V. E. S. Institute of Technology

S.E. (Semester – III)

Automation and Robotics

Autonomy Syllabus

Effective A. Y. 2023-24

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	**Pract**	**Theory**	**Pract**	**Tut**	**Total**
ARC301	Engineering Mathematics-III	3	--	3	--	1	4
ARC302	Strength of Materials	3	--	3	--	--	3
ARC303	Electronic devices and Electrical Networks	3	--	3	--	--	3
ARC304	Digital Electronics	3	--	3	--	--	3
ARC305	Transducers	3	--	3	--	--	3
ARL301	Strength of Materials and Transducers - Lab	--	2	--	1	--	1
ARL302	Electronic devices and Electrical Networks - Lab	--	2	--	1	--	1
ARL303	Digital Electronics - Lab	--	2	--	1	--	1
ARL304	Object oriented programming Lab	--	2+2*	--	2	--	2
ARM301	Mini project – 1A	--	4$	--	2	--	2
Total		**15**	**14**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA *					
ARC301	Engineering Mathematics-III	20	20	60	2	25	--	125
ARC302	Strength of Materials	20	20	60	2	--	--	100
ARC303	Electronic devices and Electrical Networks	20	20	60	2	--	--	100
ARC304	Digital Electronics	20	20	60	2	--	--	100
ARC305	Transducers	20	20	60	2	--	--	100
ARL301	Strength of Materials and Transducers - Lab	--	--	--	--	25	25	50
ARL302	Electronic devices and Electrical Networks - Lab	--	--	--	--	25	25	50
ARL303	Digital Electronics - Lab	--	--	--	--	25	25	50
ARL304	Object oriented programming Lab	--	--	--	--	25	25	50
ARM301	Mini project – 1A	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**150**	**125**	**775**

*Should be conducted batch wise

$ indicates workload of Learner (Not Faculty), Faculty Load: 1 hour per week per four groups

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	**Pract**	**Theory**	**Pract**	**Tut**	**Total**
ARC401	Engineering Mathematics -IV	3	--	3	--	1	4
ARC402	Embedded System	3	--	3	--	--	3
ARC403	Automatic Control System	3	--	3	--	--	3
ARC404	Signal Conditioning Circuit Design	3	--	3	--	--	3
ARC405	Components of Automation and Robotics system	3	--	3	--	--	3
ARL401	Embedded System and SCCD - Lab	--	2	--	1	--	1
ARL402	Automatic Control System – Lab	--	2	--	1	--	1
ARL403	Components Automation and Robotics system - Lab	--	2	--	1	--	1
ARL404	Python Programming- Lab	--	2+2*	--	2	--	2
ARM401	Mini Project -1B	--	4$	--	2	--	2
Total		**15**	**14**	**15**	**07**	**1**	**23**

*Should be conducted batch wise

$ indicates workload of Learner (Not Faculty), Faculty Load: 1 hour per week per four groups

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARC401	Engineering Mathematics -IV	20	20	60	2	25	--	125
ARC402	Embedded System	20	20	60	2	--	--	100
ARC403	Automatic Control System	20	20	60	2	--	--	100
ARC404	Signal Conditioning Circuit Design	20	20	60	2	--	--	100
ARC405	Components of Automation and Robotics system	20	20	60	2	--	--	100
ARL401	Embedded System and SCCD - Lab	--	--	--	--	25	25	50
ARL402	Automatic Control System – Lab	--	--	--	--	25	25	50
ARL403	Components of Automation and Robotics system - Lab	--	--	--	--	25	25	50
ARL404	Python Programming-Lab	--	--	--	--	25	25	50
ARM401	Mini Project -1B	--	--	--	--	25	25	50
Total		**100**	**100**	**300**	--	**150**	**125**	**775**

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)
Engineering Mathematics III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC301	Engineering Mathematics III	3	--	3	--	1	4

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC 301	Engineering Mathematics- III	20	20	60	**2**	25	--	125

Course Objectives:	
The intent of this course is	
1	To build a strong foundation in mathematics, provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
2	To prepare student to apply reasoning informed by the contextual knowledge to engineering practice, to work as part of teams on multi-disciplinary projects.
3	To prepare students to apply linear algebra concepts to model, solve and analyse real-world situations.
4	To describe the ideas of Fourier and Laplace transforms and illustrate their application in the fields of PDE, Digital Signal Processing, Image Processing, Image Processing, Theory of wave equations, Differential equations, and many others.
5	To prepare the students to use the information from Laplace transform to convert a continuous signal from the time domain to the frequency domain.
6	To prepare the students for transforming a problem with inconvenient geometry into a one with appropriate geometry by the use of Complex mapping.

