypes – Strings – Operators and its types – Functions – Header Files

Algorithmic Strategies: Iteration and Recursion – Efficiency – Role of Time and Space consumption while building an algorithm – Complexities

Practice Problems:

1. Describe a simple real world problem in your domain/department and provide a computing and non-computing solution for the same. Calculate the time and space consumed in both solutions. Compare and contrast the pros and cons in both solutions.
2. Write an algorithm, flowchart, pseudo code followed by a simple C code to do find the Factorial and Fibonacci series using both iteration and recursion.

UNIT 3 C: MAGIC BEHIND INSTANT OUTPUTS 12 Hrs.

Advanced Coding Concepts: Decision Making using Branching Statements and its types – Decision Making using Looping Statements and its types – Switch Statements – Break – Continue – Goto – Jump Statements

Case Study: Fun with Code -- Printing Alphabets / Flags of Countries / Flying Alphabet Screensaver

Practice Problems:

1. Describe a problem statement in your domain/department whose solution involves repetition of same steps and provide code as solution involving for, while and do while loops.
2. Describe a problem statement in your domain/department whose solution involves decision making and provide code as solution involving if-else, nested if-else and ladder if-else.
3. Develop a simple scientific calculator using Switch case statement.

UNIT 4 STORING GROUP OF HOMOGENOUS ELEMENTS: ARRAYS 12 Hrs.

Diving into Arrays: Definition – Syntax – Types – Representation: Row & Colum Order – Dynamic Arrays Idea behind Functions: Declaration – Definition – Types – Calling – Arguments – Prototypes – Call by Value – Call by Reference – Pointers

Case Study: Fun with Code – Simple Game Development using Arrays and Functions

Practice Problems:

1. Describe a problem statement in your domain/department where you need to work with group of same type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. You're playing UNO cards, suddenly a person is getting rev card. Write a C program to reverse the round by storing the number of players in array.
3. Write a C program for Vehicle Regulation System where odd number ending vehicles can use the road on odd days and even number ending vehicles can use the road on even days using two separate arrays to store and display the odd and even numbers.

UNIT 5 STORING GROUP OF HETROGENOUS ELEMENTS: ARRAYS 12 Hrs.

Outset of Structure and Union: Structure Definition & Declaration – Structures Fusion with: Arrays – Pointers – Functions – Union Initiation, Definition & Declaration

Working with Files: File Handling Functions – Read – Write – Other Operations – Different File Types

Case Study: Report on using File Functions to create Score Board for any game, importing it to program

Practice Problems:

1. Describe a problem statement in your domain/department where you need to work with group of different type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. Write a C program to get the details of the student (roll no, name, date of birth, state, 10th percentage and 12th percentage) using Structure. Calculate the age of the student and display the eligibility status for his admission.
   Eligibility criteria: more than 60 percent in 10th and 12th, age>=17, state==TN.
3. Write a menu driven C program for library management system with ten entries:
   (i). Add Book (ii). Add Author (iii). Add Category (iv). Book Cost
   (v). Display - Book by Author, Book by Category, Book under cost
4. Write a C program to create an employee Union with employee details (id, name, salary) Accept the details of 'n' employees, rearrange the data in ascending order of employee name, id and salary as three different functions and display it.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the difference between components of problem solving such as algorithm, flowchart, pseudo code and source code.

CO2 - Build simple solution for any given problem statement using various components of problem solving techniques and measure its efficiency in terms of time and space.

CO3 - Infer and examine the roots and foundation of C programming's key concepts like Datatypes, Operators.

CO4 - Devise and correlate the use of different core concepts such as Arrays and Functions in C language.

CO5 - Formulate real time solutions through programs using Structure and Union in C language.

CO6 - Design and Develop various Application Oriented Program for solving real time societal problems.

TEXT / REFERENCE BOOKS

1. Yashavant Kanetkar, 'Let us C', BPB Publications, Fourteenth Edition
2. R.G.Dromey "How to solve it by computer", Pearson Education, Low Price Edition.
3. Balagurusamy, "Programming in ANSI C", McGrawHill Publications, Eighth Edition.
4. Greg Perry, Dean Miller "C Programming Absolute Beginner's Guide", Third Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SPHB2101	PHYSICS LAB	L	T	P	EL	Credits	Total Marks
		1	0	0	0	1	100

COURSE OBJECTIVES

- To achieve perfectness in experimental skills and the study of practical applications will bring more confidence
- Ability to develop and fabricate engineering and technical equipment.
- To develop practical applications of engineering materials

LIST OF EXPERIMENTS

1. Determine the Rigidity modulus of a given wire by Torsional pendulum
2. To determine the angle of Minimum Deviation by I - D curve method.
3. Determine V-I characteristics of a photodiode
4. To determine the Numerical aperture of an optical fiber
5. To find the Energy gap of a semiconductor
6. Determination of Young's modulus- non-uniform bending
7. Determination of Young's modulus- Uniform bending
8. Determination of the wave length of the laser using grating- Laser.
9. Determination of thickness of a thin sheet/wire- Air wedge.
10. Determination of Numerical Aperture and acceptance angle- Optical fibre.
11. Photoelectric effect
12. Michelson Interferometer.
13. V-I characterization of solar cell
14. CRO- FUNCTIONS

Max. 15 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop skills to impart practical knowledge in real time solution.
CO2 - Understand principle, concept, working and application of new technology
CO3 - comparison of results with theoretical calculations.
CO4 - Design new instruments with practical knowledge.
CO5 - Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
CO6 - Understand measurement technology, usage of new instruments and real time applications in engineering studies

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:50 **Exam Duration: 2 Hrs.**

CAE	Evaluation of Regular Lab class	**15 Marks**	**25 Marks**
	Model practical exam	**10 Marks**	
ESE	University Practical exam		**25 Marks**

SMEB2101	COMPUER AIDED DESIGN LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To gain practical knowledge in engineering modeling through computer aided systems.
- To understand the functioning of 2D drafting and 3D modeling software's.
- To Study the capabilities of software for Drafting and Modeling.

INTRODUCTION TO CAD

Basics, Fundamentals of feature - based modeling

TWO DIMENSIONAL OBJECTS

Create basic drawing objects: Points, Lines, Circles, Arcs, Planes and their combinations
Layout and sketching
Setup a drawing with correct scales
Draw with precision using Coordinate input and object Snaps
Isometric drawings, Orthographic projections, Auxiliary views
Dimensioning, Dimension styles
Various other AutoCAD commands and relevant keyboard shortcuts

THREE DIMENSIONAL OBJECTS

Creating and editing 3D solid objects.

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of computer aided design.
CO2 - Implement the knowledge in creating a model.
CO3 - Understand the various limits and tolerances.
CO4 - Understand various dimensioning styles.
CO5 - Implement the knowledge to model various 2D and 3D models.
CO6 - Understand various commands and keyboard shortcuts for faster modeling skills.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. marks:100			**Exam Duration:3 Hrs.**
CAE	Evaluation of Regular Lab class	**15 Marks**	**50 Marks**
	Model practical exam	**10 Marks**	
ESE	University Practical Exam		**25 Marks**

SBTB1101	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	EL	Credits
		1	0	0	3	0

COURSE OBJECTIVE

- To impart knowledge on the issues related to environment
- Analyse the interrelationship between living organism and environment
- To emphasize the importance of a clean environment

UNIT 1 INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES 9 Hrs.

Definition, scope and importance, need for public awareness, forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, floods, drought, conflicts over water, dams-benefits and problems, mineral resources: use effects on forests and tribal people. water resources: use and over-utilization of surface and ground water, exploitation, environmental effects of extracting and using mineral resources, case studies food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources: Case studies. Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

UNIT 2 ECOSYSTEMS AND BIODIVERSITY 9 Hrs.

Concept of an ecosystem, structure and function of an ecosystem - producers, consumers and decomposers - energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Introduction to biodiversity, definition: genetic, species and ecosystem diversity - biogeographical classification of India - value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, biodiversity at global, national and local levels. India as a mega-diversity nation, hotspots of biodiversity, threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity, in-situ and ex-situ conservation of biodiversity.

UNIT 3 ENVIRONMENTAL POLLUTION 9 Hrs.

Definition - causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards. Solid waste management: causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management: floods, earthquake, cyclone and landslides.

UNIT 4 SOCIAL ISSUES AND THE ENVIRONMENT 9 Hrs.

From unsustainable to sustainable development, urban problems related to energy, water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problems and concerns, case studies, environmental ethics: issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products – environment protection act: air (prevention and control of pollution) act - water (prevention and control of pollution) act, wildlife protection act; forest conservation act. Issues involved in enforcement of environmental legislation, Key initiatives of Rio declaration, Vienna convention, Kyoto protocol, Johannesburg summit and public awareness.

UNIT 5 HUMAN POPULATION AND THE ENVIRONMENT 9 Hrs.

Population growth, variation among nations, population explosion, family welfare programme, environment and human health, human rights, value education, HIV / AIDS, women and child welfare, role of information technology in environment and human health, case studies. Visit to a local area to document environmental assets river/ forest / grassland / hill / mountain. Visit to a local polluted site-urban/rural/ industrial/agricultural-study of common plants, insects, birds-study of simple ecosystems, pond, river, hill slopes etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recognize the need of conservation of natural resources for the future generations.
CO2 - Differentiate the uniqueness of each and every ecosystem and biodiversity.
CO3 - Identify the environmental pollution and to control them in a sustainable way.
CO4 - Execute the possible solutions to manage the natural and manmade disasters for the sustainable living.
CO5 - Distinguish the reasons for over population and give awareness to people through media to control population growth.
CO6 - Solve the environment related problems by conserving the natural resources for the future generations

TEXT / REFERENCE BOOKS

1. Meenakshi P., Elements of Environmental Science and Engineering, 1st Edition, Prentice Hall of India, New Delhi, 2009.
2. Ravikrishnan A., Environmental Science & Engineering, 3rd Edition, Sri Krishna Publications, Chennai, 2008.
3. Wrigh R.T. & Nebel B.J., Environmental science-towards a sustainable future by Richard, 8th Edition, Prentice Hall of India, New Delhi, 2006.
4. Erach Bharucha, Text Book of Environmental Studies, 2nd Edition, University Press, Chennai, 2006.

SMTB1201	ADVANCED CALCULUS AND STATISTICS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of Advanced Calculus and Statistics to form independent judgements.
- To model the Engineering problems and obtaining its solutions mathematically.
- To attain the Science, Engineering and Computer Science analytically and logical thinking.

UNIT 1 DIFFERENTIAL EQUATIONS 9 Hrs.

Higher order linear differential equations with constant coefficients – Particular Integral for e^{ax}, sinax or cosax, x^n, $x^n e^{ax}$, xsinax, xcosax, e^{ax}sinbx or e^{ax}cosbx – Method of Variation of Parameters – Homogeneous equation of Euler's and Legendre's type.

UNIT 2 VECTOR CALCULUS 9 Hrs.

Vector Differentiation - Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields - Vector Integration – Simple problems on line, surface and volume Integrals – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (without proofs)– Simple applications involving cubes and rectangular parallelepipeds.

UNIT 3 LAPLACE TRANSORMATION 9 Hrs.

Laplace transform – Transforms of standard functions – properties – Transforms of derivatives and integrals – Transforms of the type $e^{at}f(t)$, tf(t), f(t)/t – Transform of periodic functions – Transform of unit step function and impulse function – Inverse Laplace transforms – Convolution theorem – Initial and final value theorems – Applications - Linear ordinary differential equation with constant coefficients

UNIT 4 PROBABILITY AND STATISTICS 9 Hrs.

Measures of central tendency: Mean, Median, Mode – Measures of dispersion: Standard deviation for discrete and grouped data. Definitions: Sample Space, Events – Addition Law of probability – Multiplication law of probability – Conditional probability – Baye's theorem (without proof).

UNIT 5 THEORY OF SAMPLING AND TESTING OF HYPOTHESIS 9 Hrs.

Test of Hypothesis – Large samples – Z test – Single proportion – Difference of proportions – Single mean – Difference of means – Small samples – Student 's t test – Single mean – Difference of means –Test of variance – Fisher's test – Chi square test: Goodness of fit, Independence of attributes.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Solve any higher order linear differential equations
CO2 - Apply concepts of calculus on vector and scalar valued functions
CO3 - Use Laplace Transform for transformation of functions.
CO4 - Evaluate problems on conditional probability using Baye's theorem.
CO5 - Analyze the concept of testing of hypothesis in small and large samples
CO6 - Construct the Chi-Square test for goodness of fit and independence of attributes of real data.

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eigth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.
3. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi, 2011.
4. Ross L, Differential Equations, 3rd Edition, Wiley India, 2009
5. Veerarajan T, Probability, Statistics and Random Process, 4th Edition, Tata McGraw Hill, 2014.
6. Veerarajan T, Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, 2008.
7. Venkataraman M.K., Engineering Mathematics – First Year, 2nd Edition, National Publishing Co., 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SHSB1101	TECHNICAL ENGLISH	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To comprehend and react in oral and written forms to the specialized texts
- To respond to listening, reading and writing tasks by using digital tools
- To enhance communication, collaboration and critical thinking skills

UNIT 1 **9 Hrs.**

Listening : Listening to choose the correct answer from the options given (MCQ)
Speaking : Self Introduction, Talking about likes and dislikes
Reading : Comprehending a passage- Skimming, scanning, detailed reading
Writing : Letter of Job Application, Resume, Letter to the Editor (problems and solutions)
Vocabulary : Kinds of Sentences, Affixes, Collocations, Sequence words, contextual guessing of words.
Language Focus : Parts of Speech, Tense and its types, Voice - Impersonal Passive
Language Lab work : Focus Digital literacy: students join zoom platform/ using online tools

UNIT 2 **9 Hrs.**

Listening : Listening to advertisements about a product, say true or false
Speaking : JAM on current topics, mini presentations
Reading : Identifying topic sentences by reading content
Writing : Writing compare/ contrast paragraphs, process description, E-Mail
Writing Vocabulary : Verbal phrases, Prepositions and Prepositional phrases, Concord, Discourse Markers
Language Focus : Clauses, Conjunctions, Sentence Types - Simple, Compound & Complex
Language Lab : Digital literacy: Responding to quiz using Kahoot application

UNIT 3 **9 Hrs.**

Listening : Listening to summarize the information, debates/ discussions.
Speaking : Group discussion on a given topic
Reading : To find specific information and to prepare notes using the format
Writing : Framing open ended questions- Survey Report- Arranging the sentences in the right order
Vocabulary : Paired expressions, Adjectives/ adverbs, Technical definitions, Compound Nouns Language
Focus : Punctuation, Editing, Same words used as different parts of speech
Language Lab : Digital literacy: Power point tools –Slide share to make presentation on the survey report.

UNIT 4 **9 Hrs.**

Listening : Listening to differentiate instructions and recommendations
Speaking : Debate on current issues
Reading : Reading to understand and classify the information
Writing : Instructions, Recommendations, Preparation of User Manual
Vocabulary : Classification of words, Abbreviations, Acronyms,
Language Focus : Reported Speech, Causatives, Basic Sentence Patterns
Language Lab : Digital literacy: Using online discussion forum

UNIT 5 **9 Hrs.**

Listening and summarizing : Listening to identify the structure of sentences, small talks, TED talks
Speaking : Giving impromptu talks, Speech Writing

Reading	: Read argumentative essays and paragraphs
Writing	: Essay writing, Checklist preparation, Note making
Vocabulary	: Homophones/Homonyms, Idioms and Phrases
Language Focus	: Negatives, Tag questions, Similes and Metaphors
Language Lab	: Digital literacy: Creating own Blogs and interactive exercises and quizzes online.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Classify technical words to use them in sentences framing, compose problem solving paragraphs.
CO2 - Categorize information based on the understanding of reading materials to prepare notes.
CO3 - Prepare and document to report, identify elements of editing.
CO4 - Interpret technical definitions related to the text and design a user manual using instructions.
CO5 - Summarize reading materials and outline an essay on any topic given.
CO6 - Demonstrate their language learning activities in the classroom/ online group environment.

TEXT BOOKS / REFERENCE BOOKS

1. Technical English [2019], Department of English, Sathyabama Institute of Science & Technology.
2. Beer, David F., and David McMurrey. *A Guide to Writing as an Engineer*. 4th ed., Wiley, 2013
3. Alred, Gerald J., et al. *Handbook of Technical Writing*. 11th ed., Bedford/St. Martin's, 2019.
4. Pearsall, Thomas Edward. *Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals*. McGraw-Hill Education, 2017.
5. Straus, Jane. *The Blue Book of Grammar and Punctuation.* John Wiley & Sons, 2014.
6. O'Conner, Patricia T. Woe is I: *The Grammarphobe's Guide to Better English in Plain English*. Riverhead Books, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SCYB1101	CHEMISTRY (Common to ALL Branches of B.E/ B. Tech.)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of quantum chemistry for bonds to bands and applications of energy levels in
- molecules
- To explore the concept of corrosion mechanism and design principles.
- To study the various synthetic approaches in nano chemistry and the importance of electrochemistry in batteries

UNIT 1 ATOMIC AND MOLECULAR STRUCTURE 9 Hrs.

Introduction to quantum chemistry – Motion of a quantum mechanical particle in one dimension (time-independent) – Physical meaning of wave function – Schrodinger equation for Hydrogen atom (No derivation. Only wave function). Angular and radial wave functions and probability densities – Quantum numbers – Principal, azimuthal, spin and magnetic quantum numbers – Wave functions and orbital shapes - s,p,d,f - LCAO-MO of H_2 – Band theory of solids: Conductors, semi-conductors– Role of As and Ga doping on band structures.

UNIT 2 MOLECULAR SPECTROSCOPY 9 Hrs.

Electromagnetic spectrum – Interaction of radiation with matter – Energy levels in molecules – Microwave spectroscopy – Principle – Classification of molecules based on moment of Inertia – Rotational energy expression (J levels) – Calculation of J for CO molecule – Vibrational spectroscopy – Normal modes of vibrations – Vibrations of polyatomic molecules (CO_2 and H_2O) – Determination of Force constant – Electronic transitions in organic molecules – Mathematical derivation of Beer-Lambert's law.

UNIT 3 ELECTROCHEMISTRY 9 Hrs.

Electrochemistry: Galvanic cell - Electrochemical cell representation - EMF series and its significance. Batteries: Terminology – Mechanism of Lead-acid accumulator - Mechanism of Nickel-cadmium batteries. Mechanism of Lithium batteries: Li/$SOCl_2$ cell - Li/I_2 cell - Lithium ion batteries. Mechanism of Fuel Cells: Hydrogen-oxygen fuel cells - Solid oxide fuel cell (SOFC).

UNIT 4 CORROSION SCIENCE 9 Hrs.

Introduction: Definition. Types: Dry corrosion: Mechanism - Pilling-Bedworth rule - Wet Corrosion: Mechanism. Types: Galvanic corrosion and differential aeration cell corrosion. Galvanic series and its significance. Factors influencing corrosion. Corrosion prevention: Material selection and design - Cathodic protection – Sacrificial anodic method and Impressed current method – Inhibitors – Anodic and Cathodic inhibitors.

UNIT 5 NANOCHEMISTRY 9 Hrs.

Introduction - Classification based on dimensions - Size dependent properties - Types of nanomaterials: Nanoparticles: Synthesis by chemical reduction method. Nano porous materials: Synthesis by sol-gel method. Nanowires: Synthesis by VLS mechanism. Carbon Nanotubes (CNTs): Single walled and multi walled nanotubes - Mechanical and electrical properties of CNTs - Applications of CNTs - Synthesis of CNTs by electric arc discharge method and laser ablation method.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the principles of quantum chemistry for energy quantization in molecules.
CO2 - Analyze the interaction of EMR with matter to study molecular transition.
CO3 - Assess the mechanism of energy conversion.
CO4 - Comprehend the corrosion mechanism for environmental sustainability.
CO5 - Examine the synthetic approaches to promote size dependent properties.
CO6 - Evaluate the application of chemical science concept in real world applications.

TEXT / REFERENCE BOOKS

1. A.K.Chandra, Introductory Quantum Chemistry, Tata McGraw-Hill, 4th edition, 1994.
2. Ira N. Levine, Physical chemistry, 6th Edition, 2008.
3. Ira N. Levine, Quantum chemistry, 7th Edition, 2013.
4. David W. Ball and Thomas Baer, Physical Chemistry, Wadsworth Cengage Learning, 2nd Edition, 2014.
5. Mars G Fontana, Corrosion Engineering, 3rd Edition, Tata McGraw Hill, 2008.
6. Douglas A. Skoog and Donald M.West, Principles of Instrumental Analysis, Cengage, 6thEdition, 2014.
7. P.C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai Publication, 2018.
8. David Linden, Thomas B Reddy, Handbook of Batteries, 4th Edition, McGraw-Hill, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMEB1201	ENGINEERING MECHANICS (Common to MECH, MECHATRONICS, AERO AND AUTO)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To understand the concept of Statics.
- To learn the concept of Equilibrium and the properties of surfaces and solids.
- To learn the theory of Friction and concept of Dynamics

UNIT 1 BASICS & STATICS OF PARTICLES 9 Hrs.

Introduction-Units and Dimensions-Laws of Mechanics-Vectors- Vectorial representation of forces and moments - Vector operations-resolution and composition of forces - equilibrium of a particle - Free body diagram - forces in space-equilibrium of a particle in space-equivalent systems of forces-principle of transmissibility–Resultant and Equilibrant.

UNIT 2 EQUILIBRIUM OF RIGID BODIES 9 Hrs.

Types of supports and their reactions - requirements of stable equilibrium – Moments and Couples-Varignon'st theorem- Equilibrium of Rigid bodies in two dimensions- Equilibrium of Rigid bodies in three dimensions

UNIT 3 PROPERTIES OF SURFACES AND SOLIDS 9 Hrs.

Determination of Areas - First moment of Area and the centroid - simple problems involving composite figures. Second moment of plane area-Parallel axis theorem and perpendicular axis theorem-Polar moment of Inertia – Principal moments of Inertia of plane areas – Principle axes of inertia – relation to area moments of Inertia. Second moment of plane area of simple sections like C,I,T,Z etc.

UNIT 4 FRICTION 9 Hrs.

Frictional Force - Laws of Coulomb friction - Cone of friction-Angle of repose-relation between cone of friction and angle of repose- limiting friction-Rolling resistance- Simple contact friction - Screw - Wedge– Ladder- Belt friction.

UNIT 5 KINETICS OF RIGID BODIES AND DYNAMICS OF PARTICLES 9 Hrs.

Dynamics- Classification- Kinematics- Kinetics- Types of energy-Displacement, Velocity and acceleration their relation- Relative motion - Curvilinear motion - Newton's Law - D'Alembert's Principle, Work Energy Equation- Impulse and Momentum- Impact of elastic bodies- General plane motion.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of Statics.
CO2 - Apply the concept of Equilibrium.
CO3 - Calculate the Centroid and Area MI
CO4 - Analyze the Friction in different applications.
CO5 - Understand the fundamentals of Dynamics.
CO6 - Analyze overall Rigid body system of Kinematics and Kinetics.

TEXT / REFERENCE BOOKS

1. Bhavikatti S.S., Engineering Mechanics (Multi colour Edition), New Age International publishers, 2019.
2. Bansal R.K., A Textbook of Engineering Mechanics, 6th Edition, Laxmi Publications, 2022.
3. Bedi D.S., Engineering Mechanics, Kindle Edition, Khanna Publishing Co. (P) Ltdl, 2020.
4. Khurmi R.S. and Khurmi N, Engineering Mechanics, S.Chand Publishing, 2018.
5. Beer & Johnston, "Vector Mechanics for engineers - Vol I &II", 9th Edition, Tata McGraw Hill, 2010.
6. Sharma, D.P., Engineering Mechanics, Pearson, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SEEB1203	BASIC ELECTRICAL ENGINEERING (Common to Auto, Aero, Mech, Biomed, Chemical, Mechatronics, Bio Tech)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To understand the fundamental concepts of electrical wiring and its components
- To analyze DC and AC circuit behavior.
- To impart and explore Knowledge on magnetic circuits and electrical machines.

UNIT 1 INTRODUCTION TO ELECTRICAL SYSTEMS 9 Hrs.

Basic Element Resistors, inductors and capacitors - Domestic Wiring - Wiring Materials and Accessories -Staircase Wiring - Fluorescent Tubes-Earthing-Types & Benefits

UNIT 2 D.C. CIRCUITS 9 Hrs.

Electrical Quantities - Ohm's law - Kirchhoff's laws -Resistance in series and parallel combinations - Current and Voltage division rules - Mesh analysis and Nodal analysis.

UNIT 3 A.C. CIRCUITS 9 Hrs.

Sinusoidal functions - R.M.S and Average values for Sinusoidal waveform - Phasor representation - Sinusoidal excitation applied to purely resistive, inductive and capacitive circuits - RL, RC and RLC series circuits - power and power factor - Introduction to three phase circuits.

UNIT 4 MAGNETIC CIRCUITS 9 Hrs.

Definition of MMF, Flux and Reluctance - Leakage Factor - Reluctances in Series and Parallel (Series and Parallel Magnetic Circuits)-Electromagnetic Induction-Fleming's Rule-Lenz's Law-Faraday's laws-statically and dynamically induced EMF -Self and mutual Inductance-Analogy of Electric and Magnetic.

UNIT 5 INTRODUCTION TO MACHINES 9 Hrs.

Construction and Principle of Operation of DC Generators - DC Motors - Single Phase Transformer - Stepper Motor.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental electrical concepts.
CO2 - Analyze simple DC circuits using appropriate techniques.
CO3 - Apply phasor analysis techniques to solve AC circuits
CO4 - Develop the ability to solve problems involving magnetic circuits using analytical techniques
CO5 - Demonstrate the principles and operation of various electrical machines,
CO6 - Understand the principles, construction, and applications of special machines

TEXT / REFERENCE BOOKS

1. Ramana Pilla ,HD Mehta, “Basic Electrical Engineering”, S CHAND & Company Limited, 2022
2. Mittle B.N. & Aravind Mittle, Basic Electrical Engineering, 2nd Edition, Tata McGraw Hill, 2011.
3. Theraja B.L., Fundamentals of Electrical Engineering and Electronics, 1st Edition, S.Chand & Co., 2009.
4. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, 2nd Edition, PHI Learning Private Ltd, 2010.
5. Thomas L Floyd, “ Digital Fundamentals”, 11th edtion, Pearson, 2015.
6. Sanjay Sharma, Electronic Devices and Circuits, 2nd Edition, S.K.Kataria & Sons, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1201	MATERIALS AND MEASUREMENTS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To enable students to develop a fundamental understanding of materials engineering, including the construction of phase diagrams, selection and application of heat treatment processes, and identification of suitable alloys for engineering applications.
- To facilitate the acquisition of knowledge in the properties and applications of polymers, ceramics, and composites, as well as the various testing procedures and failure mechanisms used in materials engineering.
- To provide students with the necessary skills and knowledge for accurate measurement in manufacturing, covering terminology, instruments, tolerance analysis, gauge design, surface metrology, and GD&T.

UNIT 1 CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9 Hrs.

Constitution of alloys - Solid solutions, substitutional and interstitial - phase diagrams - Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions - Iron - Iron carbide equilibrium diagram - Classification of steel and cast iron microstructure, properties, and application.

