University of Mumbai

No. AAMS_UGS/ICC/2023-24/09

CIRCULAR:-

Sub :- B.E. (Automation and Robotics).

Ref :- RB/MU-2022/CR-441/Edn-5/750, dated 07th June, 2023.

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. AAMS_UGS/ICC/2022-23/156 dated 07th November, 2022, relating to introduction of new branch for B.E. (Computer Science & Design).

They are hereby informed that the Academic Council at its meeting held on 28th November, 2022 **vide** item No. I 1 (A) and subsequently approved by the Management Council at its meeting held on 23rd February, 2022 **vide** item No. 9 and that in accordance therewith, in exercise of the powers conferred upon the Management Council under Section 74(4) of the Maharashtra Public Universities Act, 2016 (Mah. Act No. VI of 2017) for the **Ordinance 3701 relating to introduction of new branch for B.E. (Automation and Robotics) (Sem. III & IV)** from the academic year 2021-22 and to read as under:-

Ordinance 3701 relating to introduction of new branch for B.E. (Automation and Robotics).

The Existing Ordinance 3701:-

1. Automobile Engineering
2. Bio-medical Engineering
3. Chemical Engineering
4. Civil Engineering
5. Computer Engineering
6. Construction Engineering
7. Electrical Engineering
8. Electronics Engineering
9. Electronics & Telecommunication Engineering
10. Instrumentation Engineering
11. Mechanical Engineering
12. Production Engineering
13. Information Technology
14. Marine Engineering
15. Bio-technology
16. Bio-informatics
17. Printing Technology
18. Mechatronics Engineering
19. Electronics & Computer Science

20. Computer Science and Engineering
(Internet of Thing & Cyber Security including Block chain Technology)
21. Artificial Intelligence & Data Science
22. Cyber Security
23. Computer Science and Engineering
(Artificial Intelligence & Machine Learning)
24. Computer Science and Engineering (Data Science)
25. Internet of Thing
26. Artificial Intelligence & Machine Learning
27. Data Engineering
28. Civil and Infrastructure Engineering
29. Computer Science & Design

The Amended Ordinance 3701:-

1. Automobile Engineering
2. Bio-medical Engineering
3. Chemical Engineering
4. Civil Engineering
5. Computer Engineering
6. Construction Engineering
7. Electrical Engineering
8. Electronics Engineering
9. Electronics & Telecommunication Engineering
10. Instrumentation Engineering
11. Mechanical Engineering
12. Production Engineering
13. Information Technology
14. Marine Engineering
15. Bio-technology
16. Bio-informatics
17. Printing Technology
18. Mechatronics Engineering
19. Electronics & Computer Science
20. Computer Science and Engineering
(Internet of Thing & Cyber Security including Block chain Technology)
21. Artificial Intelligence & Data Science
22. Cyber Security
23. Computer Science and Engineering
(Artificial Intelligence & Machine Learning)
24. Computer Science and Engineering (Data Science)
25. Internet of Thing
26. Artificial Intelligence & Machine Learning
27. Data Engineering
28. Civil and Infrastructure Engineering
29. Computer Science & Design
30. **Automation and Robotics**

(The same is available on the University's website www.mu.ac.in).

(Prof. Sunil Bhirud)
I/c. REGISTRAR

MUMBAI – 400 032
09th June, 2023

To,

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions and the Head University Departments in Faculty of Science & Technology.

A.C/ I 1(A) /28/11/2022.
M.C//09/23/02/2023.

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Engineering.
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

Copy for information and necessary action :-

1. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
2. **College Teachers Approval Unit (CTA),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA)**
5. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
6. **The Deputy Registrar, Executive Authorities Section (EA)**
   He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
7. **The Deputy Registrar, PRO, Fort, (Publication Section),**
8. **The Deputy Registrar, Special Cell,**
9. **The Deputy Registrar, Fort Administration Department (FAD) Record Section,**
10. **The Deputy Registrar, Vidyanagari Administration Department (VAD),**

Copy for information :-

1. **The Director, Dept. of Information and Communication Technology (DICT), Vidyanagari,**
   He is requested to upload the Circular University Website
2. **The Director of Department of Student Development (DSD),**
3. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**
4. **All Deputy Registrar, Examination House,**
5. **The Deputy Registrars, Finance & Accounts Section,**
6. **The Assistant Registrar, Administrative sub-Campus Thane,**
7. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
8. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
9. **P.A to Hon'ble Vice-Chancellor,**
10. **P.A to Pro-Vice-Chancellor,**
11. **P.A to Registrar,**
12. **P.A to All Deans of all Faculties,**
13. **P.A to Finance & Account Officers, (F & A.O),**
14. **P.A to Director, Board of Examinations and Evaluation,**
15. **P.A to Director, Innovation, Incubation and Linkages,**
16. **P.A to Director, Department of Lifelong Learning and Extension (DLLE),**
17. **The Receptionist,**
18. **The Telephone Operator,**

Copy with compliments for information to :-

19. **The Secretary, MUASA**
20. **The Secretary, BUCTU.**

AC – 28/11/2022
Item No. – 6.1(N)

University of Mumbai

Syllabus for

Bachelor of Engineering

(Automation and Robotics)

Semester – (Sem III and IV)

(Choice Based Credit System)

(Introduced from the academic year 2022-23)

University of Mumbai

Syllabus for Approval

O: _____ **Title of Course**	**B.E.(Automation and Robotics)**
O: _____ **Eligibility**	Passing First Year Engineering as per the Ordinance O.6242
R: _____ **Duration of Course**	4 Years
R: _____ **Intake Capacity**	60
R: _____ **Scheme of Examination**	Choice Base Credit System
R: _____ **Standards of Passing**	40%
No. of years/Semesters:	4 years / 8 Semester
Level:	~~P.G.~~ / U.G./ ~~Diploma~~ / ~~Certificate~~ **(Strike out which is not applicable)**
Pattern:	~~Yearly~~ / Semester **(Strike out which is not applicable)**
Status:	~~Revised~~ / New **(Strike out which is not applicable)**
To be implemented from Academic Year :	With effect from Academic Year: 2022-23