7	To prepare students to apply the concept of eigenvalues and Eigen vector which will further be useful in applications like Google page rank algorithms, principal component analysis (biometric systems), and natural frequency for a structure.

Course Outcomes:

After completing this course, the students will be competent enough to comprehend the following topics:

1.	**Laplace transform:** Students will be able to apply Laplace transform and its properties to find the transform of a given function and evaluate some integrals of real value function.
2.	**Inverse Laplace transform**: Students will be capable of solving ordinary differential equations using Laplace transform as well as problems based on determining the inverse Laplace transform of specified functions.
3.	**Fourier Series:** Students will be able expand a periodic function as a Fourier series in terms of sine and cosine functions.
4.	**Complex Variable:** Students will be proficient to construct an analytic function, obtain a family of orthogonal trajectories.
5.	**Complex Integration:** Students will be able to evaluate integration of complex variable functions using the knowledge of Cauchy integral formula, residue of singular points.
6.	**Eigenvalues and Eigenvectors**: Students will be able to execute matrix diagonalization and perform basic eigenvalue and eigenvector computations.

Module	Detailed Content	No. of Hours
	Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II,	
01	**Laplace Transform:** 1.1 Definition and Condition of Existence of Laplace transform. 1.2 Laplace transform of standard functions like e^{at}, $sin(at), cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace transform: Linearity, First Shifting, Second Shifting, Change of Scale, Multiplication by t, Division by t, Laplace Transform of derivative, integral and convolution of two functions. 1.4 Evaluation of real improper integrals using Laplace transformation. 1.5 Laplace transform of some special functions: Heaviside's Unit Step function, Dirac Delta function.	7
02	**Inverse Laplace Transform:** 2.1 Definition and Inverse Laplace transform of standard functions. 2.2 Inverse Laplace transform using Partial fractions, derivatives property. 2.3 Inverse Laplace transform using Convolution property. 2.4 Applications to solve initial and boundary value problems involving Ordinary differential equations.	7
03	**Fourier Series:** 3.1 Drichlet's conditions, Definition of Fourier series and Parseval's Identity. 3.2 Fourier series of periodic function with period 2π and $2L$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series.	7

04	**Complex Variables:** 4.1 Function of complex variable f(z), Limit, Continuity and Differentiability of f(z), Analytic function. Necessary and sufficient conditions for f(z) to be Analytic. Cauchy-Riemann equations in Cartesian. 4.2 Milne-Thomson method: Determine analytic function f(z) when real part (u), imaginary part (v) or its combination is given. 4.3 Harmonic function, Harmonic conjugate and Orthogonal trajectories.	6
05	**Complex Integration:** 5.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions, Cauchy's Integral formula. 5.2 Taylor's and Laurent's series expansion. 5.3 Definition of Singularity, Zeroes, Poles of f(z), Residues, Cauchy's Residue Theorem.	7
06	**Linear Algebra (Theory of Matrices):** 6.1Characteristic Equation, Eigen values and Eigen vectors, and properties. 6.2 Cayley-Hamilton Theorem, verification and reduction of higher degree polynomials. 6.3 Similarity of matrices, diagonalizable and non-diagonalizable matrices.	5
	Total	**39**

Text Books:	
1.	Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2.	Linear Algebra and its Applications, D. C. Lay, Pearson.
3	J.L Schiff, The Laplace Transform, Springer (1999)
4	H.Dym and H.P . McKean, Fourier series and Integrals, Academic Press, 1972.
5	S.Ponnusamy and H. Silverman , Complex Variable with Applications,Birkhauser,Boston , 2006.
References:	
1.	J H Mathews and R W Howell, Complex Analysis for Mathematics and Engineering, Narosa.
2.	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
3.	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
4.	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5	M.R. Spiegal , Laplace Transforms (Schaum's Series), Mc Graw – Hill , 1965.
6	R.Radha and S. Thangavelu . Fourier Analysis, Lecture Notes,2012. https://nptel.ac.in/courses/111106046/

The distribution of the assessments will be as follows: -

1	Internal assessment	20 marks
2	Continuous assessment	20 marks
3	Term work	25 marks

1. **Internal Assessment (IA):**
   Internal Assessment will consist of one Midterm test which will be conducted when approximately 50% of the syllabus is completed. The duration of the test will be one hour.

2. **Continuous Assessment (CA):**
   Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. -

Sr.no	Rubrics	Marks
1.	Content beyond syllabus presentation	10
2.	Multiple Choice Questions (Quiz)	5

Continuous Assessment:
Total 2 Quiz/ Presentation (10 Marks each) of one hourr duration, based on overall syllabus will be conducted during a semester (Preferably before and after mid semester exam).