UNIT 2 HEAT TREATMENT 9 Hrs.

Definition - Full annealing, stress relief, recrystallization, and spheroidising - normalizing, hardening, and tempering of steel - Isothermal transformation diagrams - cooling curves superimposed on I.T. diagram - continuous cooling transformation (CCT) diagram - Austempering, Martempering - Hardenability, Jominy end quench test - case hardening, carburizing, nitriding, cyaniding, carbonitriding - Flame and Induction hardening - Vacuum and Plasma hardening - Thermomechanical treatments - elementary ideas on sintering.

UNIT 3 METALLIC AND NON-METALLIC MATERIALS 9 Hrs.

Effect of alloying elements on steel: Mn, Si, Cr, Mo, V, Ti, W. Properties and applications of stainless steel, tool steel, HSLA - Types of cast iron: grey, white and their properties and applications - Copper and its alloys, Aluminium and its alloys properties and applications - Polymers: types of polymer, commodity and engineering polymers, properties and applications- Thermoset polymers - Engineering ceramics: properties and applications - Composites: matrix and reinforcement materials, applications of composites, nano composites.

UNIT 4 MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS AND ASSEMBLY AND TRANSMISSION ELEMENTS 9 Hrs.

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

UNIT 5 TOLERANCE ANALYSIS 9 Hrs.

Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental concepts of material science, crystallography, and phase diagrams, and their applications

CO2 - Compare the different types and grades of ferrous and non-ferrous alloys, their compositions, properties, and applications, and determine the suitability of different alloys for specific engineering purposes.

CO3 - Apply the concepts of various strengthening processes, such as precipitation hardening, work hardening, and solid solution strengthening, in the making of steels and other materials, and analyse their effects on the material properties.

CO4 - Understand the methods of measurement and selection of measuring instruments, standards of measurement

CO5 - Identify and apply various measuring instruments

CO6 - Explain tolerance, limits of size, fits, geometric and position tolerances and gauge design.

TEXT / REFERENCE BOOKS

1. Avener S.H, “Introduction to Physical Metallurgy”, 2nd Edition, McGraw Hill, Indian Edition, 2017
2. Raghavan V, “Material Science and Engineering”, 5th Edition, Prentice Hall, 2005.
3. William D Callister “Material Science and Engineering”, John Wiley and Sons 2007.
4. Khurmi.R.S, Sedha R.S, “Material Science”, 4th Edition, S.Chand & Co., 2009
5. Dieter.G.E, “Mechanical Metallurgy”, 3rd Edition, McGraw Hill, 1988.
6. Beckwith T.G. and Marangoni, “Mechanical Measurements”, Addison Wesley, 2000.
7. Gupta I C, “Text Book of Engineering Metrology”, Dhanpat Rai Publishers, 2003.
8. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SCYB2101	CHEMISTRY LAB	L	T	P	EL	Credits	Total Marks
		0	0	2	0	1	50

COURSE OBJECTIVES

- To understand the basic principle involved in volumetric and instrumental analysis.
- To acquire practical knowledge in pHmetry, potentiometry and conductometry.
- To develop the skill in water analysis.

LIST OF EXPERIMENTS

1. Estimation of mixture of acids by conductometry.
2. Estimation of ferrous ion by potentiometry.
3. Determination of pKa value of glycine by pHmetry.
4. Estimation of hardness of water by EDTA method.
5. Determination of alkalinity of water
6. Estimation of Iron by photo colorimetry.
7. Estimation of copper in brass
8. Determination of high molecular weight polymer using Ostwald viscometer.

Max. 15 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Estimate the ionic conductance of mixture of acids.
CO2 - Construct a redox cell and measure its emf.
CO3 - Interpret the concept of Zwitter ion in amino acids
CO4 - Predict the quality of water sample for domestic and industrial applications.
CO5 - Demonstrate the validity of Beer-Lambert's law.
CO6 - Apply Poiseuille's law for molar mass measurements.

TEXT / REFERENCE BOOKS

1. G,H. Jeffery, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition. Persons Education 2004.
2. S. S. Dara, Experiments and Calculations in Engineering Chemistry, S. Chand and Co. 2010.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:50 **Exam Duration:2 Hrs.**

CAE	Evaluation of Regular Lab class	15 Marks	**25 Marks**
	Model practical exam	10 Marks	
ESE	University Practical exam		**25 Marks**

SMEB2201	WORKSHOP PRACTICE	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To provide the students with hands on experience on different trades of engineering like Plumbing Works, Plumbing, Foundry,
- To provide the students with hands on experience on different trades of engineering like Fitting, Carpentry
- To provide the students with hands on experience on different trades of engineering like Welding and Sheet metal.

A. PLUMBING WORKS

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
(b) Preparation of plumbing line sketches for water supply and sewage works.
(c) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

B. CARPENTRY

a) Handling of carpentry tools, A practice in marking, sawing planning and chiseling to size. Making simple joints such as half-lap, dove-tail, TEE joint and mortise and Tenon joints. (Any two joints to be practiced)
b) Use of modern materials such as plywood, chip board, Nova pan, laminated sheets (Demonstration only).

C. FITTING

Use of fitting tools-practice in marketing, fitting to size and drilling-making of simple mating and profiles such as V, Square, Dove-tail, Half-round and TEE - joints. (Any two joints to be practiced).

D. WELDING

a) Electric Arc Welding.
   I. Study on Edge preparation techniques for Arc welding.
   II. List of Welding Exercises.
   1. Lap Joint 2. Butt Joint 3. Fillet Joint 4. Tee Joint 5. V Joint 6. Corner Joint (Any two joints to be practiced)
b) Study on gas welding and gas cutting.

E. FOUNDRY

a) Sand testing - Grain fineness - Permeability test.
b) Study on Pattern Allowances.
c) Preparation of green sand molding (Solid and Split pattern)
   1. Flanges 2. Bush 3. Hexagon 4. Dumbbell
d) Metal casting technique (Demonstration only).

F. SHEET METAL

a) Tools and equipment– practice.
b) Making rectangular tray, hopper, scoop, etc. (Any one to be practiced)
c) Study on Fabrication of a small cabinet, dust bin, etc.

Max.30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Work with various components used in fluid flow pipelines and to make connections for various applications suitably.

CO2 - Handle carpentry tools for woodworking.

CO3 - Perform various fitting operations

CO4 - Make precise weld joints using arc and gas welding processes

CO5 - Make mold precisely and to place runner, riser at suitable places also they understand how to provide various allowances.

CO6 - Handle sheet metal tools for making various sheet metal components.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMTB1301	TRANSFORM TECHNIQUES AND COMPLEX ANALYSIS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS, CSE & IT)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- To model the Engineering problems and obtaining its solutions mathematically.
- To attain the Science, Engineering and Computer Science analytically and logical thinking

UNIT 1 FOURIER TRANSFORMATION 9 Hrs.

The infinite Fourier transform – Sine and Cosine transform – Properties – Inversion theorem – Convolution theorem – Parseval's identity – Finite Fourier sine and cosine transform.

UNIT 2 Z TRANSFORMATION AND DIFFERENCE EQUATIONS 9 Hrs.

Z Transform – Elementary properties – Inverse Z Transform – Partial fraction method, Convolution method, Residue method – Formation of difference equations – Solution of difference equations using Z Transform.

UNIT 3 COMPLEX VARIABLES 9 Hrs.

Analytic functions – Cauchy - Riemann equations in Cartesian and polar form – Harmonic functions – Properties of analytic functions – Construction of analytic functions using Milne – Thompson method – Some Standard Transformations – Translation, Magnification and Rotation, Inversion and Reflection and simple problems based on the above - Bilinear transformation.

UNIT 4 COMPLEX INTEGRATION 9 Hrs.

Cauchy's integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's series – Singularities – Poles and Residues – Cauchy's residue theorem and problems.

UNIT 5 PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

Formation of equations by elimination of arbitrary constants and arbitrary functions – Solutions of First Order Linear PDE – Lagrange's linear equation – Solution of Linear Homogeneous PDE of higher order with constant coefficients.

Max. 45 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Analyze Fourier Transform with its properties
CO2 - Apply Z Transform with its properties to solve difference equations.
CO3 - Create analytic function, bilinear transformation with its properties.
CO4 - Evaluate complex integration using Cauchy Integral theorem and Cauchy Residue theorem
CO5 - Create partial differential equation by eliminating arbitrary constant or functions
CO6 - Solve first order linear PDE and homogeneous higher order PDE's

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 7th Edition, Mc.Graw Hill, 2004.
3. Erwin Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley and Sons, Singapore, 2001.
4. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
5. Kandasamy P., Thilagavathy K. &Gunavathy K., Engineering Mathematics, (4th Revised Edition), S.Chand & Co., New Delhi, 2001.
6. Veerarajan T., Higher Engineering Mathematics, Tata Mcgraw Hill Publishing Co., NewDelhi, First Edition, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1301	SENSORS AND ELECTRONIC INSTRUMENTATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the characteristics of instruments and the sources and types of errors.
- To be familiar with different types of sensors.
- To know the techniques and methods for measurement of displacement, force, velocity, flow

UNIT 1 MEASUREMENTS 9 Hrs.

General Configuration and functional description of measuring Instruments-Characteristics of instruments- Static characteristics -Dynamic characteristics - Types of errors -sources of errors-methods of Elimination-Analysis of data - Limiting Errors-Relative limiting error-Combination of Quantities with limiting errors – Statistical treatment of data: Histogram, Mean, Measure of dispersion from the mean, Range, Deviation, Average deviation, Standard Deviation, variance.

UNIT 2 SENSORS & VIRTUAL INSTRUMENTATION 9 Hrs.

Sensors for Motion and Position Measurement, GPS, INS, Doppler, SONAR, Thermal Sensors – Gas Thermometric Sensors, Acoustic Temperature Sensor, Thermo-EMF Sensors, NQR Thermometry, Heat Flux Sensor, Chemical Sensor, Hall Effect Sensor, Tactile sensor, Ultrasonic sensor, High speed Image sensor. Graphical programming techniques, Data types, Advantage of Virtual Instrumentation techniques, Concept of WHILE & FOR loops, Arrays, Clusters & graphs.

UNIT 3 MEASUREMENT OF FORCE & VELOCITY 9 Hrs.

Force Measurement – Load cell, different types of load cells – elastic load cell-strain gauge load cell. Torque Measurement-Using strain gauge and magneto elastic principle. Transducers for velocity– Revolution counter-capacitive tacho-drag up type tacho, D.C and A.C tacho generators – stroboscopic methods. Measurement of Acceleration - Elementary accelerometer, Seismic accelerometer, Practical accelerometers.

UNIT 4 MEASUREMENT OF TEMPERATURE AND PRESSURE 9 Hrs.

Measurement of Temperature- Thermometer, Thermocouple, Thermistor, Pyrometer. Measurement of Pressure: Manometers – different types of manometers, Elastic pressure transducers, Dead weight Tester, Electrical types, Vacuum gauges - McLeod gauge, Knudsen gauge, thermocouple gauge, ionization gauge, Differential pressure Transmitter - electrical & pneumatic types.

UNIT 5 MEASUREMENT OF FLOW, LEVEL 9 Hrs.

Orifice, Venturi, Pitot tube, flow nozzle rotameter, Dahl tube, Positive displacement meter, turbine flow meter, electromagnetic flow meter, ultrasonic flow meter, open channel flow measurement, solid flow measurement. Level: Sight glass, float gauge, displacer, torque tube, bubbler tube, diaphragm box, Differential Pressure methods, electrical methods- resistance type, capacitance type, ultrasonic level gauging.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the characteristics of instruments and determine the errors associated with it.

CO2 - Prefer suitable sensors based on the applications.

CO3 - Understand the measurement techniques of Displacement, Force, Velocity, Industrial parameters.

CO4 - Apply the knowledge of measurement in industries.

CO5 - Select a device for particular measurement.

CO6 - Develop an appropriate method for measurement.

TEXT / REFERENCE BOOKS

1. Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, CRC Press; 2nd edition (14 August 2017)
2. John G. Webster, Halit Eren., Measurement, Instrumentation, and Sensors Handbook, CRC Press, 2nd edition (12 December 2018)
3. Dr.O.N.Pandey, Sensors and Instrumentation, 2021 Reprint S.K.Kataria and Sons
4. Subhas Chandra Mukhopadhyay. Smart Sensors, Measurement and Instrumenation Springer 2022.
5. Rangan C.S. Mani V.S.V: and Sharma G.R., “Instrumentation Devices and Systems” Tata McGraw Hill.
6. Renganathan.S, “Transducer Engineering” -Allied Publishers Limited.
7. D.V.S Murthy –“Transducer and Instrumentation”, PHI, 1st Edition.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1302	MICRO PROCESSOR AND CONTROLLER	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the architecture of Microprocessor & Microcontroller.
- To familiarize the students in writing assembly programming and interfacing with peripherals.
- To provide foundation and confidence to the students to solve real world problem using Microprocessor and Microcontroller.

UNIT 1 INTRODUCTION TO MICROPROCESSORS 9 Hrs.

Introduction, 8085 Architecture, Pin Diagram and signals, Timing Diagram, Interrupts and its types, Introduction to 8086 microprocessors and its operation.

UNIT 2 PROGRAMMING 8085 MICROPROCESSOR 9 Hrs.

8085 assembly language programming- addressing modes, Instruction formats, Instruction Classification- data transfer, arithmetic operations, logical operations, branching operations, I/O and machine control - Stack and subroutines, Example Programs.

UNIT 3 PERIPHERALS AND INTERFACING 9 Hrs.

Programmable Peripheral Interface (8255), Serial Communication Standards, Serial Data Transfer Scheme, On board Communication Interfaces-I2C Bus, SPI Bus, UART; External Communication Interfaces-RS232, USB. External Memory RAM, ROM Interface, ADC, DAC

UNIT 4 8051 MICROCONTROLLERS 9 Hrs.

Introduction to microcontrollers, Difference between microprocessor and microcontroller, Architectural of 8051, Memory architecture, Timers, Interrupts, Addressing Modes and Instruction set of 8051, Programming examples.

UNIT 5 APPLICATIONS BASED ON 8085 AND 8051 & ARM PROCESSORS 9 Hrs.

Interfacing LED, 7 segment LED Display, Stepper motor control system, Temperature control system, Motor speed control system, Timer application program, Interfacing LCD. Introduction to CORTEX Processor and its architecture, OMAP Processor and its Architecture.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the architecture and operations of various functional block of 8085.
CO2 - Write assembly language program by understanding addressing modes and the various instructions.
CO3 - Identify the need for various interfacing ICs and explain its function.
CO4 - Understand the architecture and function of various on chip modules of 8051 Microcontroller.
CO5 - Understand the addressing modes of 8051 and write programs.
CO6 - Design and develop program for various I/O units and for real world problem.

TEXT / REFERENCE BOOKS

1. Ramesh Gaonkar, “Microprocessor Architecture, Programming and applications with 8085”, 6/e, Penram International Publishing Pvt Ltd, 2013.
2. Kenneth J Ayala, “The 8051 Microcontroller”, 3rd Edition, Thomson, 2007.
3. Muhammad Ali Mazidi. “The 8051 Microcontroller and Embedded Systems”, 2nd Edition, Pearson Education, 2008.
4. Ray A.K, Bhurchandi, K.M, English- “Advanced Microprocessors and Peripherals” by Tata McGraw Hill Education
   Private Limited-Paperback Edition- 2nd Edition, 2006.
5. https://www.mikroe.com/ebooks/architecture-and-programming-of-8051-mcus/introduction.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1303	APPLIED THERMODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of thermodynamics
- To understand the air standard cycles and working principles of four stroke and stroke engines
- To familiarize with the types of air compressors, refrigeration and air conditioning systems and their working principle

UNIT 1 FIRST LAW OF THERMODYNAMICS 9 Hrs.

Concepts - concept of continuum, macroscopic approach, thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics - concept of temperature and heat. Concept of ideal gas. First law of thermodynamics - application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipment's.

UNIT 2 SECOND LAW OF THERMODYNAMICS 9 Hrs.

Second law of thermodynamics - Kelvin's and Clausius statements of second law. Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP, Clausius inequality, concept of entropy, change of property of ideal gas, principle of increase of entropy.

UNIT 3 INTERNAL COMBUSTION ENGINES & GAS POWER CYCLES 9 Hrs.

IC Engines- Introduction-Classification, Comparison between four stroke and two stroke, petrol & diesel engines Performance testing on internal combustion engines, Performance curves. Air standard cycles - Otto, Diesel and Dual cycles. Derivation of expression for air standard efficiency and mean effective pressure.

UNIT 4 AIR COMPRESSORS 9 Hrs.

Positive displacement compressor - reciprocating air compressor, work done, volumetric efficiency, Effect of clearance volume- for qualitative treatment- rotary compressors – vane type, roots blower-centrifugal compressor.

UNIT 5 REGRIGERATION & PSYCHROMETRY 9 Hrs.

Simple vapor compression refrigeration cycle, cycle with superheat & sub cooling, Performance calculations, Working principle of basic vapor absorption system (Qualitative treatment only). Psychrometry and psychrometric properties, Psychrometric processes, Air conditioning systems- winter and summer. (Qualitative treatment only).

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the thermodynamic systems and thermodynamic properties.
CO2 - Apply first law of thermodynamics in engineering applications.
CO3 - Understand the second law of thermodynamics and concept of entropy.
CO4 - Analyze gas power cycles and develop understanding of I.C engines.
CO5 - Analyze the performance of reciprocating and rotary compressors.
CO6 - Understand the concepts of refrigeration cycles and air conditioning systems.

TEXT / REFERENCE BOOKS

1. Nag P.K., “Engineering Thermodynamics”, Tata McGraw Hill Education, 2009.
2. Yunus A. Cengel, Michael A. Boles, “Thermodynamics: An Engineering Approach”, McGraw Hill Education, 2014.
3. Rajput R.K., “Thermal Engineering”, Laxmi Publications, 2010.
4. Khurmi R.S., Gupta J.K, “Thermal Engineering”, S Chand, 2006.
5. P.L. Ballaney, “Thermal Engineering”, Khanna Publisher, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRBLH31	PROGRAMMABLE LOGIC CONTROLLER AND SCADA	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVES

- To understand the need of automation in various industrial sectors
- To learn about the various technology developments such as PLC, SCADA and DCS in industrial automation
- To understand the basics of communication with its protocol.

UNIT 1 BASICS OF AUTOMATION 12 Hrs.

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines, Fundamentals of IoT

UNIT 2 PROGRAMMABLE LOGIC CONTROLLER 12 Hrs.

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming Languages- Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT 3 SUPERVISORY CONTROL AND DATA ACQUISITION 12 Hrs.

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode Functions-Tools: Tag Database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT 4 DISTRIBUTED CONTROL SYSTEM 12 Hrs.

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

UNIT 5 COMMUNICATION PROTOCOLS 12 Hrs.

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses - Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

LIST OF EXPERIMENTS

EXPERIMENT 1 Implementation of logic gates using RS Logix software
EXPERIMENT 2 Two way and four way traffic light control system using PLC
EXPERIMENT 3 Bottle filling process using PLC
EXPERIMENT 4 Automate the cylinder sequencing process using PLC
EXPERIMENT 5 Select the suitable I/O module for control of elevator using PLC 6 3 Hours
EXPERIMENT 6 Design a SCADA screen to display the plant information such as temperature, pressure and humidity using historical trends 7 3 Hours
EXPERIMENT 7 Design a SCADA screen for automatic level monitoring system 8 3 Hours
EXPERIMENT 8 Design a SCADA screen for recipe database
EXPERIMENT 9 Design a SCADA screen for alarm logging
EXPERIMENT 10 Design a SCADA screen for security access management

Max.60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Outline the need of automation in industries

CO2 - Illustrate different instructions available in PLC for various applications

CO3 - Implement supervisory control and data acquisition systems for particular applications

CO4 - Integrate the distributed control system and to differentiate the DCS over other automation systems.

CO5 - Select the proper communication buses and its protocol for industrial applications

CO6 - Develop the PLC program for various applications like traffic light control, bottle filling, cylinder actuation and elevator control

TEXT / REFERENCE BOOKS

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2002
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Continuous Assessment exams	**50 Marks**
ESE	University Practical exam	**50 Marks**

SISB4301	UNIVERSAL HUMAN VALUES	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence
- To strengthen self-reflection and to develop commitment and courage to act

UNIT 1 COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION 9 Hrs.

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self- exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

   Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT 2 UNDERSTANDING HARMONY IN THE HUMAN BEING - HARMONY IN MYSELF! 9 Hrs.

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
6. Programs to ensure Sanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

UNIT 3 UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY- HARMONY IN HUMAN-HUMAN RELATIONSHIP 9 Hrs.

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT 4 UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS COEXISTENCE 9 Hrs.

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT 5 IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9 Hrs.

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To become more aware of themselves
CO2 - To become more aware of their surroundings (family, society, nature)
CO3 - They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind
CO4 - To have better critical ability
CO5 - To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)
CO6 - To apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

TEXT / REFERENCE BOOKS

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj – PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

ASSESSMENT:

Assessment by faculty mentor	**: 10 marks**	**Self-assessment**	**: 10 marks**
Assessment by peers	**: 10 marks**	**Socially relevant project/Group**	
Activities/Assignments	**: 20 marks**	**Semester End Examination**	**: 50 marks**

SMRB2301	SENSORS AND ELECTRONIC INSTRUMENTATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To understand the working of sensors and transducers.
- To understand the characteristics of sensors.
- To calibrate voltmeter and ammeter.

LIST OF EXPERIMENTS

1. Characteristics of Thermocouple.
2. Characteristics of Potentiometer.
3. Characteristics of Strain Gauge.
4. Characteristics of LVDT.
5. Calibration of Voltmeter using Potentiometer.
6. Calibration of Ammeter using Potentiometer.
7. Characteristics of Load Cell.
8. Characteristics of Resistance Thermometer.
9. Characteristics of Thermistor.
10. Characteristics of Synchros.
11. Characteristics of Piezoelectric Sensor.
12. Characteristics of Hall Effect Sensor.
13. Proximity Sensors (Inductive)
14. Measurement of Resistance, Inductance and Capacitance Using Bridge

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the functioning of few sensors and transducers.
CO2 - Understand the characteristics of few sensors and transducers.
CO3 - Understand the process and need for calibration.
CO4 - Calibrate voltmeters and ammeters.
CO5 - Choose the sensor for measurement of few parameters.
CO6 - Use the appropriate sensor and calibrate.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMRB2302	MICRO PROCESSOR AND CONTROLLER LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To understand the operation of Microprocessor & Microcontroller.
- To develop algorithms and write assembly language programs.
- To provide knowledge to solve real time issues using Microprocessor and Microcontroller.

SUGGESTED LIST OF EXPERIMENTS - MICROPROCESSOR – 8085

1. Programs using Arithmetic operations.
2. Programs for Code conversions.
3. Largest, smallest, and Sorting of an array.
4. Counters and Time delay

SUGGESTED LIST OF EXPERIMENTS - MICROCONTROLLER- 8051

1. Data Transfer Programs.
2. Programs Using Logical Instructions.
3. Programs using Bit Manipulation Instructions.
4. Reading and Writing on Parallel port.
5. Stepper Motor controller.
6. Timer Operations.
7. Serial communication Implementation.
8. Traffic light Controller
9. Keyboard and LED Interfacing

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop algorithms for assembly programs.
CO2 - Write assembly language programs for Microprocessor and Microcontroller.
CO3 - Solve real time issues using assembly program for microprocessor and Microcontroller.
CO4 - Understand how peripheral are interfaced to the microcontrollers.
CO5 - Compare the working principle of Microcontroller over Microprocessor.
CO6 - Develop assembly language program for various applications using micro controller.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMTB1401	FOURIER SERIES AND NUMERICAL METHODS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS, CSE & IT)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of Fourier series and Numerical methods to form independent judgements.
- To Model the Engineering problems and obtaining its solutions mathematically.
- To Understand Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 FOURIER SERIES 9 Hrs.

Fourier series – Euler's formula – Dirichlet's conditions – Fourier series for periodic functions – Parseval's identity (without proof) – Half range cosine series and sine series – simple problems – Harmonic Analysis.

UNIT 2 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

One dimensional wave equation – Transverse vibrating of finite elastic string with fixed ends – Boundary and initial value problems – One dimensional heat equation – Steady state problems with zero boundary conditions – Two dimensional heat equation – Steady state heat flow in two dimensions- Laplace equation in Cartesian form (No derivations required).

UNIT 3 NUMERICAL METHODS FOR SOLVING EQUATIONS 9 Hrs.

Solution of algebraic equation and transcendental equation: Regula Falsi Method, Newton Raphson Method (including solving algebraic equations in two variables $f(x,y)=0$ and $g(x,y)=0$) – Solution of simultaneous linear algebraic equations: Gauss Elimination method, Gauss Jacobi method and Gauss Seidel method.

UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTATION AND INTEGRATION 9 Hrs.

Interpolation: Newton forward and backward interpolation formula, Lagrange's formula for unequal intervals – Numerical differentiation: Newton's forward and backward differences to compute first and second order derivatives – Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule and Simpson's $3/8^{th}$ rule.

UNIT 5 NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS 9 Hrs.

Ordinary differential equations: Taylor series method, Runge Kutta method for fourth order - Partial differential equations – Finite differences – Laplace equation and its solutions by Liebmann's process – Solution of Poisson equation – Solutions of parabolic equations by Bender Schmidt Method – Solution of hyperbolic equations.

Max. 45 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Develop Fourier series for different types of functions
CO2 - Derive and obtain the solutions of wave and heat equations
CO3 - Formulate numerical solution of algebraic, transcendental and simultaneous linear equations
CO4 - Solve interpolation, numerical differentiation and integration problems
CO5 - Analyze various numerical methods for the solution of ordinary differential equations
CO6 - Apply numerical techniques to solve partial differential equations

TEXT / REFERENCE BOOKS

1. Kreyszig E., Advanced Engineering Mathematics, (8th Edition), John Wiley and Sons (Asia)Pte Ltd., Singapore, 2001.
2. Grewal B.S., Higher Engineering Mathematics, , 41th Edition, Khanna Publications, Delhi,2011.
3. Kandasamy P., Thilagavathy K. &Gunavathy K., Engineering Mathematics, (4th Revised Edition), S.Chand & Co., New Delhi, 2001.
4. Veerarajan,T., Engineering Mathematics, Tata Mcgraw Hill Publishing Co., New Delhi, 2005
5. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata Mcgraw Hill Publishing Co., New Delhi, 2003.
6. Kandasamy P., Thilagavathy K. and Gunavathy, K., Applied Numerical Methods, S.Chand & Co., New Delhi, 2003.
7. E.Balagurusamy, Numerical Methods, McGraw-Hill Education (India) Pvt Limited, 1999.
8. B.S. Grewal, Numerical Methods In Engineering Science , Khanna Publisher, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1401	SOLID AND FLUID MECHANICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To familiarize with the behavior of structural components under different loading conditions
- To understand effect of component dimensions and shape subjected to stresses and deformations.
- To understand fluid properties, flow characteristics and basic governing equations-mass, momentum, energy and analysis of rotor dynamic machines and velocity triangles

UNIT 1 STRESS STRAIN AND DEFORMATION OF SOLIDS. 9 Hrs.

