STUDY & EVALUATION SCHEME

B. TECH 2ND YEAR 3RD SEMESTER (AUTOMATION AND ROBOTICS)

S.No.	Subject Code	Name of the Subject	Periods			Sessional Assessment			SEE	Subject Total	Credits
			L	T	P	MST	TA	Total			
Theory Subjects											EVALUATION SCHEME
1	AS-301	Mathematics-III	3	1	0	15	15	30	70	100	4
2	AR-301	Python Programming	3	1	0	15	15	30	70	100	4
3	AR-302	Digital Electronics	3	1	0	15	15	30	70	100	4
4	ME-302	Mechanics of Deformable Solids	3	1	0	15	15	30	70	100	4
5	ME-303	Engineering Materials and Application	3	1	0	15	15	30	70	100	4
6	GP-301	General Proficiency	-	-	-	-	-	50	-	50	-
		Total	**15**	**5**	**0**	**75**	**75**	**150**	**350**	**500**	**20**
Laboratory Courses											
7	AR-351	Python Lab	0	0	2	15	15	30	70	100	1
8	AR-352	Digital Electronics Lab	0	0	2	15	15	30	70	100	1
9	ME-351	Engineering Materials Lab	0	0	2	15	15	30	70	100	1
10	ME-353	Computer Aided Machine Drawing Lab	0	0	2	15	15	30	70	100	1
		Total	**0**	**0**	**8**	**60**	**60**	**120**	**280**	**400**	**4**
		GRAND TOTAL	**15**	**5**	**8**	**135**	**135**	**270**	**630**	**900**	**24**

SEMESTER- III

L	T	P
3	1	0

Paper Code- AS-301
Credit- 4

MATHEMATICS-III

Course Outcomes:

In this Course Student will learn how to -

1. Compute Laplace Transform and Inverse Laplace Transforms.
2. Compute Moments, Curve Fitting, Correlation and Regression, Probability Distribution and Chi Square Test.
3. Compute Solution of Transcendental and Polynomial Equations, Finite Differences and Interpolation.
4. Compute Solution of System of Linear Equations, Numerical Differentiation and Integration as well as Solution of Ordinary Differential Equations.
5. Compute Fourier Transforms and Z-Transforms.

UNIT - I

Laplace Transform: Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve simple linear and simultaneous differential equations.

UNIT - II

Statistical Techniques: Moments, Moment generating functions, Skewness, Kurtosis, Curve fitting, Method of least squares, Fitting of straight lines, Polynomials, Exponential curves, Correlation, Linear, non-linear and multiple regression analysis, Binomial, Poisson and Normal distributions, Tests of significations: Chi-square test, t-test.

UNIT - III

Numerical Techniques - I: Zeroes of transcendental and polynomial equations using Bisection method, Regula-falsi method and Newton-Raphson method, Rate of convergence of above methods. Interpolation: Finite differences, Newton's forward and backward interpolation, Lagrange's and Newton's divided difference formula for unequal intervals.

UNIT - IV

Numerical Techniques – II: Solution of system of linear equations, Matrix Decomposition methods, Jacobi method, Gauss Seidel method. Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson's one third and three-eight rules, Solution of ordinary differential equations (first order, second order and simultaneous) by Euler's, Picard's and fourth-order Runge- Kutta methods

UNIT – V

Integral Transforms: Fourier integral, Complex Fourier transform, Inverse Transforms, Convolution Theorems, Fourier sine and cosine transform, Applications of Fourier transform to simple one-dimensional heat transfer equations, wave equations and Laplace equations, Z- transform and its application to solve difference equations.

Text Books:

1. H.K. Das, Advanced Engineering Mathematics, S. Chand & Company Pvt. Ltd.,2022
2. Peter V. O'Neil, Advance Engineering Mathematics Thomson (Cengage) Learning, 2007.
3. Jain, Iyenger & Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, New Delhi.,2020
4. J N Kapur, Mathematical Statistics, S. Chand & Company Pvt. Ltd.2014
5. BS Grewal, Higher Engineering Mathematics, Khanna Publishers.,1965

L	T	P
3	1	0

Paper Code- AR-301
Credit- 4

PYTHON PROGRAMMING

Course Outcomes:

After studying this course, students will be able to:

1. Understanding Fundamentals of Python Programming
2. Understand and implement Control Structures.
3. Learn and implement Strings and Functions in Python.
4. Understand and implement advance functions like iteration and recursion.
5. Implement Object Oriented Programming concepts in Python

UNIT – I

Introduction: The Programming Cycle for Python, Python IDE, Interacting with Python Programs. Elements of Python, Type Conversion. Basics: Expressions, Assignment Statement, Arithmetic Operators, Operator Precedence, Boolean Expression.