3. **Term work:**
   - Total **25 Marks** Term work will be based on overall performance in the subject.
   - Attendance + Tutorials/Assignment/Viva/ Mini Project is based on application of the entire syllabus.

End Semester Theory Examination will be of 60 marks	
1	Question paper will have a total of five questions.
2	All questions have equal weightage and carry 20 marks each,
3	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Strength of Materials

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC302	Strength of Materials	3		3			3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC 302	Strength of Materials	20	20	60	2	--	--	100

Course Code	Course Name	Credits
ARC302	Strength of Materials	03
Course Objectives:		
1	To study different types of stresses, strain and deformation induced in the mechanical components due to external loads	
2	To study distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.	
3	To study the effects of component dimensions, materials and shapes on stresses and deformations.	

Course Outcomes: Learner will be able to:	
1	Demonstrate fundamental knowledge about various types of loading and stresses induced.
2	Draw the SFD and BMD for different types of loads and support conditions.
3	Analyse the stresses induced in basic mechanical components.
4	Estimate the strain energy in mechanical elements.
5	Analyse the deflection in beams.
6	Analyse buckling and bending phenomenon in columns, struts and beams.

Module	Detailed Contents	Hrs.
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, Parallel Axis theorem, Polar moment of Inertia. Stresses and Strains: Definition – Stress, Strain, Hooke's law, elastic limit, uni-axial, bi axial and triaxial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr's circle. Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk Modulus, yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading, deformation of tapering members, deformation due to self–weight, bars of varying sections, composite sections, thermal stress and strain.	**10**
2	**Shear Force and Bending Moment in Beams:** Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	**06**
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength **Direct and Bending Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:** Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	**06**

4	**Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.	**06**
5	**Deflection of Beams:** Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings **Thin Cylindrical and Spherical Shells:** Cylinders and Spheres due to internal pressure, cylindrical shell with hemi spherical ends	**07**
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula.	**04**

Text Books:	
1	Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2	Strength of Materials by Ryder, Macmillan
References:	
1	Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6th Ed, 2009
2	Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
3	Strength of Materials by Basavrajaiah and Mahadevappa, Khanna Publishers, New Delhi
4	Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
5	Mechanics of Materials by Beer, Jhonston, DEwolf and Mazurek, TMH Pvt Ltd., New Delhi
6	Mechanics of Structures by S.B.Junnarkar, Charotar Publication
7	Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
8	Introduction to Solid Mechanics by Shames, PHI
9	Strength of Materials by Nag and Chandra, Wiley India
10	Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
11	Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Electronic Devices and Electrical Networks

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC303	Electronic Devices and Electrical Networks	3		3			3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC303	Electronic Devices and Electrical Networks	20	20	60	2	--	--	100

Course Code:	Course Title	Credit
ARC303	Electronic Devices and Electrical Networks	3
Course Objectives:		
1	To introduce the concept of circuit elements, circuit laws and analyse DC circuits using various theorems.	
2	To analyse the transient & steady state response of AC circuits	
3	To synthesize the circuits using different techniques	

4	To familiarize the student with BJT circuits. To analyse the DC biasing circuits of BJT.	
5	To familiarize the student with FET and MOSFET circuits. To analyse the DC biasing of FET circuits.	
6	To design different types of voltage regulators and discuss the power amplifiers.	
Course Outcomes:		
1	Analyse DC circuits using different theorems	
2	Evaluate transient and steady state values of passive electrical networks	
3	Synthesize the networks using canonical forms	
4	Demonstrate the application of diodes and formulate the DC analysis of BJT.	
5	Apply the basic construction and characteristics of FET and MOSFET and to formulate the DC analysis of FET.	
6	Discuss the power amplifiers and design power supply using different IC	

Module		**Content**	**Hrs**
1		**Network Theorems:**	**8**
	1.1	Analysis of networks with dependent sources: mesh analysis, nodal analysis, super mesh and super node concept,	
	1.2	Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem.	
2		**Transient Analysis:**	**6**
	2.1	Initial Conditions in Elements, Solution of a First order and Second order differential equations,	
	2.2	Transients and steady state response in R-L, R-C and RLC Circuits.	
3		**Fundamentals of Network Synthesis:**	**6**
	3.1	Causality and stability, Hurwitz polynomials, positive real functions,	
	3.2	Synthesis of one port networks with two kinds of elements. Properties and synthesis of L-C, R-C, R-L driving point impedances- Foster Forms I & II, Cauer Forms I & II types of	