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

08/12/22

Dr. Shivram Garje
Dean,
Faculty of Science and Technology

AC – 28/11/2022
Item No. 6.1 (N)

Justification for
B.E. (Automation and Robotics)

1.	Necessity for starting the course:	**It is need of Automation and Robotics Industry**
2.	Whether the UGC has recommended the course:	**AICTE has recommended the course**
3.	Whether all the courses have commenced from the academic year 2019-2020 (2022-23):	**Commenced from Academic year 2022-23**
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?	**Course is self-financed**
5.	To give details regarding the duration of the Course and is it possible to compress the course?	**Duration : 4 years**
6.	The intake capacity of each course and no. of admissions given in the current academic year:	**60 Seats**
7.	Opportunities of Employability / Employment available after undertaking these courses:	**Available**

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome-based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, where in focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill-based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2022-23. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2023-24, 2024-25, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In this particular syllabus wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. Efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current syllabus based on the recommendation of AICTE model curriculum overall credits are reduced to 170, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
University of Mumbai

Program Structure for Second Year Automation and Robotics Engineering
University of Mumbai (With Effect from 2022-2023)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	Pract	Tut	Total
ARC301	Applied Mathematics-III	3	--	1	3	--	1	4
ARC302	Strength of Materials	3		--	3		--	3
ARC303	Electronics devices and Electrical Networks	3	--	--	3	--	--	3
ARC304	Digital Electronics	3	--	--	3	--	--	3
ARC305	Transducers	4	--	--	4	--	--	4
ARL301	Strength of Material and Transducers - Lab	--	2	--	--	1	--	1
ARL302	Electronics devices and Electrical Networks - Lab	--	2	--	--	1	--	1
ARL303	Digital Electronics - Lab	--	2	--	--	1	--	1
ARL304	Skill base Lab course: Object oriented programming with Java	--	4#	--	--	2	--	2
ARM301	Mini project – 1A	--	4$	--	--	2	--	2
Total		**16**	**14**	**1**	**16**	**07**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
ARC301	Applied Mathematics-III	20	20	20	80	3	25	--	125
ARC302	Strength of Materials	20	20	20	80	3	--	--	100
ARC303	Electronics devices and Electrical Networks	20	20	20	80	3	--	--	100
ARC304	Digital Electronics	20	20	20	80	3	--	--	100
ARC305	Transducers	20	20	20	80	3	--	--	100
ARL301	Strength of Materials and Transducers - Lab	--	--	--	--	--	25	25	50
ARL302	Electronics devices and Electrical Networks - Lab	--	--	--	--	--	25	25	50
ARL303	Digital Electronics - Lab	--	--	--	--	--	25	25	50
ARL304	Skill base Lab course: Object oriented programming with Java	--	--	--	--	--	25	25	50
ARM301	Mini project – 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini project
 # Out of 4 hours, 2-hour theory (entire class) and 2 hours practical (batches)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ARC401	Applied Mathematics -IV	3	--	1	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	4	--	--	4	--	--	4
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	Skill base Lab course: Python Programming	--	4#	--	--	2	--	2
ARM401	Mini Project -1B	--	4$	--	--	2	--	2
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
ARC401	Applied Mathematics -IV	20	20	20	80	3	25	--	125
ARC402	Embedded System	20	20	20	80	3	--	--	100
ARC403	Automatic Control System	20	20	20	80	3	--	--	100
ARC404	Signal Conditioning Circuit Design	20	20	20	80	3	--	--	100
ARC405	Components of Automation and Robotics system	20	20	20	80	3	--	--	100
ARL401	Embedded System and SCCD - Lab	--	--	--	--	--	25	25	50
ARL402	Automatic Control System – Lab	--	--	--	--	--	25	25	50
ARL403	Components Automation and Robotics system Lab	--	--	--	--	--	25	25	50
ARL404	Skill base Lab course: Python Programming	--	--	--	--	--	25	25	50
ARM401	Mini Project – 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

 # Out of 4 hours, 2-hour theory (entire class) and 2 hours practical (batches)

Course Code	Course Name	Credits
ARC301	**Applied Mathematics-III**	**3**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem-solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.	CO Mapping
1	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of LaPlace transform, Laplace Transform(L)of Standard Functions like $e^{at}, sin(at), cos(at)$, And t^n , $where\ n \geq 0$. *1.2* Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, *1.3.* 1.3 Laplace Transform of derivatives and integrals (Properties without proof)	**06**	**CO1**
	1.4 Evaluation of integrals by using Laplace Transformation. **Self- learning topics:** Heaviside's Unit Step function, Laplace Transform. Of Periodic functions, Direct Delta Function.		**CO2**

2	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	**06**	
3	**Module: Fourier Series:** *3.1* Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) *3.2* Fourier series of periodic function with period 2π and $2l$, Fourier series of even and odd functions, Halfrange Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and ortho normal set of functions, Fourier Transform.	**07**	**CO3**
4	**Module: Complex Variables:** 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of, $f(z)$, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof) 4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part(u) / Imaginary part(v) / its combination (u + v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	**07**	**CO4**
5	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree Polynomial matrix. 5.3 Functions of square matrix, Similarity of matrices, Diagonalization of matrices **Self- learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	**07**	**CO5**
6	**Module: Linear Programming and Non-linear programming problems** 6.1 Types of solutions, standard and canonical of LPP, Basic and feasible solutions, slack variables, surplus variables, simplex method 6.2 NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers 6.3 NLPP with two equality constraints 6.4 NLPP with inequality constraints – Karush-Kuhn-Tucker conditions	**06**	**CO6**

	Self-learning Topics: Analytical methods of solving two and three Dimensional problems.		