UNIT-II

Conditionals and Loops: Conditional statement in Python: if-else statement, its working and execution, Nested-if statement and Else-if statement in Python, Expression Evaluation and Float Representation. Loops: Purpose and working of loops, while loop including its working, For Loop, Nested Loops, Break and Continue.

UNIT - III

Strings and Functions: Strings: Length of the string, Concatenation and Repeat operations, Indexing and Slicing of Strings. Python Data Structure: Tuples, Unpacking Sequences, Lists, Mutable Sequences, List Comprehension, Sets, Dictionaries, Functions: Parts of a Function, Execution of a Function, Keyword and Default Arguments, Scope Rules, Higher Order Functions: Treat functions as first-class Objects, Lambda Expressions.

UNIT – IV

Classes and Files: Generate prime numbers with the help of Sieve of Eratosthenes algorithm, File I/O: File input and output operations in Python Programming Exceptions and Assertions Modules: Introduction, Importing Modules, Abstract Data Types: Abstract data types and ADT interface in Python Programming, Classes: Definition and operations in the classes, Special Methods (such as __init__, __str__, comparison methods and Arithmetic methods etc.), Class Example, Inheritance, Inheritance and OOP.

UNIT -V

Iterators and Recursion: Recursive Fibonacci, Tower of Hanoi, Search: Simple Search, Binary Search, Estimating Search Time in Simple Search and Binary Search, Sorting and Merging: Selection Sort, Merge List, Merge Sort, Higher Order Sort.

Text Book:

1. Allen B. Downey, ''Think Python; How to Think Like a Computer Scientist, 3rd edition, Updated for Python 3, Shroff/O„Reilly Publishers, 2024 (http://greenteapress.com/wp/thinkpython/)
2. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. John V Guttag, —Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013.
4. Python Training Guide –Mercury Learning and Information USA, BPB Publications.
5. Lutz, Mark, Programming Python: Powerful Object-Oriented Programming, O Rielly

L	T	P
3	1	0

Paper Code- AR-302
Credit- 4

DIGITAL ELECTRONICS

Course Outcomes:

After studying this course, students will be able to:

1. Identify various number systems, binary codes and formulate digital functions using Boolean algebra.
2. Design and implement combinational logic circuits.
3. Design and implement sequential logic circuits.
4. Compare the operation of various analog to digital and digital to analog conversion circuits.
5. Explain the basic concepts of programmable logic devices and VHDL.

UNIT -I

Number Systems and Codes: Binary, Octal and hexadecimal conversions- ASCII code, Excess -3 code, gray code, BCD, Error detection codes-Parity method. Signed numbers- representation, addition and subtraction, Fixed point and floating-point representation. Logic gates, Universal gates, TTL and CMOS logic families-Internal diagram of TTL NAND gate and CMOS NOR gate. Comparison of CMOS and TTL performance.

UNIT -II

Boolean Laws and theorems, Sum of Products method, Product of Sum method – K map representation and simplification (up to four variables) - Pairs, Quads, Octets, don't care conditions. Combinational circuits: Adders -Full adder and half adder, Subtractors- half subtractor and full subtractor, 4 - bit parallel binary adder / subtractor, Carry Look ahead adders.

UNIT – III

Comparators, Parity generators and checkers, Encoders, Decoders, BCD to seven segment decoder, Code converters, Multiplexers, Demultiplexers, Architecture of Arithmetic Logic Units (Block schematic only).

UNIT – IV

Flip-Flops, SR, JK, D and T flip-flops, JK Master Slave Flip-flop, Preset and clear inputs, Conversion of flip-flops, Registers -SISO, SIPO, PISO, PIPO, Up/Down Counters: Asynchronous Counters – Modulus of a counter – Mod-N counters Ring counter, Johnson Counter Synchronous counters, Design of Synchronous counters.

UNIT - V

State Machines: State transition diagram, Moore and Mealy Machines Digital to Analog converter Specifications, Weighted resistor type, R-2R Ladder type. Analog to Digital Converter Specifications, Flash type, Successive approximation type. Programmable Logic Devices - PAL, PLA, FPGA (Introduction and basic concepts only) Introduction to Verilog, Implementation of AND, OR, half adder and full adder.