		realization	
4		**Diodes & Bipolar Junction Transistor:**	**7**
	4.1	Diode applications: Clipper and Clamper.	
	4.2	Device structure and physical operation, characteristics, BJT Common Emitter configuration as an amplifier and switch, DC Analysis of BJT Circuits, Biasing BJT Amplifier Circuits, Stability Analysis. Different collector loads in switching circuits.	
5		**Field effect Transistors:**	6
	5.1	Introduction to JFET, Types, Construction, Operation, Static Characteristics. FET as an amplifier and a switch. Biasing of FET amplifiers and its analysis (CS).	
	5.2	MOS Field effect Transistors: Introduction to MOSFET, Device structure and physical operation, characteristics.	
6		**Power Amplifier:**	6
	6.1	Definition and amplifier types, Series fed class A amplifier, Class B amplifier operation and circuits, Amplifier distortion, Push Pull Amplifier,	
	6.2	Power supply design: Using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and 317.	
		Total	**39**

Textbooks:	
1	Kuo Franklin F., “Network analysis and synthesis”, Wiley International, 1962.
2	Van Valkenburg M.E., “Network analysis”, Eastern Economy Edition, 1983.
3	Robert L. Boylestad, Louis Nashelsky, “Electronic Devices and Circuit Theory”, PHI publishers, 2004
4	Thomas L. Floyd, Electronic Devices, Pearson 2015.
5	D. A. Neamen, Micro Electronic Circuit Analysis and Design, McGraw-Hill, New Delhi, 2010.
Reference Books:	
1	Hayt William, Kemmerly Jr.Jack E., “Engineering circuit Analysis”, Tata McGraw Hill, 2002.
2	Edminister Joseph A., Nahvi Mohmood, “Electric Circuits”, Tata McGraw Hill, 1999.
3	Shyammohan Sudhakar, “Circuits and Networks Analysis and Synthesis”, Tata McGraw Hill.
4	J. Millman and C. C. Halkias, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill Publishing Company, 1988.
5	D. A. Bell, ―Electronic Devices and Circuits‖, OUP, India, 2010.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation	10 marks
4.	Creating Proof of concept	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	6 marks

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Digital Electronics

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC304	Digital Electronics	3		3			3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC304	Digital Electronics	20	20	60	2			100

Course Code:	Course Title	Credit
ARC304	Digital Electronics	3
Prerequisite:		
Course Objectives:		
1	To provide an understanding of the principles of digital electronics and use of number systems.	
2	To provide knowledge about combinational logic circuits.	

3	To describe working and design methods of sequential circuits.	
4	To familiarize with the basics of asynchronous sequential circuits and design techniques.	
5	To make students understand basic logic families and their applications.	
6	To provide understanding of memory devices and basics of FPGA.	
Course Outcomes:		
1	Represent numerical values in various number systems and perform number conversions between different number systems.	
2	Analyse and design digital combinational circuits using logic gates.	
3	Formulate and design Sequential logic circuits.	
4	Formulate and design asynchronous sequential logic circuits.	
5	Apply the concept of logic families and their application to design the digital system	
6	Explain nomenclature and technology in memory devices and concepts of FPGA	

Module		**Content**	**Hrs**
1.		**Binary number system & Boolean**	**9**
	1.	Binary Arithmetic, Binary codes: Weighted, BCD,8421, Gray code, Excess 3 code, ASCII, Error detecting code.	
	1.2	Reduction Methods: Boolean laws, De-Morgan's Theorems, Minimization of Boolean Expressions, Sum of Products (SOP), Product of Sums (POS), Karnaugh map minimization, Don't care conditions.	
2		**Design of Combinational logic circuits:**	**9**
	2.1	Adders, Subtractors, Code converters, Parity checker, magnitude comparators, BCD adder	

	2.2	Multiplexer, Demultiplexer, Encoder and Decoder. Implementation of combinational logic circuits using Multiplexer and Demultiplexer. Hazards in combinational logic circuits and elimination	
3		**Sequential logic circuits:**	**6**
	3.1	Flip flops- SR, D, Master Slave JK and T-Realization of one flip flop using other flip flops,	
	3.2	Asynchronous & Synchronous counters, Modulo n counters, Mealy/Moore models – Concept of state, State diagram, state assignment, State table, ASM chart.	
	3.3	Shift registers- different types - SISO, SIPO, PIPO, PISO, Ring counter and Twisted Ring counter	
4		**Asynchronous Sequential Circuits:**	**4**
	4.1	Circuit Diagram- primitive state/flow table,	
	4.2	Minimization of primitive state table	
5		**Logic Families:**	**5**
	5.1	Basics of digital integrated circuits, basic operational characteristics and parameters, TTL, Schottky clamped TTL, tri-state gate ECL, IIL	
	5.2	MOS devices, CMOS, comparison of logic families-PMOS, NMOS, E2CMOS, Bi CMOS	
6		**Memory and programmable logic devices:**	**6**
	6.1	PROM/EPROM/EEPROM/EAPROM - Programmable Logic Devices-Programmable Logic Array (PLA), Programmable Array Logic (PAL)	
	6.2	Introduction to Complex Programmable Logic Device (CPLD), VHDL and Verilog – Implementation of AND, OR, Adders using VHDL and Verilog Introduction and basic concepts of FPGA programming	
		Total	**39**