Assessment:

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per university pattern for practical.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows–

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part(a) from module 3 then part (b)will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Engineering Mathematics, Dr. B.S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R.K. Jain and S.R.K. Iyengar, Narosa Publication
4. Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6. Complex Variables and Applications, Brown and Churchill, McGraw- Hill Education,
7. Textbook of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

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) Analyze the stresses induced in basic mechanical components.
4) Estimate the strain energy in mechanical elements.
5) Analyze the deflection in beams.
6) Analyze buckling and bending phenomenon in columns, struts and beams.

Module	Detailed Contents	Hrs.	CO Mapping
1	**Moment of Inertia:** Area moment of Inertia, Principal Axes and Principal Moment of Inertia, Parallel Axis theorem. **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. **Elastic Constants**: 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.	05	CO1
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.	03	CO2
3	**Stresses in Beams:** Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution. **Stresses:** Core of sections, Chimneys subjected to wind pressure. **Shear Stress in Beams:**	03	CO3

	Distribution of shear stress, across plane sections used commonly for structural purposes.		
4	**Strain Energy:** Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear.	**03**	**CO4**
5	**Deflection of Beams:** Deflection of Cantilever, simply supported using double integration and Macaulay's Method for different types of loadings **Thin Cylindrical and Spherical Shells:** Stresses and deformation in thin cylindrical and spherical shells subjected to internal pressure.	**04**	**CO5**
6	**Columns and Struts:** Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine formula	**02**	**CO6**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part(b) will be from any module other than module3)
4. Only Four questions need to be solved.

References:

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

Course Code	Course Name	Credits
ARC303	Electronics devices and Electrical Networks	03

Course Objectives:

1. To introduce the concept of circuit elements, circuit laws and analyze 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 basic electronic devices and circuits.
5. To analyse the DC biasing circuits of various electronic circuits.
6. To design different types of voltage regulators and discuss the power amplifiers.

Course Outcomes: On successful completion of the course, students will be able to:

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	Details	Hrs	CO Mapping
1	**Network Theorems:** Analysis of networks with dependent sources: mesh analysis, nodal analysis, super mesh and super node concept, source transformation technique, superposition theorem, Thevenin's theorem.	04	CO1
2	**Transient Analysis:** Initial Conditions in Elements, Transients and steady state response in R-L, R-C and RLC Circuits.	04	CO2
3	**Fundamentals of Network Synthesis:** Network Functions- One port & Two port Networks-Poles & Zeros Causality and stability, Hurwitz polynomials, positive real functions, synthesis of one port networks with two kinds of elements.	03	CO3
4	**Diode applications:** Clipper and Clamper. **Bipolar Junction Transistor:** Device structure and physical operation, characteristics, BJT as an amplifier and a switch, DC Analysis of BJT Circuits.	04	CO4
5	**Field effect Transistors:** Introduction to JFET, Types, Construction, Operation, Static Characteristics. FET as an amplifier and switch. **MOS Field effect Transistors:** Introduction to MOSFET, Device structure and physical operation, characteristics.	03	CO5

6	**Power Amplifier:** Definition and amplifier types, Series fed class A amplifier, Class B amplifier operation and circuits, Amplifier distortion, Push Pull Amplifier, Power supply design: Using 78xx series, 79xx series and adjustable voltage IC regulators like 723 and 317.	**06**	**CO6**

Assessment:

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on Minimum 02 Modules) and the other is either a class test or assignment on live problems.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Text Books:

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.

Course Code	Course Name	Credits
ARC304	Digital Electronics	03

Course Objectives: The course is aimed

1. To provide an understanding of the principles of digital electronics and useof 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 designtechniques.
5. To provide understanding of memory devices and state machines.
6. To make the students understand basic logic families and their applications

Course Outcomes: On successful completion of course learner/student will be able to:

1. Represent numerical values in various number systems and perform numberconversions between different number systems.
2. Analyze and design, digital combinational circuits using logic gates withIEEE/ANSI standard symbols.
3. Formulate and design sequential logic circuits.
4. Formulate and design asynchronous sequential logic circuits.
5. Explain nomenclature and technology in memory devices.
6. Apply the concept of logic families and their application to design the digital system.

Details of Syllabus:

Module	Contents	Hrs.	CO mapping
1	**Binary number system:** Binary Arithmetic, Binary codes: Weighted, BCD, 8421, Gray code, Excess 3 code, ASCII, Error detecting code. **Reduction methods:** Boolean laws, De-Morgan ‘s Theorem, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS).	03	CO1
2	**Design of combinational logic circuits:** Adders, Subtractors, Code conversion, Parity checker, Magnitude comparators, BCD adder, Multiplexer, Demultiplexer, Encoder and Decoder. Implementation of combinational logic circuits using Multiplexer and Demultiplexer.	06	CO2
3	**Sequential logic circuits:** Flip flops- SR, D and Master slave JK, T, Realization of one flip flop using other flip flops, Asynchronous & Synchronous counters, Modulo n counter, shift registers. Mealy/Moore models – Concept of state, State diagram, state assignment.	04	CO3

4	**Asynchronous sequential circuits:** Circuit Design – primitive state / flow table, Minimization of primitive state table, state assignment, Excitation table, Excitation map, cycles.	**05**	**CO4**
5	**Logic families:** Basics of digital integrated circuits, basic operational characteristics and parameters. TTL, Schottky clamped TTL, tri-state gate ECL, IIL, MOS devices CMOS comparison of logic families.	**03**	**CO5**
6	**Memory and programmable logic devices:** PROM / EPROM / EEPROM / EAPROM Programmable Logic Devices – Programmable Logic Array (PLA), Programmable Array Logic (PAL),Introduction to Complex Programmable Logic Device (CPLD), Introduction and basic concepts of FPGA, VHDL.	**03**	**CO6**

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on Minimum 02 Modules) and the other is either a class test or assignment on live problems.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Text Books

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. B. Ram, *"Fundamentals of Microprocessors and Microcontrollers",* Dhanpat Rai Publications, 2004.