Rigid bodies and deformable solids - stability, strength, stiffness - tension, compression and shear stresses - strain, elasticity, Hooke's law, limit of proportionately, modules of elasticity, stress-strain curve, lateral strain - temperature stresses deformation of simple and compound bars - shear modulus, bulk modulus, relationship between elastic constants - bi axial state of stress - stress at a point - stress on inclined plane - principal stresses and principal planes – Mohr's circle of stresses.

UNIT 2 BENDING MOMENT IN BEAMS &TORSION OF SHAFTS 9 Hrs.

Introduction, Types of beams, loads and reactions, Shear force and bending moment in beams – Cantilevers – Simply supported beams. Numerical on shear force and bending moment diagrams for cantilevers – Simply supported beams subjected to various loading condition- SFD and BMD for uniformly distributed load (UDL) and point load. Torsion-Introduction, assumptions, derivation of torsional equations, torsional rigidity/stiffness of shafts. Power transmitted by solid and hollow circular shafts.

UNIT 3 FLUID PROPERTIES & EQUATIONS OF MOTION 9 Hrs.

Fluid Properties, Fluid Statics: Hydrostatic Law - Hydrostatic force on submerged plane- surfaces. Manometers - Simple U tube and differential manometers - Buoyancy - Meta- centric height - determination of stability of floating bodies and submerged bodies- basic equations of motion: Types of fluid flow - Continuity, momentum and energy equations - Euler's and Bernoulli's Equation and its applications. -Flow Measurement: Orifice meter, Venturi meter, Piezometer, Pitot Tube.

UNIT 4 FLOW THROUGH ORIFICES, NOTCHES, WEIRS AND PIPES 9 Hrs.

Flow through orifices: Classification - Hydraulic co-efficient - Flow through rectangular orifice, Notches and weirs. Laminar and Turbulent flow: Reynolds experiment - Major and minor losses in pipes - Darcy Weisbach's equation, Chezy's formula - pipes in series and pipes in parallel - total energy line - hydraulic gradient line - Equivalent pipe

UNIT 5 PUMPS & TURBINES 9 Hrs.

Centrifugal Pumps: Definition - Operations - Velocity Triangles - Performance curves - Cavitations - Multistaging. Reciprocating Pumps: Operation - Slip - indicator Diagram - Separation - Air vessels. Hydraulic Turbines: Classification of hydraulic turbines - Working principle of Pelton wheel, Francis and Kaplan turbines - velocity triangles - draft tube - hydraulic turbine characteristics. Dimensional Analysis: Buckingham's Theorem, Non-Dimension Numbers, Similarities of Flow- Model studies

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze material strength using stress-strain relationships.
CO2 - Analyze Beam strength using shear force and bending moment diagram.
CO3 - Analyze the hydrostatic force on submerged bodies
CO4 - Apply Bernoulli's energy equation in incompressible fluid flow problems
CO5 - Analyze the loss of energy in pipes
CO6 - Analyze the performance of pumps and turbines

TEXT / REFERENCE BOOKS

1. Rajput.R.K. "Strength of Materials", 4th Edition, S.Chand & co, New Delhi, 2002.
2. Khurmi, R.S, "Strength of Materials", 23rd Edition, S.Chand & Co, 2008
3. Bansal.R.K,. "Fluid Mechanics & Hydraulics Machines", 9th Edition, Laxmi Publications, 2005.
4. Kumar K. L., "Engineering Fluid Mechanics", 8th Edition, Eurasia Publication.2009

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRBLH41	MACHINING AND MANUFACTURING PROCESSES	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVES

- To illustrate theory of machining processes and operations of machine tools.
- To Study various metal casting and joining processes
- To Develop Different laws and equations for solving metal forming problems

UNIT 1 CASTING AND FORMING PROCESSES 12 Hrs.

Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, molding sand, Properties of molding sands, Core making, Defects and remedies, Principle and equipment of Permanent mold casting, Investment casting, Centrifugal casting, Continuous casting. Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Rolling, Open and closed die forging, Forging operations Extrusion: Types, Process parameter Wire and Tube Drawing: Wire and tube drawing process, Die profile Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes.

UNIT 2 SHEET METAL FORMING AND WELDING PROCESSE 12 Hrs.

Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Design of strip lay-out, blanking die design, Introduction to Drawing, bending dies, Methods of reducing forces, Formability and forming limit diagrams. Classification of joining processes, welding terminology and types of joints Arc Welding. Weld inspection, Defects in various joints and their remedies. Theories of Metal Cutting Introduction: material removal processes, types of machine tools – theory of metal cutting: chip formation, orthogonal cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

UNIT 3 CENTRE LATHE AND SPECIAL PURPOSE LATHES 12 Hrs.

Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes – automats – single spindle, Swiss type, automatic screw type, multi spindle - Turret Indexing mechanism, Bar feed mechanism.

UNIT 4 SHAPER, MILLING, DRILLING, BORING, PLANER AND BROACHING 12 Hrs.

Reciprocating machine tools: shaper, planer, slotter - Milling: types, milling cutters, operations - Hole making: drilling - Quill mechanism, Reaming, Boring, Tapping - Sawing machine: hack saw, band saw, circular saw; broaching machines: broach construction – push, pull, surface and continuous broaching machines.

UNIT 5 ABRASIVE PROCESSES, GEAR CUTTING, CNC MACHINE TOOLS AND PART PROGRAMMING 12 Hrs.

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centerless grinding – honing, lapping, super finishing, polishing and buffing, abrasive jet machining - Gear cutting, forming, generation, shaping, hobbing. Numerical control (NC) machine tools – CNC: types, constructional details, special features. Part programming fundamentals – manual programming – computer assisted part programming.

LIST OF EXPERIMENTS

1. Lathe Operations: Turning, Taper Turning, Knurling, Thread cutting – Internal and External.
2. Shaping Machines: Machine of plane and inclined surfaces, grooving – V grooving.
2. Study of Planning.
3. Grinding: Exercise involving cylindrical grinding – Surface grinding – single point tool grinding in tool and cutter
4. Milling: Cutting of spur gear.
5. Boring: Simple exercise in boring machine.
6. Hobbing: Making of spur and helical gear.
7. Slotting: Key way cutting (external).
8. Measurement of cutting forces in turning (tool dynamometer).
9. Practices in Capstan and Turret lathes (at least one exercise).

Max.60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Appreciate the conditions required for casting and welding process.
CO2 - Understand and preform hot and cold working process
CO3 - Explain sheet metal forming process
CO4 - Describe the constructional and operational features of center lathe and other Special purpose lathes.
CO5 - Describe the constructional and operational features of shaper, planner, milling, Drilling, sawing and broaching machines, grinding and other super finishing processes
CO6 - Summarize numerical control of machine

TEXT / REFERENCE BOOKS

1. Hajra Choudhary. S.K. and Hajra Choudhary A.K, “Elements of Manufacturing Technology, Vol. 1 st Edition, Media Publishers 2013.
2. P. N. Rao, “Manufacturing Technology Vol. I & II”, Tata McGraw Hill Publishers, 2nd Edition 2002
3. P. C. Sharma, “Production Engineering”, Khanna Publishers, 1999
4. R. K. Jain, “Production Technology”, Khanna Publishers, 2001
5. K. C. Chawala, “Composite Materials”, Springer, ISBN 978- 0387743646, ISBN 978- 0387743653 3
6. Brent Strong, “Fundamentals of Composites Manufacturing: Materials, Methods”, SME Book series, 2008
7. Pabla B.S. and Adithan M., “CNC Machines”, 1 st Edition, New Age International, 2012.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular class	**50 Marks**
ESE	University Practical exam	**50 Marks**

SCSBDPROJ	DESIGN THINKING AND INNOVATION	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To enable students to understand the Design Thinking methodology of carrying out the Product Development
- To Expose students to the design process as a tool for innovation
- To gain experience of prototypes with creative thinking

UNIT 1 INTRODUCTION TO DESIGN THINKING 7 Hrs.

Introduction to Design Thinking, Creative Thinking, Lateral Thinking, Vertical Thinking, Importance of Design Thinking, History of Design Thinking, Design Thinking Methodology - Empathize –Define – Ideate – Prototype – Test

Activities: Formation of team, Design Thinking Case Studies Discussion

UNIT 2 VISUALIZATION 7 Hrs.

Product Observation and Visualization, Visualization Techniques, Mind Mapping, PERSONA, Johari Window, DCAFE, VAL, Technology Driven Product, User Driven Products, Empathy for design, Human Centered Design, Mind Set of Human Centered Designer

Activities: Human Centered Design relevant Products Brain Storming

UNIT 3 IDEATION 7 Hrs

Ideation, Idea Generation Techniques, Brainstorming of Solution, Story Board, Root Causes, Individual Ideation, Group Ideation, SCAMPER, TRIZ

Surveys: Stake holder Survey – Presentation on Stake holder's survey and Literature survey, SWOT Analysis – Finalize the identified problem

UNIT 4 SPECIFICATION DEVELOPMENT 7 Hrs.

Description Problem Environment, Creation of Stakeholder's Profiles Development of Low-cost Prototypes, Development of Task-Analysis, Comparison with Benchmark Products, Development of Customer Specification, Development of Evaluation Criteria

Activities: Specific Problem selection to proceed with the work – Team presentation on identified problems and various possible solutions

UNIT 5 PROTOTYPE AND EXPERIMENTATION 7 Hrs.

Prototype Process, Journey of Prototype Process, Development of Low-cost Prototypes, Development of Task-Analysis, Comparison with Benchmark Products, Reverse Engineering, Kano Model, Lean Startup for Prototype Development

Activities: Functional decomposition diagram, Decision on implementation, Work Breakdown

UNIT 6 DESIGN THINKING FOR STRATEGIC INNOVATION 7 Hrs.

Innovation Management-Changing Management Paradigms-Design Thinking related to Science and art-Design Thinking in Business-Linking Design Thinking Solution to Business Challenges.

Activities: Documentation, Poster presentation and Proof of concept display

Max. 42 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Formulate the problems through design thinking framework
CO2 - Visualize the end products through innovative designs
CO3 - Apply the different idea generation techniques and to design the innovative products
CO4 - Analysis the consumer requirements towards the specification of the product can be evolved
CO5 - Develop prototypes and to do validation
CO6 - Evaluate the value of the product and understand the market demands towards the business development.

TEXT / REFERENCE BOOKS

1. MaurícioVianna, YsmarVianna, Brenda Lucena and Beatriz Russo," Design thinking: Business innovation", MJV Technologies and innovation press, 2012.
2. Thomas Lockwood,"Design Thinking: Integrating Innovation'', Customer Experience and Brand Value", Allworth Press, 2010.
3. Edward Debone,"How to have Creative Ideas", Vermilon Publication, 2007.
4. Tom Kelley and Jonathan Littman,"The Art of Innovation", Profile Books Ltd, 2008.
5. Mueller Roterberg, Christian, "Handbook of Design Thinking", Hochschule Ruhr West, 2018.
6. Clayton M. Christensen Michael E. Raynor, "The Innovator's Solution", Harvard Business School Press Boston, USA, 2003.
7. Geoffrey Petty," how to be better at Creativity", The Industrial Society, 1999.
8. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York,USA
9. Kelley, Tom and Littman, "Jonathan, The art of innovation: Lessons in creativity from IDEO, Americas leading design firm", New York: Random House, 2001.
10. Power Point Presentation by School of Design Thinking Workshop at Sathyabama Institute of Science and Technology
11. https://dschool.stanford.edu/
12. https://www.ideo.com/
13. NPTEL Design Thinking Course, https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mg23/

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB2401	HYDRAULICS LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To practically perform various principles of Fluid Mechanics.
- To understand the principle of flow measurements by various types of flow measuring devices.
- To evaluate the performance of hydraulic machines.

FLUID MECHANICS LAB

1. Measurement of friction factor in pipe flow.
2. Determination of discharge coefficient for venturimeter.
3. Determination of discharge coefficient for orifice meter.
4. Determination of discharge coefficients for notches.
5. Determination of Meta centric height of ship model.
6. Determination of Co-efficient of discharge of Orifice and Mouth Piece.
7. Determination of Co-efficient of velocity in Pitot tube.

FLUID MACHINERY LAB

1. Study and Performance characteristics of Centrifugal Pump.
2. Study and Performance characteristics of Reciprocating Pump.
3. Study and Performance characteristics of Multistage Centrifugal Pump.
4. Study and Performance characteristics of Gear Pump.
5. Study and Performance characteristics of Jet Pump.
6. Study and Performance characteristics of Deep well Turbine Pump.
7. Study and Performance characteristics of Pelton Wheel Turbine.
8. Study and Performance Characteristics of Francis Turbine.
9. Study and Performance characteristics of Kaplan Turbine.

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Measure the discharge coefficient for venturi meter, orifice meter, notches and orifice.
CO2 - Measure the velocity coefficient for pitot tube.
CO3 - Analyze the stability of ship model by measuring the Meta centric height.
CO4 - Estimate performance parameters of a given Centrifugal and Reciprocating pump.
CO5 - Evaluate the performance of gear pump and jet pump.
CO6 - Evaluate the performance of various types of turbines

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMRB2402	METALLURGY AND METROLOGY LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- Generate knowledge and skill in use of precision instruments.
- Learn a basic understanding of various instruments used in linear and angular.
- To know the micro structure of different materials

LIST OF EXPERIMENTS IN METROLOGY

1. Angle measurement using Sine bar
2. Angle measurement using Bevel Protractor.
3. Bore Measurement by two ball and four ball method
4. Testing Squareness of a Tri-square using Slip Gauges.
5. Measurement of dimensions with Tool Maker's Microscope
6. Measurement of gear tooth thickness
7. Gear profile checking using Profile projector
8. Composite error in gears using Parkinson Gear Tester
9. Measurement of surface finish.
10. Electronic Comparator

LIST OF EXPERIMENTS IN METALLURGY LAB

1. To study the metallurgical microscope.
2. Studying the preparation of a specimen for metallographic examination
3. To study the microstructure of plain carbon steel (Low carbon steel, medium carbon steel and high speed steel).
4. To study the effect of heat treatment on plain carbon steel (Annealing, Normalizing and Hardening)
5. To study the microstructure of alloy steels (Stainless steels, Tool steels)
6. To study the microstructure of cast iron (Grey cast iron, white cast iron, malleable cast iron and spheroidal graphite cast iron)
7. To study the microstructure of light alloys (Aluminium alloy and Magnesium alloy)
8. To study the microstructure of heavy alloys (Copper alloy, Nickel alloy)
9. To determine the Hardenability of steel by Jominy end quench testing.
10. To study the hardness of ferrous and non-ferrous alloys

Max.30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Perform the angular measurement using Sine Bar and Bevel Protractor.
CO2 - Compare the dimension of the given geometry using various measurement method.
CO3 - Calculate the surface finish and quality of the given component.
CO4 - Categorize the material from its microstructure
CO5 - Ability to relate properties to microstructure.
CO6 - Understand various crystal structures and relationship to properties and Ability to select metals and alloys for industrial applications

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMRB1501	DESIGN OF MECHATRONIC SYSTEMS	L	T	P	EL	Credits	Total Marks
		2	0	2	1	3	100

COURSE OBJECTIVES

- To familiarize students with basic of systems and its design.
- To provide students an understanding of control and drives.
- To teach students various interfacing techniques.

UNIT 1 SYSTEMS AND DESIGN 9 Hrs.

Mechatronic systems Introduction: Applications of mechatronics system. Systems like CDROM, scanner Elements of mechatronics system: Sensor, actuator, plant, and controller. Integrated mechanical-electronics design philosophy. Examples of real life systems – Integrated design issue in mechatronic – mechatronic key element, mechatronics approach – control program control – adaptive control and distributed system – Design process – Type of design – Integrated product design – Mechanism, load condition design and flexibility – structures – man machine interface, industrial design and ergonomics, information transfer, safety.

UNIT 2 CONTROL AND DRIVES 9 Hrs.

Control devices – Electro hydraulic control devices, electro pneumatic proportional controls – Rotational drives – Pneumatic motors: continuous and limited rotation – Hydraulic motor: continuous and limited rotation – Motion convertors, fixed ratio, invariant motion profile, variators. Smart sensor concept and utility of compliant mechanisms in mechatronics Microcontrollers for mechatronics: Interfacing. Microcontroller programming philosophy.

UNIT 3 REAL TIME INTERFACING 9 Hrs.

Real time interface – Introduction, Elements of a data acquisition and Control system, overview of I/O process, installation of I/O card and software – Installation of the application software – over framing. Modeling DC motor, importance of and modeling friction in mechatronic systems. Lagrange formulation for system dynamics, example of 2R manipulator; Selection of sensor and actuators, use of modeling for the same. Representation of systems and control design in linear domain

UNIT 4 CASE STUDIES -1 9 Hrs.

Case studies on data acquisition – Testing of transportation bridge surface materials – Transducer calibration system for Automotive application – strain gauge weighing system – solenoid force – Displacement calibration system – Rotary optical encoder – controlling temperature of a hot/cold reservoir – sensors for condition monitoring – mechatronic control in automated manufacturing.

UNIT 5 CASE STUDIES – II 9 Hrs.

Case studies on data acquisition and Control – thermal cycle fatigue of a ceramic plate – pH control system. De-icing temperature control system – skip control of a CD player – Auto focus Camera. Case studies on design of mechatronic product – pick and place robot – car park barriers – car engine management – Barcode reader.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the difference between traditional and Mechatronic design approach.
CO2 - Analyze types of hydraulic /pneumatic drives and controls.
CO3 - Demonstrate the installation procedure of a real time data acquisition system.
CO4 - Develop a data acquisition for a Mechatronic system.
CO5 - Develop a data acquisition and control system
CO6 - Design and Develop a Mechatronics product

TEXT / REFERENCE BOOKS

1. Bolton (2015), "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education Limited, ISBN - 9781292076683.
2. Devdas Shetty, Richard A. Kolkm (2010), "Mechatronics System Design", Cengage Learning, ISBN - 9781439061992.
3. Clarence W. de Silva, Farbod Khoshnoud, Li Maoqing, Saman K. Halgamuge (2015)
4. "Mechatronics: Fundamentals and Applications", Taylor & Francis, ISBN:9781482239317.
5. Maksat Kalimoldayev, Sergii Pavlov, Waldemar Wojcik, "Mechatronic Systems - Applications in
6. Transport, Logistics, Diagnostics, and Control"(2021), CRC Press, ISBN:9781000487299.
7. Victor Giurgiutiu, Sergey Edward Lyshevski, "Micromechatronic, Modeling, Analysis, and
8. Design with MATLAB, Second Edition", (2016), CRC Press, ISBN:9781439883105
9. Brian Morriss (1994), "Automated Manufacturing Systems – Actuators Controls, Sensors and Robotics", McGraw-Hill Inc., ISBN - 9780028023311.
10. Bradley, D. Dawson, N.C. Burd and A.J. Loader (1993), "Mechatronics: Electronics in products and Processes", CRC Press, ISBN – 9780748757428.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

S14BLH41	POWER ELECTRONICS	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVES

- To impart knowledge on different types of power semiconductor devices and its switching characteristics.
- To study the operation, characteristics and performance parameters of controlled rectifiers.
- To understand the operations of choppers and inverters.

UNIT 1 POWER SEMICONDUCTOR DEVICES 12 Hrs.

Switching characteristics of Power Diode, Power BJT, Power MOSFETS, IGBT and Thyristor - Thyristor Turn-ON methods - Firing circuits –voltage and current Commutation techniques.

- SCR Triggering Circuits
- Voltage Commutated Chopper.
- Current Commutated Chopper.

UNIT 2 PHASE CONTROLLED RECTIFIERS 12 Hrs.

Principle of phase controlled converter operation - single phase half wave converter, semi converter & full converter with R, RL & RLE load - Freewheeling diode - Three phase full converter with RL load.

- Single Phase Half & Fully Controlled Bridge Rectifier for different loads.
- Simulation of Single phase and Three phase Controlled Rectifier.

UNIT 3 DC CHOPPERS 12 Hrs.

DC - DC: Principle of operation of Step down and step up choppers - Control Strategies - One, Two and Four quadrant operation.

- Simulation of Buck, Boost, Buck-Boost Converter
- MOSFET Based Buck & Boost Converter.
- Four quadrants chopper

UNIT 4 AC CHOPPERS 12 Hrs.

AC - AC Chopper: Single phase AC voltage controllers with R & RL load. Single phase step up and step down cycloconverters.

- Single phase AC voltage controller
- Single phase step down Cyclo converter

UNIT 5 INVERTERS 12 Hrs.

Principle of operation: Single phase half bridge & full bridge voltage source inverters –Series Inverters – Parallel Inverters. Three phase Voltage source inverters (120° and 180° mode.

- SCR based series and Parallel Inverter
- Single phase IGBT PWM inverter
- Simulation of single phase and three phase half and full bridge inverter

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the turn on and turn off methods of SCR

CO2 - Examine the performance of controlled rectifier with different load

CO3 - Compare and analyze the DC chopper quadrant operation from controlling the power flow.

CO4 - Analyze the AC chopper to control the voltage and frequency of AC power.

CO5 - Design a single phase inverter for household application

CO6 - Apply inverters concepts to design of series and parallel inverters

TEXT / REFERENCE BOOKS

1. Rashid M.H., “Power Electronics circuits Devices and Applications”, Prentice Hall, 3rd Edition, New Delhi, 2013.
2. P.S.Bimbhra, “Power Electronics”, Khanna Publishers, 4th Edition, 2017.
3. P.C.Sen, “ Power Electronics”, Tata Mc Graw Hill Company, New Delhi, 2015.
4. M.D.Singh and K.B.Khanchandani, “Power Electronics” TMH, New Delhi, 2nd Edition, 2008.
5. Ned Mohan, Tore .M. Undel and William P. Robbins “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 3rd Edition, 2003.
6. Philip T. Kerin, “Elements of Power Electronics” Oxford University Press, 2004 Edition.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular class	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMEB1502	MECHANICS OF MACHINES	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- Provide the insights of the fundamentals of Mechanisms and Flywheels.
- Understand the basics of Balancing of Rotating and Reciprocating unbalance systems.
- Enhance knowledge of Single degree - Free and Damped Vibrations and forced vibrations

UNIT 1 MECHANISMS AND FLY WHEELS 9 Hrs.

Mechanisms – Terminology and definitions – Kinematic pairs- Kinematics inversions of 4 bars and slider crank chain – Kinematic analysis in simple mechanisms.
Flywheel- Turning moment diagrams – Fluctuation of Energy and speed – Energy stored in Flywheel – Mass of Flywheel – Dimensions of Flywheel.

UNIT 2 BALANCING 9 Hrs.

Balancing – Static and Dynamic Balancing of Rotating Masses - Balancing of several masses rotating in same plane and in different planes. Balancing of Reciprocating Masses- Partial Balancing of locomotives – Variation of tractive force, Hammer blow and swaying couple.

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UNIT 3 FUNDAMENTALS OF VIBRATION 9 Hrs.

Basic features of vibratory systems - Lumped mass systems - Degrees of freedom - Free vibration of Longitudinal, Transverse and Torsional systems of Single degree of freedom - Equations of motion - Natural frequency – Whirling of shafts and critical speed - Dunkerley's Method. Damped free vibration - Types of Damping –Critical damping coefficient - Damping Factor – Logarithmic Decrement.

UNIT 4 FORCED VIBRATION 9 Hrs.

Forced vibration of single degree freedom system with damping - Response to periodic forcing- Harmonic Forcing - Force transmissibility and amplitude transmissibility. Reciprocating and rotating unbalance - vibration isolation and transmissibility-- Support motion - self excited vibration with examples.

UNIT 5 GOVERNORS AND GYROSCOPES 9 Hrs.

Governors - Types - Centrifugal governors – Watt- Porter– Characteristics –Sensitivity – Stability – Hunting – Isochronism – equilibrium speed - Controlling Force. Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in Aero planes, Ships and Two wheelers.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of Mechanisms and Flywheel.
CO2 - Understand the principle of Rotating and Reciprocating masses
CO3 - Understand the basics of Single degree - Free and Damped Vibrations
CO4 - Learn about Forced Vibrations.
CO5 - Apply the fundamentals of Gyroscopes.
CO6 - Analyze the fundamentals of Governors

TEXT / REFERENCE BOOKS

1. Khurmi R.S & Gupta J.S, “Theory of Machines”, 16th Edition, S.Chand & Company, 2005, Reprint 2020.
2. Singh V.P, “Mechanical Vibrations”, 3rd Edition, Dhanpatrai & Co., 2016.
3. Ghosh A. and Malik A.M, “Theory of Mechanism and Machines”, 4th Edition, Affiliated East West Press (P) Ltd. 2009 Reprint 2020.
4. Ashok G. Ambekar, “Mechanism and Machine Theory”, 3rd Edition, PHI Learning Private limited, 2011.
5. Rattan S. S, Theory of Machines, 4th Edition, Tata Mcgraw Hill, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1503	ACTUATION SYSTEMS FOR MECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT 1 HYDRAULIC PUMPS 9 Hrs.

Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. The source of Hydraulic Power: Pumps Classification of pumps, pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. L1, L2, L3.

UNIT 2 HYRAULIC MOTORS, ACTUATORS AND VALVES 9 Hrs.

Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors). Control Components in Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves – types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. L1, L2, L3, L4

UNIT 3 HYDRAULIC CIRCUITS 9 Hrs.

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT 4 PNEUMATIC CONTROL 9 Hrs.

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder – Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod – Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols. Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders – supply air throttling and Exhaust air throttling and Exhaust air throttling. L1, L2, L3, L4.

UNIT 5 SIGNAL PROCESSING ELEMENTS 9 Hrs.

Signal Processing Elements: Use of Logic gates – OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependent controls- types – construction – practical applications, Time dependent controls principle, Construction, practical applications. L1, L2, L3, L4 Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro- Pneumatic Control: Principles – signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the Fluid power and operation of different types of pumps.
CO2 - Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CO3 - Explain the different types of Hydraulic circuits and systems
CO4 - Explain the working of different pneumatic circuits and systems
CO5 - Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.
CO6 - Design pneumatic and hydraulic circuits and predict the responses.

TEXT / REFERENCE BOOKS

1. Robert H. Bishop, " Mechatronic Systems, Sensors, and Actuators Fundamentals and Modeling ", CRC Press, 2017.
2. Abdullah M. Asiri, Inamuddin, Rajender Boddula, “Actuators and Their Applications Fundamentals, Principles, Materials, and Emerging Technologies ”, Wiley, 2020
3. Robert H. Bishop, “Mechatronics an Introduction ”, Taylor & Francis , 2017
4. Jorn Malzahn, Monica Daley, Navvab Kashiri, Nikos Tsagarakis, " Advances in Mechatronics and Biomechanics towards Efficient Robot Actuation”, Frontiers Media SA, 2019

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB2501	MECHATRONICS AND SIMULATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To give a basic introduction to Mechatronics Elements.
- To provide students knowledge on hydraulic and pneumatic systems.
- To design the feedback circuits, the importance of electro-pneumatic circuit and PLC

LIST OF EXPERIMENTS

1. Introduction to Mechatronics
2. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion
3. Stepper motor interface
4. Traffic light interface.
5. Speed control of DC motor.
6. Study of various types of transducers.
7. Study of hydraulic, pneumatic and electro-pneumatic circuits.
8. Modelling and analysis basic hydraulic, pneumatic and electrical circuits using software.
9. Study of PLC and its applications.
10. Study of image processing

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Measuring of physical quantity such as displacement, force and temperature and also the operation of signal conditioning circuits.