Text Book:

1. Floyd T.L, Digital Fundamentals, 10/e, Pearson Education, 2011.
2. C.H.Roth and L.L.Kinney Fundamentals of Logic Design, 7/e, Cengage Learning, 2021
3. Mano M.M, Logic and Computer Design Fundamentals, 4/e, Pearson Education.
4. A Anand Kumar, Fundamental of Digital Circuits, Prentice Hall
5. Roy Chaudari, Linear Integrated Circuits, 6/e, New Age International Publications,2021
6. S. Saliva Hanan, Digital Circuits and Design, Oxford University Press

L	T	P
3	1	0

Paper Code- ME-302
Credit- 4

MECHANICS OF DEFORMABLE SOLIDS

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Recognize various types loads applied on machine components of simple geometry
2. Able to understand the nature of internal stresses that will develop within the components
3. Evaluate the strains and deformation that will result due to the elastic stresses developed within the materials for simple types of loading
4. Able to understand the influence of twisting on shaft and the energy theorems.
5. Analyze and design beams, shafts and hollow cylinders.

UNIT -I

Stress and strains:

Introduction, normal stress and strain, shear stress and strain, stresses on inclines sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's circle for plane stress, three dimensional states of stress & strain, equilibrium equations, generalized Hook's law, theories of failure. Thermal Stresses.

UNIT- II

Mechanics of Beams

Transverse loading on beams, point and distributed loads; Shear force and bend moment diagrams; Types of beam supports – simply supported, over-hanging, cantilevers, fixed and guided beams; Static determinacy and indeterminacy; Theory of bending of beams, pure bending stress distribution and neutral plane, second moment of area; Different cross-sections of beams; Shear stress distribution.

Deflection of Beams

Deflection of a beam using the double integration method; Computation of slopes and deflection in beams; Myosotis method for computing deflections and slopes.

UNIT -III

Helical and Leaf Springs

Deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Columns and Struts

Buckling and stability, slenderness ratio, combined bending and direct stress, middle third and middle quarter rules, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling.

UNIT- IV

Bending

Simple bending theory, concept of pure bending, bending stresses in beams or derivation of elastic flexural formula, section modulus and comparison of different cross-section of beams under bending condition.

Shear stress

Concept of different shear stress and its distribution in various cross-section.

Torsion and Twist

Torsion stresses and deformation of circular and hollow shafts; Polar moment of area, stepped shafts; Deflection of shafts fixed at both ends; Stresses and deflection of helical springs.

Energy Theorem

Principle of virtual work; Minimum potential energy theorem; Castigliano's theorems; Maxwell reciprocity theorem.

UNIT -V

Thin and Thick cylinders

Thin cylinders & spheres: Introduction, difference between thin walled and thick-walled pressure vessels, thin-walled spheres and cylinders, hoop and axial stresses and strain, volumetric strain.

Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, compound cylinders, stresses in rotating shaft and cylinders, stresses due to interference fits.

Text /Reference Books:

1. E. P. Popov, "Engineering Mechanics of Solids," Pearson, 2015.
2. Timoshenko and Gere, "Mechanics of Materials",2/e CBS Publishers, 2022.
3. R. Subramanian, "Strength of Materials," Oxford University Press, 2007.
4. D.S. Bedi, "Strength of Materials", Khanna Book Publishing. 2022.
5. D.S. Bedi, "Engineering Mechanics", Khanna Book Publishing. 2021.
6. F. P. Been, R. Johnson Jr and J. J. Dewole, "Mechanics of Materials," Tata Mc Graw Hill, Delhi 2005.
7. L.S Srinath, Advanced Mechanics of Solids, McGraw Hill, 2017.

L	T	P
3	1	0

Paper Code- ME-303
Credit- 4

ENGINEERING MATERIALS AND APPLICATIONS

Course Outcomes:

At the end of this course students will

1. Know the range of engineering materials, their mechanical properties and applications
2. Know various methods to measure the mechanical properties of materials
3. Learn how to improve the properties of ferrous alloys through various heat treatments
4. Interpretation of equilibrium phase diagrams of alloys
5. Different heat treatment methods to tailor the properties of Fe-C alloys.