References 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 McGrawHill Publishing Company Limited, 2003.
3. R. P. Jain, *"Modern Digital Electronics",* Tata McGraw–Hill publishing company limited, 2003.
4. Thomas L. Floyd, *"Digital Fundamentals",* Pearson Education, 2003.

Course Code	Course Name	Credits
ARC305	**Transducers**	**04**

Course Objectives: The course is aimed

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 for Displacement, level, temperature measurement.
4. To provide an understanding of the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure and vacuum measurement, force, torque and power measurement.
5. To study electrochemical sensors and transducers used for density and viscosity measurement

Course Outcomes: On successful completion of course learner/student will be able to:

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 displacement and Temperature transducers and their applications.
3. Formulate and design the solutions for given applications using appropriate level, speed, vibration sensors and transducer.
4. Explain working, principle of strain gauges and pressure transducer.
5. Identify types of flow and use different transducers for flow measurement.
6. Explain the terminologies of electrochemical sensors and their applications in industry. Identify sensors for power, density, humidity, PH measurement.

Details of Syllabus:

Module	Details	Hrs.	CO mapping
1	**Instrumentation Systems**: - Introduction, Block diagram, Functional elements of measurement system, Static and Dynamic characteristics of transducers. **Sensor and Transducer**: Definition, classification, selection criteria, transducer specifications.	**03**	**CO1**
2	**Transducers for Displacement:** Resistance type transducers: Potentiometer, piezo resistive effect. Inductive type transducers: LVDT, RVDT (transfer function, linearity, sensitivity, source frequency dependence, phase null, and signal conditioning). Selection and properties of materials for LVDT and general electromagnetic sensors. 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.	**08**	**CO2**

	Transducers for Temperature: Modes of heat transfer, laws of conduction, convection and radiation, Temperature scales, classification of Temperature Sensors, Overview of Temperature Sensor Materials. Resistance Temperature Detector (RTD): Principle, types, configurations, construction and working of RTD, Signal Measurement techniques for RTD. Thermistors: Principle, Types (NTC and PTC), Characteristics, Construction and working of thermistor, Materials, Specification of Thermistors, applications 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. Pyrometers: Principle, construction and working of radiation and optical Pyrometers and its applications.		
3	**Level Transducers:** Need for level measurement, classification of Level, Measurement Techniques. Construction and working of displacer, float system, bubbler and DP CELL, ultrasonic, capacitive, microwave, radar, radioactive type, laser type transducer. **Speed and Vibration measurement**: stroboscope, toothed rotor, eddy current, electromagnetic transducer, AC and DC tachometer, hall effect proximity pickup, photoelectric, photo reflective, pulse counting method, seismic, piezoelectric.	**03**	**CO3**
4	**Strain Measurement** Introduction types of strain gauges, gauge factor calculation, materials for strain gauge. **Pressure Measurement** Pressure scales, units and relations, classification Primary pressure sensors – elastic elements like bourdon tube, diaphragm, bellows, Calibration using Dead Weight Tester **Electrical/secondary Pressure Transducers**: Capacitive, piezo-electric and its material, variable reluctance, LVDT, strain gauge. **High Pressure Measurement**: Bulk modulus cell, Bridgeman type, capsule. **Differential pressure measurement**: Materials, construction, working of DP Cell **Pressure measurement using manometer**: U – Tube types, well type, inclined type, micro manometer. **Vacuum Measurement:** Units and relations, Mcleod gauge, Pirani gauge, thermocouple gauge.	**05**	**CO4**
5	**Fundamentals of Flow measurement** 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. **Flow measurement** **Head type**: Orifice, Venturi, nozzle, pitot tube, annubar, characteristics of Head type flow meters, **Variable area type**: Rotameter	**06**	**CO5**

6	**Miscellaneous Measurement** **Force measurement**: strain gauge, LVDT, piezoelectric. **Torque**: Torsion bar, strain gauge. **Power:** Dynamometer, instantaneous power measurement, alternator power measurement **Density measurement** – Displacement and float type densitometers. Hydrometers, Radiation and Ultrasonic densitometers **Viscosity measurement** – Capillary tube viscometer, Efflux type viscometer, variable area viscometer **Introduction to Advances in sensor technology**: Smart sensors, MEMS. Nano sensors, Semiconductor sensors, Optical fiber sensors.	**06**	**CO6**

Internal Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respectivelecture hours as mentioned in the syllabus.

Text Books

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, 2 nd Ed.,Tata McGraw Hill.
5. D.V.S. Murthi, ―Instrumentation and Measurement Principles‖, PHI, New Delhi, Second ed. 2003.