CO2 - Applying a suitable sensor and image processing technique for Mechatronics systems.

CO3 - Design appropriate circuits to automate and control the hydraulic, pneumatic and electric actuators.

CO4 - Apply PLC, PID and 8085 micro controller as a control unit in Mechatronics system.

CO5 - Developing a model of pneumatic circuits by using simulation software.

CO6 - Developing a model of hydraulic circuits by using simulation software.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3Hrs**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMRBLH61	AUTOMOTIVE ELECTRONICS	L	T	P	EL	Credits	Total Marks
		3	0	2	1	4	100

COURSE OBJECTIVE

- The intention and purpose of this course is to study the basics of electronics, emission controls and its Importance in automobiles.
- To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
- To study the various blocks of control units used for control of fuel, ignition and exhaust systems.

UNIT 1 INTRODUCTION 12 Hrs.

Basic Electronics systems in SI & CI engines, various parameters to be controlled in electronics - engines system. Electronic dash board instruments – On board diagnosis system, Layout of an electric vehicle -tractive effectiveness.

UNIT 2 IGNITION AND INJECTION SYSTEMS 12 Hrs.

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT 3 SENSOR AND ACTUATORS 12 Hrs.

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle angle, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

UNIT 4 ENGINE CONTROL SYSTEMS AND REGULATORS 12 Hrs.

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system.Engine cooling and warm up control, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuel injection and closed loop lambda control exhaust emission control, on-board diagnostics.

UNIT 5 CHASSIS AND SAFETY SYSTEMS 12 Hrs.

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars.

LIST OF EXPERIMENTS - AUTO ELECTRICAL LAB

1. Testing of batteries and battery maintenance.
2. Testing of starting motors, generators and alternators.
3. Testing of regulators and cut outs.
4. Diagnosis of ignition system faults.
5. Study of Automobile electrical wiring.
6. Identification of fault on Multipoint Fuel Injection System (MPFI).
7. Identification of fault on Common Rail Direct Injection (CRDI) system.
8. Tuning of horns and sound level measurement.
9. Making of starting and Ignition circuits.
10. Making of generating and lighting circuits.

11. Study of electronic control module.
12. Study of electronic fuel feed system.

LIST OF EXPERIMENTS - AUTO ELECTRONICS LAB

1. Study of rectifiers and filters.
2. Study of logic gates, adder and flip-flops.
3. Study of SCR and IC timer.
4. Micro controller programming and interfacing.
5. Interfacing ADC and DAC for Data Acquisition and Control Application.
6. Interfacing Actuators.
7. Fault Diagnosis of various sensors.

Max. 60 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Know the importance of the electronics in automobiles.
CO2 - Understand the electronic fuel injection/ignition components and their function.
CO3 - Understand the working of sensors, actuators in automobiles
CO4 - Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.
CO5 - Diagnose electronic engine control systems problems with appropriate diagnostic tools.
CO6 - Analyses the chassis and vehicle safety system.

TEXT / REFERENCE BOOKS

1. Ribbens, “Understanding Automotive Electronics”, 8th Edition, Elsevier, Indian Reprint, 2016
2. Barry Hollembeak, Automotive Electricity, Electronics and Computer Controls, Delmar Publishers, 2015.
3. Richard K. Dupuy Fuel System and Emission controls, Check Chart Publication, 2000.
4. Ronald. K. Jurgon, Automotive Electronics Handbook, McGraw-Hill, 1999.
5. Tom Denton, Automobile Electrical and Electronics Systems, Edward Arnold Publishers, 2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs.**

CAE	Evaluation of Regular class	**50 Marks**
ESE	University Practical exam	**50 Marks**

SMRB1601	FINITE ELEMENT ANALYSIS AND COMPUTER AIDED DESIGN	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To implement the finite element method efficiently in order to solve a particular equation for simple problems and Solve simple and complicated 2D structural problems for stress analysis under impact loads from general engineering aspects
- To provide the fundamental information about computer graphics, elements of CAD/CAM and basic understanding about transformations, clipping, windowing and hidden line removal.
- To provide understanding of various wireframe, surface and solid modelling techniques used for generating computer models

UNIT 1 INTRODUCTION 9 Hrs.

Historical Background– Basic Concepts of FEM – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems–Residual Methods- Variational Formulation of Boundary Value Problems – Ritz Method.

UNIT 2 ONE DIMENSIONAL AND TWO DIMENSIONAL PROBLEMS 9 Hrs.

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher Order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices- Solution of problems from solid mechanics and heat Transfer-Bar, Beam Elements – Applications to Heat Transfer. Basic Boundary Value Problems in Two Dimensions – Triangular, quadrilateral, higher order elements – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

UNIT 3 SOLUTION TO PLANE ELASTICITY PROBLEMS AND ISO PARAMETRIC FORMULATION 9 Hrs.

Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Body forces and temperature effects – Stress calculations - Plate and shell elements. Natural Co-ordinate System – Lagrangian Interpolation Polynomials – ISO-parametric Elements – Formulation –Numerical Integration – 1D -2D Triangular elements – rectangular elements – Introduction to Analysis Software-– h & p elements, Errors and Types.

UNIT 4 INTRODUCTION TO CAD 9 Hrs.

Elements of CAD, Elements of CAM, CAD/CAM integration, Advantages and applications. Computer graphics: Input and output devices, CAD/CAM databases, Requirements of Computer graphics packages. Transformations: Geometric transformation versus viewing transformation, Basic transformation matrices, such as translation, rotation and scaling.

UNIT 5 GEOMETRIC MODELLING, I AND II 9 Hrs.

Wireframe modelling of analytical curves, such as line, circle and conics, and synthetic curves, such as Hermite cubic spline, Bezier curve and B-Spline curve. Surface modelling of analytical surfaces, such as plane surface, ruled surface, surface of revolution and tabulated cylinder, and synthetic surfaces, such as Hermite cubic surface, Bezier surface and B-Spline surface. Solid modelling techniques: Constructive solid geometry (CSG) representation and Boundary representation. Assembly modelling: Assembly of part drawing, Approaches, Interferences of positions and orientation. Graphics standards: Product data exchange, File format of DXF, IGES and STEP files. Capabilities of modelling & analysis packages.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To understand the basics of matrix manipulations required for Finite Element Analysis.

CO2 - Apply finite element formulations to solve one dimensional and 2 dimensional Problems.

CO3 - Apply finite element method to solve two dimensional Vector and Iso parametric element problems.

CO4 - Appreciate the importance of ethical issues pertaining to the effective utilization of FEA in Mechanical engineering.

CO5 - Understand the fundamental information about computer graphics, elements of CAD/CAM and apply the knowledge of transformations, clipping, windowing and hidden line removal for simple problems

CO6 - Learn various wireframe and surface modeling techniques used for generating computer models

TEXT / REFERENCE BOOKS

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 4th Edition, Tata McGraw-Hill, 2020.
2. Nam-Ho Kim, “Introduction to Nonlinear Finite Element Analysis”, Springer, 2016
3. Ioannis Koutromanos, “Fundamentals of Finite Element Analysis”, 1st Edition, John Wiley and Sons, 2018
4. G.Ramamurthy, “Applied Finite Element Analysis: 2nd Edition, Wiley, 2019
5. P. Nageshwar Rao, “CAD/CAM: Principles and Applications, 3rd Edition, Tata Mcgraw Hill, 2017
6. J. Srinivas, “CAD/CAM: Principles and Applications, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1602	EMBEDDED SYSTEM DESIGN	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge on the Building Blocks of Embedded System, Various Embedded Development Strategies,
- To impart knowledge on Bus Communication in processors, Input/output interfacing and processor scheduling algorithms
- To understand Real time operating system

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS 9 Hrs.

Embedded Systems - Overview - Structural units, selection of processor - memory devices - Memory management methods - Timer and Counting devices, Watchdog Timer, Real Time Clock

UNIT 2 EMBEDDED NETWORKING 9 Hrs.

Introduction - I/O Ports - Communication protocols: RS232, RS422, RS 485, CAN Bus - Serial Peripheral Interface (SPI) - Inter Integrated Circuits (I2C).

UNIT 3 EMBEDDED FIRMWARE DEVELOPMENT 9 Hrs.

Embedded Product Development Life Cycle- Objectives, Different Phases Of EDLC, Modelling of EDLC; Data Flow Graph, State Machine Model, Sequential Program Model, V Model

UNIT 4 EMBEDDED SYSTEM DESIGN 9 Hrs.

Introduction to basic concepts of RTOS-Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing

UNIT 5 EMBEDDED SYSTEM APPLICATION 9 Hrs.

Line Follower robot, Linear conveyor control system, Temperature monitoring and control system FOR FURTHER READING Real Time Application, Device control using Mobile, Security Alert system Automatic Car Control system, Mobile operating Land Rover

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To introduce the Building Blocks of Embedded System
CO2 - Analyze the internal hardware parts of embedded systems architecture
CO3 - Implement an embedded system for a given Networking application
CO4 - Execute the various Embedded Development Strategies
CO5 - Analyze various processor scheduling algorithms
CO6 - Analyze the basics of Real time operating system application

TEXT / REFERENCE BOOKS

1. Peckol, Embedded system Design, John Wiley & Sons,2010
2. Lyla B Das, Embedded Systems-An Integrated Approach, Pearson, 2013
3. Shibu. K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2017
4. Raj Kamal, Embedded System-Architecture, Programming, Design, Tata McGraw Hill, 2013
5. C.R.Sarma, Embedded Systems Engineering, University Press (India) Pvt. Ltd, 2013 6. Han-Way Huang, Embedded system Design Using C8051, Cengage Learning, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1603	MICRO AND NANO ELECTRO MECHANICAL SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of micro and nano electromechanical devices
- To know the fabrication process of Microsystems
- To know the design concepts of micro sensors and micro actuators and nano systems.

UNIT 1 INTRODUCTION TO MICRO NANO MECHANICAL SYSTEMS 9 Hrs.

Introduction to MEMS & materials, fabrication processes – Nano electro mechanical systems (NEMS) – a journey from MEMS to NEMS - MEMS vs. NEMS - MEMS based nanotechnology – fabrication, film formation and micromachining - NEMS physics.

UNIT 2 FABRICATION TECHNIQUES 9 Hrs.

Structure of silicon and other materials - Silicon wafer processing – bulk micromachining - Nano structuring- Nano defects - Nano particles and Nano layers-science and synthesis of Micro and Nano materials-lithography-based micromachining-Photolithography - vacuum systems - etching methods - deposition methods - LIGA and laser-assisted processing. Laws and Application of MEMS: Scaling effects - Scaling laws in miniaturization- Application of MEMS and Microsystems. Future Directions of MEMS.

UNIT 3 MICRO AND NANO SENSORS 9 Hrs.

Si active tactile sensor - Fabric tactile sensor and its application – accelerometer - capacitive silicon – wall in-tube flow sensor and its application- Inertial Sensors – Gyroscope – Pressure Sensors – Piezo resistive –Capacitive – micro channel heat sinks – optical MEMS – Visual Display– optical data switching – RF MEMS – MEMS variable capacitors – MEMS switches – Resonators- Pressure Sensor, Nano tweezers.

UNIT 4 MICRO AND NANO ACTUATORS 9 Hrs.

Requirement for Micro Actuators - Nano Positioners - Micro Mechanical Testing Apparatus - Classification of Micro Actuator-Electrostatic Distributed Actuator-Force Distance various Actuators– Inch Worm, Zipper and Scratch Drive -Thermal Actuation - Bimorph - Buckle Beam -Electro thermal Actuator - Electro Thermal Relay with Mechanical Latch – Piezoelectric Actuation Advantages - MEMS Switch -Thin Film Bulk Acoustic Resonator (FBAR) - Magnetic Actuation- External Magnetic Field Actuators - Variable Reluctance Actuators -Shape Memory Actuators- micro valves - micro pumps, Micro Fluids: Fundamentals of fluid mechanics- Basic components of a micro fluidic system- Micro flows Micro pumps- Capillarity and Surface Tension- Micro pumping methods- Micro dispensers Micro nozzles.

UNIT 5 MICRO AND NANO SYSTEMS 9 Hrs.

Micro engine driven by electro statically actuated comb drive – Micro robots and Nano robots –Micro insects - Night Vision System – Bio MEMS-MEMS as Gas sensors – Development of Proximity Sensor - MEMS based Current sensors - MEMS for Smart homes - MEMS for Visually impaired -MEMS Sensors for object detection - MEMS based touch sensors.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the basics of micro/nano electromechanical systems including their applications and advantages

CO2 - Recognize the use of materials in micro fabrication

CO3 - Describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.

CO4 - Analyze the key performance aspects of electromechanical transducers

CO5 - Analyze the key performance aspects of sensors and actuators

CO6 - Comprehend the theoretical foundations of quantum mechanics and Nano systems

TEXT / REFERENCE BOOKS

1. Qing-An Huang, " Micro Electro Mechanical Systems ", Springer Nature Singapore, 2018.
2. Sergey Edward Lyshevski, “Nano- and Micro-Electromechanical Systems”, CRC Press, 2018.
3. Sergey Edward Lyshevski, “MEMS and NEMS Systems, Devices, and Structures”, CRC Press , 2018
4. James J. Allen, " Micro Electro Mechanical System Design”, CRC Press, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB2601	MODELING AND ANALYSIS LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To create complex engineering assemblies using appropriate assembly constraints.
- To generate freeform shapes in part mode to visualize components.
- To develop 'G' and 'M' codes for turning and milling components and to generate automated tool paths for a given engineering component.

A. CAD LAB

1 Drafting: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances.

2. Part Modeling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation.

3. Feature based and Boolean based modeling and Assembly Modeling. Study of various standard Translators. Design of simple components.

4. Introduction to solid modeling and Finite Element Analysis software Basics, Fundamentals of modeling and analysis. Need and importance of Analysis.

5 Exercises on modeling and assembly. Creation of higher end 3D solid models like Knuckle Joint, Cotter joint. Creation of assembled views of joints and couplings.

B. ANALYSING LAB

Exercises on Structural Analysis Practice on Ansys Software for the following exercises:

1. Cantilever beam with Point load at the end.
2. Simply supported beam with inclined load.
3. Overhanging beam with Uniformly distributed load (UDL).
4. Determination of deflection for a Truss system.
5. Determination of deflection in a Pressure vessel

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basics of cad modeling operations.

CO2 - Construct the part modeling of a given part drawings and create the assembly of the part drawings for the given mechanical components.

CO3 - Solve simple structural, heat and fluid flow problems using standard software

CO4 - Solve simple structural, heat and fluid flow problems using standard software.

CO5 - Apply and develop the solution or to do the Research in the area of Design and Simulation.

CO6 - Design and validate the technological solution to defined problem and communicate clearly and effectively for the practical applications

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50Marks**

SMRB1701	MEDICAL MECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand how to measure biochemical parameters and various physiological information.
- To study the use of radiation for diagnostic and therapy.
- To study about recorders and advanced equipment in medicine

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to the physiology of cardiac, nervous & muscular and respiratory systems. Transducers and Electrodes: Different types of transducers & their selection for biomedical applications. Electrode theory, selection criteria of electrodes & different types of electrodes such as, Ag – Ag Cl, pH, etc.

UNIT 2 BIO-MEDICAL SENSORS AND TRANSDUCERS 9 Hrs.

Basic transducer principles Types — resistive, inductive, capacitive, fiber-optic, photoelectric, chemical, active and passive transducers and their description and feature applicable for biomedical instrumentation – Bio, Nano sensors and application. Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference

UNIT 3 MEDICAL MEASUREMENT SYSTEMS 9 Hrs.

Blood pressure measurement: by ultrasonic method – plethysmography – blood flow measurement by electromagnetic flow meter, cardiac output measurement by dilution method – phonocardiography – vector cardiography.

UNIT 4 MEDICAL MONITORING SYSTEMS 9 Hrs.

Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – cardiac pacemaker –defibrillator patient safety - electrical shock hazards - Centralized patient monitoring system.

UNIT 5 RECORDERS AND ADVANCED SYSTEMS 9 Hrs.

Oscillagraphic – galvanometric - thermal array recorder, photographic recorder, storage oscilloscopes, electron microscope. Biotelemetry, Diathermy, Audiometers, Dialysers, Lithotripsy. CASE STUDIES: Hot wire Anemometry for respiratory flow measurements.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain different measurement techniques used in physiological parameters measurement.
CO2 - Describe the different sensors and transducer principles used in bio medical application
CO3 - Describe the signal conditioning circuits used in biomedical engineering.
CO4 - Comment on various measurement systems used in diagnostics.
CO5 - Comment on various monitoring systems used in diagnostics
CO6 - Differentiate the working of recorders and explain the advanced systems used in medicine.

TEXT / REFERENCE BOOKS

1. Khandpur R S., "Handbook of Biomedical Instrumentation", TMH, 2014
2. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd edition, Prentice Hall of India, 2011.
3. Geddes L.A., and Baker, L.E., Principles of Applied Bio-medical Instrumentation, 3rd Edition, John Wiley and Sons, 2010
4. Tompkins W J., "Biomedical Digital Signal Processing", Prentice Hall of India, 2000.
5. Arumugam M. "Bio-Medical Instrumentation", Anuradha Agencies, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB1702	ROBOTICS AND MACHINE VISION SYSTEM	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To know about the principles and applications of vision system in modern manufacturing environment.
- To learn about the algorithms in vision.
- To know about the recognition of object.

UNIT 1 BASICS OF ROBOTICS 9 Hrs.

Introduction- Basic components of Robot-Laws of robotics- classification of robot-work space accuracy-resolution –repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives.

UNIT 2 ROBOT END EFFECTORS 9 Hrs.

Robot End effectors: Introduction- types of End effectors- Mechanical gripper- types of grippers mechanism- gripper force analysis- other types of gripper- special purpose grippers.

UNIT 3 ROBOT MECHANICS 9 Hrs.

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation-forward & inverse kinematics- trajectory planning. Robot Dynamics: Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

UNIT 4 MACHINE VISION FUNDAMENTALS 9 Hrs.

Machine vision: image acquisition, digital images-sampling and quantization-levels of computation Feature extraction-windowing technique- segmentation- Thresholding- edge detection- binary morphology - grey morphology

UNIT 5 ROBOT PROGRAMMING 9 Hrs.

Robot programming: Robot Languages- Classification of robot language-Computer control and robot software-Val system and Languages- application of robots.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Knowledge or gadgets of vision systems
CO2 - Ability to understand the image capturing and processing techniques
CO3 - Ability to apply the vision system in other machines
CO4 - Knowledge for recognizing the objects.
CO5 - Knowledge in application of vision and image processing in robot operations.
CO6 - Perform hands- on experience of Palletizing Operations

TEXT / REFERENCE BOOKS

1. Sathya Ranjan Deb, robotics Technology & flexible Automation Sixth edition, Tata Mcgraw-Hill Publication, 2003.
2. Gorden M.Dair, Industrial Robotics, PHI 1988.
3. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, Robotics: Sensing, Vision& Intelligence, Tata Mcgraw-Hill Publication, 1987.
4. John.J.Craig, Introduction to Robotics: Mechanics & control, Second edition-2002.
5. M.P.Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB2701	ROBOTICS AND CAM LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To write programming for simple operations like pick and place.
- To expose students to modern control systems (Fanuc).
- To know the application of various CNC machines like CNC lathe, CNC Milling etc.

LIST OF EXPERIMENTS

A. ROBOTICS LAB

1. Basic cylinder sequencing operations using Pneumatic trainer Kit.
2. Simulation of basic Hydraulic and Pneumatic circuits using software.
3. Experiment on cylinder sequencing for A+ B+ A- B- using pneumatic trainer kit.
4. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
5. Design and testing of fluid power circuits to control (i) Velocity (ii) direction and (iii) force of single and double acting actuators.
6. Proportional Integral Derivative (PID) controller interfacing.
7. Study of Boolean operations in Lab view and interfacing of Sensors in Lab view.
8. Speed control of stepper and servo motor using micro processor kit.
9. A/D and D/A Conversion.
10. Study of Image Processing Technique.
11. Basic operations on pick and place robot using (i) linear mode (ii) Re-orient mode.

B. CAM LAB

1 Study of CNC Machines.

2 Study of G-codes and M-codes.

CNC Milling

1. Part Programming for Linear Milling Cycle.
2. Part Programming for Drilling Cycle.
3. Part Programming for Contouring Cycle.
4. Part Programming for Circular Pocketing Cycle.
5. Part Programming for Rectangular Pocketing.
6. Part Programming for Mirroring Cycle.

CNC Lathe

7. Part Programming for Facing and Turning Cycle and Step turning cycle.
8. Part Programming for Profile Turning.
9. Part Programming for Taper Turning Cycle.
10. Part Programming for Grooving Cycle.
11. Part Programming for Thread Cutting Cycle

Max. 30 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Provide sufficient knowledge of industrial robot.
CO2 - Understand basic knowledge of robot programming
CO3 - Understand the concepts of work volume, configuration of industrial robot.
CO4 - Generate CNC part program for milling of component.
CO5 - Generate CNC part program for turning of component.
CO6 - Perform machining of complex profiles on CNC machine using auto generated CNC code.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks:100 **Exam Duration:3 Hrs**

CAE	Evaluation of Regular Lab class Model practical exam	**50 Marks**
ESE	University Practical exam	**50Marks**

SMRB3001	INTELLIGENT MANUFACTURING TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide students with the concepts of planning manufacturing systems.
- To learn computer integrated manufacturing and enterprise integration
- To create knowledge-based systems and developed group technology

UNIT 1 INTRODUCTION 9 Hrs.

Computer integrated manufacturing systems – structure and functional areas of CIM system - AD, CAPP, CAM, CAQC, ASRS and advantages of CIM Manufacturing communication systems – MAP/TOP OSI model, data redundancy, top-down and bottom-up approach, volume of information. Intelligent manufacturing – system components, system architecture and data flow, system operation

UNIT 2 COMPONENTS OF KNOWLEDGE 9 Hrs.

Components of knowledge based systems – basic components of knowledge based systems, knowledge representation, comparison of knowledge representation schemes, interference engine, knowledge acquisition. Machine learning – concept of artificial intelligence, conceptual learning, artificial neural networks -biological neuron, artificial neuron, types of neural networks, applications in manufacturing.

UNIT 3 AUTOMATED PROCESS PLANING 9 Hrs.

Automated process planning – variant approach, generative approach, expert systems for process planning, feature recognition, phases of process planning Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design, equipment selection problem, modelling the manufacturing equipment selection problem, problem solving approach in KBSES, structure of the KBSES.

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UNIT 4 GROUP TECHNOLOGY 9 Hrs.

Group technology: models and algorithms – visual method, coding method, cluster analysis method, matrix formation – similarity coefficient method, sorting-based algorithms, bond energy algorithm, cost based method, cluster identification method, extended ci method.

UNIT 5 KNOWLEDGE BASED TECHNOLOGY 9 Hrs.

Knowledge based group technology - group technology in automated manufacturing system, structure of knowledge-based system for group technology (KBSGT) – data base, knowledge base, clustering algorithm.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the structure and functional areas of CIM system
CO2 - Assess the performance of manufacturing systems
CO3 - Develop a systematic approach for design and implementation of manufacturing systems
CO4 - Suggest a new procedure to improve the productivity of existing manufacturing systems
CO5 - Utilize online collaboration tools to work in complex teams.
CO6 - Develop a knowledge-based technology in automated manufacturing systems

TEXT / REFERENCE BOOKS

1 Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, 8th edition, PHI, 2008
2 Yagna Narayana, “Artificial Neural Networks”, PHI, 2009.
3 Andre Kusaic, “ Intelligent Manufacturing Systems”, PHI,1989
4 Hamid R.Parsaei and Mohammad Jamshidi, “Design and Implementation of Intelligent Manufacturing Systems”, PHI, 2009

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3002	AUTOMATION IN MANUFACTURING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide the fundamentals, components and industrial applications of automation.
- To provide the automation facilities offered by automation in machine tools, manufacturing and materials handling.
- To provide basic knowledge of the modern automation systems.

UNIT 1 INTRODUCTION TO AUTOMATION 9 Hrs.

Developments in manufacturing technology, Need of automation, Levels of automation, Strategies, advantages, limitations and applications of automation. Analog-to-digital conversion, Digital-to-analog conversion, Input and output, Numbering systems, Mechanisms and machine elements. Components of a control system, Mathematical characterization and transfer functions, Laplace transforms and system response.

UNIT 2 FUNDAMENTALS OF INDUSTRIAL CONTROLS 9 Hrs.

Review of control theory, logic controls, sensors and actuators, Data communication and LAN in manufacturing. Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.

UNIT 3 AUTOMATION FOR MACHINE TOOLS 9 Hrs.

NC, DNC and CNC machine tools, Indexing mechanisms, Part identification, Automatic tool changers, Automatic assembly transfer systems. NC Programming. Line balancing, Automated assembly, CMM, Machine vision.

UNIT 4 AUTOMATION FOR MATERIALS HANDLING 9 Hrs.

Part identification techniques, Material handling equipment: Conveyors, Industrial vehicles, AGVs, AS/RS, Robot Technology: Robot classification, Parts of robot system and industrial applications.

UNIT 5 MODERN AUTOMATION AND APPLICATIONS 9 Hrs.

Rapid prototyping techniques and applications. Applications of artificial intelligence and expert systems in automation, Industry 4.0: Generations of industrial revolution, Smart manufacturing and Applications. Case studies and automation circuit design for a variety of industrial applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall the fundamentals and control theory of automation systems.

CO2 - Understand the basics components, such as controllers, sensors and actuators used in the automation Systems.

CO3 - Examine various automations systems and techniques used for machine tools and quality testing.

CO4 - Know various automations systems and techniques used for materials handling and storage.

CO5 - Describe various modern automations systems, such as rapid prototyping, artificial intelligence and industry 4.0

CO6 - Apply automation principles for a variety of industrial applications.

TEXT / REFERENCE BOOKS

1. Mikell P. Groover, "Automation, Production Systems, and Computer-integrated Manufacturing", Prentice Hall, 2008.
2. Stamatios Manesis, George Nikolakopoulos, "Introduction to Industrial Automation", CRC Press, 2018.
3. Frank Lamb, "Industrial Automation: Hands On", McGraw Hill Professional, 2013.
4. A.K.Gupta and S.K.Arora, "Industrial Automation and Robotics", Firewall Media, 2007.
5. Shimon Y. Nof, "Springer Handbook of Automation", Springer Science & Business Media, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3003	COMPUTER INTEGRATED MANUFACTURING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To familiarize the student with current trend in production management activities.
- To prepare them to use modern technologies in future management systems.
- To remove all the barriers between all the functions within an operation

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to CAD, CAM, CIM, Types of production, Concurrent engineering, Elements of CIM systems, CIM wheel, CIM components, Needs and Benefits of CIM, NC,CNC, DNC-applications, advantages and disadvantages , Functions of NC, CNC, DNC.

UNIT 2 GROUP TECHNOLOGY AND CELLULAR MANUFACTURING 9 Hrs.

Group technology - Role of G.T in CAD/CAM integration - Part families - Classification and Coding - DCLASS, MICLASS, OPTIZ coding systems - Benefits of GT. Cellular manufacturing -Machine cell design and layout-Quantitative analysis in cellular Manufacturing - Rank order Clustering method.