UNIT- I

Engineering Materials and Classification

Metals, plastics, ceramics and composites; Relevant properties (physical, mechanical, thermal, electrical, chemical), cost; Range of applications; Material designation and standards; Ashby diagrams; Selection criteria and process

UNIT-II

Mechanical Properties and Testing

Tensile compression, torsion, fatigue, fracture and wear tests; Young's modulus; Relations between true and engineering stress-strain curves; Generalized Hooke's law; Yielding and yield strength; ductility, resilience, toughness and elastic recovery; Hardness measurement their relation to strength; SN curve, endurance and fatigue limits; Introduction to non-destructive testing (NDT).

UNIT-III

Metal and Alloys

Iron and steel; Stainless steel and tool steels; Copper & its alloys – brass, bronze & cupro-nickel; Aluminium & Al-Cu-Mg alloys; Nickel based superalloys & Titanium alloys; Phase diagrams and interpretation of microstructure; Iron Iron-carbide phase diagram and cooling (TTT) diagrams of slopes and deflection in beams; Myosotis method for computing deflections and slopes.

Heat Treatment

Heat treatment of Steel; Annealing, tempering, normalizing, spheroidising, austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening.

UNIT-IV

Polymers, Ceramics and Composites

Polymers – Classification and applications; Polymerization techniques; Ceramics – Oxide ceramics, ceramic insulators, bio-ceramics and Glasses; Composites – Reinforcement, matrix, metal matrix composites, ceramic composites, polymer composites; Other advanced materials – biomaterials, optical materials, high temperature materials, energy materials, and nanomaterials.

UNIT-V

Electrical and Magnetic Materials

Conducting and resisting materials – types, properties and applications; Semiconducting materials – properties and applications; Magnetic materials – Soft and hard magnetic materials and applications; Superconductors and dielectric materials – properties and applications; Smart materials; Sensors and actuators, Piezoelectric, magnetostrictive and electrostrictive materials.

Text/Reference Books:

1. W. D. Callister, "Materials Science & Engineering," Wiley India, 2014.
2. K. G. Budinski and M.K. Budinski, "Engineering Materials", PHI India, 2002
3. V. Raghavan, "Material Science and Engineering', PHI India, 2015.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.
5. M.F. Ashby and D.R.H. Jones, Engineering Materials 1 - An Introduction to Properties, Applications and Design, Butterworth-Heinemann, USA, 2011

L	T	P
0	0	2

Paper Code- AR-351
Credit- 1

PYTHON PROGRAMMING LAB

Course Outcomes:

1. Develop and execute basic Python programs using appropriate syntax and data types.
2. Define and use functions, and manipulate built-in data structures like lists, tuples, and dictionaries.
3. Implement decision-making and iterative constructs to solve problems using Python.
4. Perform file input/output operations in Python for data storage and retrieval.
5. Apply Python programming techniques to implement basic searching and sorting algorithms.

List of the Experiments:

1. To read and write simple Python programs.
2. To develop Python programs with conditionals and loops.
3. To define Python functions and to use Python data structures — lists, tuples, dictionaries
4. To do input/output with files in Python
5. Write a Python Program to perform Linear Search
6. Write a Python Program to perform Binary Search
7. Write a Python Program to perform selection sort
8. Write a Python Program to perform insertion sort.

Note: The instructor may add/ modify the list as per his/her wisdom for better hands on the students.

L	T	P
0	0	2

Paper Code- AR-352
Credit- 1

DIGITAL ELECTRONICS LAB

Course Outcomes:

1. Verify the truth tables of basic logic gates and implement logic functions using universal gates.
2. Design and implement combinational circuits such as half/full adders, subtractors, and code converters.
3. Develop and analyze magnitude comparators, multiplexers, and demultiplexers used in digital systems.
4. Construct and demonstrate sequential logic circuits including various types of flip-flops and shift registers.
5. Perform flip-flop conversions and analyze the behavior and timing characteristics of sequential logic components.

List of the Experiments:

1. Truth table verification of different logic gates- AND, OR, NOT, NAND, NOR, X-OR, and X-NOR.
2. Realization of basic Gates using universal Gates.
3. Design of half and full adder circuits.
4. Design of half and full subtractor circuits.
5. Design of code converters circuits-Binary to Gary code, and Gray to Binary code.
6. Design of magnitude comparator circuits.
7. Study of multiplexer (MUX) and demultiplexer (DEMUX) circuits.
8. Design of shift register.
9. Study of different types of Flip Flops (FFs)-SR-FF, JK-FF, D-FF, and T-FF.
10. Conversion from one Flip Flop (FF) to others.

Note: The instructor may add/ modify the list as per his/her wisdom for better hands on the students.