References 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. B.E. Jones, Instrument Technology.
7. Chortle Keith R., Fundamentals of Test, Measurement Instrument Instrumentation, ISA

Publication.
8. Alan S Morris, Measurement and Instrumentation Principles; 3rd Edition
9. Sawhney A.K., ―Mechanical Measurement‖, Dhanpatrai and Co.
10. Bansal R.K., ―Fluid Mechanics and Hydraulic Machines‖, Laxmi publications.
11. David W. Spitzer, ―Industrial Flow Measurement‖, ISA Publication

Course Code	Course Name	Credits
ARL301	**Strength of Materials and Transducers Lab**	**01**

Course Objectives: The course is aimed

1. To make student understand the identification, construction, working principals of various transducers used for Displacement measurement, Temperature measurement, Level measurement, Strain measurement, Pressure measurements, flow measurement and miscellaneous measurement.
2. To experimentally verify the principle and characteristics of various transducers.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Plot and validate the performance characteristics of displacement transducers.
2. Validate the characteristics of various temperature transducers.
3. Describe the construction and operation of various level transducers.
4. Explain the working principles of strain gauges and pressure transducers.
5. Learn basic fundamentals of flow transducers, identify types of flow and use different transducers for flow measurement, along with tension tests
6. Demonstrate the performance characteristics of miscellaneous transducers and perform hardness test on metals

List of Experiments:

Sr. No	Detailed Contents	CO Mapping
1	Study of Linear variable differential transformer (LVDT)	**CO1**
2	Study of Flapper Nozzle System	**CO1**
3	Study and plot characteristics of resistance temperature detector (RTD)	**CO2**
4	Study and plot characteristics of thermocouple	**CO2**
5	Level measurement using Ultrasonic Level transducer	**CO3**
6	Strain Measurement using strain - gauge	**CO4**
7	Pressure drop measurement across pipe fittings	**CO4**
8	Flow measurement using Orifice	**CO5**
9	Tension test on mild steel bar (stress-strain behavior, determination of yield strength and modulus of elasticity	**CO5**
10	Impact test on metal specimen (Izod/Charpy Impact test)	**CO5**
11	Hardness test on metals – (Brinell/ Rockwell Hardness Number)	**CO6**

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the list of Experiments given in the lab plan & the Oral Examination will be based on syllabus of Strength of Materials and Transducers.

Term Work:

Term work shall consist of minimum 04 Experiments and any 02 practical should be verified with simulation software**.**

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments)	: 10 Marks
Laboratory work (journal)	: 10 Marks
Attendance (class Room plus Lab Practice)	: 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work

Course Code	Course Name	Credits
ARL302	Electronic devices and Electrical Networks Lab	01

Course Objectives:

1. To verify 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 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.

Course Outcomes: On successful completion of the course, Students will be able to:

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

Sr No	Contents	CO Mapping
1.	Verify the Network Theorems using with constant sources	CO1
2.	Verify the Network Theorems using with dependent sources	CO1
3.	Verify the Transient Analysis for RL circuit.	CO2
4.	Verify the Transient Analysis for RC circuit	CO2
5.	Synthesis of RC circuits	CO3
6.	Synthesis of RL circuits	CO3
7.	Design the Diode circuit as Clipper and Clamper.	CO4
8.	Verify the input -output characteristics of BJT in CE configuration.	CO4
9.	Analyse the JFET circuit and validate its transfer characteristics.	CO5
10.	Analyse the MOSFET circuit and validate its transfer characteristics.	CO5
11.	Simulate the class A power amplifier and analyse with the help of simulation software.	CO6
12.	Design of fixed voltage regulator using fixed regulator IC.	CO6

List of Experiments:

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on Theory syllabus.

Term Work:

Term work shall consist of minimum 02 tutorials from CO1 - CO3 and 02 experiments from CO4 - CO6.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments)	: 10 Marks
Laboratory work (journal)	: 10 Marks
Attendance (Theory plus Lab Practice)	: 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Course Code	Course Name	Credits
ARL303	Digital Electronics- Lab	1

Course Objectives:

1. To provide an understanding of the principles of digital electronics and useof 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 designtechniques.
5. To provide understanding of memory devices and state machines.
6. To make the students understand basic logic families and their applications.

Course Outcomes: On successful completion of course learner/student will be able to:

1. Demonstrate numerical values in various number systems and performnumber 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. Demonstrate nomenclature and technology in memory devices.
6. Analyze logic families and their application to design the digital system

Syllabus: Same as that of Subject Digital Electronics.

List of Experiments:

Sr. No	Detailed Contents	CO Mapping
1	Implement conversion of Gray/Binary code.	**CO1**
2	Truth table verification and implementation of all gates using Universal gates.	**CO2**
3	Realise full adder using 2:1 Multiplexer.	**CO3**
4	Realise full Subtractor using 2:1 Multiplexer.	**CO3**
5	Implementation of various flip-flops.	**CO4**
6	Design and implement modulo-n counter.	**CO5**
7	Design and implement ring counter.	**CO5**
8	Implement BCD to seven segments display.	**CO6**
9	Design of logic gate using Verilog and VHDL	**CO6**

Any other experiment based on syllabus which will help students to understand topic/concept.

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the list of Experiments given in the syllabus & the Oral Examination will be based on ARC304 Digital Electronics.

Term Work:

Term work shall consist of minimum 04 Experiments and any 02 practical should be verified with simulation software.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Course Code	Course Name	Credits
ARL304	Object Oriented Programming Lab	02

Course Prerequisites:

FEL204 - C-Programming

Course Objectives:

1. To learn the basic concepts of object-oriented programming
2. To study JAVA programming language
3. To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc.
4. To explain components of GUI based programming.

Course Outcomes:

After successful completion of the course student will be able to:

1. To apply fundamental programming constructs.
2. To illustrate the concept of packages, classes and objects.
3. To elaborate the concept of strings, arrays and vectors.
4. To implement the concept of inheritance and interfaces.
5. To implement the concept of exception handling and multithreading.
6. To develop GUI based application.