UNIT 3 COMPUTER AIDED PROCESS PLANNING 9 Hrs.

Approaches to computer aided process planning- Varient approach and generative approach - CAPP. Material Requirement Planning (MRP), Manufacturing Requirement Planning (MRP-II), Inventory control, hop floor control (SFC), Enterprise Resources Planning (ERP).

UNIT 4 FLEXIBLE MANUFACTURING SYSTEM AND AUTOMATED GUIDED VEHICLE SYSTEMS 9 Hrs.

Types of Flexibility-FMS-Components- application and Benefit, FMS Planning and Control, Quantative analysis in FMS. Automated Guided Vehicle (AGV) system -Applications, Vehicle Guidance Technology-Vehicle management and safety.

UNIT 5 MONITORING AND QUALITY CONTROL 9 Hrs.

Types of production monitoring system, process control and strategies, direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques.

CO2 - Formulate competitive priorities and manufacturing strategy for a given production system to derive strategic advantage.

CO3 - Apply MRP and JIT systems for inventory control in production systems.

CO4 - Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc., as they apply to factory management and factory floor operations.

CO5 - Design push and pull systems using the principles of factory dynamics.

CO6 - Design factory systems for shop floor control, production scheduling, aggregate planning and capacity planning.

TEXT / REFERENCE BOOKS

1. Mikell P. Groover. Automation, Production Systems, and Computer-integrated Manufacturing, Pearson, 2018.
2. Radhakrishnan.P, Subramanyan. S, 'CAD/CAM/CIM', New Age International publishers, 2009.
3. James A. Rehg, Henry W. Kraebber, "Computer Integrated Manufacturing' Pearson Prentice Hall, 2001.
4. A. Alavudeen, N. Venkateshwaran, 'Computer Integrated Manufacturing' PHI Learning, 2008.
5. V.D. Hunt, 'Computer Integrated Manufacturing Handbook ', Springer US, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3004	VIRTUAL AND AUGMENT REALITY IN INDUSTRY 4.0	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce augmented reality, the tool of industry 4.0.
- To describe the history and recent developments of AR
- To provide the technological components needed for AR

UNIT 1 INTRODUCTION TO AUGMENTED REALITY 9 Hrs.

History of AR - Augmented reality characteristics – Difference between Augmented Reality and Virtual Reality – AR technological components – Technologies used in AR – Feature Extraction – Hardware components – AR devices – Importance of AR - Real world uses of AR – AR types – Software tools available for AR.

UNIT 2 TECHNOLOGIES NEEDED FOR AUGMENTED REALITY 9 Hrs.

Hardware technology – virtual scenes – 3D objects – AR components – Display – HMD – Eyeglasses – Contact Lenses – significance of AR – AR powered devices – AR application development drawbacks – Compatibility – Performance – AR libraries – Motion tracking – Environmental understanding – Anchors.

UNIT 3 TECHNOLOGY INTEGRATION AND IMPLEMENTATION OF AUGMENTED REALITY 9 Hrs.

Technology use and integration in industrial settings – Assistive training to faculty members – Planning and administration for implementation – AR implications – Practical data – AR labs – Platforms to form AR content – Coordinated utilization of AR application s – Hands-on preparation.

UNIT 4 AUGMENTED REALITY AND VIRTUAL REALITY FOR MICRO LEARNING 9 Hrs.

Micro learning techniques – Utilizing VR for learning – VR for Practical online assessment – VR info graphics – Virtual case considerations - Utilizing AR for learning – Accessible learning – sensible data – elevated learner engagement - VR technology – Components of VR – VR Hardware – VR applications – Civil Engineering – Real Estate – Biology and Medicine – Virtual Mall – VR in Education – Virtual Laboratory – Factory Planning – Automobile Industry.

UNIT 5 TOOLS AND APPLICATIONS OF AUGMENTED REALITY 9 Hrs.

Tools available for Augmented Reality and Recognition – Software Tools – Google Poly – Unity – software approaches – recognition types – native software solutions – ARKit – ARCore – software development kit - Cloud services - AR business applications – weather prediction – market prediction – smart cities - AR application for Education - AR application for Healthcare sector – Agriculture – Civil Engineering – Architecture – Archaeology – Crime and Security – Games – IoT - – Use cases – Social Media – Gaming – Education – Healthcare – Shopping and Business.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the characteristics of AR and VR
CO2 - Describe how VR systems work and list the application of VR
CO3 - Understand the design and implementation of the hardware that enables VR systems
CO4 - Understand the system of human vision and its implication on perception and rendering
CO5 - Explain the concepts of motion and tracking in VR systems
CO6 - Describe the importance of interaction and audio in VR systems.

TEXT / REFERENCE BOOKS

1. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”, 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Meging Real and Virtual Worlds”, 2005.
4. Burdea, Grigore C and Philippe Coiffet, “Virtual Reality Technology”, Wiley Interscience, India, 2003.
5. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3005	DIGITAL MANUFACTURING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn the concept of NC and CNC technologies on practical problems with feedback and adaptive control. To learn the configuration of CNC system, PLC programming for CNC and also case studies on machine structure elements.
- To learn the mechatronics elements in CNC measuring system and tooling system, EEPROM tools, automatic tool changing system, tool magazine and sensors in CNC.
- To learn about the CNC programming tools with computer assisted programming using APT, generation and execution of APT programs.

UNIT 1 INTRODUCTION OF NC, CNC, DNC AND ADAPTIVE CONTROL 9 Hrs.

Classification of machine tools – types, functions and processes - fundamentals of NC and CNC technologies Adaptive control - types, application and benefits - general configuration of adaptive control and function – reasons for process change - practical problems with adaptive control - example for feedback and adaptive control.

UNIT 2 MECHATRONIC ELEMENTS IN CNC MACHINE TOOLS 9 Hrs.

CNC systems - configuration of the CNC system – interfacing – monitoring – diagnostics - machine data - compensations for machine accuracies - PLC in CNC – PLC programming for CNC, steps in programming and case studies - machine structure -types of loads on CNC machine - guide ways and types Mechanical transmission elements - elements for rotary motion to linear motion - ball screw and types - roller screw and types - rack and pinion - various torque transmission elements - requirements of feed drives and spindle drive.

UNIT 3 MECHATRONICS ELEMENT IN CNC MEASURING SYSTEM AND TOOLING 9 Hrs.

Measuring systems - feedback devices - velocity feedback - analog and digital - position feedback - rotary and linear. Tooling - requirement and planning - preset, qualified and semi qualified tools. Fixtures – requirement - unified and modular fixtures - tool identification - touch trigger probe- tool coding - EEPROM tools. Tool condition monitoring - various indirect and direct methods. Identification and gauging of work piece. Tool locking system - ball lock mechanism and contact pressure monitoring. Automatic tool changing system - types and benefits - tool magazine – sensors in CNC.

UNIT 4 CNC PROGRAMMING 9 Hrs.

Machine axes identification - primary, secondary and tertiary - manual CNC programming - Milling programming fundamentals - compensation and offset in milling -fixed cycles in milling - repetitive programming - loops, sub programs and macros. Turning programming fundamentals - compensation and offset in turning - fixed cycles in turning. Computer assisted programming in APT - basic geometry definition - cutter motion definition - postprocessor statements - generation and execution of APT programs.

UNIT 5 TESTING AND MAINTENANCE OF CNC MACHINES 9 Hrs.

Verification of technical specification and functional aspects, Verification during idle running & machine tool and the work piece accuracy - Installation of CNC machines - Maintenance of CNC machines - machine elements – hydraulic elements - electrical and electronic elements – maintenance schedules.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Get the knowledge of the differences of NC, CNC and DNC.

CO2 - Analyze architecture of CNC and to identify the mechatronic elements and its functions in CNC machine reliable performance.

CO3 - Realize the functions of instrumentation systems

CO4 - Write the part programming in CNC machine.

CO5 - Perform the testing and maintenance of various sub systems of CNC

CO6 - Evaluation of computer coding program

TEXT / REFERENCE BOOKS

1. HMT Limited, “Mechatronics”, Tata Mcgraw-Hill Publishing Co Ltd, 2017.
2. Groover, M.P., “Automation, Production System and CIM”, Prentice Hall of India Pvt. Ltd, 2016.
3. Stenerson and Curran, “Computer Numerical Control-Operation and Programming”, PHI Learning Pvt. Ltd., 2008.
4. Jayakumar, V., and Mahendran, B., “Computer Aided Manufacturing”, Lakshmi Publications, 2005.
5. Jonathan Lin, S.C., “Computer Numerical Control (From Programming to Networking)”, Delmar Publishers Inc., 2000.
6. Radhakrishnan, P., “CNC Machine”, New Central Book Agency, 2000.
7. Sehrawatt, M.S., and Narang, J.S., “CNC Machine”, DhanpatRai And Co, 2002. 8. Grahamt.Smith, “Advanced Machining: The Handbook of Cutting Technology”, IFS Publications Ltd., 1989

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMEB3023	ADDITIVE MANUFACTURING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.
- To coordinate the creation of standards related to materials, processes, equipment and finished-part properties
- To study the basic manufacturing processes and tools used.

UNIT 1 INTRODUCTION TO ADDITIVE MANUFACTURING 9 Hrs.

Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Vat Photo polymerization AM Processes: Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, Material Jetting and Binder Jetting AM Processes.

UNIT 2 EXTRUSION - BASED AM PROCESSES 9 Hrs.

Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio Extrusion, Contour Crafting, Process Benefits and Drawbacks,Applications of Extrusion-Based Processes. Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

UNIT 3 POWDER BED FUSION AM PROCESSES 9 Hrs.

Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

UNIT 4 DIRECTED ENERGY DEPOSITION AM PROCESSES 9 Hrs.

Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Materials science for AM – Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship.

UNIT 5 POST PROCESSING OF AM PARTS 9 Hrs.

Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control. Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Introduction to 4D printing and Smart materials used.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principle and process parameters of AM processes
CO2 - Explore the applications of AM processes in various fields
CO3 - Select the suitable material and process for fabricating a given product
CO4 - Apply the knowledge in Material science in Additive Manufacturing Components.
CO5 - Design and develop a product for AM Process.
CO6 - Select a proper material for 4D printing based on the applications

TEXT / REFERENCE BOOKS

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 978-1-4471-0703-3 Published: 06 December 2012
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
4. Amit Bandyopadhyay and Susmita Bose, ―Additive Manufacturing‖, 1st Edition, CRC Press.,United States, 2015
5. Milan Brandt, ―Laser Additive Manufacturing: Materials, Design, Technologies, and Applications‖, Woodhead Publishing., United Kingdom, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3006	SIGNALS AND CONTROL SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge regarding the various types of system and different transfer function analyzing techniques associated with control systems.
- To analyze the response and error of various types of system in time domain.
- To understand the stability analysis of frequency domain systems.

UNIT 1 SYSTEM CONCEPTS 9 Hrs.

Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques

UNIT 2 TIME RESPOSE ANALYSIS OF CONTROL SYSTEMS 9 Hrs.

Standard test signals, Time response of first order and second order systems with unit step as input, Time domain specification, Classification of systems on the basis of Causal/non-Causal, Concept of stability- P, PI, PD and PID controllers.

UNIT 3 FREQUENCY RESPONSE AND STABILITY ANALYSIS OF CONTROL SYSTEM 9 Hrs.

Frequency Response of the System - Condition of BIBO stability in time domain. Correlation between Time and Frequency Response - Gain and Phase Margin - Bode Plot The concept of stability- Routh Hurwitz stability Criterion - Root Locus Analysis.

UNIT 4 CLASSIFICATION OF SIGNALS 9 Hrs.

Continuous time signals (CT signals) and Discrete time signals (DT signals) –Basic operations on signals-elementary signals- Step, Ramp, Pulse, Impulse, Exponential – Classification of CT and DT signals – Periodic, aperiodic signals- Deterministic and Random signals-even and odd signals – Real and Complex signals – Energy and power signals.

UNIT 5 FOURIER & LAPLACE TRANSFORM 9 Hrs.

Continuous time Fourier Transform – Fourier series: Representation of Fourier series in terms of sine, cosine, exponential functions. The complex Fourier spectrum, Properties of Fourier series, convergence of Fourier series, Gibbs phenomenon. Fourier transform of singular functions. Inverse Fourier transform. Unilateral Laplace Transform analysis with examples -Inverse Laplace transform using partial fraction expansion method – Relation between Fourier transform and Laplace transform.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the types of control systems in different domains.
CO2 - Analyze the response of any linear time invariant system.
CO3 - Determine and analyze the stability of the system.
CO4 - Perform the analysis of the control system by Routh Hurwitz and Root Locus.
CO5 - Understand mathematical description and representation of continuous and discrete time signals.
CO6 - Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier transform and Laplace transform.

TEXT / REFERENCE BOOKS

1. I.J.Nagarath and M.Gopal, “Control System Engineering” New Age International (p) Limited Publishers, 2nd Edition, 2009.
2. Kausuhio Ogata, “Modern Control Engineering”, Prentice Hall of India PVT. Ltd, 5th Edition, 2010.
3. Richard Dorf, “Modern Control Systems”, Pearson Education Ltd, 11th Edition 2009.
4. M.N. Bandyo padhyay, “Control Engineering, Theory and Practice” PHI, 4th Print, 2006.
5. N.K.Sinha, “Control Systems”, New Age International Private Limited Publishers, 3rd Edition, 200, reprint 2008.
6. A.Nagoorkani, “Control System”, RBA Publications, 3rd Edition, reprint 2012.
7. U.A.Bakshi and S.C.Goyal, “Control System Engineering”, Technical Publication, 2nd Revised reprint 2007.
8. P.Ramesh Babu et al, ‘Signals and Systems’, 4th Edition, Scitech publishers, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3007	ADVANCED CONTROL THEORY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide a strong concept on the compensator design and on advanced control system analysis and design techniques
- To analyze the behavior of discrete time systems and nonlinear control systems.
- To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.

UNIT 1 CONTROLLERS 9 Hrs.

Types of controller- Feedforward-Feedback-Cascade-P, PI and PID. Compensator design: Realization of compensators – lag, lead and lag-lead -Design of compensator using bode plot.

UNIT 2 COMPENSATOR DESIGN 9 Hrs.

Realization of compensators – lag, lead, and lag-lead. Design of compensator using root locus. Design of P, PI and PID controller using Ziegler-Nichols tuning method.

UNIT 3 STATE SPACE ANALYSIS OF SYSTEMS 9 Hrs.

Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation-controllable, observable, diagonal and Jordan canonical forms- solution of time invariant autonomous systems, forced system-state transition matrix relationship between state equations and transfer function. Properties of state transition matrix-Computation of state transition matrix using Laplace transform-Cayley-Hamilton method. Conversion from canonical form to phase variable form.

UNIT 4 STATE FEEDBACK CONTROLLER DESIGN 9 Hrs.

Controllability & observability. State feed-back design via pole placement technique. Sampled data control system: Pulse Transfer function-Stability of sampled data system -Routh Hurwitz criterion and Jury's test. Introduction to state-space representation of sampled data systems.

UNIT 5 NONLINEAR SYSTEMS & PHASE PLANE ANALYSIS 9 Hrs.

Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through harmonic linearization - Determination of describing function of nonlinearities (relay, dead zone and saturation only) – application of describing function for stability analysis of autonomous system with single nonlinearity. Concepts- Construction of phase trajectories for nonlinear systems and linear systems with static nonlinearities - Singular points – Classification of singular points. Definition of stability- asymptotic stability and instability Liapunov methods to stability of linear and nonlinear, continuous time systems.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design compensators using classical techniques
CO2 - Design of P, PI and PID controller using various methods
CO3 - Computation of state transition matrix
CO4 - State feed-back design via pole placement technique
CO5 - Analyze both linear and nonlinear system using state space methods.
CO6 - Analyze the stability of discrete system and nonlinear system.

TEXT / REFERENCE BOOKS

1. Nagoor A. Kani, Advanced Control Theory, CBS Publishers & Distributors, ISBN 9789389396294, 2020
2. Gibson J. E., F.B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
3. Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
4. Roland Burns, Advanced control engineering, Elsevier Science, ISBN:9780750651004, 2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3008	EMBEDDED PROGRAMMING FOR MECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To impart knowledge on the Building Blocks of Embedded System, Various Embedded Development Strategies,
- To impart knowledge on Bus Communication in processors, Input/output interfacing and processor scheduling algorithms
- To understand Real time operating system

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS 9 Hrs.

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT 2 EMBEDDED NETWORKING 9 Hrs.

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard — RS422 — RS 485 — CAN Bus -Serial Peripheral Interface (SPI) — Inter Integrated Circuits (I2C) –need for device drivers.

UNIT 3 EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT 9 Hrs.

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

UNIT 4 RTOS BASED EMBEDDED SYSTEM DESIGN 9 Hrs.

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication — synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

UNIT 5 EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT 9 Hrs.

Case Study of Washing Machine- Automotive Application- Smart card System Application-ATM machine –Digital camera.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the Structural units in Embedded processor
CO2 - Analyse the internal hardware parts of embedded systems architecture
CO3 - Implement an embedded system for a given Networking application
CO4 - Execute the various Embedded Development Strategies
CO5 - Analyse various processor scheduling algorithms
CO6 - Analyse the basics of Real time operating system application

TEXT / REFERENCE BOOKS

1. Peckol, Embedded system Design, John Wiley & Sons,2010
2. Lyla B Das, Embedded Systems-An Integrated Approach, Pearson, 2013
3. Shibu. K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2017
4. Raj Kamal, Embedded System-Architecture, Programming, Design, Tata McGraw Hill, 2013
5. C.R.Sarma, Embedded Systems Engineering, University Press (India) Pvt. Ltd, 2013 6. Han-Way Huang, Embedded system Design Using C8051, Cengage Learning, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3009	MACHINE VISION AND IMAGE PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision
- To develop Applications using image processing and Machine Vision

UNIT 1 VISION SYSTEM 9 Hrs.

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics-Cameras – Camera-Computer interfaces - Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours.

UNIT 2 OBJECT RECOGNITION 9 Hrs.

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept. values – Applications: Transforming sensor reading, Mapping Sonar Data, aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing.

UNIT 3 IMAGE PROCESSING CONCEPTS 9 Hrs.

Image Processing Concepts: Image Transforms, Image Enhancement, Image Filtering, Colour Image Processing, Image Segmentation; Image Descriptors and Features: Texture Descriptors, Colour Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, Saliency.

UNIT 4 FUNDAMENTALS OF MACHINE LEARNING 9 Hrs.

Fundamentals of Machine Learning: Linear Regression, Basic Concepts of Decision Functions, Elementary Statistical Decision Theory, Parameter Estimation, Clustering for Knowledge Representation, Dimensionality Reduction, Linear Discriminant Analysis.

UNIT 5 APPLICATIONS OF COMPUTER VISION 9 Hrs.

Applications of Computer Vision: Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Auto encoder, Machine Learning Algorithms and their Applications in Image Segmentation, Gesture Recognition, Object recognition, template matching, classification; Object detection and tracking: background modeling, kernel-based tracking, particle filters.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Knowledge or gadgets of vision systems.
CO2 - Ability to understand the image capturing and processing technique
CO3 - Understand various methods for digital image processing and analysis and relate or apply them to different applications.
CO4 - Carry out in-depth analysis of the digital image data with different image data models, pattern recognition algorithms and learning theory
CO5 - Understand the fundamentals Decision Functions, Elementary Statistical Decision Theory
CO6 - Implement various image processing and machine learning algorithms

TEXT / REFERENCE BOOKS

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, WILEY-VCH, Weinheim,2008.
2. Damian m Lyons,“Cluster Computing for Robotics and Computer Vision”, World Scientific, Singapore, 2011.
3. Rafael C. Gonzalez and Richard E.woods, “Digital Image Processing”, Addition – Wesley Publishing Company, New Delhi, 2007.
4. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson Education India, 2015
5. Manas Kamal Bhuyan, Computer Vision and Image Processing - Fundamentals and Applications, CRC Press, 2020
6. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
7. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, 4th Edition, Pearson, 2018

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A : 10 Questions of 2 marks each - No choice **20 Marks**
PART B : 2 Questions from each unit with internal choice, each carrying 16 marks **80 Marks**

SMRB3010	MACHINE FAULT DIAGNOSIS AND SIGNAL PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts in Machine fault diagnosis and Condition Monitoring
- To implement the real time on board diagnostic model in various industrial applications
- To provide students with the state of the art techniques in machinery

UNIT 1 INTRODUCTION 9 Hrs.

Condition Monitoring in manufacturing industries; Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques - Case studies

UNIT 2 SENSORS FOR CONDITION MONITORING 9 Hrs.

Accelerometers, strain gauges, eddy current probes, LVDT for measurement of displacement, velocity and acceleration; Temperature transducers, radiation pyrometers and thermal imaging devices.

UNIT 3 SIGNAL PROCESSING AND ANALYSIS 9 Hrs.

Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions - Time domain and Frequency domain and Time frequency analysis

UNIT 4 FAULT DIAGNOSIS & MAINTENANCE 9 Hrs.

Maintenance Principles, Failure mode analysis - Equipment down time analysis - Breakdown analysis - condition based maintenance. Vibration, Acoustic emission and vibro acoustics signal analysis; intelligent fault detection system, Case studies

UNIT 5 MACHINE LEARNING 9 Hrs.

AI techniques, Supervised, unsupervised and reinforcement Learning Methods, case studies

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify and define the benefits of condition-based monitoring and fault diagnosis
CO2 - Understand the concept of monitoring using sensors
CO3 - Demonstrate understanding in the selection of particular maintenance strategies
CO4 - Define effective signal processing for implementing condition-based monitoring
CO5 - Identify the optimum maintenance strategy for different types of equipment
CO6 - Define the machine learning techniques using various algorithms

TEXT / REFERENCE BOOKS

1. Ethem Alpaydin, Introduction to Machine Learning (2010), The MIT Press, Cambridge, London
2. K. P. Soman, Data mining theory and practice (2006), Prentice-Hall of India.
3. Amiya Ranjan Mohanty , Machinery Condition Monitoring: Principles and Practices (2015), CRC Press
4. Mishra, R.C., Pathak, K., Maintenance Engineering and Management (2012), Prentice Hall of India.
5. Clarence W. De Silva, Sensors and Actuators: Control System Instrumentation (2007), CRC Press Taylor and Francis Group.
6. Boualem Boashash, Time Frequency Signal Analysis and Processing: A Comprehensive Reference (2015), Elsevier.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3011	ADAPTIVE AND PREDICTIVE CONTROL OF MECHATRONICS SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the student familiarize with adaptive and predictive control schemes.
- To learn convex optimization, constrained and unconstrained optimal control.
- To learn Predictive Control formulations, and associated mathematical guarantees on robustness, optimality and recursive feasibility.

UNIT 1 INTRODUCTION 9 Hrs.

Definition of adaptive control system - functions of adaptive control - Different approaches to Adaptive Control - gain scheduling - Relay feedback. Conventional methods of Identifications - step response, impulse response, Bode plot - Identification of linear time-invariant systems

UNIT 2 CLASSIFICATION OF ADAPTIVE CONTROL 9 Hrs.

Definitions - Auto tuning - Types of adaptive control - Recent trends in self-tuning - Robustness studies - Multivariable systems - Model updating - General-purpose adaptive regulator.

UNIT 3 PREDICTIVE CONTROL 9 Hrs.

Limitations of classical control, Optimization-based Control, Origins of PC, applications, Models of dynamic systems, Analysis of Discrete-time Linear Systems, Analysis of Discrete-time Non-linear systems.

UNIT 4 FEASIBILITY AND STABILITY OF MPC 9 Hrs.

Receding horizon MPC, Terminal Conditions, Stability guarantees, Recursive feasibility of MPC, Controlled Invariance, set representations, Reachable & Invariant sets, set computations, Reachability & Controllability, Robust MPC, Reference tracking, Soft constraints, Generalizing MPC.

UNIT 5 EXPLICIT MPC 9 Hrs.

Offline-online control, Multi-Parametric Programming (mpQP, mpLP), Real-time MPC via explicit feedback laws, Computation tool, Uncertainty models, bounded additive noise, Robust open-loop MPC, Hybrid Systems, Optimal Control of Hybrid Systems. Gradient and Newton methods, Preconditioning and convergence, Alternating minimization, Interior point methods, Software, Recent research outcomes - guest lecturer (TBD).

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recognize control problems where Adaptive Control (AC) offers advantages over classical control methods.

CO2 - Formulate constrained optimal control problems as Adaptive Control optimizations, and deploy the correct solvers to obtain sequences of control signals.

CO3 - Recognize control problems where Model Predictive Control (PC) offers advantages over modern optimal control method.

CO4 - Formulate constrained optimal control problems as Predictive Control optimizations, and deploy the correct solvers to obtain sequences of control signals.

CO5 - Verify that closed-loop control with the designed APC has guarantees on stability, optimality, robust constraint satisfaction and recursive feasibility of the underlying optimization.

CO6 - Implement MPC algorithms using the Multi-Parametric Optimization toolbox in MATLAB.

TEXT / REFERENCE BOOKS

1. F. Borrelli, A. Bemporad and M. Morari, “Predictive Control for Linear and Hybrid
2. Systems”, Cambridge University Press, 2017.
3. Yao, B. “Adaptive Control, Lecture Notes”, Purdue University, 2013.
4. N.T Nguyen, Model-Reference Adaptive Control-A Primer by Nguyen, Springer, 2018.
5. Borrelli, Francesco, Alberto Bemporad, and Manfred Morari, Predictive control for linear and hybrid systems. 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3012	ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the various characteristics of intelligent agents
- To understand the different search strategies in AI
- To represent knowledge in solving AI problems and understand the different ways of designing software agents

UNIT 1 INTRODUCTION 9 Hrs.

Introduction -Definition - Future of Artificial Intelligence - Characteristics of Intelligent Agents - Typical Intelligent Agents - Problem Solving Approach to Typical AI problems.

UNIT 2 PROBLEM SOLVING METHODS 9 Hrs.

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems - Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning - Stochastic Games.

UNIT 3 KNOWLEDGE REPRESENTATION 9 Hrs.

First Order Predicate Logic - Prolog Programming - Unification - Forward Chaining-Backward Chaining - Resolution - Knowledge Representation - Ontological Engineering-Categories and Objects - Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information.

UNIT 4 SOFTWARE AGENT 9 Hrs.

Architecture for Intelligent Agents - Agent communication - Negotiation and Bargaining - Argumentation among Agents - Trust and Reputation in Multi-agent systems.

UNIT 5 APPLICATIONS AI 9 Hrs.

Applications - Language Models - Information Retrieval- Information Extraction - Natural Language Processing - Machine Translation - Robot - Hardware - Perception - Planning – Moving.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Define the Characteristics of Intelligent Agents
CO2 - Represent a problem using first order and predicate logic
CO3 - Select appropriate search algorithms for any AI problem
CO4 - Choose the apt agent strategy to solve a given problem
CO5 - Design software agents to solve a problem
CO6 - Design applications for Natural Learning Process that uses Artificial Intelligence.