Textbooks:	
1	M. Morris Mano, “Digital Design”, Prentice Hall of India, 2003.
2	John .M Yarbrough, “Digital Logic Applications and Design”, Thomson-Vikas publishing house, 2002.
3	Barry B. Brey, “The Intel Microprocessors”, Pearson/Prentice Hall, 2006.
4	R. P. Jain, “Modern Digital Electronics”, Tata McGraw–Hill publishing company limited, 2003
Reference Books:	
1	Charles H. Roth., “Fundamentals of Logic Design”, Thomson Publication Company, 2003.
2	Donald P. Leach and Albert Paul Malvino, “Digital Principles and Applications”, Tata McGraw Hill Publishing Company Limited, 2003.
3	Thomas L. Floyd, “Digital Fundamentals”, Pearson Education, 2003.

Internal Assessment:

1. Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation.	10 marks
4.	Creating Proof of concept.	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks

7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Transducers

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC305	Transducers	3		3			3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARC305	Transducers	20	20	60	2			100

Prerequisite:	
Course Objectives:	
1	To explain the measurement systems, errors of measurement.
2	To provide an understanding of the operation of sensors and transducers.
3	To familiarize the student with the Identification, classification, construction, working principle and application of various transducers used in Industry for Temperature, Pressure & Vacuum, Level & Flow measurement
4	To provide an understanding of the construction, working principle and application of various transducers used for measurements of strain, displacement, force, torque and power, viscosity & density.

Course Outcomes:	
1	Explain the measurement systems, errors of measurement. List and compare various standards used for selection of transducers/sensors.
2	Describe the working principles of Temperature transducers and their applications.
3	Understand the working principles of Pressure & Vacuum Gauges and their applications.
4	Understand the working principles of Level transducers and their applications.
5	Identify types of Flow and understand working of different transducers for Flow measurement.
6	Understand working principle of various sensors used for strain, displacement, force, power, torque, viscosity & density measurement.

Module		**Content**	**Hrs**
1		**Introduction to Measurement Systems**	**4**
	1.1	Introduction, Block diagram, Functional elements of measurement system, Static and Dynamic characteristics of transducers. Errors, Remedies for Errors.	
	1.2	Definition of Sensor & Transducer, classification, selection criteria, transducer specifications.	
2		**Transducers for Temperature Measurement**	**10**
	2.1	Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of Temperature Sensor Materials	
	2.2	Resistance Temperature Detector (RTD): Principle, types, configurations, construction and working of RTD, 2 wire, 3 wire and 4 wire RTD Element, Lead wire compensation in RTD, self-heating effect, Specifications, advantages, disadvantages and applications of RTD	

	2.3	Thermocouple: Principle, thermo electric effect, See-beck effect, Peltier effect, Laws of thermocouple, types of thermocouples with characteristic curve, Thermocouple table, Sensitivity, constructional features of Thermocouples. Thermocouple specifications, cold junction compensation method, thermopile, Thermowell material of construction and its specifications.	
	2.4	Thermistor, NTC & PTC Types, applications.	
	2.5	Pyrometers: Principle, construction and working of radiation and optical Pyrometers and its applications Comparative study for Temperature transducers	
3		**Transducers for Pressure & Vacuum Measurement**	**6**
	3.1	Pressure scales, units and relations, classification	
	3.2	**Primary pressure sensors** – elastic elements like bourdon tube, diaphragm, bellows, properties and selection of elastic materials, Calibration using Dead Weight Tester	
	3.3	**Electrical/secondary Pressure Transducers**: Capacitive, piezo-electric and its material, variable reluctance, LVDT, strain gauge	
	3.4	**High Pressure Measurement**: Bulk modulus cell, Bridgeman type, capsule	
	3.5	**Differential pressure measurement**: construction & working of DP Cell	
	3.6	**Pressure measurement using manometer**: U – Tube types, well type, inclined type, micro manometer	
	3.7	**Vacuum Measurement:** Units and relations, Mcleod gauge, Pirani gauge, thermocouple gauge.	
4		**Transducers for Level Measurement**	**6**
	4.1	Need for level measurement, classification of Level Measurement Techniques.	
	4.2	Construction and working of displacer, float system, bubbler and DP CELL, ultrasonic, capacitive, microwave, radar, radioactive type, laser type transducer.	
	4.3	Level gauges, resistance, thermal, TDR/PDS type, solid level detectors, fibre optic level detectors, Level switches. Comparative study for level transducers.	