Module	Contents	Hrs.	CO Mapping
1	**Introduction to Object Oriented Programming** OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing, Java Virtual Machine, Basic programming constructs: variables, data types, operators	02	CO1
2	**Class, Object, Packages and Input/output** Class, object, data members, member functions, Constructors, types, static members and functions, Method overloading, Packages in java	02	CO2
3	**Array, String and Vector** Array, Strings, String Buffer,	02	CO3
4	**Inheritance** Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritance using interface	03	CO4
5	**Exception handling and Multithreading** Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks, user defined exception, Thread lifecycle, thread class methods	03	CO5
6	**GUI programming in JAVA** Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class.	03	CO6

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. Dietal and Dietal, 'Java: How to Program', 8/e, PHI

3. 'JAVA Programming', Black Book, Dreamtech Press.
4. "Learn to Master Java programming", Staredu solutions

Digital material:

1. www.nptelvideos.in
2. www.w3schools.com
3. www.tutorialspoint.com
4. https://starcertification.org/Certifications/Certificate/securejava

List of Laboratory Experiments/ Assignments:

Sr. No.	Detailed Contents	CO mapping
1.	Program on accepting input through keyboard.	**CO1**
2.	Programs on class and objects	**CO2**
3.	Program on method and constructor overloading.	**CO2**
4.	Program on Packages	**CO2**
5.	Program on 2D array, strings functions	**CO3**
6.	Program on String Buffer	**CO3**
7.	Program on types of inheritance	**CO4**
8.	Program on abstract class and abstract methods.	**CO4**
9.	Program using super and final keyword	**CO5**
10.	Program on Exception handling	**CO5**
11.	Program on Graphics class	**CO6**
12.	Program on applet class	**CO6**

Term Work:

Students will submit term work in the form of journal that will include:

1. Term Work: Term work shall consist of minimum 05 programs from the list of suggested programs
2. Two assignments covering whole syllabus

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

The distribution of marks for term work shall be as follows: 25 Marks (Total Marks):

Experiments: 15 marks
Assignments: 05-marks
Attendance**:** 05 marks

Practical and oral examination will be based on the suggested experiment list and the entire syllabus.

Course code	Course Name	Credits
ARM301	**Mini Project-1A**	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 Outcomes: 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 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

- Studentsshallformagroupof3to4students, 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 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, 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 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:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- 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 orresearchorganisationshavingexperienceofmorethanfiveyearsapproved by head of Institution.
- StudentsshallbemotivatedtopublishapaperbasedontheworkinConferences/studentscompetitions.

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.

Course Code	Course Name	Credits
ARC401	**Applied Mathematics-IV**	**03**

Pre-requisite:

1) Engineering Mathematics-I,
2) Engineering Mathematics-II,
3) Engineering Mathematics-III,

Course Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Course Outcomes: Learner will be able to….

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using green's theorem, Stoke's theorem &Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems & Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

Module	Contents	Hrs.	CO Mapping
1	**Linear Algebra – Vector Spaces:** Vectors in n-dimensional vector space, norm, dot product, Cauchy schwarz inequality (with proof), Unit vector. Orthogonal projection, orthonormal basis, Gram-Schmidt process for vectors Vector spaces over real field, sub spaces **Self-learning topics:** Linear combinations, linear dependance and independence, QR decomposition	**06**	**CO1**

2	**Module: Complex Integration** Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). Taylor's and Laurent's series (without proof). Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**06**	**CO2**
3	**Module: Statistical Techniques** Karl Pearson's Coefficient of correlation (r) and related concepts withproblemsarman'sRankcorrelationcoefficient(R)(Repeated&nonrepeated ranksproblems), Lines of regression, Fitting of first- and second-degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**	**CO3**
4	**Module: Probability Theory:** Conditional probability, Total Probability and Baye's Theorem. Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin & about the mean). **Self-learning Topics:** Properties variance and covariance,	**07**	**CO4**
5	**Module: Probability Distribution and Sampling Theory-I** Probability Distribution: Poisson and Normal distribution, Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Students' t-distribution (Small sample). Test the significance of singles ample mean and two independent sample means and paired t-test) **Self-learning Topics: Test** of significance of large samples, Proportion test, Survey based project.	**07**	**CO5**
6	**Module: Sampling theory-II** Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. Analysis of variance: F-test (significant difference between variances of two samples) **Self-learning Topics:** ANOVA**:** One way classification, Two-way classification (short-cut method).	**07**	**CO6**

Assessment:

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per university pattern for practical.
2) Students must be courage to write atleast 6 class tutorials on entire syllabus.
3) A group of 4-6students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10marks depending on the performance of the students.

The distribution of Term Work marks will be as follows–

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment for 20marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying20marks
2. Question1willbecompulsoryandshouldcover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part(a) from module3 then part (b)will befromanymoduleotherthanmodule3)
4. Only Four questions need to be solved.

References:

1. Higher Engineering Mathematics, Dr. B.S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosapublication,4. Vector Analysis, Murray R. Spiegel, Schaum Series
4. Complex Variables and Applications, Brown and Churchill, McGraw Hill education
5. Probability, Statistics and Random Processes, T. Veerarajan, McGraw Hill education.

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

Module	Details	Hrs	CO Mapping
1	**Introduction to Embedded Systems** Definition, Characteristics, Classification, Applications, Design metrics of Embedded system and Challenges in optimization of metrics.	03	CO1
2	**8051 Microcontroller** Comparison between Microprocessor and Microcontroller, Features, architecture and pin configuration, CPU timing and machine cycle, Input / Output ports, Memory organization, Counters and timers, Interrupts.	04	CO2
3	8051 Assembly Language Programming: Instruction set, Addressing mode,	06	CO3

	Assembler directives and programs. **8051 Peripherals:** Input / Output ports, Counters and timers. Serial Port, Interrupts. **Interfacing:** LCD, Matrix Keypad, 7 Segment, Relay, DC Drive using H bridge, Stepper Motor, Servo Motor, ADC and DAC		
4	**Introduction to Cortex M0+ processors:** Features of M0+ processors, Basics of ARMV6 architecture, Core Registers.	**04**	**CO4**
5	**ARM7** Introduction & Features of ARM 7, Architectural, Instruction set: Data processing, Data Transfer, Control flow.	**03**	**CO5**
6	**Case Studies:** Data acquisition system, Digital weighing machine, Washing machines.	**02**	**CO6**

Assessment:

Internal Assessment:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

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
8. Steve Furber, "ARM System on chip Architecture", Pearson,2nd edition.
9. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand& Sons Inc., Edition 2014.