L	T	P
0	0	2

Code- ME-351
Credit- 1

ENGINEERING MATERIAL LAB

Course Outcomes:

1. To learn about stress and strain and UTM.
2. Understand phase transformation.
3. Learn cyclic load tests.
4. Study about various NDT methods.

List of Experiments: (At least 8 of the following)

1. Strength test of a given mild steel specimen on UTM with full details and stress versus strain plot on the machine.
2. Other tests such as shear bend tests on UTM.
3. Impact test on impact testing machine like Charpy, Izod or both.
4. Hardness test of given specimen using Rockwell and Vickers/Brinell testing machines.
5. Spring index test on spring testing machine.
6. Fatigue test on fatigue testing machine.
7. Creep test on creep testing machine.
8. Experiment on deflection of beam, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young's modulus of beam.
9. Torsion test of a rod using torsion testing machine.
10. Study of NDT (non-destructive testing) methods like magnetic flaw detector, detector, eddy current testing machine, dye penetrant tests.

L	T	P
0	0	2

Paper Code- ME-353
Credit- 1

COMPUTER AIDED MACHINE DRAWING LAB

Course Outcomes:

1. Identify the national and international standards pertaining to machine drawing.
2. Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings
3. Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.
4. Preparation of the part or assembly drawings as per the conventions.

List of Experiments: (At least 8 of the following)

1. To Review of graphic interface of the software, basic sketching commands and navigational commands
2. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section)
3. To draw the Hidden line conventions and Precedence of lines.
4. To draw the Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids).
5. To draw Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part).
6. To study the Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Seller's thread, American Standard thread.
7. To draw the Key, Coupling and Joints.
8. To Assemble Drawings the Plummer block (Pedestal Bearing)
9. To Assemble Drawings the Lever Safety Valve
10. To Assemble Drawings the I.C. Engine connecting rod
11. To Assemble Drawings the Screw jack (Bottle type)
12. To Assemble Drawings the Tailstock of lathe
13. To Assemble Drawings the Machine vice
14. To Assemble Drawings the Tool head of shaper

SEMESTER IV

L	T	P
3	1	0

Paper Code- AS-401
Credit- 4

NUMERICAL METHODS

Course Outcome:

After studying this course, students will be able to:

1. An understanding the Roots Equations
2. Know the System of Simultaneous Linear Equations
3. An understanding the Curve Fitting and least square regression
4. An Understanding the Numerical Differentiation and Integration.
5. An understanding the Ordinary Differential Equations.

UNIT - I

Roots of equation, Bracketing Methods: Graphical methods, bisection method, false-position method, open methods: simple one point iteration, Newton Raphson method, secant method, multiple roots, system of non-linear equations.

UNIT - II

System of linear algebraic equations: Gauss elimination method, matrix inversion method, error analysis and system condition, Jacobi method, Gauss Seidel method, LU Decomposition methods, Crout Decomposition, Banded systems, Cholesky Decomposition, eigen values and eigen vectors problems.

UNIT - III

Curve fitting: least squares regression: linear regression, polynomials, Lagrange interpolating polynomials, spline interpolation, Newton's Forward, Backward and Central Difference formula, Sterling's formula. Fourier approximation

UNIT - IV

Numerical differential and Integration: Newton-Cotes integration formulas: Trapezoidal rule, Simpson's rule, integration with unequal segments, open integration formulas, Integration of equations: Romberg integration, Gauss Quadrature, improper integrals. Numerical Differentiation: High- Accuracy Differentiation formulas, Richardson extrapolation, Derivatives of unequally spaced data.

UNIT -V

Ordinary Differential equations: Euler's method, modification and improvements of Euler's method, Runge-Kutta methods, Taylor's series method, boundary value problems. Partial Differential Equations: Finite Difference –Elliptic equations; Laplace equation; Parabolic equation, explicit method, implicit method, Crank – Nicolson method, Parabolic equations in two spatial dimensions.

Text/ Reference Books:

1. Numerical Methods for Engineers; S C Chapra, R P Canale, 8th Edition, Tata McGrawHill, 2021
2. Erwin kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2010.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 45th Edition, 2020.

L	T	P
3	1	0

Paper Code- AR-401
Credit- 4

HYDRAULIC & PNEUMATIC DRIVES FOR ROBOTS

Course Outcome:

After studying this course, students will be able to:

1. Understand various actuation systems and robotic grippers, and compare their characteristics and applications in robotic systems.
2. Demonstrate knowledge of fluid properties, basic fluid laws, and measurement techniques used in fluid power systems.
3. Analyze the construction, working principles, and applications of various fluid power control valves including directional, pressure, and flow control valves.
4. Explain the components and working of hydraulic and pneumatic power supply systems, including air compressors, filters, and FRL units.
5. Design and analyse fluid power circuits and actuators, including electro-hydraulic and electro-pneumatic systems used in robotic applications.