5		**Transducers for Flow Measurement**	**8**
	5.1	Introduction to fluid flow: properties of fluid, types of fluid, Reynolds number, types of fluid flow, continuity equation. Bernoulli's equation, hydrostatic law, Pascal's law, flow through pipes – major and minor losses, flow measurement through open channel-weirs and notches, Materials used for flow sensors, performance of materials, corrosion resistors, erosion, effect of vapor pressure.	
	5.2	**Head type**: Orifice, Venturi, nozzle, pitot tube, annubar, characteristics of Head type flow meters, **Variable area type**: Rotameter	
	5.3	**Velocity and Inertia based flowmeters**: Turbine, electromagnetic, ultrasonic, positive displacement, anemometers, mass flow meters, solid flow measurements.	
6		**Miscellaneous Measurement**	**5**
	6.1	**Strain Measurement** Introduction types of strain gauges, gauge factor calculation, materials for strain gauge, resistance strain gauge bridges, temperature compensation and applications of strain gauges.	
	6.2	**Transducers for Displacement:** Resistance type transducers: Potentiometer, piezo resistive effect. Inductive type transducers: LVDT, RVDT. Capacitance type transducers with applications. **Digital transducers**: translation and rotary encoders (absolute position and incremental position encoders). **Proximity Sensors**: inductive, capacitive, optical, ultrasonic, hall effect and magnetic. **Pneumatic transducer**: Flapper – nozzle transducer.	
	6.3	**Force measurement**: strain gauge, LVDT, piezoelectric. **Torque**: Torsion bar, strain gauge. **Power:** Dynamometer, instantaneous power measurement, alternator power measurement.	
	6.4	**Density measurement** – Displacement and float type densitometers. Hydrometers, Radiation and Ultrasonic densitometers **Viscosity measurement** – Capillary tube viscometer, Efflux type viscometer, variable area viscometer.	
		Total	**39**

Textbooks:	
1	B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, 01-Oct-2003 - Electronic instruments - 632 page.
2	Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003) - 344 pages.
3	A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996.
4	Rangan, Mani, Sharma. Instrumentation systems and Devices, 2nd EdTata McGraw Hill.
5	D.V.S. Murthi, Instrumentation and Measurement Principles‖, PHI, New Delhi, 2nd ed. 2003.
Reference Books:	
1	Doeblin E.D., Measurement system, Tata McGraw Hill., 4th ed, 2003.
2	Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003.
3	Neubert Hermann K. P., Instrument Transducer, 2nd ed., Oxford University Press, New Delhi, 2003.
4	Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
5	S.P. Sukhatme, Heat Transfer, 3rd edition, University Press.
6	Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA Publication.
7	Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition
8	Sawhney A.K., ―Mechanical Measurement‖, Dhanpatrai and Co.
9	Bansal R.K., ―Fluid Mechanics and Hydraulic Machines‖, Laxmi publications.
10	David W. Spitzer, ―Industrial Flow Measurement‖, ISA Publication

Internal Assessment:

1. Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment: -

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following: -

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more: - NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Wins in the event/competition/hackathon	10 marks
3.	Content beyond syllabus presentation.	10 marks
4.	Creating Proof of concept.	10 marks
5.	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6.	GATE Based Assignment test/Tutorials etc	10 marks
7.	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	5 marks
8.	Multiple Choice Questions (Quiz)	5 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Strength of Materials and Transducers Lab

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL301	Strength of Materials and Transducers Lab	--	2	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARL301	Strength of Materials and Transducers Lab	--	--	--	--	25	25	50

Lab Objectives:	
1	To make student understand the identification, construction, working principals of various transducers used in Industry for Temperature measurement, Pressure and Vacuum measurement, Level measurement, Flow measurement and also other miscellaneous measurements.
2	To understand strength of material – using hardness test & tension test
Lab Outcomes:	
1	Validate the characteristics of various Temperature transducers.

2	Understand working of Pressure & Vacuum transducers and calibration of pressure gauges.
3	Understand the construction and operation of various Level transducers.
4	Understand the construction and operation of various Flow transducers.
5	Demonstrate the performance characteristics of miscellaneous transducers.
6	To understand strength of material – using hardness test & tension test.