Course Code	Course Name	Credits
ARC403	Automatic Control Systems	03

Course Objectives:

1. The students should be able to learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective.
2. The students should learn how to represent system by transfer function and block diagram reduction method and Mason's gain formula.
3. The students should able to learn time response analysis and demonstrate their knowledge to frequency response.
4. Students can be able to learn stability analysis of system using Root locus, bode plot, polar plot, and Nyquist plot.
5. Students should able to learn state models for different physical systems

Course Outcomes: Student will be able to

1. Identify open and closed loop control system
2. Formulate mathematical model and transfer function for physical systems.
3. Use standard test signals to identify performance characteristics of first and second-order systems.
4. Apply root locus technique for stability analysis.
5. Analyse performance characteristics of system using Frequency response
6. Formulate state variable model for mechanical and electrical systems.

Details of Syllabus:

Module	Content	Hrs	CO Mapping
1	**Introduction** Definition of control system, open loop and closed loop system, examples. Development of automatic control systems, classification of control system, examples	03	CO1
2	**Mathematical Models of Physical Systems and Transfer function** Definition of physical systems, principle of superposition and homogeneity, linear/non-linear, time variant/time invariant systems, Definition of transfer function, transfer functions of physical systems	04	CO2
3	**Time Response Analysis** Standard test signals, transient and steady state behaviour of first and second order systems, steady state errors in feedback control systems.	03	CO3
4	**Stability Analysis and Root Locus** Concepts of Stability: Concept of absolute, relative and robust stability, routh stability criterion. Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems.	03	CO4
5	**Frequency Response and Stability Analysis** Correlation between time and frequency response, Bode plots, Nyquist stability criterion, frequency response specifications, stability analysis using-bode	04	CO5
6	**State Variable Models:** State variable models of mechanical systems and electrical systems. Concept of state transition matrix, properties of state transition matrix,	03	CO6

Internal Assessment:

Internal Assessment consists of two tests out of which, one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems.

End Semester Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weight age of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

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, 2017.

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 Hall International, 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.

Course Code	Course Name	Credits
ARC404	Signal Conditioning Circuit Design	03

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.	CO mapping
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.	**03**	**CO1**
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)	**04**	**CO2**

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.	**04**	**CO3**
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**	**CO4**
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.	**03**	**CO5**
6.	**Transducer Signal Conditioning** Signal Conditioning of Temperature, Pressure, optical, strain gauges, Displacement and piezoelectric transducers signal conditioning.	**03**	**CO6**

Internal Assessment:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus wherein sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

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.

Course Code	Course Name	Credits
ARC405	Components of Automation and Robotics	04

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.	03
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 Hydraulic components: Hydraulic pumps (centrifugal, gear, lobe), Pressure regulation method, Loading valves, Hydraulic valves, Selection and comparison of pneumatic, hydraulic and electric systems	05
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.	05

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; 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	**06**
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, Limit switches, emergency push button, Tactile switch, Switch specifications. **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.	**04**
6	**Components of Industrial Robot** Manipulators, End Effectors, Feedback devices, Controllers, and Locomotive devices.	**03**

Assessment:

Internal Assessment:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI). Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise 6 questions, each carrying 20 Marks.
2. Total 4 questions need to be solved.
3. Question No. 1 will be compulsory and based on entire syllabus where in sub questions of 4 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to number of respective Lecture hours as mentioned in the syllabus.

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

Course Objectives:

1. To explain the assembly and C programming concepts.
2. To explain addressing modes and instruction set of MCS-51/ARM and develop programs using instructions.
3. To give knowledge of integrated hardware of MCS-51/ARM and 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 signal conditioning.
6. To impart knowledge of design considerations of analog signal conditioning of components

Course Outcomes: The students will be able to:

1. Develop programs to configure the peripherals in 8051/ARM and to design and interface peripheral components with MCS 51/ARM.
2. Design programs to use interrupt in 8051/ARM.
3. Design and interface peripheral components using communication protocols.
4. Design and implement various linear and non-linear applications using op-amp.
5. Apply principles of analog signal conditioning for op-amp based circuit design.
6. Apply concepts of digital signal conditioning for op-amp based circuit design

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	Interfacing of LEDs /switches with any embedded core. (8051/ARM etc)	CO1
4	To develop a program for interfacing 7- segment displays with MCS-51.	CO1
5	To develop programs for Timer or External Interrupts of MCS-51.	CO1

6	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM, etc)	CO1
6	To develop a program for interfacing ADC/DAC with MCS-51 using C language.	CO2
7	To develop programs for Timer or External Interrupts of MCS-51.	CO2
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
10	Interfacing of a DC motor (speed and Direction control) with any embedded core. (8051/ARM etc.)	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 design and implement Astable and Monostable Multivibrator using IC 555	CO4
15	To Implement Precision rectifiers using Op-amp.	CO4
16	To design and demonstrate integrator and differentiator using Op-amp.	CO4
17	To design of RC phase shift oscillator using Op-amp	CO4
18	To design and demonstrate second order LPF and HPF.	CO5
19	To design and demonstrate general signal conditioning circuit to convert sensor output to 4-20 mA	CO5
20	To design and demonstrate Analog to Digital converter circuit or Digital to Analog converter circuit	CO6

Assessment:

Practical/Oral Examination:

Practical/Oral examination will be based on the entire syllabus.

