V. E. S. Institute of Technology

S.E.

Automation and Robotics

(Semester – IV)

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 IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract.	Theory	Pract.	Tut.	Total
ARC401	Applied 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**	**7**	**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	Applied 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**

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC 401	Applied Mathematics -IV	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC 401	Applied Mathematics-IV	20	20	60	2	25	--	125

Pre-requisite:	
1)	Engineering Mathematics-I,
2)	Engineering Mathematics-II
3)	Engineering Mathematics-III,

Course Objectives:	
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 acknowledge the importance of sampling design and analysis methods for research and management in many other fields
4	To get familiar with the mathematical formulation of a real-world problem, acquaint with the problem-solving techniques theoretically, tackle several parameters into account while dealing with the problem and make aware the students about the applications of various forms of Linear Programming.
5	To prepare the students to use a powerful statistical software platform SPSS (Statistical Package for the Social Sciences) for the analysis of statistical data in the future.

Course Outcomes: Learner will be able to….	
1.	**Probability theory** Students will understand various probability measures, distribution functions, and their characteristics. They will be able to Compute probability using probability distribution of discrete and continuous Random variable. Additionally, the knowledge regarding Bayes theorem will help them take various real-life problems that arise in the medical fields and industries
2.	**Probability Distribution and Sampling Theory -1** Students will know fundamental concepts of testing of hypothesis, formulation of statistical hypothesis in real-life situations, developing best test procedures to test the hypothesis, and the principles underlying sampling as a means of making inferences about a population. They can also apply the idea of probability distribution to engineering problems.
3.	**Sampling theory - 2** Students will be able to analyze real-life data by using different nonparametric test procedures
4.	**Statistical Techniques** Students will apply the concept of Correlation and Regression, fitting of curve to the given data sets.
5.	**Linear Programming Problems** Students should be able to formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms**.** Linear programming models can be solved by them using the simplex method, Big M method and Dual simplex method
6.	**Non-Linear Programming Problems** Students will be able to solve Non-Linear Optimization problems using Lagrange's multiplier method and Karush Kuhn Tucker Method.

Module	Detailed Content	No. of Hours
Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III		
01	**Probability Theory** 1.1 Definition and basics of probability, conditional probability. Total Probability theorem and Bayes' theorem. Applications of Baye's theorem. 1.2 Discrete and continuous random variable with probability distribution and probability density function. 1.3 Expectation, Variance, Moment generating function, Raw and central Moments, Covariance, Correlation coefficient, Skewness and Kurtosis of distribution and their properties.	08
02	**Probability Distribution and Sampling Theory: -1** 2.1 Probability Distribution: Binomial, Poisson and Normal distribution. 2.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Test of significance of mean and difference between the means of two samples for large samples. 2.3 Degree of freedom, Student's t-distribution, Test of significance of mean and difference between the means of two samples for small samples.	08
03	**Sampling Theory: -11** 3.1Chi-Square Test: Test of goodness of fit. Contingency table and Test of independence of attributes, Yate's Correction. 3.2 Analysis of variance: F – Test, 3.3 ANOVA: One-way classification, Two- way classification test.	05
04	**Statistical Techniques:** 4.1 Karl Pearson's coefficient of correlation (r). 4.2 Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks). 4.3 Fitting of first- and second-degree curves. 4.4 Lines of regression.	06
05	**Linear Programming Problems:** 5.1 Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method. 5.2 Artificial variables, Big-M method (Method of penalty)	05
06	**Nonlinear Programming Problems:** 6.1 NLPP with no constraint, one equality constraint (two or three variables) using the method of Lagrange's multipliers. 6.2 NLPP with two equality constraints. 6.3 NLPP with inequality constraints: Karush-Kuhn-Tucker (KKT) conditions.	07
	Total	**39**

Text Books:	
1.	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
2.	Gupta and Kapoor, Fundamental of Mathematical Statistics, S Chand
3.	Operations Research, Hira and Gupta, S. Chand Publication.
4.	E.K.P. Chong, and S.H. Zak: An Introduction to Optimization, 3rd Edn, Wiley Interscience 2008
References:	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2.	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
3.	Operations Research: An Introduction, Hamdy A Taha, Pearson.
4	D.G. Luenberger , Linear and NonLinear Programming, 2nd Edn, Kluwer,2003.
5	Draper,N.R., and Smith, H .(2003) , Applied Regression Analysis,New York :Wiley
	Feller, William. An Introduction to Probability Theory and its Applications. Vol. I and II. New York,NY: Wiley ,1968-1971

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

Mid Term Test: One 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.