UNIT - I

Introduction: Robot Actuation, Robotic Grippers, Characteristics of Actuating Systems, Comparison of Actuating Systems.

UNIT - II

Fluid Power Systems: Introduction of Fluid Power Systems, Properties of Fluids and Selection, Pascal's Law and Pressure Measurement, Fluid Flow and Measurement, Gas Laws.

UNIT - III

Control Valves: Fluid power control elements and standard graphical symbols, Directional, Pressure and Flow Control Valves – Construction and Working, Rotary Valves, Pilot-Operated Valves Servo-valves.

UNIT - IV

Hydraulic and Pneumatic Power Supplies: Hydraulic Power Packs, Hydraulic Loading Valve and Filters, Air Compressors & Receivers, Air Treatment and FRL Units, Pressure Regulation in Fluid Power Circuits.

UNIT - V

Fluid Power Actuators: Linear actuators and their Construction, Rotary actuators and their Construction, Mounting Arrangements, Cylinder Dynamics, Speed Control.

Fluid Power Circuits & Control: Control of Single and Double Acting Hydraulic Cylinders, Control of Single and Double Acting Pneumatic Cylinders, Electrical Controls for Fluid Power Circuits, Electro-hydraulic and Electro- Pneumatic Circuits, Examples of Fluid Power Circuits in Robotics.

Text Books/ Reference Books:

1. Saeed B. Niku, "Introduction to Robotics – Analysis, Control, Applications",3/e, Wiley India Pvt. Ltd., 2024.
2. R. Mittal, Nagrath, "Robotics and Control", McGraw Hill Education, 2022.
3. Hydraulics and Pneumatics, Jagadeesha T; I. K. International Publishing House Pvt. Ltd.,2015.
4. Hydraulics and Pneumatics, Andrew Parr; Jaico Books, 1993.

L	T	P
3	1	0

Paper Code- AR-402
Credit- 4

CONTROL SYSTEM

Course Outcome:

After studying this course, students will be able to:

1. Appreciate the role of the control system.
2. Analyze the mathematical model of the control system.
3. Solve to get a time domain response.
4. Analyze stability of the system.
5. Use bode plot for frequency domain analysis and analyze the control system in state space.

UNIT - I

Introduction to Control System:
Introduction to control system block diagram. Importance of Control Systems. Components of control. Explanation with the help of the liquid level control system. Significance of actuators and sensors. Types of actuators, Types of sensors. Open loop control and closed loop control. Use of relays, switches and contactors for simple and sequential control systems.

UNIT - II

Control system representation:
Mathematical representation of simple mechanical, electrical, thermal, hydraulic systems. Block diagram representation and reduction. Signal flow graph. Transfer function of these systems. Pole zero concepts.

UNIT - III

Time domain analysis:
Time response of first order, second order systems. Analysis of steady state error, Type of system and steady state error. Time response specifications. Effect of parameter variation on open loop and closed loop system response, sensitivity. Effect of feedback on system response, stability and disturbance.

UNIT - IV

Stability:
Concept of stability, Effect of pole zero location on stability, Routh- Hurwitz criterion. Root Locus method for analysis of gain margin, phase margin and stability.

UNIT - V

Control system analysis in frequency domain:
Concept of frequency domain behavior, Bode Plot for analyzing systems in frequency domain. Frequency domain performance specifications. Correlation between time domain and frequency domain specification. Nyquist Analysis.

Abhishek Ameer

State Space Approach: Representation of system in state space, Converting transfer function model into state space model. Non uniqueness of state space model, Canonical representation, Eigenvalues, Solution of state equations, Concept of State feedback control, controllability, Observability.

Text Books/ Reference Book:

1. Nagrath & M. Gopal "Control System Engineering",8/e, Anshan, 2025.
2. Norman S. Nice, "Control System Engineering", Wiley, 2019.
3. Smarajit Ghosh, "Control Systems Theory & Applications", Pearson Education, 2007.
4. Katsuhiko Ogata," Modern Control Engineering", Prentice Hall, 2010.