Term Work:

Term work shall consist of minimum 06 experiments and two assignments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments): 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

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

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 able to examine time response analysis of first and second order systems.
4. Students can be able to inspect stability analysis of system using Root locus, Bode plot, polar plot.
5. The students should be able to examine the controllability and observability of LTI systems

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 and calculate the steady state error.
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. Inspect the time response specifications of systems by using root-locus.
5. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system
6. Verify the controllability and observability of the given systems

List of the Laboratory Experiments

Sr. No	Contents	CO Mapping
1	To plot the frequency response of first-order system	**CO1**
2	To plot the time response of second – order systems	**CO2**
3	To interpret the effect of damping factor on the performance of second order system.	**CO2**
4	To examine steady state errors for Type 0, 1, 2 systems	**CO3**
5	To inspect the relative stability of systems by Root-Locus using Simulation Software	**CO4**
6	To inspect the stability of systems by Bode plot using Simulation Software	**CO5**
7	To determine the frequency response specifications from Polar plot of system	**CO5**
8	To Verify the controllability and observability of the given systems	**CO6**

Practical and Oral Examination:
Practical Examination will be based on performing one Experiment in the laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on subject

Term Work:

Term work shall consist of minimum 05 experiments and two assignments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments): 10 Marks

Laboratory work (programs / journal) : 10 Marks

Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

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

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	Study of various pneumatic / hydraulic control system components	CO4
9	Study of various electro-pneumatic control system components.	CO4
10	Study of different types of control valve actuator.	CO5
11	Calibration of I to P and / P to I converter.	CO5

12	Study characteristics of control valve	CO5
13	Study of pressure/temperature/level/flow switches and control relays.	CO6

Note:

1. Minimum of Five 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.

Practical/Oral Examination:

Practical Examination will be based on performing one Experiment in the Laboratory from the List of Experiments given in the syllabus & the Oral Examination will be based on Entire subject.

Term Work:

Term work shall consist of minimum Five Experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments/assignments) : 10 Marks
Laboratory work (journal) : 10 Marks
Attendance (class Room plus Lab Practice) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work

Course Code	Course Name	Credits
ARL404	Skill base Lab course Python Programming	02

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes: Upon completion of the course, students will be able to

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object-oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python

Details of Syllabus:

Module	Contents	Hrs.	CO Mapping
1	**Introduction to Python** Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures. Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements	8	CO1
2	**Functions and File I/O Handling** Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code. File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, *with* keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	6	CO2
3	**Object Oriented Programming** Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes. Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	9	CO3

4	**Graphical User Interface and Image processing** Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes. Database: Sqilite database connection, Create, Append, update, delete records from database using GUI. Basic Image Processing using OpenCV library, simple image manipulation using image module.	**9**	**CO4**
5	**Numpy, Pandas, Matplotlib, Seaborn, Scipy** Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy. Introduction to Pandas, Understanding Data frame, View and Select Data, Missing Values, Data Operations, File read and write operation. Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn. Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	**10**	**CO5**
6	**Python Applications** GUI based applications, Applications in Image Processing, Networking, Machine Learning, Linear Regression, Logistic Regression, Classification using K nearest neighbor, Support Vector Machines	**10**	**CO6**

Reference Books:

1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, "Head First Python" O'Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, "Introduction to Machine Learning with Python", O'Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, "Python Cookbook: Recipes for Mastering Python 3", O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, "Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application", Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: https://www.python.org/downloads/
2. Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/
3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

List of the Laboratory Experiments:

Module	Contents	CO mapping
1.	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set s = {10, 2, -3, 4, 5, 88} a. Number of items in sets s b. Maximum element in sets s c. Minimum element in sets s d. Sum of all elements in sets s e. Obtain a new sorted set from s, set s remaining unchanged f. Report whether 100 is an element of sets s g. Report whether -3 is not an element of sets s.	CO1
2.	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. Generate and print a list of tuples containing name, age and salary from the 3lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	CO2
3.	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	CO3
4.	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain individual histograms. 4.Write Python program for histogram equalization 5 Write Python Program for edge detection 6. Write Python Program for image segmentation	CO4

	7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	
5.	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: a. Find and print the name of the country with the highest GDP b. Find and print the name of the country with the lowest GDP c. Print text and input values iteratively d. Print the entire list of the countries with their GDPs e. Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a. a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	CO5
6.	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server. 7. Write Python Program to study image morphological operations.	CO6

Practical and Oral Examination:
Practical and Oral examination will be based on entire syllabus.
Term Work:
Term Work: Term work shall consist of minimum 6 programs from the list of suggested programs and one Mini-project of your choice.

The distribution of marks for term work shall be as follows:
Laboratory work (Performing Experiments): 10 Marks
Laboratory work (programs/ journal/Mini-project) : 10 Marks
Attendance : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Note:
1. Use of free cloud service such as Google Colab to run python scripts is encouraged.
2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

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

Course Objectives

1. Toacquaintwiththeprocessofidentifyingtheneedsandconvertingitintotheproblem.
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 member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analysetheimpactofsolutionsinsocietalandenvionmentalcontextforsustainabledevelopment.
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

- 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.
- Students' hall submits 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.
- Studentsshallconvertthebestsolutionintoworkingmodelusingvariouscomponentsoftheirdomain areas 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 be adopted 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.
- Insecondsemesterexpectedworkshallbeprocurementofcomponents/systems, building of working 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 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 skill sets
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's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini-Project Practical/Oral Examination:

- ReportshouldbepreparedaspertheguidelinesissuedbytheUniversityofMumbai.
- 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.
- Students shall be motivated to publish a paper based on the working 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

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