Rubrics:
1. Content beyond syllabus presentation.
2. Multiple Choice Questions (Quiz).
Total 2 Quiz/ Presentation (10 Marks each) will be conducted during a semester (Preferably before and after mid semester exam).

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

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

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.

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Automation and Robotics
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Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC402	Embedded System	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Se Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC 402	Embedded System	20	20	60	2	--	--	100

Course Code	Course Name	Credits
ARC402	**Embedded System**	**03**

Course Objectives:	
1)	To give an overview of embedded systems and make students aware of design challenges and technology.
2)	To impart knowledge of fundamentals of the MCS-51 microcontroller family and working of the system
3)	To make the students understand various programming tools and development of software using assembly and higher-level language.
4)	To give knowledge of integrated hardware of MCS-51.
5)	To give knowledge of interfacing of MCS-51 with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc.
6)	To make the students capable of developing applications using learned concepts of hardware, software and interfacing.

Course Outcomes: Learners will be able to:	
1)	Explain the architecture of embedded systems.
2)	Design systems to use the MCS51 features.
3)	Design applications using peripherals of MCS51 microcontroller.
4)	Design and develop interfacing circuits of advanced peripheral components with MCS51.
5)	Explain the architecture of M0+ ARM processors.
6)	Investigate, recommend and design sophisticated applications based on MCS-51.

Module	Details	Hrs
1	**Introduction to Embedded Systems** Basic structure, Design Metric, Current Trends, RISC and CISC architecture 8051 Architecture: Features and Variants, architecture and pin configurations, CPU timing and machine cycle, Memory organization.	05
2	8051 Assembly Language Programming: Instruction set, Addressing mode, Assembler directives and programs. **8051 Peripherals:** Input / Output ports, Counters and timers.	10
3	**Advanced Peripherals:** Serial Port, Interrupts, Enhanced Capture & Compare Port, I2C & SPI Protocol Peripheral.	08
4	**Interfacing:** Button and Button Debouncing, LED, Seven Segment Display, Stepper Motor, H bridge Drive, ADC & DAC	07
5	**Introduction to Cortex M0+ processors:** Features of M0+ processors, Basics of ARMV6 architecture, Core Registers, Exception Models.	05
6	**Case Studies:** **Software Models for Embedded System (DFG, CDFG, STATE MACHINE, Sequential)** Data acquisition system, Digital weighing machine, Washing machines, Traffic light controller, home automation and irrigation.	04
	Total	**39**

Text Books:	
1)	Mazidi M.A., The8051 Microcontroller & Embedded systems, Pearson Education Second edition.2006
2)	Kenneth Ayala, The8051 Microcontroller, Thomson Delmar Learning, Third Edition.2005
3)	Steve Heath, Embedded Systems Design, Newness publication, Second edition, ISBN 0 7506 5546
4)	The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors, 2nd Edition

Reference Books:	
1)	David Simon, Embedded Software Primer, Pearson Education, ISBN 81-7808-045-
2)	Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, Wiley Student Edition. ISBN No.812650837X
3)	P.S. Manoharan, P. S. Kannan, Microcontroller based system design, SciTech Publications (India)Pvt. Ltd. ISBN No. 8183715982

4)	8051 / MC151 / MCS251 Datasheets
5)	Microcontrollers-Architecture, Programming, Interfacing and System Design, Pearson Education India; Second edition (2011), ISBN-10: 8131759903.
6)	Cortex-M0+ Technical Reference Manual r0p1
7)	ARMv6-M Architecture Reference Manual

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

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

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.

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Course Code	Course Name	Credits
ARC403	Automatic Control Systems	03

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC403	Automatic Control Systems	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA *					
ARC403	Automatic Control Systems	20	20	60	2	--	--	100

Course Objectives:	
1)	The students should be able to learn the type of Systems, dynamics of physical systems, classification of control system, analysis and design objectives.
2)	The students should learn how to represent the system by transfer function using block diagram reduction method and Mason's gain formula.
3)	The students should be able to learn time response analysis and demonstrate their knowledge of frequency response.
4)	Students should learn stability analysis of systems using Root locus, bode plot, polar plot, and Nyquist plot.