L	T	P
3	1	0

Paper Code- AR-403
Credit- 4

ROBOTICS

Course Outcomes (CO):

After studying this course, students will be able to:

1. Understand the types, components, and classification of robots, including kinematic systems.
2. Analyze robot kinematics and dynamics, focusing on translation and rotation representation, coordinate transformation.
3. Explore various sensors and vision systems used in robotics, including contact, proximity, position, and vision applications.
4. Apply control theories to robotics, including P, PD, PID, and advanced control laws.
5. Develop skills in control hardware and interfacing, focusing on embedded systems architecture, integration with sensors and actuators, and programming for robot applications.

UNIT - I

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems, Kinematics systems; Definition of mechanisms and manipulators, social issues and safety.

UNIT - II

Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modelling: Equations of motion: Euler-Lagrange formulation

UNIT - III

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

UNIT - IV

Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls, Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

UNIT - V

Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

Text Book (s)/ Reference Book(s):

1. Saha, S.K., "Introduction to Robotics, McGraw-Hill Higher Education, New Delhi, 2022.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2023.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill, .
5. Mukherjee S., "Essential of Robotics process and Automation", Khanna Publishing House, Delhi, 2025.

L	T	P
3	1	0

Paper Code- AR-404
Credit- 4

MICROPROCESSOR & MICROCONTROLLER

Course Outcomes (CO):

At the end of this course students will demonstrate the ability to:

1. Apply a basic concept of digital fundamentals to Microprocessor based personal computer system.
2. Analyze a detailed software & hardware structure of the Microprocessor.
3. Learn the basics of 8086 Microprocessor and Peripheral Devices like timer, USART etc.
4. Understand the difference between Microprocessors & Microcontrollers, and details Architecture of 8051 Microcontroller.
5. Learn the concept of 8051 instruction set and implement them to design projects on real time problems.

UNIT - I

8085 MICROPROCESSORS: History and Evolution of Microprocessor and their Classification, Architecture of 8085 Microprocessor, Address / Data Bus multiplexing and demultiplexing, Status and Control signal generation, Instruction set of 8085 Microprocessor, Classification of instructions, addressing modes, timing diagram of the instructions.

UNIT - II

Hardware Interfacing with 8085: Methods of data Transfer and Interrupts of 8085 microprocessors: Classification of interrupts, Programming using interrupts, Direct Memory Access, Serial and parallel data transfer, Interfacing of Memory Chips with 8085 Microprocessor, Interfacing of 8085 with 8155/8156 (RAM), 8355/8755 (ROM), Interfacing of Programmable Devices with 8085 Microprocessor, 8279 programmable Keyboard/Display interface, 8255A programmable Parallel interface, 8254 programmable Interval Timer, 8259A programmable Interrupt Controller, Assembly language programming.

UNIT - III

16-bit low power MCU: Introduction to microcontrollers and embedded systems, Von Neumann (Princeton) and Harvard architecture, RISC and CISC machine, Architecture, Programming Techniques, Addressing Modes, Programming System registers and configuration I/O ports pull up/down registers concepts, Low Power aspects of MSP430: low power modes, Active vs Standby current consumption.

UNIT - IV

Configuring Peripherals in MSP430: External interrupts and software interrupt, interrupt programming, Watchdog timer, Clock Tree in MSP430, Timer/ counter interrupt, Programming MSP430 timer, counter programming, Real Time Clock (RTC), PWM control, timing generation and measurements. Analog interfacing and data acquisition: ADC and Comparator in MSP430, data transfer using DMA.

UNIT - V

Serial Communication Interfaces in MSP430: Basics of serial communication, mode of serial communication, RS232, serial communication issue, Serial port programming. Implementing and programming UART, I2C, SPI interface using MSP430, interfacing external devices, external memory, keyboards, display devices, DAC/ADC, DC Motor, Stepper Motor, Servomotor, power management, Sensor Interfacing and signal conditioning. Case Study: MSP430 based embedded system application using the interface protocols for communication with external devices: "A Low-Power Battery less Wireless Temperature and Humidity Sensor with Passive Low Frequency RFID.

Text Books/ Reference Book:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publication (India) Pvt. Ltd.
2. DV Hall, "Microprocessors Interfacing", Tata McGraw Hill Publication.
3. N. Senthil Kumar, M. Saravanan, S. Jeevananthan, "Microprocessors and Microcontrollers", Oxford University Press Publication, 2020.
4. Getting Started with the MSP430 Launchpad by Adrian Fernandez, Dung Dang, Newness publication ISBN-13: 978-0124115880, 2023
5. MSP430 microcontroller basics 1st Edition by John H. Davies (Author), Newnes Publication ISBN-13: 978-0750682763, 2022.