TEXT / REFERENCE BOOKS

1. Gerhard Weiss, Multi Agent SystemsÃ¢??, Second Edition, MIT Press, 2013.
2. Bratko, Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. David L. Poole and Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010
4. S. Russell and P. Norvig, Artificial Intelligence: A Modern ApproachÃ¢??, Prentice Hall, Third Edition, 2009
5. M. Tim Jones, Artificial Intelligence: A Systems Approach(Computer Science)Ã¢??, Jones and Bartlett Publishers, Inc.; First Edition, 2008
6. https://nptel.ac.in/courses/106105079

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3013	INDUSTRIAL INTERNET OF THINGS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the IoT concepts and standards
- To use various components of IoT system
- To analyze the challenges in IoT implementation

UNIT 1 IOT CONCEPTS 9 Hrs.

IoT – Technologies that led to evolution of IoT – IoT and SCADA – IoT and M2M – IoT and Big Data – International standard – Operating platforms – Communication protocols – Modbus – Profibus – RS485 – RTU – Ethercat.

UNIT 2 COMPONENTS OF IOT SYSTEM 9 Hrs.

Design of IoT systems – Device configuration and addressing – Interfacing IoT sensors and actuators – IoT cloud building blocks – Platform specific dashboard – MQTT Server – Time series database – Data monitoring, visualization and IoT analytics.

UNIT 3 SECURITY IN IOT MQTT vs HTTP 9 Hrs.

Performance – Security considerations – Firmware updates – Cryptography basics – Cryptography in IoT – Privacy considerations and design guidelines – Individual privacy.

UNIT 4 IOT CASE STUDY 9 Hrs.

Lighting as a service – Intelligent traffic systems – Smart parking – smart water management – smart cities – IoT for health services – IoT for OEE evaluation – IoT for Smart Factory and Smart Home Automation.

UNIT 5 CHALLENGES IN IOT IMPLEMENTATION 9 Hrs.

Big data management – Connectivity challenges – Dashboard development challenges – privacy implementation – Mission critical applications. For Further Reading Implementation on two platforms – Amazon IoT cloud – Microsoft Azure basics – Open source IoT platform on local machine.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Get the Knowledge of theory and practice related to Industrial IoT Systems
CO2 - Implement the IoT concepts and its standards.
CO3 - Develop components of IoT system
CO4 - Configure IoT platform for the security and privacy.
CO5 - Apply IoT system for transportation, health care and agriculture.
CO6 - Analyze the challenges in IoT implementation.

TEXT / REFERENCE BOOKS

1. Michael Miller, The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, QUE , 26 March 2015
2. Arsheep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Orient Blackswan Private Limited – New Delhi; First edition, 2015.
3. Srinivasa K. G., Siddesh G. M., Hanumantha Raju R., Internet of Things, Cengage Learning I ndia Pvt. Ltd., 2018.
4. Adrian Mcewen, Hakin Cassimally, Designing The Internet of Things, Wiley, 2015

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	:	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	:	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3014	INDUSTRIAL MACHINE LEARNING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- Determine the factors involved in decision support that can improve business performance across the provider/payer ecosystem
- Identify opportunities for business applications in healthcare by applying journey mapping and pain point analysis in a real-world context
- Identify differences in methods and techniques in order to appropriately apply to pain points using case studies

UNIT 1 ADVANCED MACHINE LEARNING 9 Hrs.

Deep learning for customer services, Chatbot: Deep learning approach, AI powered marketing systems, Deep learning in cyber security, Types of cyber-attacks in banks, Deep learning methods used in cyber security, Deep learning v/s restricted Boltzmann machines, Convolution Neural Networks (CNNs), Recurrent neural networks, Machine learning techniques: Loan underwriting & sentiment/news analysis, Sentiment or news analysis, Current challenges and opportunities: Banking and security domain.

UNIT 2 MACHINE LEARNING IN BANKING AND SECURITIES 9 Hrs.

Role of machine learning in banking sector, Use of AI in banking and finance, Fraud detection, Customer data management, Personalized marketing, Challenges of banking sector and securities, Widely used machine learning algorithms in banking and security, Fraud prevention and detection systems, Rule based and machine learning based approach in fraud detection, Anomaly detection: Ways to expose suspicious transactions in banks, Advanced fraud detection systems, Risk management systems

Case study: Application of machine learning for financial risk management, Credit risk analysis using machine learning classifier, Investment prediction systems

UNIT 3 MACHINE LEARNING IN HEALTHCARE AND LIFE SCIENCES 9 Hrs.

Applications of machine learning in health and life sciences, Role of machine learning in drug discovery, Medical image analysis, Why deep learning for medical image analysis, Neural network and deep learning architecture, Comparisons between architecture of different types of deep learning models, Machine learning in genetics and genomics, Genomics and AI background, Interpreting deep learning models, Predictive medicine: Prognosis and diagnostics accuracy, Predictive medicine: Examples, ML applications in breast cancer diagnosis and prognosis.

UNIT 4 MACHINE LEARNING IN EDUCATION 9 Hrs.

Advantages of machine learning in education, learning analytics, Academic analytics, Action research, Educational data mining, Recommender system, Personalized adaptive learning, Learning analytics process

Case study: Sentimental analysis for student's feedback using ML, Recommender systems in education, Domain model, Learner model, Students classification algorithm, Recommendation model, Case study: Application of ML in predicting students' performance, Proposed methodology, Data description, Sample data sets, Visualization, Selection of machine learning technique.

UNIT 5 MACHINE LEARNING IN MEDIA AND COMMUNICATION 9 Hrs.

Machine learning in communication, media and entertainment, Usage of machine learning in media and entertainment industry, Machine learning techniques for customer sentiment analysis, World embedding's, Sentiment analysis with long short term memory networks, Real-time analytics in

communication, media and entertainment industries, Real time analytics and social media, Deep learning for social media analytics, Recommendations engines, Collaborative filtering, Memory based collaborative filtering, Model based collaborative filtering, Content based filtering, Hybrid recommendation systems, Summary of recommendation systems, Deep learning techniques on recommender systems

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Comprehend advanced concepts of machine learning and deep learning.
CO2 - Analyze concepts of machine learning on banking domain
CO3 - Apply concepts of Machine Learning in Healthcare sectors.
CO4 - Appreciate the various applications in Education sectors.
CO5 - Identify the applications in Media and Communication Sectors.
CO6 - Recognize and apply various machine learning concepts on case studies from different business sectors.

TEXT / REFERENCE BOOKS

1. Application of machine learning in industries, IBM ICE Publications
   Machine Learning Algorithms for Industrial Applications, Studies in Computational Intelligence, Springer Book series,2021.
2. Pedro Larrañaga, David Atienza, Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, Industrial Applications of Machine Learning, ISBN 9780367656874, CRC press, 1st edition, 2020
3. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning, ISBN: 978-0262035613
4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer series in statistics, 2nd edition, 2019, ISBN: 978-0387848570
5. John D. Kelleher, Brian Mac Namee, and Aoife D'Arcy, 13. Fundamentals of Machine Learning for Predictive DataAnalytics: Algorithms, Worked Examples, and Case Studies, MIT press, 1st edition, 2020
6. Drew Conway and John Myles White, Machine Learning for Hackers: Case Studies and Algorithms to Get you Started, First Edition, O'Reilly Media, 2020

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3015	VEHICLE DYNAMICS AND AERO DYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To familiarize with dynamic analysis of vehicles.
- To demonstrate the ability to design a system, component or process to meet the desired needs within realistic constraints.
- To understand the concepts of fluids and its properties.

UNIT 1 CONCEPT OF VIBRATION AND VERTICAL DYNAMICS 9 Hrs.

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Design and analysis of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tire stiffness.

UNIT 2 TIRES 9 Hrs.

Tire forces and moments, Tire structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire-road friction. Test on Various road surfaces. Tire vibration.

UNIT 3 LATERAL DYNAMICS AND LONGITUDINAL DYNAMICS 9 Hrs.

Steady-state handling characteristics. Steady state response to steering input. Testing of handling characteristics. Direction control of vehicles. Roll center, Roll axis, Vehicle underside forces. Stability of vehicle on banked road, during turn. Aerodynamic forces and moments. Equation of motion. Tire forces, rolling resistance, Load distribution for three wheeler and four wheeler. Prediction of Vehicle performance. ABS and stability control

UNIT 4 FLUID PROPERTIES, PUMPS AND TURBINES 9 Hrs.

Properties of fluids–Specific gravity, specific weight, viscosity, compressibility, vapor pressure and gas laws – capillarity and surface tension. Flow characteristics: Impact of jets Centrifugal Pumps, Hydraulic Turbines: Classification of hydraulic turbines – Working principle of Pelton wheel, Francis and Kaplan turbines –velocity triangles- Propeller fundamentals.

UNIT 5 BASIC AERODYNAMICS 9 Hrs.

Types of flow - velocity field and acceleration. Viscous fluid flow - Laminar and turbulent flow. Theory of streamline, Stream function, velocity potential, relation between stream function and velocity potential, circulation. Basic elementary flows– Source, sink, free and forced vortex, uniform parallel flow.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand vibration modes and its problems related to Automobile Engineering.
CO2 - Able to understand how passenger comfort is achieved along with vehicle stability.
CO3 - Ability to design and conduct experiments on tires on different road conditions.
CO4 - Student can able to know working principle of Pumps and Turbine
CO5 - Analyze the fluid properties and flow characteristics
CO6 - Understand the concepts of Aerodynamics.

TEXT / REFERENCE BOOKS

1. Singiresu S. Rao, "Mechanical Vibrations", 6th Edition, Prentice Hall, 2017.
2. Dieter Schramm, " Vehicle Dynamics- Modeling and Simulation", Springer, 2016.
3. Wong. J. Y., "Theory of Ground Vehicles", 5th Edition, Wiley-Interscience, 2013.
4. Hans B Pacejka, "Tire and Vehicle Dynamics", 3rd Edition, SAE International, 2012.
5. John C. Dixon," Tires, Suspension, and Handling", 4th Edition, Society of Automotive Engineers Inc, 2013.
6. Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2013.
7. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", 2nd Edition, Elsevier Limited, 2014
8. NakhaieJazar. G., "Vehicle Dynamics: Theory and Application", 2nd edition, Springer, 2014.
9. Bansal.R.K,". Fluid Mechanics & Hydraulics Machines", 9th Edition, Laxmi Publications, 2010.
10. Kumar, K.L., Fluid Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi,2012.
11. Irving H. Shames, Fluid Mechanics, 3rd Edition, McGraw-Hill, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	:	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	:	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3016	AUTOTRONICS AND VEHICLE AUTOMATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students understand the evolution of electronics in automobiles and basics of charging and starting system
- To acquaint students with various engine control systems.
- To teach the students about various chassis and safety system operation and applications

UNIT 1 INTRODUCTION, IGNITION AND INJECTION SYSTEMS 9 Hrs.

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V and Euro VI standards – Equivalent Bharat Standards, Ignition systems: Ignition fundamentals - Electronic ignition systems – Programmed, Ignition – Distribution less ignition - Direct ignition – Spark Plugs. Electronic fuel, Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT 2 SENSOR AND ACTUATORS 9 Hrs.

Automotive Sensors: Introduction – Working principle of sensors – Throttle position sensors – Manifold pressure sensors – Mass air flow sensors - Engine coolant temperature sensors – Vehicle speed sensors – Crank shaft position sensors – Exhaust gas oxygen sensors. Study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator

UNIT 3 ENGINE AND CHASSIS CONTROL SYSTEMS 9 Hrs.

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU"s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles. Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system

UNIT 4 ELECTRIC, HYBRID VEHICLE AND CONTROL SYSTEMS 9 Hrs.

Electric and Hybrid vehicle introduction, History and development of Electric and hybrid vehicle- System layout – Basic system components – Fuel cell Electric vehicle, Hybrid vehicle: series hybrid vehicle and parallel hybrid vehicle – CNG Electric Hybrid vehicle. Working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars

UNIT 5 VEHICLE INTELLIGENCE 9 Hrs.

Introduction – Basic Structure - Vision based autonomous road vehicle – Architecture for dynamic vision systems – Features applications. An application of mobile robot vision to a vehicle information system – Object detection – Collision warning and advanced systems – Low tire pressure warning systems

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Acquire the basic knowledge in fundamentals of automotive, Ignition and Injection systems.
CO2 - Understand the various types of sensors used in automotive applications.
CO3 - Acquire the knowledge about Engine control systems.
CO4 - Become familiar with advanced comfort and safety systems used in automobiles
CO5 - Acquire the basic knowledge in intelligent technologies applied in modern automotive systems.
CO6 - Draw the architecture for dynamic vision systems

TEXT / REFERENCE BOOKS

1. Smith Manilal Solanki "Autotronics" First Edition, Nirali Prakashan, Pune, India, 2020
2. Heinz Heisler, “Advanced Vehicle Technology”, second edition, Butterworth – Heinemann, New York, 2002.
3. N. K. Giri, “Automobile Mechanics”, Eleventh reprint, Khanna Publishers, Delhi, 2016
4. Ribbens, "Understanding Automotive Electronics", 7th Edition, Elsevier, Indian Reprint, 2013.
5. Tom Denton, “Automotive Electric and Electronic Systems”,3rd Edition, Elsevier, 2004.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3017	ELECTRIC AND HYBRID VEHICLES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the fundamentals concepts, principles of hybrid, electric and fuel cells
- To understand the analysis and design of hybrid, electric and fuel cells
- To understand the basics of battery and its types

UNIT 1 INTRODUCTION TO ELECTRIC VEHICLE 9 Hrs.

Layout of an electric vehicle, performance of electric vehicles – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantages and limitations, specifications, system components, electronic control system.

UNIT 2 HYBRID VEHICLES 9 Hrs.

Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, series and parallel hybrid electric drive train design.

UNIT 3 ELECTRIC DRIVE TRAINS. 9 Hrs.

DC motors, AC motors, permanent magnet motors, brushless DC and reluctance motors, Characteristics, regenerative braking. DC generators, AC generators, voltage and frequency regulations. Control system principles, speed and torque control – DC motors and AC motors.

UNIT 4 ENERGY STORAGES & MODELING OF HYBRID VEHICLES 9 Hrs.

Electrochemical batteries – types of batteries – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power energy efficiency. Ultra capacitors. Modelling of Hybrid Electric Vehicle Range: Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.

UNIT 5 ENERGY MANAGEMENT 9 Hrs.

Energy Management Strategies: energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working of different configuration of electric vehicles.
CO2 - Analyse the hybrid vehicle configuration.
CO3 - Differentiate electric and hybrid vehicles.
CO4 - Understand the properties of batteries and its types.
CO5 - Evaluate the electric vehicle drive systems and hybrid electric vehicles.
CO6 - Design of solar cell and fuel cell.

TEXT / REFERENCE BOOKS

1. Iqbal Hussain, “Electric and Hybrid vehicles Design fundamentals”, CRC press, second edition 2013.
   James Larmine, John Lowry, “Electric vehicle technology explained” second edition, John & Wiley sons 2012.
2. Mehradad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC press, 2010.
3. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Butterworth – Heinemann, 2002.
4. Ronald K Jurgen. “Electric and Hybrid Vehicle – Electric Vehicles”, SAE, 2011.
5. Ron Hodlinson and John Fenton, “Light Weight Electric/Hybrid Vehicle Design”, Butterworth-Heinemann, 1st Edition 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3018	RF IC DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To present the concepts of design and Analysis of modern RF and wireless communication integrated circuits.
- To acquaint the students with the behavior of passive and active electronic components at Radio frequencies
- To familiarize the students in the principles, analysis, and design of CMOS Radio frequency (RF) integrated circuits for wireless communication systems.

UNIT 1 INTRODUCTION 9 Hrs.

RF systems – basic architectures, Transmission media and reflections, Maximum power transfer-Parallel RLC tank, Q Series RLC networks, matching-Pi match, T Match-Interconnects and skin effect-Resistors, capacitors-Inductors-MOS device review

UNIT 2 DISTRIBUTED SYSTEMS 9 Hrs.

Transmission lines, reflection coefficient -The wave equation, examples - Lossy transmission lines-Smith charts – plotting Gamma-Bandwidth estimation using open-circuit time constants-Bandwidth estimation using short-circuit time constants Risetime, delay and bandwidth- Zeros to enhance bandwidth -Shunt-series amplifiers, tuned amplifiers - Cascaded Amplifiers

UNIT 3 NOISE & RF POWER AMPLIFIERS 9 Hrs.

Intrinsic MOS noise parameters-Power match versus noise match - large signal performance, design examples & Multiplier based mixers- Subsampling mixers-Class A, AB, B, C amplifiers- Class D, E, F amplifiers-RF Power amplifier design examples

UNIT 4 VOLTAGE CONTROLLED OSCILLATORS 9 Hrs.

Resonators -Negative resistance oscillators-Linearized PLL models-Phase detectors, charge pumps - Loop filters, PLL design examples Frequency division, integer-N synthesis -Fractional frequency synthesis

UNIT 5 PHASE NOISE & RADIO ARCHITECTURES 9 Hrs.

GSM radio architectures- CDMA, UMTS radio architectures-General Considerations-Circuit examples Thermal noise, flicker noise review- Noise figure

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand passive components at RF frequencies and required circuit theory
CO2 - Interpret the properties of active and passive components at high frequency Applications
CO3 - Develop RF Components and transmission lines used in RF circuit design
CO4 - Design high frequency amplifiers and low noise amplifiers
CO5 - Compare different types of mixers
CO6 - Analyze oscillators and synthesizers at RF frequencies

TEXT / REFERENCE BOOKS

1. Thomas H. Lee, Cambridge, The Design of CMOS Radio-Frequency Integrated Circuits, UK: Cambridge University Press, 2004
2. Phillip E. Allen and Douglas R. Holberg- CMOS Analog Circuit Design Oxford University Press - 3rd Ed., -2011
3. Behzad Razavi, RF Microelectronics, Prentice Hall.
4. Ludwig, Rf Circuit Design, 2nd Ed., Pearson
5 Matthew.M.Radmanesh, "Radio Frequency and Microwave Electronics Illustrated", Pearson, Education, First impression, 2006.
6. D.M.Pozar, "Microwave Engineering", Wiley India Limited, Third Edition, 2007

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3019	MOBILE ROBOTICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the principles of mobile robots and manipulators
- To enhance the understanding of differential-drive robot position, and kinematic constraints of different wheel drives
- To apply the principles of the degree of mobility, steerability, and maneuverability of different wheel drives.

UNIT 1 INTRODUCTION TO MOBILE ROBOTS AND MANIPULATORS AND THEIR LOCOMOTION 7 Hrs.

Introduction: key issues for locomotion; legged mobile robots: leg configurations and stability, examples of legged robot locomotion; Wheeled Mobile Robots: wheeled locomotion-the design space.

UNIT 2 MOBILE ROBOT KINEMATICS 11 Hrs.

Introduction; kinematic models and constraints: representing robot position, forward kinematic models, wheel kinematic constraints: fixed, caster and Omni wheels, robot kinematic constraints, examples: robot kinematic models and constraints.

UNIT 3 MOBILE ROBOT MANEUVERABILITY 9 Hrs.

Degree of mobility, degree of steerability, robot maneuverability; mobile robot workspace: degrees of freedom, holonomic robots, path and trajectory considerations; motion control (kinematic control): open loop control (trajectory following), feedback control.

UNIT 4 MOBILE ROBOT DYNAMICS 9 Hrs.

Introduction, general robot dynamic modeling - Newton-Euler and Lagrange, differential-drive Wheeled mobile robot, three-Wheel omnidirectional mobile robot, four mecanum-wheel omnidirectional robot.

UNIT 5 SENSORS FOR MOBILE ROBOTS 9 Hrs.

Sensor classification, characterizing sensor performance, wheel/motor sensors, heading sensors, ground-based beacons, active ranging, motion/speed sensors, vision based sensors; representing uncertainty: statistical representation, error propagation: combining uncertain measurements.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Differentiate between mobile robots and manipulators
CO2 - Model the forward kinematic equations for various wheel drives
CO3 - Explain degree of maneuverability of various drives and kinematic control concepts
CO4 - Solve equation of motion and dynamic model for various mobile robots
CO5 - Discuss the challenges involved in sensory perception for mobile robots
CO6 - Discuss the active ranging sensor application and explain error propagation and uncertainty in mobile robots.

TEXT / REFERENCE BOOKS

1. Roland Siegwart, Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004.
2. Spyros G. Tzafestas, Introduction to Mobile Robot Control, Elsevier, 2014.
3. Gregory Dudek, Michael Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 2010
4. George A. Bekey, Autonomous Robots, MIT Press, 2005

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3020	BIO-INSPIRED ROBOTICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the biological systems with reference to robotic system
- To develop biologically inspired robotic applications
- To Design and construct a simple Bio-Inspired robot

UNIT 1 FUNDAMENTALS OF TRADITIONAL ROBOTIC MANIPULATORS 9 Hrs.

Fundamentals of traditional robots, History and taxonomy of traditional robots. Different popular robot configurations, Homogenous Transformations, Forward kinematics, Inverse kinematics, and Dynamics of serial manipulators.

UNIT 2 FUNDAMENTALS OF BIOLOGICALLY INSPIRED ROBOTICS 9 Hrs.

Introduction to Bio-inspired robot, Role of biological inspiration in robot design, Bio-inspired Morphologies, Bio-inspired Sensors- Vision sensor, Audition sensor, Touch sensor, Smell sensor, Taste sensor, Internal Sensors.

UNIT 3 BIO-INSPIRED ACTUATORS AND CONTROL SYSTEMS 9 Hrs.

Fundamentals of Bio-inspired Actuators, Comparison of Traditional Actuators and Bio-inspired Actuators, Types of Bio-inspired Actuators – Locomotion, Grasping, Drilling, Bio-inspired Control Architectures- Behavior-Based Robotics, Learning Robots, Evolving Robots, Developing Robots.

UNIT 4 SOFT ROBOTICS AND HARD ROBOTICS 9 Hrs.

Soft Robotics, Structural Difference between Hard and Soft Robots, Bio-inspiration in Soft Robotics, Hydrostatic Skeletons, Muscular Hydrostats, Soft Active Plant Structure, Soft Robots, Actuators, Pneumatic Artificial Muscles, Electroactive Polymers, Shape Memory Alloys.

UNIT 5 DESIGN AND FABRICATION OF BIO-INSPIRED ROBOTICS 9 Hrs.

Energetic anatomy, Collective robotics, Bio hybrid robots. Case studies and mini projects in Design and Fabrication of Biologically Inspired Robots.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the Fundamental of Traditional robotics.
CO2 - Formulate bioinspired motion
CO3 - Understand Bio-inspired Actuators and Control Systems
CO4 - Analyze control architecture and behavior with reference to kinematics
CO5 - Evaluate collective and Bio hybrid robotics / create electromechanical robotic system
CO6 - Design and make a Bio Inspired Robot

TEXT / REFERENCE BOOKS

1. Thomas R. Consi and Barbara Webb, Biorobotics - Methods and Applications, MIT Press, 2001.
2. Yunhui Liu and Dong Sun, Biologically Inspired Robotics, CRC Press, 2012.
3. Ralf Simon King, BiLBIQ: A Biologically Inspired Robot with Walking and Rolling Locomotion, Springer, 2013.
4. Karl Williams, Amphibionics - Build Your Own Biologically Inspired Robot, McGraw-Hill Education, 2003.
5. G. A. Bekey. Autonomous Robots. MIT Press, 2005
6. Karl Williams. Amphibionics: Build Your Own Biologically Inspired Reptilian Robot. McGraw-Hill/TAB Electronics, 2003
7. David Cook. Robot Building for Beginners. Apress, 2002

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3021	PRODUCT DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the principles of generic development process; product planning; customer need analysis for new product design and development.
- To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
- To apply the principles of product architecture and Industrial design for new product development.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, Product Planning, Identifying Customer Needs - organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: establishing target specifications, setting the final specifications.

UNIT 2 BASIC CONCEPTS 9 Hrs.

Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, and reflect on the results and the process. Concept Selection: Overview of methodology, concept screening, and concept scoring. Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process.

UNIT 3 PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN 9 Hrs.

Product development management - establishing the architecture - creation - clustering - geometric layout development.

Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement - management of the industrial design process - technology driven products - user - driven products - assessing the quality of industrial design.

UNIT 4 DESIGN FOR MANUFACTURING AND ECONOMICS 9 Hrs.

Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Product Development Economics: Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.

UNIT 5 PROTOTYPING AND ROBUST DESIGN 9 Hrs.

Prototype basics - Principles of prototyping- Prototype Technologies - Planning for prototypes - Robust design – Seven step process of Robust Design through Design of Experiments- Need and Importance of Intellectual Property.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the generic development process; product planning; customer need analysis for new product design

CO2 - Set product specifications and generate, select, screen, test concepts for new product design and development

CO3 - Establish the product development management Process and Product Architecture

CO4 - Apply the Industrial design process for technology and user driven products.

CO5 - Apply the design for manufacturing principles and the concept of economic principles in new product

CO6 - Apply the Prototyping techniques and Design of Experiment principles to develop a robust design

TEXT / REFERENCE BOOKS

1. Karl T Ulrich and Stephen D Eppinger, “Product Design and Development”, 7th Edition, McGraw Hill, 2020
2. Kevin Otto and Kristin Wood, “Product Design - Techniques in Reverse Engineering and New Product Development”, Pearson Education, 2016.
3. David G Ullman, “The Mechanical Design Process.” McGrawhill Inc Singapore, 2017
4. George E Dieter, Linda C. Schmidt, “Engineering Design”, McGraw Hill Education, 2017
5. Ali Jamnia, “Introduction to Product Design and Development for Engineers”, 1st Edition, Taylor & Francis, 2018

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMEB3026	COMPUTATIONAL FLUID DYNAMICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To understand the flow, temperature field in engineering problems and
- To understand diffusion in mass transfer operations.
- Students can develop a Computational Fluid Dynamics code to solve chemical engineering problems.

UNIT 1 OUTLINE OF CFD AND CONSERVATION LAWS 9 Hrs.

Need of CFD, Problem solving in CFD, Elements of CFD Software, Governing Equations of Fluid flow and Heat Transfer, Mass conservation, Momentum and Energy equation, Differential and Integral forms, Conservation and non-conservationform.

UNIT 2 TURBULENCE MODELLING 9 Hrs.

Transition from Laminar to Turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, Reynolds stress equation models.

UNIT 3 FINITE VOLUME METHODS AND SOLUTIONS 9 Hrs.

Introduction, One dimensional steady state diffusion, Two-dimensional diffusion problems, Discretized equations for diffusion problems, One-dimensional unsteady state heat conduction, Discretization of transient convection-diffusion equation, Solution procedures for unsteady flow calculations, Implementation of Inlet, outlet and wall boundary conditions, Constant pressure boundary condition.

UNIT 4 CFD METHODS 9 Hrs.

CFD Methods for the Eular Equation- Linearization and Jacobian Matrix, Eigen values and Eigenvectors, Flux Splitting Methods. CFD Methods Navier-Stokes Equations-Beam Warming Algorithm, Mac Cormack's scheme, Upwind Techniques.

UNIT 5 GRID GENERATION 9 Hrs.

Structured Grid generation, Unstructured Grid generation, Adaptive Grid generation, Physical aspects, simple and multiple connected regions, grid generation by PDE solution.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the basic concept of CFD and conservation laws in chemical engineering.
CO2 - Ability to develop model for a given fluid flow system.
CO3 - Adapt finite volume techniques for fluid flow and heat transfer models.
CO4 - Apply finite difference method for mass transfer problems.
CO5 - Solve computational fluid flow problems using finite volume techniques.
CO6 - Get familiarized to develop grid generation and analysis of complex fluid-flow systems.