Course Outcomes: Student will be able to	
1)	Identify open and closed loop control systems.
2)	Formulate mathematical models for physical systems.
3)	Simplify representation of complex systems using reduction techniques.
4)	Use standard test signals to identify performance characteristics of first and second-order systems.
5)	Apply root locus technique for stability analysis.
6)	Analyze performance characteristics of the system using Frequency response.

Details of Syllabus:

Module	Content	Hrs
1	**Introduction:** Definition of control system, open loop and closed loop system, examples. Development of automatic control systems, classification of control systems with examples.	04
2	**Mathematical Models of Physical Systems:** Definition of physical systems, principle of superposition and homogeneity, linear/non-linear, time variant/time invariant systems. Types of dynamic model, linear elements of electrical and mechanical systems.	06
3	**Derivation of Transfer function:** Definition of transfer function, transfer functions of physical systems, block diagram algebra, reduction rules, signal flow graphs-definition, construction, properties, and Mason's gain formula.	07
4	**Time Response Analysis:** Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types.	08

5	**Stability Analysis and Root Locus:** Concepts of stability, definitions, bounded input – bounded output stability, relative stability and robust stability, Routh stability criterion. Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems.	06
6	**Frequency Response and Stability Analysis** Correlation between time and frequency response, polar plots, Bode plots, Nyquist stability criterion, frequency response specifications, stability analysis using-bode, polar, definitions and significance of gain margin and phase margin.	08
	Total	**39**

Text Books.	
1)	Nagrath I. G., Gopal M., Control System Engineering, New Age International (P) Ltd. Publishers, 2021
2)	Kuo Benjamin C., ―Automatic Control Systems‖,10th Edition, Prentice Hall of India, New Delhi, 201

Reference Books	
1)	Gopal M. ―Control Systems Principles and Design‖, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998
2)	Nise Norman S., ―Control Systems Engineering‖, 3rd.Edition, John Wiley and Sons, Inc.-2000
3)	K. Ogata, Modern Control Engineering, Prentice Hall of India, 4th edition, 2002.
4)	Lewis Paul H., Chang Yang, ―Basic Control Systems Engineering‖, Prentice HallInternational, Inc. 1997.
5)	Raymond T. Stefani, Bahram Shahian, late Clement J. Savant and, late Gene H. Hostetter, ―Design of Feedback Control Systems‖, 4th Edition., Oxford, University Press, New Delhi, 2001.

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

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

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
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Course Code	Course Name	Credits
ARC404	Signal Conditioning Circuit Design	03

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC404	Signal Conditioning Circuit Design	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC404	Signal Conditioning Circuit Design	20	20	60	2	--	--	100

Course Objectives:	
1)	To introduce the students the basic properties of Op-amp, analysis and design of electronic circuits using Op-amp
2)	To give the knowledge about the various components of analog signal conditioning
3)	To impart knowledge of design considerations of analog signal conditioning of components.
4)	To give the student's knowledge about various components digital signal conditioning.
5)	To make the students capable to apply knowledge to design various transducer signal conditioning circuits

Course Outcomes: On successful completion of course learner/student will be able to:	
1)	Describe op-amp parameters and types and derivation of operational amplifiers
2)	Design the various operation amplifier circuits for linear applications.
3)	Formulate and design non-linear applications of op-amp.
4)	Design of analog signal conditioning circuits\
5)	Design of Digital signal conditioning circuits
6)	Apply signal conditioning concepts to design various transducer/ sensors signal conditioning circuits

Prerequisite: Knowledge of various sensors and basic electronics.

Details of Syllabus:

Module	Contents	Hrs.
1.	**Fundamentals of Operational Amplifier** Block diagram of Operational amplifier, Ideal Op Amp, characteristics of op-amp, op-amp parameters, Operational amplifier open loop and closed loop configurations, Inverting and non-inverting amplifier.	04
2.	**Linear Applications of Operational Amplifier** Amplifiers: Adder, subtractor, difference amplifier, Integrator, and practical integrator, Differentiator and practical differentiator, Current to Voltage converter, voltage to current converter (grounded and floating load), Instrumentation amplifier with three Op-amps, and application of Op-Amp in Transducer Measurement System.	08
3.	**Nonlinear Applications of Operational Amplifier** Comparator and its characteristics, Zero Crossing Detector (ZCD), Schmitt trigger, window detector, Sample and Hold Circuit, Peak to Peak Detector, Precision half wave and full wave rectifiers, Sine wave oscillators using op-amp.: Barkhausen criteria, Wein bridge oscillator, RC phase shift oscillator. Waveform Generators: Square wave generator and triangular wave generator, Design and applications of Multivibrators: Astable, Monostable using IC 555, PLL.	08
4.	**Analog Signal Conditioning** Standard analog signals, Signal Level and bias changes, Linearization, conversion, filtering and impedance matching, concept of loading. Voltage divider, Wheatstone bridge circuits, Active filter. Guidelines for analog signal conditioning design and design-based problems.	04
5.	**Digital Signal Conditioning** Converters – ADCs and their different types, DACs and their different types, V to F and F to V converters. Characteristics of digital data – digitized value, sampled data system and linearization.	07
6.	**Transducer Signal Conditioning** Signal Conditioning of Temperature, Pressure, optical, strain gauges, Displacement and piezoelectric transducers signal conditioning. Data logger circuit, Data acquisition system (Block Diagram Level)	08
	Total	**39**