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Paper Code- AR-451
Credit- 1

HYDRAULIC & PNEUMATIC DRIVES FOR ROBOTS LAB

Course Outcomes:

After the completion of this Lab, the students will be able to:

1. Select a suitable DC control valve.
2. Select a suitable actuator for a given robotic application.
3. Understand the functioning of different valves, actuators and fluid power circuits.
4. Design fluid power actuation system for robotic application.

List of Experiments: (At least 8 of the following)

1. To study components and functioning of a hydraulic power pack.
2. To study components and functioning of a pneumatic fluid power supply.
3. To study different types of DC control valves and actuators in hydraulic fluid power systems.
4. To study different types of DC control valves and actuators in pneumatic fluid power systems.
5. To study the working of speed and pressure control valves in fluid power circuits.
6. To study a pneumatic logic circuit using a pilot operated DC valve.
7. To operate a linear hydraulic actuator using 4/2 and 4/3 DC valves.
8. To operate rotary pneumatic or hydraulic motors using two and three position DC valves.
9. To operate single acting and double acting linear pneumatic actuators using 3/2 and 5/2 DC
10. electro pneumatic valves respectively.
11. 10.To study the application of fluid power circuits in robots

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Paper Code- AR-452
Credit- 1

CONTROL SYSTEM LAB

Course Outcomes:

At the end of this course, the students will demonstrate the ability to:

1. Develop the mathematical model of different components of linear feedback control system using simulation and experiments.
2. Analyze the transient characteristics of different first order and second order systems using simulation and experiments.
3. Determine the performance of system using root locus.
4. Carry out the stability analysis of linear feedback control system using Bode plot and Nyquist plot.
5. Demonstrate an industrial application (like Bottle filling/ Pick and Place control) using PLC.

List of Experiments: (At least 8 of the following)

1. To study input out characteristic of various control system components.
2. To obtain step response and find time response specification of electrical system, hydraulic system, pneumatic system and thermal system.
3. To obtain transfer function and poles zeros of DC motor experimentally.
4. To obtain root locus experimentally.
5. Use Matlab to study the effect of feedback gain on system response.
6. Use Matlab to study the effect of damping factor zeta on time control performance specifications.
7. Use Matlab to obtain root locus for a given system and find performance specifications
8. there from. Study effect of addition of zero and pole on root locus.
9. Use Matlab to get a bode plot and obtain gain margin and phase margin for various systems.
10. Use Matlab to obtain state space representation from transfer function, find Eigenvalues, Analyze controllability, observability and stability.

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Paper Code- AR-453
Credit- 1

MICROPROCESSOR & MICROCONTROLLER LAB

Course Outcomes:

1. Understand and apply the basic architecture and instruction set of 8085 microprocessor through hands-on programming and interfacing exercises.
2. Demonstrate the ability to interface peripheral devices (such as 8255, 8279, and 8254) with the 8085 microprocessor and implement interrupt-driven applications.
3. Develop embedded C programs to configure and control various features of the MSP430 microcontroller including GPIO, timers, interrupts, and ADCs.
4. Design and implement real-time embedded systems using MSP430 for serial communication, sensor interfacing, and peripheral control using I2C/SPI protocols.

List of Experiments: (At least 8 of the following)

1. Identification of components, understanding buses, clock, and status signals.
2. Addition, subtraction, multiplication, and division of 8-bit/16-bit numbers.
3. AND, OR, XOR operations, conditional/unconditional jumps.
4. Draw timing diagrams for a few sample instructions (e.g., MOV, MVI, LDA).
5. Program using different modes (Mode 0, Mode 1) to control LEDs and read switch status.
6. Keypress detection and displaying characters on a 7-segment display.
7. Generate time delays and square wave outputs.
8. Writing interrupt-driven programs (e.g., RST 7.5, INTR) and demonstration using LED toggling.
9. Introduction to Code Composer Studio (CCS), GPIO programming (blink LED).
10. Perform basic math and logical operations using MSP430 C code.
11. Write a program to demonstrate different power-saving modes.
12. Use external push-button to trigger interrupts and toggle LEDs.
13. Generate PWM for LED dimming or servo control.
14. Read analog voltage using onboard ADC and display digital equivalent.
15. Demonstrate RTC features using timer interrupts and time display.
16. Interface MSP430 with PC terminal; send and receive characters.