TEXT / REFERENCE BOOKS

1. Anderson, J.D., Computational Fluid Dynamics: The Basics with Applications, 4nd Edition, McGraw Hill International Editions, 2018.
2. Chung T.J., Computational Fluid Dynamics, 2nd Edition, Cambridge University Press, 2018.
3. Fletcher, C.A.J., Computational Techniques for Fluid Dynamics, 3rd Edition Springer Verlag, 2017.
4. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 4th Edition, Pearson Education Ltd., 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	:	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	:	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3022	DRONE TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students to understand the basic concepts of UAV drone systems
- To introduce the stability and control of an aircraft
- To impart introductory knowledge of Drones and their components

UNIT 1 INTRODUCTION TO DRONES 9 Hrs.

Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, applications.

UNIT 2 DESIGN OF UAV DRONE SYSTEMS 9 Hrs.

Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.

UNIT 3 AVIONICS HARDWARE OF DRONES 9 Hrs.

Autopilot, AGL-pressure sensors servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration.

UNIT 4 COMMUNICATION, PAYLOADS AND CONTROLS 9 Hrs.

Payloads, Telemetry, Tracking, controls-PID feedback, radio control frequency range, modems, memory system, simulation, ground test-analysis-trouble shooting.

UNIT 4 NAVIGATION AND TESTING 9 Hrs.

Waypoints navigation, ground control software, System Ground Testing, System In-flight Testing, Future Prospects and Challenges

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Get the knowledge about Unmanned Aircraft Systems
CO2 - Ability to design UAV drone system
CO3 - To understand working of different types of engines and its area of applications.
CO4 - To understand static and dynamic stability dynamic instability and control concepts
CO5 - To know the loads taken by aircraft and type of construction and also construction materials in them
CO6 - Perform the Testing on waypoint navigation, ground control systems

TEXT / REFERENCE BOOKS

1. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 2010. 2. Robert C.
2. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007
4. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998
5. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics.
6. Kimon P. Valavanis • George J. Vachtsevanos, “Handbook of Unmanned Aerial Vehicles”, Springer, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	:	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	:	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3023	DATA ACQUISITION AND VIRTUAL INSTRUMENTATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To impart the concepts of virtual instrumentation.
- To apply concepts of LabVIEW in developing graphical programs.
- To develop skills in data acquisition, instrumentation and control.

UNIT 1 REVIEW OF DIGITAL INSTRUMENTATION 9 Hrs.

Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC.

UNIT 2 INTRODUCTION TO VIRTUAL INSTRUMENTATION AND LAB VIEW 9 Hrs.

Introduction to Virtual Instrumentation and LabVIEW: History of Instrumentation Systems, Evolution of Virtual Instrumentation, Premature challenges, Programming Requirements, Drawbacks of Recent Approaches, Conventional Virtual Instrumentation, Distributed Virtual Instrumentation, Virtual Instrumentation versus Traditional Instruments, Advantages, Basics of LabVIEW, Advantages of LabVIEW, Software Environment, Front panel, Block diagram, Data Flow Programming.

UNIT 3 PROGRAMMING TECHNIQUES 9 Hrs.

VIS & Sub VIS, Loops & Charts, Arrays, Clusters, Graphs, Case & Sequence structures, Feedback Nodes, Formula Nodes, Local and Global Variable, String, State Machines, File Input/output and String Handling.

UNIT 4 DATA ACQUISITION WITH LABVIEW 9 Hrs.

Introduction, transducers, Signals, Signal conditioning, DAQ Hardware configuration, DAQ Hardware, Analog inputs, Analog outputs, counters, Digital I/O, DAQ software architecture, DAQ assistant, interfacing with Assistants, Interfacing Instruments.

UNIT 5 ADVANCED TOPICS IN LABVIEW 9 Hrs.

Inter-process Communication, Other Related Tools (Queue, Semaphore, Rendezvous and Occurrence), Wait for Front Panel Activity, Data Sockets, Programmatically Printing Front Panels, IMAQ Vision.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand Virtual Instrumentation and Lab View
CO2 - Describe various aspects of VI.
CO3 - Comprehend the aspects of VI.
CO4 - Apply the concepts of VI for the given logic.
CO5 - Analyze the software and hardware components of VI.
CO6 - Evaluate the given expression /problem using VI and also develop LabVIEW program for a given application

TEXT / REFERENCE BOOKS

1. Gary Johnson, “LABVIEW Graphical Programming”, McGraw Hill, 2nd Edition,1997.
2. Lisa K. Wells and Jeffrey Travis, “LABVIEW for Everyone”, PHI, 1997.
3. Skolkoff, “Basic concepts of LABVIEW 4”, PHI, 1998.
4. Jerome, Jovitha, “Virtual Instrumentation and LABVIEW”, PHI Learning, New Delhi, 1st Edition, 2010.
5. Sanjay Gupta and Joseph John, ” Virtual Instrumentation using LabVIEW”, Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2005.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3024	INDUSTRY 4.0 AND 5.0 TECHNOLOGIES AND APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand different contributing technologies that enable industry 4.0 and 5.0.
- To make aware of how the industry 4.0 and 5.0 technologies can be applied to diverse applications.
- Learn the design and analysis of Industry 4.0 systems for Energy and various applications.

UNIT 1 INTRODUCTION TO INDUSTRY 4.0 AND 5.0 13 Hrs.

History of industrial revolutions, Industry 4.0: Definition, core values, contributing technologies, and challenges. Industry 5.0: Definition, core values, contributing technologies, and challenges. Industrial internet of things, 5G, Smart sensors, Digital twins and simulations, Augmented reality, Virtual Reality, Computer vision systems, Robotics and automation, 3D Printing, Cloud computing, Cyber security, and Big data analytics.

UNIT 2 INDUSTRY 4.0 FOR DESIGN, MANUFACTURING & FACTORY OPERATIONS 9 Hrs.

Cyber-physical systems, Product development: AR/VR enabled CAD, Customized CAD, Cloud based CAD, Digital twin and live simulation, and Additive manufacturing. Smart Manufacturing: Digital manufacturing, Cloud based manufacturing, IoT based manufacturing, Advanced CNC machines and programming, and Micro electro mechanical systems.

UNIT 3 ADDITIONAL CONTRIBUTING TECHNOLOGIES TO INDUSTRY 5.0 9 Hrs.

Extended reality, Cobots and exoskeletons, Smart sensors and bio-based technologies, Artificial intelligence and machine learning, enhanced additive manufacturing (4D printing), Cloud, cognitive and edge computing, 6G and beyond, Internet of everything, Industrial block chain, Network slicing, Private mobile networks, and Individualized human-machine interaction technologies, Autonomous Vehicles like self-propelled vehicles, drones, and unmanned vehicles.

UNIT 4 INDUSTRY 5.0 FOR MASS PERSONALIZATION, SOCIETY 5.0 AND SDGs 9 Hrs.

Realization of sustainable development goals (SDGs), Society 5.0, and Mass personalization with industry 5.0 technologies, Focus on customer experiences, Hyper-customization, Responsive and distributed supply chain management, Interactive products, Human cyber-physical systems, Collaborative production, Smart and sustainable logistics, Automated accounting, Preventive and predictive maintenance, End-to-end engineering, Mobile and autonomous transportation.

UNIT 6 CASE STUDIES 5 Hrs.

Case studies on the diverse applications of Industry 4.0 and Industry 5.0 like transportation, energy, infrastructure, factory operations, logistics, autonomous mobility, product design, smart cities, smart nation, clean environment, etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the core values, contributing technologies, and challenges of industry 4.0 and 5.0.

CO2 - Justify how different technologies contribute to industry 4.0.

CO3 - Recommend the industry 4.0 technologies to product design, manufacturing, and factory operations.

CO4 - Justify how different technologies contribute to industry 5.0.

CO5 - Recommend industry 5.0 contributing technologies to realize SDGs, Society 5.0 and mass personalization.

CO6 - Prepare a report with the current trends, what industry 4.0 and/or 5.0 technologies can help make these operations smarter, and the benefits and challenges of their implementation for the given case study/ application.

TEXT / REFERENCE BOOKS

1. Uthayan Elangovan, “Industry 5.0: The Future of the Industrial Economy”, CRC Press, 2021.
2. Mahmoud Numan Bakkar and Elspeth McKay, "Advanced Research and Real-World Applications of Industry 5.0", IGI Global Publisher, 2023.
3. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA, 2017.
4. Jean-Claude André, “Industry 4.0: Paradoxes and Conflicts”, Wiley Publications, 2019.
5. Oliver Grunow, “Smart Factory and Industry 4.0. The current state of Application Technologies”, Studylab Publications, 2016
6. Sang C. Suh, U. John Tanik, John N Carbone, and Abdullah Eroglu, “Applied Cyber-Physical Systems”, Springer Publications, New York, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3025	DRIVING ASSISTANCE SYSTEMS AND AUTONOMOUS VEHICLES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students to understand the basic concepts of Advances Driving Assistance Systems
- To make the students to the latest sensors used in Autonomous vehicles
- To get the knowledge on Future -Integration of ADAS Technology into Vehicle Electronics

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to the Concept of Automotive Electronics, Automotive Electronics Overview- History & Evolution -Infotainment, Body, Chassis, and Powertrain Electronics -Advanced Driver Assistance Electronic Systems.

UNIT 2 SENSOR TECHNOLOGY FOR ADVANCE DRIVER ASSISTANCE SYSTEMS 9 Hrs.

Basics of Radar Technology and Systems - Ultrasonic Sonar Systems- Lidar Sensor Technology and Systems - Camera Technology - Night Vision Technology -Other Sensors - Use of Sensor Data Fusion - Integration of Sensor Data to On-Board Control Systems

UNIT 3 ADAVANCED DRIVER ASSISTANCE SYSTEMS TECHNOLOGY 9 Hrs.

Basics of Theory of Operation-Applications – Legacy -Applications – New -Applications - Future - Integration of ADAS Technology into Vehicle Electronics - System Examples - Role of Sensor Data Fusion.

UNIT 4 AUTONOMOUS VEHICLES & VEHICLE PROGNOSTICS TECHNOLOGY 9 Hrs.

Driverless Car Technology -Moral, Legal, Roadblock Issues - Technical Issues - security issues monitoring of vehicle components - basic maintenance - end-of-life predictions -advanced driver assistance system sensor alignment and calibration

UNIT 5 MAINTENANCE OF ADAS WITH EXAMPLES 9 Hrs.

Failure Modes – Self Calibration • Sensor Testing and Calibration • Redundant Systems • Standard Manufacturing Principles, Toyota, Nissan, Honda, Hyundai • Volkswagen, BMW, Daimler • Fiat Chrysler Automobiles • Ford, General Motors

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Become familiar with the various types of advanced driver assistance systems
CO2 - Analyse the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles.
CO3 - Understand the concept of remote sensing and the types of sensor technology needed to implement remote sensing
CO4 - Create the fundamental theory of operation of electronic control systems
CO5 - Apply the fundamentals of on-board vehicle networks
CO6 - Identify the failure modes, sensor testing and calibration of various vehicle

TEXT / REFERENCE BOOKS

1. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006
2. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003.
3. Romil Rawat, A. Mary Sowjanya, Syed Imran Patel, Varshali Jaiswal, Imran Khan, Allam Balaram Autonomous Vehicles Volume 1: Using Machine Intelligence Print ISBN:9781119871958 |Online ISBN:9781119871989 |DOI:10.1002/9781119871989© 2023 Scrivener Publishing LLC
4. Yan Li, Hualiang Shi, Advanced Driver Assistance Systems and Autonomous Vehicles, Springer 2022
5. Lentin Joseph, Amit Kumar Mondal, Autonomous Driving and Advanced Driver-Assistance Systems (ADAS), Applications, Development, Legal Issues, and Testing, https://doi.org/10.1201/9781003048381, CRC Press, 1st edition 2021

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3026	BIOMECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To characterize and relate the behaviors of skeletal and muscular systems for engineering solutions.
- To design artificial structural elements for replacements.
- To simulate and develop the applications of bio-mechatronics.

UNIT 1 BIOMECHANICS 9 Hrs.

Introduction to Bio-Mechanics, Relation between Mechanics and Medicine, Newton's Laws, Stress, Strain, Shear Rate, Viscosity, Visco-Elasticity, Non-Newtonian Viscosity, Soft Tissue Mechanics, Mechanical Properties of Soft Biological Tissues - Bio Fluid Mechanics - Introduction to Bio mechatronic Systems

UNIT 2 MECHANICS IN SKELETAL AND MUSCULAR SYSTEM 9 Hrs.

Bones, Types and Functions - Axial and Appendicular Skeleton. Joints: Definition, Types and Functions, Mechanical Properties of Bones. Kinetics and Kinematics Relationship of Skeletal and Muscular System.

UNIT 3 CONTROL MECHANISM OF BIOLOGICAL SYSTEMS 9 Hrs.

Skeletal Muscles Servo Mechanism, Cardio Vascular Control Mechanism, Respiratory Control Mechanism – Interfacing Techniques with Natural Servo Mechanism.

UNIT 4 PROSTHETIC AND ORTHOTIC DEVICES 9 Hrs.

Analysis of Force in Orthopaedic Implants, Hand and Arm Replacement, Different Types of Models for Externally Powered Limb Prosthetics, Lower Limb, Upper Limb Orthotics, and Material for Prosthetic and Orthotic Devices, Functional Electrical Stimulation, Sensory Assist Devices. Exoskeletons, Exo musculatures, Space Suits, Physical Therapy and Rehabilitation, Wheelchairs and other Mobility Assistance.

UNIT 5 SIMULATION AND MODELLING OF BIOMECHANTRONICS 9 Hrs.

Physics-Based Modelling and Simulation of Biological Structures - Variables of Interest – Geometry - Introduction to Model the Skeletal System Using Open Source Software – Human Leg Prosthesis And Normal Gait vs. Prosthesis Leg Analysis - Upper Extremity Kinematic Model – Application in Sports, exercise, entertainment.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Know the fundamentals of biomechanics.
CO2 - Describe and relate the behaviors of skeletal and muscular systems
CO3 - Realize the servomechanism of biological systems for bio mechatronics development.
CO4 - Design the artificial bio Mechatronics systems.
CO5 - Establish and develop the applications of bio mechatronics.
CO6 - Evaluation and simulation of the bio model

TEXT / REFERENCE BOOKS

1. Dawson. D and Right, “Introduction to Bio-mechanics of Joints and Joint Replacement”, Mechanical Engineering Publications Ltd., 1989.
2. Susan J.Hall, “Basics Bio-Mechanics”, McGraw-Hill, 2002.
3. Gillian Pocock & Christopher D.Richards, “The Human Body”, Oxford University Press, 2009.
4. Jacob Segil, “Handbook of Biomechatronics”, Acadamic Press, 2018.
5. Marko Popovic, Biomechatronics, Academic Press, 2019.
6. Scott L. Delp., “OpenSim: Open-Source Software to Create and Analyze Dynamic Simulations of Movement”, IEEE Transaction on Biomedical Engineering, Vol.54 No.11, 2007

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3027	UNMANNED AERIAL SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn and understand the various components of UAVs. .
- To impart knowledge on maintenance of drone equipment.
- To understand the various regulatories and regulations.

UNIT 1 INTRODUCTION TO UNMANNED AERIAL VEHICLES (UAV) 9 Hrs.

Overview and background: history of UAVs, classifications of UAVs, lift generation method. Contemporary applications like military, government and civil areas. Operational considerations like liability / legal issues, ethical implications LOS / BLOS.

UNIT 2 UNMANNED AERIAL SYSTEM (UAS) COMPONENTS 9 Hrs.

Platforms - configurations - characteristics – applications. Propulsion: internal combustion engines, turbine engines, electric systems. On-board flight control – Payloads: sensing/surveillance, weaponized UAS and delivery. Communications: command/control, telemetry. Launch/recovery systems - Ground control stations.

UNIT 3 BASIC CONCEPTS OF FLIGHT 9 Hrs.

Aerodynamics: lift, weight, thrust, and drag. Flight performance: climbing vs. gliding flight, range / endurance - Stability and control: flight axes, flight controls, autopilots. Emergency identification and handling - Fixed wing operations: Types of fixed wing drones, make, parts, terminology and operation.

UNIT 4 DRONE EQUIPMENT MAINTENANCE 9 Hrs.

Maintenance of drone, flight control box - Maintenance of ground equipment- batteries - Scheduled servicing - Repair of equipment - Fault finding and rectification - Weather and meteorology.

UNIT 5 REGULATORIES AND REGULATIONS 9 Hrs.

Homeland regulatories: FCC, FAA and foreign regulatory. Regulations: FCC compliance, UAS registration, Federal Aircraft Regulations (FARs) - Safety considerations

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand and familiarize the basic concepts on UAVs
CO2 - Select and choose the components of UAV
CO3 - Understand the basic concepts of flight
CO4 - To maintain the drone equipment.
CO5 - To understand various regulatories and regulations.
CO6 - Finding fault and safety precautions

TEXT / REFERENCE BOOKS

1. Paul Fahlstrom, Thomas Gleason, “Introduction to UAV Systems”, 4th edition, John Wiley & Sons, 2012.
2. Randal W. Beard and Timothy W. McLain, “Small Unmanned Aircraft: Theory and Practice “, Princeton University Press, 2010.
3. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, CRC Press, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3028	MECHATRONICS IN AERO SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn about the aircraft system and its automation requirements.
- To learn about various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
- To learn about GPS and other navigation techniques used in aircraft.

UNIT 1 OVERVIEW OF AIRCRAFT ENGINEERING 9 Hrs.

Aircraft Systems Engineering Overview - Concept Map - The Seven Steps Systems Engineering - Conceptual System Design - Fundamentals - Components of an Airplane - Functions - Motions of a Plane - Components of a Helicopters - Functions Helicopters. Types of Aerial Vehicles – functions – Unmanned aerial vehicles - Quadcopter – Drone – Micro Aerial Vehicles.

UNIT 2 SENSORS AND MEASUREMENTS 9 Hrs.

Sensors – Gyroscope - Rate Gyros - Rate Integration and Free Gyro, Vertical and Directional Gyros, Laser Gyroscopes, Accelerometers. Direct Reading Compass, Classification of Aircraft Instruments - Engine Power and Control Instruments - Measurement of RPM, Manifold Pressure, Torque, Exhaust Gas Temperature, EPR, Fuel Flow, Engine Vibration, Monitoring Air Data Instruments - Airspeed, Altitude, Vertical Speed Indicators. Static Air Temperature, Angle of Attack Measurement - Instrument Displays Panels and Cockpit Layout.

UNIT 3 MECHANISMS AND ACTUATORS 9 Hrs.

Types of Actuation Systems - Linear and Non-Linear Actuation System, Valves, Modelling of Actuation Systems, Flight Control - Landing Gear - Brake Actuation - Servo-Loop Analysis Actuator Design - Testing Methodologies, Performance Testing Equipment's for Sensors and Actuation Systems

UNIT 4 STABILITY AND CONTROL 9 Hrs.

Automatic Flight Control Systems – Auto Pilot – Longitudinal – Lateral - Fly-By-Wire Flight and Digital Fly-By-Wire Flight Control Systems - Elements, Architecture, System Design. Longitudinal and Lateral Control Law Design - Back Stepping Algorithm – Active Control Technology 60

UNIT 5 NAVIGATION 9 Hrs.

Introduction to Navigation – Types – Inertial Navigation Systems - Radio Navigation - Approach and Landing Aids - Ground Controlled Approach System – Surveillance Systems-Radio Altimeter – GPS - Integration of GPS and INS.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the aircraft system and its automation requirements.
CO2 - Study about various sensors, measurement, actuators, navigation systems and its control of aircraft systems.
CO3 - Understand various actuators and other mechanisms related to aircraft.
CO4 - Understand the stability and control of an aircraft.
CO5 - Understand about GPS and INS
CO6 - Application of GPS and other navigation techniques used in aircraft.

TEXT / REFERENCE BOOKS

1. Collinson R.P.G, _Introduction to Avionics, Chapman and Hall, India, 1996.
2. Ian Moir and Allan Seabridge, Aircraft Systems Mechanical, electrical, and avionics subsystems integration, John Wiley & Sons Ltd, 2009.
3. Jane‘s Unmanned Aerial Vehicles and Targets, Jane‘s Information Group; ASIN: 0710612575, 1999.
4. Nelson R.C _Flight stability & Automatic Control, McGraw Hill, 1989.
5. Pallet, E.H.J. Aircraft Instruments & Integrated systems, Longman Scientific and Technical, McGraw-Hill, 1992.
6. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
7. Stevens B.L & Lewis F.L, Aircraft control & simulation, John Wiley Sons, New York, 1992.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	:	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	:	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3029	HAPTICS AND AUGMENTED REALITY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the structure of haptic system and to aware the tele-operation for various applications.
- To acquire the knowledge on modelling for haptic system development relevant to the human.
- To emphasize the significance of knowledge in virtual and augmented reality.

UNIT 1 INTRODUCTION TO HAPTICS 9 Hrs.

Definition - Importance of Touch - Tactile Proprioception - Tactual Stereo Genesis - Kinesthetic Interfaces - Tactile Interfaces - Human Haptics - Overview of Existing applications - Basics of Force Feedback Devices - Kinesthetic Vs. Tactile Haptic Devices - Configurations of Kinesthetic Devices - Types of Kinesthetic Devices.

UNIT 2 KINESTHETIC HAPTIC DEVICES AND TELEOPERATION 9 Hrs.

Mechatronics in Haptics System - Haptic Kinematics - Haptic Dynamics - Existing Kinesthetic Devices - Haptic Device Static Rendering - Haptic Device Dynamic Rendering - Control of Haptic Devices - Stability Analysis of Haptic Devices - Stability Analysis of the Rendered Model -Passivity of the Rendered Model. Types of Sensors - Measurement of Haptic Parameters - Types of Actuators - Genesis of Tele-Operation - Tele-Operation Controllers -Tele-Operator Transparency - Stability Analysis of Tele-operator - Tracking and Transparency - Surface Haptic - Exogenous Force Inputs.

UNIT 3 HUMAN HAPTICS ITS PLATFORM 9 Hrs.

Introduction - Types of Haptic Sensing - Active vs. Passive Touch – Mechano reception Mechano receptive Afferents - Kinesthetic Sensing - Force Sensing and Proprioception Introduction to Psychophysics - Measurement Thresholds - Laws of Psychophysics - Weber's Law - Fechner's Law - Fitt's Law - Psychophysical Methods of Limit, Constant Stimuli and Adjustment - Introduction to Virtual Reality Modelling Language (VRML) – Open Haptic Platform - OpenGL- Virtual Environment Manager - Modelling of Simple Haptic System.

UNIT 4 VIRTUAL AND AUGMENTED REALITY 9 Hrs.

The Reality – Virtuality Continuum - Virtual Reality Definitions - Software, Hardware, Sensation and Perception - Multi-Modal Interaction Challenges - System Architecture of Virtual Reality. Aspects of Geometrical Modelling and Environmental Modelling General Solution for Calculating Geometric & Illumination Consistency in the Augmented Environment. Usability Guidelines - Design and Implementation of an Immersive User Experience - Case Study for VR and AR.

UNIT 5 MIXED REALITY 9 Hrs.

System Architecture of a Mixed Reality System - Common Interaction Techniques for Mixed Reality Environments - Common Navigation Techniques - Common Interface for MR - Menu Design Directions - Haptic Control Panel - Performance of an Interaction Techniques, Advanced Interaction Techniques, Design and Implementation of an Immersive User Experience - Case Study for MR.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recognize the haptic technology and its concepts in various haptic systems.
CO2 - Classify the elements of haptics system and tele-operation in detail.
CO3 - Design and use the devices in human haptic applications.
CO4 - Combine and build the virtual and augmented reality-based models.
CO5 - Develop the design and model the hardware of mixed reality.
CO6 - Analyze the design model with augmented reality

TEXT / REFERENCE BOOKS

1. Burdea, G. C. and P. Coffet. “Virtual Reality Technology”, Wiley-IEEE Press, 2006.
2. Eckehard Steinbach et al, “Haptic Communications”, Vol. 100, 4:937-956, 2012
3. Hannaford B and Okamura A. M “Haptics: Handbook of Robotics”, Springer, pp. 718-735, 2008.
4. Kenneth Salisbury, Francois Conti and Federico Barbagli, “Haptic Rendering: Introductory Concepts”, pp. 24 -32, 2004.
5. Jean-Pierre Bresciani, Knut Drewing and Marc O. Ernst. “Human Haptic Perception and the Design of Haptic-Enhanced Virtual Environments: The Sense of Touch and Its 67 Rendering”, STAR 45, pp. 61–106, 2008.
6. MacLean K. E, “Haptic Interaction Design for Everyday Interfaces: Reviews of Human Factors and Ergonomics”, 4:149194, 2008.
7. Weir D. W and Colgate J. E “Stability of Haptic Display: Haptic Rendering: Foundations, Algorithms, and Applications”. AK Peters, 2008.
8. Sherman, William R. and Alan B. Craig. “Understanding Virtual Reality – Interface, Application, and Design”, Morgan Kaufmann, 2002.
9. Yuichi Ohta, Hideyuki Tamura, “Mixed Reality: Merging Real and Virtual Worlds”, Springer-Verlag, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3030	BATTERY MANAGEMENT SYSTEM	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To introduce learner to batteries, its parameters, modelling and charging requirements.
- To develop battery management algorithms for batteries
- Learn to keep the battery within the safety operation region in terms of voltage, current, and temperature.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.

UNIT 2 BATTERY MANAGEMENT SYSTEM REQUIREMENT 9 Hrs.

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power.

UNIT 3 BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION, CELL BALANCING 9 Hrs.

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing.

UNIT 4 MODELLING AND SIMULATION 9 Hrs.

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs

UNIT 5 DESIGN OF BATTERY BMS 9 Hrs.

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the role of battery management system
CO2 - Identify the requirements of Battery Management System
CO3 - Interpret the concept associated with battery charging / discharging process
CO4 - Calculate the various parameters of battery and battery pack
CO5 - Design the model of battery pack
CO6 - Modelling and simulation of an electric vehicle

TEXT / REFERENCE BOOKS

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3031	TOTAL QUALITY MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To facilitate the understanding of Quality Management principles and process.
- The required skill, understanding and confidence to partake in and play a significant role in the implementation of a total quality management system in the organization, in turn supporting career growth and progression.
- The necessary confidence and knowledge to train other professionals on total quality management,

UNIT 1 INTRODUCTION TO QUALITY MANAGEMENT 9 Hrs.

Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality.

UNIT 2 PRINCIPLES AND PHILOSOPHIES OF QUALITY MANAGEMENT 9 Hrs.

Overview of the contributions of Deming, Juran Crosby, Masaaki Imai, Feigenbaum, Ishikawa, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

UNIT 3 STATISTICAL PROCESS CONTROL AND PROCESS CAPABILITY 9 Hrs.

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed. Process capability – meaning, significance and measurement – Six sigma concepts of process capability.Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve.Total productive maintenance (TMP) – relevance to TQM, Terotechnology. Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations.

UNIT 4 TOOLS AND TECHNIQUES FOR QUALITY MANAGEMENT 9 Hrs.

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Bench marking and POKA YOKE.

UNIT 5 QUALITY SYSTEMS ORGANIZING AND IMPLEMENTATION 9 Hrs.

Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the various approaches of TQM
CO2 - Infer the customer perception of quality
CO3 - Analyze customer needs and perceptions to design feedback systems.
CO4 - Apply statistical tools for continuous improvement of systems
CO5 - Develop and use common charting methods for problem solving and data collection.
CO6 - Apply the tools and techniques of quality management to manufacturing and services processes

TEXT / REFERENCE BOOKJS

1. Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
2. Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
3. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
4. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3032	COLLABORATIVE ROBOTICS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To know the fundamentals of Collaborative Robotics
- To introduce Swarm robot and trajectory planning for Swarm
- To introduce Modular Robotics and its Mechanics

UNIT 1 INTRODUCTION TO COBOTICS 9 Hrs.

Collaborative Robotics- Properties - Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT 2 SWARM ROBOTICS 9 Hrs.

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT 3 MODULAR ROBOTICS 9 Hrs.

Module Designs - Modular Robot Representation -Modular Serial Robot Kinematics – Kinematic Calibration for Modular Serial Robots- Modular Serial Robot Dynamics - Modular Parallel Robot Kinematics

UNIT 4 NATURALLY INSPIRED COLLABORATION 9 Hrs.

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model, Majority Rule , Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Socio physics and Contrarians.

UNIT 5 RECONFIGURABLE ROBOTS 9 Hrs.

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage - Reconfigurable Formation Control of Multi-Agents – Self Assembly Modular Robot Platform Based on Sambot - Swarm Dynamics Emerging from Asymmetry.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Gain knowledge about various types of robots and their applications
CO2 - Recognize the fundamentals of Collaborative Robotics
CO3 - Apply Swarm robot's technology in real time applications
CO4 - Analyze and select the suitable concept of Modular Robotics and its Mechanics for modelling a collaborative robot
CO5 - Create various Natural models for robot collaboration
CO6 - Develop collaborative robots for various requirement in industrial tasks.

TEXT / REFERNCE BOOKS

1. Guilin Yang, I-Ming Chen, “Modular Robots: Theory and Practice”, Springer, 2022.
2. GiandomenicoSpezzano, “Swarm Robotics”, Applied Sciences, MDPI, 2019.
3. Heiko Hamann, “Collective Decision-Making in Swarm Robotics: A Formal Approach”, Springer, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3033	ADVANCED ROBOTIC MATERIALS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To extend the knowledge and skills of students in designing and developing autonomous machines and researching
- To provide the necessary knowledge and skills in order for a student to be fully capable of designing a simple and functional robot.
- To learn the testing and characterization of different robotic materials

UNIT 1 ADVANCED METALLIC MATERIALS 9 Hrs.

Fundamental principles of advanced materials and application of advanced materials to robotics using a multidisciplinary science-based approach. Liquid-solid Transformation-Nucleation and kinetics of growth, interface morphologies, non-equilibrium freezing, segregation. Nucleation in the solid state transformations, diffusion in solid state, diffusion equations for steady state and transient conditions, Strengthening methods and mechanisms.

UNIT 2 STRUCTURAL MATERIALS FOR ROBOTS 9 Hrs.

Aluminium, copper, magnesium, steel, nickel and titanium alloys. Recent advances in materials development- Hi-Entropy alloys, functionally gradient materials, shape memory alloys, metallic composite for soft robotics, computational metamaterials

UNIT 3 COMPOSITES IN ROBOTICS 9 Hrs.

Types of matrices and reinforcements, principles, properties and applications, stretchable elastomeric sensor and ionic polymer for robotics, kevlar, biodegradable smart materials, macroscopic composites, three-dimensional, periodic cellular architecture. Special processing techniques of material for robotics.

UNIT 4 MATERIAL TESTING 9 Hrs.

Introduction to thin film sand sensor material, energy material and refractory materials, Mechanical, Chemical and Thermal Methods

UNIT 5 MATERIALS CHARACTERIZATION TECHNIQUES FOR ADVANCED AND ROBOTIC MATERIAL 9 Hrs.

Metallurgical, chemical and thermal methods Scanning electron microscopy, transmission electron microscopy and energy dispersive analyses, X-ray diffraction, atomic force microscopy, Field array NDT techniques for futuristic materials, surface patterning techniques

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Gain knowledge about Advanced metallic materials used in Robots
CO2 - Gain knowledge about Composite materials used in Robots
CO3 - Gain knowledge about thermodynamics of nucleation and strengthening mechanisms
CO4 - Analyze metallic, functional and polymer materials and its processing
CO5 - Acquire knowledge in high performance materials and techniques for robotics
CO6 - Analyze structure properties, and performance using advanced material characterization techniques.

TEXT / REFERENCE BOOKS

1. Bhushan Bharat, “Springer Handbook of Nanotechnology”, Springer, 2017
2. SohelRana and Raul Fangueiro, “Advanced Composite Materials for Aerospace Engineering: Processing, Properties and Applications”, Woodhead Publishing, 2016.
3. Rowe Jason, “Advanced Materials in Automotive Engineering”, Woodhead Publishing, 2016.
4. Cantor Brian, Hazel Assender and Patrick Grant, “Aerospace Materials”, CRC Press, 2015.
5. Park Joon and Roderic S. Lakes, “Biomaterials: an Introduction”, Springer Science & Business Media, 2007. Cao Guozhong, “Nanostructures &Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB3034	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices, display devices and power semiconductors.
- To understand the mechanisms of current flow in semi-conductors and special semiconductor devices.
- To acquire the knowledge of equivalent circuits of amplifiers and oscillators.

UNIT 1 PN JUNCTION DEVICES 9 Hrs.

PN junction diode- construction and operation, Applications- Rectifiers- Half Wave and Full Wave Rectifier, Clipper and Clamping Circuits, Zener diode- construction and VI characteristics. LED, Laser diodes, LDR, Photo transistor. Solar cell, CCD.

UNIT 2 TRANSISTORS & SEMICONDUCTOR DEVICES 9 Hrs.

Bipolar junction transistors, Construction of CB, CC, and CE transistors. Input and Output characteristics of Emitter configuration, Base configuration and Collector configuration. FET parameters, FET as voltage variable resistor, comparison of BJT and FET -SCR, DIAC, TRIAC, UJT Thyristors and IGBT–Structure and characteristics.

UNIT 3 AMPLIFIERS 9 Hrs.

Hybrid model- Analysis of CE, CC and CB amplifiers using Hybrid equivalent circuits to obtain gain, input impedance and output impedance- Approximate Model- Analysis of CE, CC and CB amplifiers using Approximate model equivalent circuits to obtain gain, input impedance and output impedance - General filter consideration, Inductor Filter, capacitor filter, L-Section filter, multiple L-C section, RC filter.

UNIT 4 5 MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9 Hrs.

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – FET as common source amplifier, FET as common drain amplifier.

UNIT 5 FEEDBACK AMPLIFIERS AND OSCILLATORS 9 Hrs.

Advantages of negative feedback – voltage / current, series, Shunt feedback —Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the knowledge of basic semiconductor materials; understand the fabrication processes
CO2 - Analyze the characteristics of various electronic devices like diode, transistor etc.
CO3 - Classify and analyze the various circuit configurations of Transistor and MOSFETs.
CO4 - Acquire knowledge of simple BJT circuits design and implement circuits with transistor biasing
CO5 - Compare the frequency response characteristics of BJT and FET amplifiers.
CO6 - Apply the knowledge of feedback concepts and understand oscillators.

TEXT / REFERENCE BOOKS

1. Donald A Neaman, ―Semiconductor Physics and Devices, 4th Edition, Tata Mc GrawHill Inc. 2012.
2. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, ―Electronic Devices and circuits, 3rd Edition, Tata McGraw- Hill, 2008.
3. David Bell, "Fundamentals of Electronic Devices and Circuits", 5th Edition, Oxford University Press 2012.
4. Millman J and Halkias .C, Integrated Electronics, TMH, 2nd Edition 2017.
5. S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, Electronic Devices and Circuits, TMH, 2nd Edition, 2017.
6. Donald. A. Neamen, Electronic Circuits Analysis and Design, Mc Graw Hill Education (India) Private Ltd., 3rd Edition, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB4001	INTRODUCTION TO MECHATRONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To create a strong base on the various sensors and transducers in mechanical system.
- To learn interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems
- To design control system for computer application like CNC

UNIT 1 INTRODUCTION 9 Hrs.

Mechatronics: Definition, introduction to mechatronics, review of basic electronics and Key Issues - Evolution - Elements - Mechatronics Approach to Modern Engineering, Industrial design and safety Design.

UNIT 2 SENSORS AND TRANSDUCERS 9 Hrs.

Introduction and background, difference between transducer and sensor, transducers types, transduction principle, photoelectric transducers- thermistors, thermos devices, thermocouple, inductive transducers capacitive transducers, piezoelectric transducers, piezoelectric transducers. Hall Effect transducers, Fiber optic transducers, Signal Processing - Data Display

UNIT 3 ACTUATION SYSTEMS 9 Hrs.

Introduction to Mechanical Types and Electrical Types - Pneumatic & Hydraulic Systems - Applications - Selection of Actuators, Actuators for mechatronic applications, Kinematics of robot manipulator links.

UNIT 4 DIGITAL AND CONTROL SYSTEMS 9 Hrs.

Digital logic neuron system, Types of Controllers - Programmable Logic Controllers - applications - ladder diagrams - Microprocessor Applications in Mechatronics: Temperature measurement system, Domestic washing machine - Programming Interfacing - Computer Applications: CNC drilling machine

UNIT 5 RECENT ADVANCES 9 Hrs.

Digital electronics, basic logic functions, logic gates, logic ICs, Biomedical robotics and applications, Manufacturing Mechatronics - Automobile Mechatronics - Medical Mechatronics - Office Automation – Case Studies

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the approach of Mechatronics to engineering concepts
CO2 - Classify the different types of sensors, transducers
CO3 - Explains the actuator and use of robot kinematics.
CO4 - Distinguish the different control and interfacing techniques.
CO5 - Analyses the applications of mechatronics in the fields of automobile, robotics, medicine.
CO6 - Identification of key elements of mechatronics system and its representation in terms of block diagram

TEXT / REFERENCE BOOKS

1. Bolton. W “Mechatronics: Electronic Control System for Mechanical & Electrical Engineering”, 2nd Edition Pearson Education, 2004.
2. Histand, M. B., Alciatore, D. G. (2007). Introduction to Mechatronics and Measurement Systems 3rd ed., WCB/McGraw-Hill, Boston. ISBN: 9780072963052.
3. Ramachandran. K.P,Vijaya Raghavan. G.K, Mechatronics, A.R.S. Publications, Second Edition, 2008.
4. Bradly.D.A, Dawson.D, Burd. N.C, Loader. A.J “Mechatronics: Electronics in Products and Processes” Nelson Publisher, 2004.
5. Dan Necsulescu, “Mechatronics”, Pearson Education, 2005.
6. Bishop, Robert H, "Mechatronics Hand book", CRC Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB4002	ELECTRICAL AND ELECTRONIC CERAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide in-depth knowledge about the fundamentals of various ceramic materials in electrical, electronics and energy related application.
- To prepare future materials scientist and engineers who can fit in academia and industry for relevant scientific breakthrough.
- To be well versed with fundamental theories, processing, fabrication of advanced ceramic materials for electrical, electronics and energy related applications that is adopted by industries.

UNIT 1 STRUCTURE OF CERAMIC MATERIALS 9 Hrs.

Introduction Brief Review of Structure in Materials, bonding in Materials, Packing of Atoms in Metals, Interstices of Covalent Ceramics, Structure of Covalent Ceramics, Ionically Bonded Ceramic Structures, Compounds based on FCC packing of Ions, Other Cubic Structures, Orthogonal Structure, Structure based on HCP packing of Ions.

UNIT 2 DEFECT CHEMISTRY AND DEFECT EQUILIBRIA 9 Hrs.

Point Defects, Defect Reactions, Defect Structures in Stoichiometric Oxides, Dissolution of Foreign cations in an Oxide, Concentration of Intrinsic Defects, Intrinsic and Extrinsic Defects, Units for Defect Concentration, Defect Equilibria, Defect Equilibria in Stoichiometric Oxides, Defect Equilibria in Non-Stoichiometric Oxides, Defect Equilibria in Non – Stoichiometric Oxides, Defect Structures involving Oxygen vacancies and Interstitials, Defect Equilibrium Diagram.

UNIT 3 DIFFUSION AND CONDUCTION IN CERAMICS 9 Hrs.

Diffusion, Diffusion Kinetics, Examples of Diffusion in Ceramics, Mobility and Diffusivity, Analogue to the Electrical Properties, Conduction in Ceramics, Ionic conduction: Basic facts, Ionic and Electronic Conductivity, Characterization of Ionic Conduction, Theory of Ionic Conduction, Conduction in glasses, Fast Ion Conductors, Nernst Equation and Application of Ionic Conductors.

UNIT 4 DIELECTRIC CERAMICS 9 Hrs.

Basic Properties: Dielectrics in DC Electric Field, Mechanisms of Polarization, Microscopic Approach, Determination of Local Field, Analytical Treatment of Polarizability, Effect of Alternating Field on the Behavior of a Dielectric Material, Frequency Dependence of Dielectric properties: Resonance, Dipolar Relaxation, Circuit Representation of a Dielectric and Impedance analysis, Impedance Spectroscopy, Dielectric Breakdown, Basic Mechanisms of Breakdown.

UNIT 5 MAGNETIC CERAMICS 9 Hrs.

Magnetic Moments, Macroscopic view of Magnetization, Classification of Magnetization, Classification of Magnetism, Diamagnetism, Ferromagnetism, Anti ferromagnetic materials, Ferromagnetic Materials, Magnetic Losses and Frequency Dependence, Magnetic Ferrites.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Apply the theoretical knowledge imparted during course to carry out independent research and developmental work related to ceramic materials for different emerging applications.

CO2 - To be well versed with fundamental theories, processing, fabrication of advanced ceramic materials for electrical, electronics and energy related applications that is adopted by industries.

CO3 - Prepare future materials scientist and engineers who can fit in academia and industry for relevant scientific breakthrough.

CO4 - Design conventional and advanced ceramics materials for future technological needs.

CO5 - Design conventional and advanced ceramics materials for future technological needs.

CO6 - Solve problems and case studies related to capacitor materials, electrical insulator, devices, magnetic ceramics, ceramic conducting and semiconducting materials for sensor, fuel cell, battery.

TEXT / REFERENCE BOOKS

1. Mohsen Mhadhbi, (2021), “Advanced Ceramic Materials”, Intech Open, ISBN:9781838812041
2. A. Fletcher, (2013), “Advanced Materials 1991-1992. II. Directory”, Elsevier Science, ISBN:9781483293516.
3. David W. Richerson, (2012), “The Magic of Ceramics”, Wiley, ISBN:9781118392300.
4. Jose James, Pramoda Kumari Pallathadka, Sabu Thomas, (2019), “Polymers and Multicomponent Polymeric Systems Thermal, Thermo-Mechanical and Dielectric Analysis”, CRC Press, ISBN:9780429943478
5. Yet-Ming Chiang, Dunbar P. Birnie, W. David KingeryPhysical Ceramics: Principles for Ceramic Science and Engineering, ISBN 9780471598732

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMRB4003	RESOURCE MANAGEMENT TECHNIQUES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To solve problems in linear programming and Integer programming
- To develop in a student efficient and effective deployment of an organization's resources when they are needed
- To analyze and appreciate variety of performance measures for various optimization problems

UNIT 1 INTRODUCTION AND LINEAR PROGRAMMING 9 Hrs.

Operations Research(OR)- Nature – Characteristics – Phases - Role of OR in Decision making - Outline of OR Models Linear Programming – Formulation of L.P.P. problems –Solution by graphical method, simplex method, Big M methods.

UNIT 2 TRANSPORTATION AND ASSIGNMENT MODEL 9 Hrs.

Transportation problem – Initial Basic feasible solution- Northwest corner method, Least Cost method, Vogel's approximation method – Test for optimality-MODI method. Assignment problems- Hungarian assignment models-Travelling salesman problems

UNIT 3 RESOURCE SCHEDULING AND NETWORK ANALYSIS 9 Hrs.

Problem of Sequencing – Problem with N jobs and 2 machines N Jobs 3 machines N Jobs and m machines and 2 Jobs m machines (Graphical method). Project Management -Basic concepts–Network construction and scheduling Critical Path Method (CPM) & Program evaluation review technique (PERT) and resource leveling by network techniques, time – Cost trade off.

UNIT 4 INVENTORY CONTROL 9 Hrs.

Inventory Control – Various Types of inventory models – deterministic inventory models – Production model, Purchase model– with and without shortage- Economic Order Quantity (EOQ) – Buffer stock – Shortage quantity, Probabilistic inventory models – Quantity Discount and Price Breaks

UNIT 5 QUEUEING THEORY, GAME THEORY AND REPLACEMENT MODELS 9 Hrs.

Queuing theory – Poisson arrivals and exponential service times, Single channel models only, Concepts of Game problem. Two- person zero-sum game. Pure and Mixed strategies. Saddle point and its existence, Mixed Strategy of game theory, Concept of Dominance. Dominance and Graphical method of solving game problems. Replacement policy for items whose maintenance cost increases with time- Consideration of time value of money - Replacement policy- Individual, Group replacement of items that fail completely and suddenly.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Formulate the linear programming problems.
CO2 - Analyze transportation and assignment problems.
CO3 - Develop the scheduling systems and Analyze CPM and PERT methods.
CO4 - Describe the different inventory modals
CO5 - Design the Queuing theory and examine the replacement model.
CO6 - Know about replacement policy, Individual and group displacement

TEXT / REFERENCE BOOKS

1 K. Malik, S. K. Yadav, S. R. Yadav, Optimization Techniques. I K International Publishing House Pvt. Ltd; First Edition edition, 2013.
2 PK Gupta, D.S Hira Operations Research. S Chand seventh revised edition, 2014.
3 Sharma S.D, Operation research Theory,Methods and Application, 17th Edn., Kedar Nath Ram Nath Publication, 2010.
4 Nita H Shah, Ravi M Gor & Hardik Soni, Operation research, 4th Edn., PHI, 2010.
5 Edwin K. P. Chong & Stanislaw H. Zak," An Introduction to Optimization" Wiley India, 2017.
6 Mohan, Kusum Deep, Optimization Techniques. New Age Science, 2009.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SBAB4001	PRINCIPLES AND PRACTICES OF MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To analyze how the field of Management has evolved and its significant contributions
- To analyze and apply the critical role of managers in modern organizational settings.
- To illustrate and evaluate the importance of planning, organizing, directing and controlling in decision making.

UNIT 1 **9 Hrs.**

Introduction: Definition, Functions, Process, Scope and Significance of Management. Nature of Management, Managerial Roles, Managerial Skills and Activities, Difference between Management and Administration. Significance of Values and Ethics in Management.

UNIT 2 **9 Hrs.**

Schools of Management: Evolution of Management Thought - Contributions of F.W. Taylor, Henry Fayol, Elton Mayo, Approaches of Management Thought (including MBO & MBE) Functions of Management. Concept of Leadership- Theories and Styles.

UNIT 3 **9 Hrs.**

Planning and Organizing: Nature, Scope, Objective and Significance of Planning, Elements and Steps of Planning, Decision Making Organizing Principles, Span of Control, Line and Staff Relationship, Authority, Delegation and Decentralization. Effective Organizing, Organizational Structures, Formal and Informal Organizations, Staffing.

UNIT 4 **9 Hrs.**

Directing: Effective Directing, Supervision, Motivation: Different Theories of Motivation - Maslow, Herzberg, Mc Clelland, Vroom, Porter and Lawler, Job Satisfaction. Communication Process, Channels and Barriers, Effective Communication.

UNIT 5 **9 Hrs.**

Controlling and Coordinating- Elements of Managerial Control, Control Systems, Management Control Techniques, Effective Control Systems. Coordination Concept, Importance, Principles and Techniques of Coordination, Concept of Managerial Effectiveness.

Max. 45 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - To provide an understanding of basic management concepts, principles, and practices.
CO2 - To develop planning and decision-making strategies in an organization.
CO3 - To summarize the concept and complete the process of organizing.
CO4 - To develop an understanding of staffing, leadership, directing and motivation in an organization.
CO5 - To predict the dynamics of controlling and its emerging issues in management.
CO6 - Assess managerial practices and choices relative to ethical principles and standards

TEXT / REFERENCE BOOKS

1. Stephen P. Robbins, David A. Decenzo, Fundamentals of Management, Pearson Education, 9th Edition
2. Harold Koontz, O'Donnell and Heinz Weihrich, Essentials of Management. New Delhi, 9th edition, Tata McGraw Hill
3. Management Fundamentals: Concepts, Applications, & Skill Development, 6th edition, Sage.
4. Richard L. Daft, Principles Of Management, Cengage Learning.
5. Prasad, L.M. Principles and Practice of Management, Sultan Chand
6. Jhunjhunwala J Mohanty, Management Principles and Applications, Himalaya Publishing House

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

S41BPB41	VENTURE CREATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To develop an entrepreneurial mindset, understand the concept of entrepreneurship and identify personal strengths and weaknesses
- To develop a value proposition, business model canvas, build MVP to create sustainable differentiation for the venture with a well-structured business plan, unit economics, go-to-market strategies and funding plan for managing business growth
- To build an idea pitch and deliver it with confidence to potential stakeholders

UNIT 1 INTRODUCTION TO ENTREPRENEURSHIP 9 Hrs.

Defining Entrepreneurship, evolution the concept & Emerging Trends in Entrepreneurship (Domain specific), Understanding the unique opportunities; Why be an Entrepreneur? Entrepreneurship in Indian Scenario & Its role in economic development; Success stories of Entrepreneur (Domain specific); Entrepreneurial style assessment tool; Developing the Entrepreneurial mindset- Attributes & skills, recognizing your sweet spot for starting up; Principles of Effectuation; Myths about Entrepreneurship; Types of Entrepreneurs; Entrepreneur vs Intrapreneur; Role of Entrepreneurial Teams.

UNIT 2 DESIGN THINKING & OPPORTUNITY DISCOVERY 9 Hrs.

Introduction to Design Thinking for startups; Design Thinking principles & process; Define the problem using Design thinking principles and validate Problem; Generation of ideas, Idea generation techniques and evaluating creative ideas; Identify problem worth solving; Sharpen your Problem Pitch.

UNIT 3 CUSTOMER, MARKETS AND CREATING A SUSTAINABLE DIFFERENTIATION 9 Hrs.

Differentiate between a customer and a consumer; Who is your customer and what is your segment; Customer Job, Pains, and Gains using Value Proposition Canvas; Build solution using Value Proposition Canvas; Market Estimation-TAM, SAM, SOM; Competitive analysis; Minimum viable product – what is MVP: Build - Measure - Learn, differentiate between solution Demo & MVP; How to validate MVP- Achieve a Product – Market fit.

UNIT 4 BUSINESS MODEL, BUSINESS PLANNING AND GO TO MARKET STRATEGIES 9 Hrs.

Introduction to Business model, Business plan; Lean approach 9 block lean canvas model; Financial feasibility: Costs, revenue streams, Pricing, Financial Projections, Key Financial Metrics using financial template, managing growth & targeting scale, Unit economics; Selecting the Right Channel; Introduction to Digital Marketing and tools; Branding strategy.

UNIT 5 FUNDING STRATEGY 9 Hrs.

Sources of funds: Debt & Equity; Map the Start-up Lifecycle to Funding Options; Build an Investor ready pitch deck.

Max. 45 Hrs.

COURSE OUTCOME

On completion of the course, student will be able to

CO1 - Define entrepreneurship and explain emerging trends in entrepreneurship
CO2 - Identify and evaluate business opportunities and assess market potential
CO3 - Conduct customer discovery, market research, build a lean canvas, develop a business plan and marketing strategies
CO4 - Identify sources of funding and develop a funding strategy,
CO5 - Understand basic legal requirement for starting and running a business
CO6 - Build an idea pitch and deliver it with confidence to various stakeholders

TEXT / REFERENCE BOOKS

1. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.
4. Roy, R. (2017). Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press.
5. Chandan, J. S., & Rana, S. S. (2019). Entrepreneurship Development and Management. New Delhi: McGraw Hill Education.
6. Sinek, S. (2011). Start with Why: How Great Leaders Inspire Everyone to Take Action. Portfolio.
7. Choudhary, R., & Mehta, N. (2019). From Zero to One: How to Build a Successful Startup in India. Notion Press.
8. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
9. Mitra, P., & Banerjee, A. (2019). Startup Minds: The Entrepreneur's Journey from Idea to Success. SAGE Publications India.
10. Thiel, P. (2014). Zero to One: Notes on Startups, or How to Build the Future. Crown Business.
11. Zappos, T. (2010). Delivering Happiness: A Path to Profits, Passion, and Purpose. Business Plus.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**

SMEB3037	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To empower the students with knowledge of entrepreneurship skills.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

UNIT 1 INTRODUCTION TO ENTREPRENEURSHIP 9 Hrs.

Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, Myths about entrepreneurs, agencies in entrepreneurship management and future of entrepreneurship types of entrepreneurs. Pros and Cons of being an entrepreneur , Women entrepreneurs- problems and promotion, Types of Entrepreneurs , Characteristics of a successful entrepreneur , Competency requirement for entrepreneurs - Awareness of self-competency and its development.

UNIT 2 MOTIVATION AND PRODUCT 9 Hrs.

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives. Product - Definition, types, criteria in the selection of a product. Market research-definition, techniques. SWOT Analysis- definition, scope, importance

UNIT 3 BUSINESS CONCEPT 9 Hrs.

Business enterprise – definition, steps involved in starting a business venture –formalities, licensing and registration procedures-Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opport MODULEy, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies. Industrial estates – role and types

UNIT 4 BUSINESS PLAN 9 Hrs.

Business Plan- Definition, importance- Preparing Business Plan - Financial aspects of the Business Plan - Marketing aspects of the Business Plan - Human Resource aspects of the Business Plan - Technical aspects of the Business Plan - Social aspects of the Business Plan - Problems and prospects of Business Plan.

UNIT 5 SUPPORT TO ENTREPRENEURS 9 Hrs.

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify your entrepreneurship traits.
CO2 - Develop awareness about entrepreneurship and successful entrepreneurs.
CO3 - Identify the business opportunity
CO4 - Apply the prospects of business plan.
CO5 - Develop an entrepreneurial mind-set by learning key skills such as design, personal selling, and communication.
CO6 - Understand the DNA of an entrepreneur and assess their strengths and weaknesses from an entrepreneurial perspective

TEXT / REFERENCE BOOKS

1. S.S.Khanka, “Entrepreneurial Development” S.Chand& Co. Ltd. Ram Nagar New Delhi,1999.
2. Kurahko&Hodgetts, ” Entrepreneurship – Theory, process and practices”, Thomson learning 6th edition, 2018
3. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 9 th Edition, Cengage Learning, 2018.
4. Rajeev Roy, "Entrepreneurship" 2 nd Edition, Oxford University Press, 2017.
5. Hisrich R D, Peters M P, “Entrepreneurship” 8 th Edition, Tata McGraw-Hill, 2018

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A	**:**	10 Questions of 2 marks each - No choice	**20 Marks**
PART B	**:**	2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**