Suggested List of Experiments:

Sr. No.	Name of the Experiment	CO Mapping
1	Study and plot characteristics of resistance temperature detector (RTD).	CO1
2	Study and plot characteristics of Thermistors (PTC and NTC).	CO1
3	Study and plot characteristics of thermocouple.	CO1
4	Understand construction & working of Pressure Gauge.	CO2
5	Study of U-Tube Manometer	CO2
6	Study of Dead Weight Tester.	CO2
7	Level measurement using Ultrasonic Level transducer.	CO3
8	Level measurement using Capacitive type Level transducer.	CO3
9	Study of Tubular Level Gauges.	CO3
10	Pressure drop measurement across pipe fittings	CO4
11	Flow measurement using Orifice / Venturi / Nozzle	CO4
12	Flow measurement using Rotameter.	CO4
13	Flow measurement using Electromagnetic Flow Meter.	CO4
14	Flow measurement using Mass Flow Meter	CO4
15	Strain Measurement using strain - gauge	CO5
16	Study of Linear variable differential transformer (LVDT)	CO5
17	Study of Flapper Nozzle System	CO5
18	To understand strength of material – using hardness test	CO6
19	To understand strength of material –using tension test.	CO6

Term Work:

Term work should consist of 10 experiments

1. Journal must include at least 2 assignments.
2. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work
3. **Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Continuous assessment exam

Based on the subject and related lab of ARC302, ARC303

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Electronic Devices and Electrical Networks Lab Work

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL302	Electronic devices and Electrical Networks - Lab	--	2	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Prac & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARL302	Electronic devices and Electrical Networks - Lab	--	--	--	--	25	25	50

Lab Objectives:	
1	To verify the concept of circuit elements, circuit laws and analyze DC circuits using various theorems.
2	To analyze the transient & steady state response of AC circuits
3	To synthesize the circuits using different techniques
4	To verify operation of Diode and BJT electronic devices and circuits.
5.	To verify operation of FET and MOSFET electronic devices.
6.	To design different types of voltage regulators and discuss the power amplifiers.

Lab Outcomes:	
1	Analyse DC circuits using different theorems
2	Evaluate transient and steady state values of passive electrical networks
3	Synthesize the networks using canonical forms
4	Demonstrate the application of diodes and formulate the DC analysis of BJT.
5.	Apply the basic construction and characteristics of FET and MOSFET and to formulate the DC analysis of FET.
6.	Discuss the power amplifiers and design power supply using different IC

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Verify the Network Theorems using constant sources
2	Verify the Network Theorems using dependent sources
3	Verify the Transient Analysis for RL circuit.
4	Verify the Transient Analysis for RC circuit
5	Verify the Transient Analysis for RLC circuit
6	Synthesis of RC circuits
7	Synthesis of RL circuits
8	Synthesis of LC circuits
9	Design the Diode circuit as Clipper and Clamper.
10	Verify the input -output characteristics of BJT in CE configuration.
11	Verify operation of BJT switch for different collector loads
12	Implementation of a biasing circuit for BJT and estimate the parameters.
13	Analyse the JFET circuit and validate its transfer characteristics.
13	Analyse the MOSFET circuit and validate its transfer characteristics.
14	Simulate class A power amplifier and analyse with help of simulation software.
15	Design of fixed voltage regulator using fixed regulator IC.
16	Design of fixed voltage regulator using adjustable regulator IC.

Term Work:	
1	Term work should consist of minimum 05 tutorials from units 1 to 3 and minimum 05 experiments from units 4 to 6.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Digital Electronics Lab

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL303	Digital Electronics - Lab	--	2	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARL303	Digital Electronics - Lab	--	--	--	--	25	25	50

Prerequisite:	
Lab Objectives:	
1	To provide an understanding of the principles of digital electronics and use of number systems.
2	To give knowledge about combinational circuits,
3	To describe working and design methods of sequential circuits.
4	To familiarize with the basics of asynchronous sequential circuits and design techniques.

5.	To make the students understand basic logic families and their applications.
6.	To provide understanding of memory devices and state machines.
Lab Outcomes:	
1	Demonstrate numerical values in various number systems and perform number conversions between different number systems.
2	Exemplify operation of logic gates using IEEE/ANSI standard symbols. Analyze and design, digital combinational circuits.
3	Design and validate sequential logic circuits.
4	Design and verify asynchronous sequential logic circuits.
5.	Analyse logic families and their application to design the digital system.
6.	Demonstrate nomenclature and technology in memory devices.

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	**Name of the Experiment**
1	Implement conversion of Gray/Binary code.
2	Truth table verification and implementation of all gates using Universal gates.
3	Implementation of half/ full adder/ Subtractor.
4	Implementation of magnitude comparator.
5	Realise full adder using 2:1 Multiplexer.
6	Realise full Subtractor using 2:1 Multiplexer.
7	Implementation of various flip-flops.
8	Design and implement SR flip flop into other flip flops.