Text Books:	
1)	Ramakant Gaikwad, *"Op-amp & Linear ICs",* PHI Pearson Education, 2003.
2)	C. D. Johnson, *"Process Control Instrumentation Technology"*, 2016.
3)	D. E. Pippenger and E. J. Tobanen, *"Linear and Interface Circuits Applications",* McGraw Hill, 1988.
4)	William D. Stanley, ―Operational Amplifiers with Linear Integrated Circuits‖, Pearson.

Reference Books:	
1)	Roy Choudhary, *"Linear Integrated Circuits",* Wiley Eastern, 1991.
2)	Coughlin & Driscoll, *"Op-amp and Linear ICs"* 6th Edition, PHI 2002.
3)	Sergio Franco, *"Design with op-amp analog ICs"* McGraw Hill, 1988.
4)	Robert G. Seippel, *"Transducer Interfacing – Signal Conditioning for Process Control",*Prentice Hill, 2000.

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

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

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.

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Semester IV

Course Code	Course Name	Credits
ARC405	Components of Automation and Robotics	03

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARC405	Components of Automation and Robotics	3	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Exam Dur (Hrs)			
		Mid Test (MT)	CA*					
ARC405	Components of Automation and Robotics	20	20	60	2	--	--	100

Course Objectives:	
1)	To impart knowledge of different control system components like Hydraulic, Pneumatic, Electrical & Electronics and their comparison.
2)	To make the students learn different types of Transmitters.
3)	To make the students to understand concept of control valve, different types, their working & selection criteria.
4)	To make the students to learn various Auxiliary process control components and its applications
5)	To give the students an overview of Industrial Control components & their Need in Instrumentation.

Course Outcomes: On successful completion of course learner/student will be able to:	
1)	Explain and select various pneumatic system components and circuits.
2)	Select and compare various control systems like Hydraulic, pneumatic and electric.
3)	Apply knowledge to classify, select and use various transmitters.
4)	Classify and select various control valves and their accessories.
5)	Describe and select industrial components and study their usage.
6)	Demonstrate major components of industrial robot.

Module	Contents	Hours
1	**Overview of Automation components** Introduction, significance of Automation components. Need and Classification. Industrial applications.	02
2	**Pneumatic and Hydraulic Components:** Pneumatic components: ISA symbols, Instrument Air and Plant Air. Air compressor system and its accessories. Directional control valves and special types of pneumatic valve such as Pilot-operated valves, non-return valves, Flow control valves, Sequence valves, and Time delay valve, Linear actuators- Single-acting, Double-acting, and special type of double acting cylinder, process Control Pneumatics: Pneumatic logic gates, Pneumatic Circuits-Standard Symbols used for developing pneumatic circuits, Sequence diagram. Hydraulic components: Hydraulic pumps (centrifugal, gear, lobe), Pressure regulation method, Loading valves, Hydraulic valves, Selection and comparison of pneumatic, hydraulic and electric systems	06
3	**Field Transmitters:** Need for transmitters, Standardization of signals, concept of live zero and dead zero, classification of transmitters: Conventional, SMART, Digital Conventional Electronic type transmitters - temperature; Pressure (gauge); differential pressure; level (capacitive type); flow transmitter (magnetic); SMART /Intelligent transmitter; Block schematic and working of transmitter, specifications and features, applications of transmitters. Digital Transmitter: Block diagram and working of FF transmitters, specifications and features. Applications	10
4	**Final control Elements & accessories** **Control Valves:** Need and specifications of Control Valve; Control valve terminology; Control valve constructional details; Air to Open (AO), Air to Close (AC); MOC (Material of construction); classification of control valve; applications, advantages, disadvantage of Globe, Ball, Needle, Butterfly, Diaphragm, Pinch, Gate, Solenoid; Flow characteristics (Inherent and Installed): Valve positioners: necessity, types-motion balance and force balance, Effect on Performance of control valve; Feeders & dampers. **Actuators:** Types of actuators, Specifications, selection guidelines. **Converters:** Need for Converters and types, working of Pneumatic to Electrical and Electrical to Pneumatic converters. **VFD:** introduction and Need, working of AC & DC drives. **Safety valves:** working of safety valve, relief valve and their application. **Accessories:** Volume boosters, Air relays, solenoid valve	10

5	**Auxiliary control components** **Panel Switches**: Construction, symbolic representation, working, application of Toggle switches, Push buttons, Selector switches, DIP switches, Rotary switches, Thumbwheel switches, Drum switch, emergency push button, Tactile switch, Switch specifications. CAM SWITCHES MAGNETIC contactors, PILOT Light. **Industrial switches:** Temperature, Flow, Level and, Pressure Switch, Vibration switch. **Control Relays:** Construction, working, specifications, and applications of Electro-mechanical relay, Solid state relays. Interposing relays and Overload relays. **Contactors/starters:** Construction, working, specifications and applications of starters and contactors. Comparison between relays and starters /contactors. Alarm annunciators and its sequences	06
6	**Components of Industrial Robot** Manipulators, End Effectors, Feedback devices, Controllers, and Locomotive devices, Limit switches, proximity switches. Overview of DC motor, stepper motor and servo motor.	05
	Total	**39**

Text Books Recommended:	
1)	Andrew Parr, Hydraulic &pneumatics; A Technicians & Engineers Guide, Second Edition
2)	Control Valve Handbook – Forth Edition, Fisher.
3)	Pneumatics workbook Basic Level - FESTO
4)	C. L. Albert and D.A. Coggan, “Fundamentals of Industrial Control”, ISA, 1992.
5)	Bela G. Liptak, “Instrument Engineer’s Hand Book – Process Control”, Chilton Company, 3rd Edition, 1995.
6)	Andrew Williams, “Applied instrumentation in the process industries”, 2 nd Edition, Vol. 1 & 3, Gulf publishing company.
7)	Guy Borden, Paul G Friedman, style Editor Control Valves- ISA
8)	Process Instruments & Control Handbook, Douglas. M. Considine, McGraw-Hill

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

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

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.

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Semester IV

Course Code	Course Name	Credits
ARL401	Embedded Systems and SCCD - Lab	01

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL401	Embedded Systems and SCCD - Lab	--	2	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		Internal Assessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA*					

		--	--	--	--	25	25	50

Course Objectives:	
1)	To explain the assembly and C programming concepts.
2)	To explain addressing modes and instruction set of MCS-51 and develop programs using instructions.
3)	To give knowledge of integrated hardware of MCS-51 and o study different SFRs associated with integrated peripherals and to give knowledge of interfacing of MCS-51 with different peripheral devices such as LCD, keyboard, Memory, ADC, DAC etc.
4)	To introduce the students the basic properties of Op-amp, analysis and design of electronic circuits using Op-amp.
5)	To give the knowledge about the various components analog and digital signal conditioning
6)	To make the students capable to apply knowledge to design various transducer signal conditioning circuits

Course Outcomes: The students will be able to:	
1)	Develop programs to configure the peripherals in 8051 and to design and interface peripheral components with MCS 51
2)	Design programs to use interrupt in 8051.
3)	Design and interface peripheral components using communication protocols.
4)	Evaluate op-amp parameters and design various linear and non-linear applications using op-amp.
5)	Apply principles of analog & digital signal conditioning for op-amp based circuit design.
6)	Design and develop signal conditioning circuits for different transducers

List of Experiment:

Sr. No.	Details	CO Mapping
1	To develop programs using Timer /Counter of MCS-51.	CO1
2	To develop programs using the Ports of MCS-51 using C programming.	CO1
3	To develop programs for Timer or External Interrupts of MCS-51.	CO2
4	To develop a program for interfacing 7- segment displays with MCS-51.	CO1
5	To develop a program for interfacing LCD displays with MCS-51 in C language.	CO1
6	To develop a program for interfacing ADC/DAC with MCS-51 using C language.	CO1
7	To develop a program for Serial Communication with PC using C programming.	CO3
8	To develop a program for I2C/SPI Communication using C programming.	CO3
9	To develop a program for frequency measurement using ECCP and C programming.	CO1
10	To develop a program for DC/ Stepper motor control using C programming.	CO3
11	To implement Adder and Subtractor using Op-amp	CO4
12	To design Instrumentation Amplifier using 3 Op-amps.	CO4
13	To design and demonstrate I to V and V to I converter circuit	CO4
14	To Implement Precision rectifiers using Op-amp.	CO4
15	To design and demonstrate integrator and differentiator using Op-amp.	CO4
16	To design and demonstrate second order LPF and HPF.	CO4
17	To design and implement Astable and Monostable Multivibrator using IC 555	CO5
18	To design and demonstrate Analog to Digital converter circuit or Digital to Analog converter circuit	CO5
19	Design signal conditioning circuit for Temperature Transducers like RTD/Thermocouple/Thermistor	CO6
20	Design signal conditioning circuit to convert sensor output to 0-5V OR 4-20mA	CO6

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)**

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Semester IV

Course Code	Course Name	Credits
ARL402	Automatic Control Systems - Lab	01

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL402	Automatic Control Systems – Lab	--	2	--	1	--	1

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Pract & oral	Total
		Internal Assessment	End Sem Ex	Ex Dur (Hrs			

				a m	**)**			
		Mid Test (MT)	**C A ***					
		--	--	--	--	25	25	50

Course Objectives:	
1)	The students should be able to examine steady-state and frequency response of the Type 0, 1, and 2 systems.
2)	The students should be able to examine steady-state and frequency response of first and second order electrical systems.
3)	The students should be able to examine time response analysis of first and second order systems.
4)	Students should inspect the stability of the system using Root locus, Bode plot, polar plot.

Course Outcomes: On successful completion of course learner/student will be able to:	
1)	Plot time and frequency response of first-order electrical system.
2)	Plot time response of second-order system.
3)	Demonstrate the way to obtain the transfer function and validate transient and steady-state response using test signals such as step, ramp, and parabolic.
4)	Understand the effect of the damping factor on system response.
5)	Inspect the time response specifications of systems by using root-locus.
6)	Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of the system.

List of the Laboratory Experiments

Sr. No	Contents	CO Mapping
1	To plot the effect of time constant on first – order systems response.	**CO1**
2	To plot the time response of first-order systems.	**CO2**
3	To plot the time response of second- order systems.	**CO2**
4	To examine steady state errors for Type 0, 1, 2 systems.	**CO3**
5	To study the block diagram reduction technique by using simulation software.	**CO3**
6	To interpret the effect of the damping factor on the performance of the second order system.	**CO4**
7	To inspect the relative stability of systems by Root-Locus using simulation software.	**CO5**
8	To inspect the stability of systems by Bode plot using simulation software	**CO6**
9	To determine the frequency response specifications from Polar plot of system	**CO6**
10	To inspect the stability of systems by Nyquist plot using simulation software.	**CO6**

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
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Semester IV

Course Code	Course Name	Credits
ARL403	Components of Automation and Robotics systems - Lab	01

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL403	Components of Automation and Robotics systems - Lab	--	2	--	1		1

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Pract & oral	Total
		Internal Assessment	End Sem	Ex Dur (H			

				Exam	rs)			
		Mid Test (MT)	**CA***					
ARL 403	**Components of Automation and Robotics systems - Lab**	--	--	--	--	25	25	50

Course Objectives: The course is aimed at	
1)	To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure and vacuum measurement, force, torque and power measurement
2)	To study electro-chemical sensors and transducers used for density and viscosity measurement
3)	To impart knowledge of different control system components like Hydraulic, Pneumatic and Electrical and their comparison.
4)	To make the students to learn different process components and auxiliary process control components.

Course Outcomes: On successful completion of course learner/student will be able to:	
1)	Explain working principle of strain gauges, pressure transducers
2)	Learn Basic fundamentals of flow transducers identify types of flow and use different transducers for flow measurement.
3)	Explain the terminologies of electrochemical, density, humidity, pH measurement sensors, and their applications in industry.
4)	Study, select and implement various pneumatic, hydraulic and electro-pneumatic system components and circuits.
5)	Apply knowledge to classify, select and use various Transmitters, control valves and their accessories
6)	Describe the Need of Auxiliary process control components and study their industrial usage

List of the Experiments:

Sr. No.	**Details**	**CO Mapping**
1	Strain gauge characteristics and weight measurement	**CO1**
2	Study use of semiconductor strain gauges for pressure measurement	**CO1**
3	Study measurement of pressure using bellows, diaphragm, bourdon tube, manometer.	**CO1**
4	Test and calibration of pressure gauges using dead weight tester.	**CO1**
5	Measurement of flow using orifice/venturi tube/nozzle/pitot tube	**CO2**
6	Measurement of flow using rotameter/ electromagnetic flow meter.	**CO2**
7	Study and characterization of pH meter/ conductivity meter.	**CO3**
8	Measurement of Density/Viscosity	**CO3**
9	Study of various pneumatic / hydraulic control system components	**CO4**
10	Study of various electro-pneumatic control system components.	**CO4**
11	Study operation and calibration of flow/ level/ temperature transmitter	**CO5**
12	Study of different types of control valve actuator.	**CO5**
13	Calibration of I to P and / P to I converter.	**CO5**
14	Study characteristics of control valve	**CO5**
15	Study different types and operation of control valve and valve positioner	**CO6**
16	Study of pressure/temperature/level/flow switches and control relays.	**CO6**

Note:	
1)	Minimum of Ten experiments can be conducted during the semester for term work and practical examination
2)	Factory visit is advised to understand the working of the control system components.
3)	Assignments based on syllabus which will help students to understand the Topic can be given during the semester as a support to Evaluate Term work.

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)**

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Course Code	Course Name	Credits
ARL404	Python Programming	02

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theory	Pract	Theory	Pract	Tut	Total
ARL404	Python Programming	--	2+2*	--	2	--	2

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Pract & oral	Total
		Internal Assessment	End Sem Exam	Ex Dur (Hrs)			

		Mid Test (MT)	**CA***					
ARL 404	**Python Programming**	--	--	--	--	25	25	50

Course Objectives: To know the basics of algorithmic problem solving	
1)	To read and write simple Python programs
2)	To develop Python programs with conditionals and loops.
3)	To define Python functions and call them
4)	To use Python data structures –- lists, tuples, dictionaries.

Course Outcomes: Upon completion of the course, students will be able to	
1)	Read, write, execute by hand simple Python programs.
2)	Represent compound data using Python lists, tuples, dictionaries.
3)	To develop python programs to plot and analyze the data.
4)	To learn simple Python programs for file handling and I/O operations.
5)	Implement simple python programs for Machine learning applications
6)	To develop Graphical User Interface for different Python programs

Details of Syllabus:

Module	Contents	Hrs.	CO Mapping
1	**Introduction: Python Basics:** Why Python for scientific computing? Python versions: IDE, features of IDE, commonly used IDE, Setting Working Directory, Creating and saving a script file, File execution, clearing console, removing variables from environment, clearing environment, Commenting script files, Variable creation, Arithmetic and logical operators, Data types and associated operations , Mathematical functions.	**04**	**CO1**
2	**Advance Data Types, Control Flow, and Functions:** Numbers, Sequences, passing arguments to functions, Statements and Expressions, Operators and Math's, Conditionals, Loops, Strings, List, Tuples, Set Operation, Dictionary (Dict), Range, Date and Times. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.	**04**	**CO2**
3	**Numerical Python (Numpy) and Visualizing Data:** Array operations, Numpy Side Effects, 2D Numpy Arrays, Numpy Basic Statistics, Universal Functions, Examples using linear algebra operations. Matplotlib and Pylab, Introduction, Simple plots, Line API, Legend API, Figures, Subplots, Axes and Ticks, Histograms, Visualizing matrix data.	**06**	**CO3**
4	**Python File Handling, Python File I/O and Regular Expression:** Python File Handling: Create, Open, Append, Read, Write functions Python File I/O: Open a file, Read or write (perform operation), File Methods, Close the file. Regular Expression: Basis, findall, search, split, sub	**04**	**CO4**
5	**Machine Learning in Python(scikit-learn):** Classification, Regression, Clustering, Dimensionality Reduction, Ensemble methods, Feature extraction, Feature selection, Supervised Models	**04**	**CO5**
6	**Graphical User Interface (GUI) Development using Python:** Introduction to Tkinter, Tkinter Programming, Creating a GUI application, Tkinter Widgets: Operator & Description, Standard attributes, Geometry Management.	**04**	**CO6**

Text Books:	
1)	Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd edition, Updated for Python 3, Shroff/O ‘Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2)	Guido van Rossum and Fred L. Drake Jr, ―An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

References:	
1)	John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013
2)	Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Interdisciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3)	Timothy A. Budd, Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd, 2015.
4)	Kenneth A. Lambert, Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5)	Raúl Garreta , Guillermo Moncecchi, Learning scikit-learn: Machine Learning in Python, Packt Publishing (November 25, 2013)
6)	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013.
7)	John Grayson, Python and Tkinter Programming, Manning Publications; First Edition edition (January 2000)

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	Write a program to demonstrate different number data types in Python.	CO1
2.	Write a program to perform different Arithmetic Operations on numbers in Python	CO2
3.	Write a program to create, concatenate and print a string and accessing sub-string from a given string.	CO2
4.	Write a program to create, append, and remove lists in python.	CO2
5.	Write a program to demonstrate working with tuples in python	CO2
6.	Write a program to demonstrate working with dictionaries in python.	CO3
7.	Write a python program to find largest of three numbers.	CO3
8.	Write a Python program to convert temperatures to and from Celsius, Fahrenheit.	CO4
9.	Write a Python script that prints prime numbers less than 20.	CO5
10.	Write a python program to find factorial of a number using Recursion.	CO5
11.	Write a program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides).	CO5
12.	Write a script named copyfile.py. This script should prompt the user for the names of two text files. The contents of the first file should be input and written to the second file.	CO4
13.	Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.	CO4
14.	Write a program to generate different sinusoidal signal and plot it using Matplotlib.	CO5
15.	Using scipy's quad function, write a program that solves the following integral numerically:$I = \int_0^1 \quad cos\, cos\, (2\pi x)\, dx.$	CO6
16.	Write a function with name plotquad which takes the same arguments as the quad command (i.e. f, a and b) and which • (i) creates a plot of the integrand f(x) and • (ii) computes the integral numerically using the quad function. The return values should be as for the quad function.	CO6
17.	Write a python program to retrieve elements of an array using indexing, sort them in order. Also write a program to print stars to form a right-angled triangle and equilateral triangle	
18.	Write a python program to find the transpose of a matrix and to multiply two matrices.	
19.	Write a Python program to calculate gross salary and net salary of employee. Take user input for basic salary. Gross salary= basic +DA+HRA; Net salary= Gross salary-PF-Income tax. DA is 80% of basic salary; HRA 15% of basic; PF is 12% of basic; Tax is 10% of gross salary.	

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)**

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned			
		Theoy	Pract	Theory	Pract	Tut	Total
ARM401	Mini Project-1B	--	4$	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract & oral	Total
		InternalAssessment		End Sem Exam	Ex Dur (Hrs)			
		Mid Test (MT)	CA *					
ARM401	Mini Project-1B	--	--	--	--	25	25	50

Course Code	Course Name	Credits
ARM401	Mini Project-1B	02

Course Objectives:	
1)	To acquaint with the process of identifying the needs and converting it into the problem.
2)	To familiarize the process of solving the problem in a group.
3)	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4)	To inculcate the process of self-learning and research.

Course Outcome: Learner 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 a member of a group or leader.
4)	Draw the proper inferences from available results through theoretical/experimental/simulations
5)	Analyze the impact of solutions in societal and environmental context for sustainable development.
6)	Use standard norms of engineering practices
7)	Excel in written and oral communication.
8)	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
9)	Demonstrate project management principles during project work

Guidelines for Mini Project	
1)	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.

2)	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.
3)	Students' hall submits implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4)	A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5)	Faculty supervisor may give inputs to students during mini-project activity; however, focus shall be on self-learning.
6)	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/supervisor.
7)	Students shall convert the best solution into working/ software model using various components of their domain areas and demonstrate.
8)	The solution to be validated with proper justification and report to be compiled in the standard format.
9)	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 2insemesters Vand VI.
10)	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 be adopted on case-by-case basis.

Guidelines for Assessment of Mini-Project: Term Work	
1)	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.
2)	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.

3)	Distribution of Term work marks for both semesters shall be as below; Marks awarded by guide/supervisor based on logbook 10 Marks Marks awarded by review committee 10 Marks Quality of Project report 05 Marks

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 components/systems, building of working/software prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working/software 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 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:	
1)	Report should be prepared as per the guidelines issued by the Department.
2)	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3)	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