9	Design and implement JK flip flop into other flip flops.
10	Design and implement modulo-n counter.
11	Design and implement ring counter.
12	Design and implement universal shift register.
13	Implement BCD to seven segments display.
14	Design of logic gates using FPGA programming

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	**Total 25 Marks** **(Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Object Oriented Programming Lab

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL304	Object oriented programming Lab	--	2+2*	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARL304	Object oriented programming Lab	--	--	--	--	25	25	50

Prerequisite: C-Programming	
Lab Objectives:	
1	Describe the principles of Object-Oriented Programming (OOP).
2	To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3	Utilize the object-oriented paradigm in program design.
4	To lay a foundation for advanced programming.

5.	Develop programming insight using OOP constructs.
6.	Understand the applications of OOP.
Lab Outcomes: On successful completion of the course student will be able to:	
1	Describe the basic principles of OOP.
2	Design and apply OOP principles for effective programming.
3	Develop programming applications using OOP language.
4	Implement different programming applications using packaging.
5.	Analyse the strength of OOP.
6.	Percept the Utility and applicability of OOP

Module	Contents	Hrs.
1	**C++ Overview** Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object-oriented programming language. C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members. Branching - If statement, If-else Statement, Decision. Looping – while, do-while, for loop Nested control structure- Switch statement, Continue statement, Break statement. Array- Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.	**03**
2	**Overloading**- Concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function**- Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor**- Definition, Types of Constructors, Constructor Overloading, Destructor.	**07**
3	**Inheritance**- Introduction, Types of Inheritance, Inheritance, Public and	**04**

	Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism**- concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4	**Templates** Template Definition, Generic Function, Generic Class, Template function Overloading **I/O Streams & Files** Streams Hierarchy, Input Streams & Output Streams, what is File? Implementing various file operations on basic data types (write, read, append and modify), Implementing various file operations on object data types (write, read, append and modify), Random Access Files (seekp, seekg, tellp, tellg)	**04**
5	**Java History, Java Features**, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools. **Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize () method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length **Arguments**. String: String Class and Methods in Java.	**04**
6	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces**: defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator. **Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw	**04**

Reference Books:

1. The C++ Programming Language (4th Edition) By Bjarne Stroustrup
2. C++ Primer (5th Edition) By Stanley B. Lippman, Josee Lajoie, and Barbara E Moo
3. Effective Modern C++ (2014) By Scott Meyers
4. Ivor Horton, 'Beginning JAVA', Wiley India.
5. Dietal and Dietal, 'Java: How to Program', 8/e, PHI
6. 'JAVA Programming', Black Book, Dreamtech Press.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Program on various ways to accept data through keyboard and unsigned right shift operator.
2	Program on branching, looping, labelled break and labelled continue.
3	Program to create class with members and methods, accept and display details for single object.
4	Program on constructor and constructor overloading
5	Program on method overloading
6	Program on passing object as argument and returning object
7	Program on creating user defined package
8	Program on 1D array
9	Program on 2D array
10	Program on String
11	Program on String Buffer
12	Program on Vector
13	Program on single and multilevel inheritance (Use super keyword)
14	Program on abstract class
15	Program on interface demonstrating concept of multiple inheritance
16	Program on dynamic method dispatch using base class and interface reference.
17	Program to demonstrate try, catch, throw, throws and finally.
18	Program on concept of synchronization
19	Design a small User Input Mini Project using the OOPM concepts

Term Work:
Term work should consist of 10 experiments.
Journal must include at least 2 assignments.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Total 25 Marks **(Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)**

Program Structure for Second Year Automation and Robotics

Scheme for Autonomous Program

(With Effect from 2023-2024)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARM301	Mini Project-1A		4[$]	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (Hrs)			
		Mid Test (MT)	CA*					
ARM301	Mini Project-1A	--	--	--	--	25	25	50

Prerequisite: C-Programming	
Lab Objectives:	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems
3	To inculcate the process of self-learning and research
Lab Outcomes: On successful completion of the course student will be able to:	
1	Identify problems based on societal/research needs.

2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Analyse the impact of solutions in societal and environmental context for sustainable development
5.	Excel in written and oral communication.
6.	Demonstrate project management principles during project work

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/supervisor.
- Students shall try to convert the best solution into working model using various components of their domain and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e., Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can bead opted on case-by-case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on

continuous basis, minimum two reviews in each semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on logbook 10
    - Marks awarded by review committee 10
    - Quality of Project report 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem
    - Second shall be on finalization of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype/software model, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype/software model to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype/software model and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalization of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution

5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skillsets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the department.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal/External Examiners preferably from academia or industry or research organizations having experience of more than five years approved by Head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points:

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skillsets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication