

RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna
University Chennai)

B.E. ROBOTICS AND AUTOMATION
R-2023
CURRICULUM
(CHOICE BASED CREDIT SYSTEM)

DEPARTMENT VISION:

To be a department of excellence in academics, research and technological advancement in Robotics and Automation with a concern for society.

DEPARTMENT MISSION:

- To impart high technical knowledge, strong fundamentals, practical skills and creative knowledge for making successful professionals in Robotics and Automation
- To foster students by infusing leadership qualities to become successful Engineer
- To inculcate the entrepreneurial qualities for creating, developing and managing global engineering ventures

Programme Educational Objectives (PEOs):

PEO I

To impart students with strong and comprehensive knowledge in the analytical, scientific and engineering fundamentals for solving engineering problems

PEO II

To disseminate students with necessary skills, knowledge and leadership qualities for successful careers in industry

PEO III

To instil students with Technical expertise, Ethical practices and Team spirit and a concern towards greener society

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- PSO 1: Design and develop efficient Automation system to enhance the quality of life by applying fundamentals of Basic Science, Mechanical and Mechatronics Engineering
- PSO 2: Analyse and improve the performance of Manufacturing and Production system by implementing the Soft and hard Computing methods
- PSO 3: Manage and lead a professional or an entrepreneur career in industries by applying modern Engineering, Management principles and best practices

RAJALAKSHMI ENGINEERING COLLEGE
(An Autonomous Institution Affiliated to Anna University Chennai)
CURRICULUM AND SYLLABUS REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
B.E. ROBOTICS AND AUTOMATION

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	HS23111	Technical Communication I	HSMC	2	2	0	0	2
2.	MA23112	Algebra and Calculus	BS	4	3	1	0	4
3.	GE23111	Engineering Graphics	ES	4	2	2	0	4
4.	RO23111	Introduction To Mechanical Systems	ES	3	2	1	0	3
LAB ORIENTED THEORY COURSE								
5.	EE23132	Basic Electrical Engineering	ES	5	3	0	2	4
LABORATORY COURSE								
6.	GE23121	Engineering Practices – Civil and Mechanical	ES	2	0	0	2	1
7.	GE23122	Engineering Practices- Electrical and Electronics	ES	2	0	0	2	1
MANDATORY COURSE								
8.	MC23112	Environmental Science and Engineering	MC	3	3	0	0	0
9.	GE23117	தமிழர்மரபு /Heritage of Tamils	HSMC	1	1	0	0	1
TOTAL				26	16	4	6	20

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	MA23212	Differential Equations and Complex Variables	BS	4	3	1	0	4
LAB ORIENTED THEORY COURSE								
2.	CY23131	Chemistry for Electronics Engineering	BS	5	3	0	2	4
3.	PH23131	Physics of Materials	BS	5	3	0	2	4
4.	GE23233	Problem solving and Python programming	ES	6	2	0	4	4
LABORATORY COURSE								
5.	HS23221 / HS23222	Technical Communication II / English for Professional Competence	HSMC	2	0	0	2	1
6.	RO23221	Computer Aided Modeling Laboratory	ES	4	0	0	4	2
MANDATORY COURSE								
7.	GE23217	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	1	1	0	0	1
8.	MC23111	Indian Constitution and Freedom Movement	MC	3	3	0	0	0
TOTAL				30	15	1	14	20

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	MA23311	Transforms and Partial Differential Equations	BS	4	3	1	0	4
2.	RO23311	Analog and Digital Electronics	PC	3	3	0	0	3
3.	RO23312	Theory of Mechanisms and Machines-I	PC	4	3	1	0	4
4.	RO23313	Sensors in Automation	PC	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
5.	RO23331	Elements of Manufacturing Processes	PC	5	3	0	2	4
6.	RO23332	Mechanics of Materials	ES	5	3	0	2	4
LABORATORY COURSE								
7.	CS23422	Python Programming for Machine Learning	ES	4	0	0	4	2
TOTAL				28	18	2	8	24

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23411	Fluid Power Systems	PC	3	3	0	0	3
2.	RO23412	Industrial Automation and Control	PC	3	3	0	0	3
3.	RO23413	Microcontrollers and Real Time Embedded Systems	PC	3	3	0	0	3
4.	RO23414	Robot Kinematics	PC	4	3	1	0	4
LAB ORIENTED THEORY COURSE								
5.	MA23432	Statistics and Numerical Methods	BS	5	3	0	2	4
LABORATORY COURSE								
6.	RO23421	Mechanisms and Robotics laboratory	PC	4	0	0	4	2
7.	RO23422	Industrial Automation Laboratory-I	PC	4	0	0	4	2
8.	GE23427	Soft skills – I	EEC	2	0	0	2	1
TOTAL				28	15	1	12	22

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23511	AI for Robotics	PC	3	3	0	0	3
2.	RO23512	Theory of Mechanisms and Machines-II	PC	4	3	1	0	4
3.	ME23511	Machine Design	PC	3	3	0	0	3
4.		Open Elective – I	OE	3	3	0	0	3
5.		Professional Elective –I	PE	3	3	0	0	3
LABORATORY COURSE								
6.	RO23521	Mobile Robotics laboratory	PC	4	0	0	4	2
7.	RO23522	Industrial Automation Laboratory-II	PC	4	0	0	4	2
8.	RO23523	Internship	EEC	2	0	0	2	1
9.	GE23527	Soft Skills – II	EEC	2	0	0	2	1
TOTAL				28	15	1	12	22

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	ME23612	Design of Transmission systems	PC	3	3	0	0	3
2.	RO23611	Resource Management Techniques	HSMC	4	3	1	0	4
3.		Professional Elective – II	PE	3	3	0	0	3
4.		Professional Elective – III	PE	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
5.	RO23631	Robotic operating System	PC	4	2	0	2	3
6.	RO23632	Robotic Vision and Intelligence	PC	5	3	0	2	4
LABORATORY COURSE								
7.	RO23621	Innovation and Design thinking for Robotics and Automation	EEC	3	0	1	2	2
8.	GE23627	Problem solving Techniques	EEC	2	0	0	2	1
TOTAL				27	17	2	8	23

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.	RO23711	Aerial Robotics	PC	3	3	0	0	3
2.	RO23712	Humanoid Robotics	PC	3	3	0	0	3
3.		Professional Elective – IV	PE	3	3	0	0	3
4.		Open Elective – II	OE	3	3	0	0	3
LAB ORIENTED THEORY COURSE								
5.	RO23731	Robot Dynamics and Motion Planning	PC	5	3	0	2	4
LABORATORY COURSE								
6.	RO23721	Robotics and Automation Problem Solving using AI, ML and DL	PC	4	0	0	4	2
7.	RO23722	Project Work- Phase I	EEC	4	0	0	4	2
TOTAL				25	15	0	10	20

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY COURSE								
1.		Professional Elective - V	PE	3	3	0	0	3
2.		Professional Elective - VI	PE	3	3	0	0	3
PRACTICAL COURSE								
3.	RO23821	Project Work- Phase II	EEC	16	0	0	16	8
TOTAL				22	6	0	16	14

TOTAL NO. OF CREDITS: 165

SUMMARY

DEPARTMENT OF ROBOTICS AND AUTOMATION											
	Subject Area	Credits Per Semester								Credits Total	Percentage %
	Semester	I	II	III	IV	V	VI	VII	VIII		
1.	Humanities, Social Studies and management science (HSMC)	3	2				4			9	5.4
2.	Basic Sciences (BS)	4	12	4	4					24	14.6
3.	Engineering Sciences (ES)	13	6	6						25	15.2
4.	Professional Core (PC)			14	17	14	10	12		67	40.6
5.	Professional Electives (PE)					3	6	3	6	18	10.9
6.	Open Electives (OE)					3		3		6	3.6
7.	Project Work/ Employability Enhancement Course (PR/EEC)				1	2	3	2	8	16	9.7
	TOTAL	20	20	24	22	22	23	20	14	165	
8.	Non-Credit*/ (Mandatory)	√	√	–	-	-	-	-	-		

Professional Elective Verticals

Department of Robotics & Automation						
REGULATIONS 2023						
Category	Common verticals		Dept. Verticals- R&A			Diversified
	VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6
Offered in	COMPUTATIONAL ENGINEERING	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	APPLIED ROBOTICS	DESIGN AND MANUFACTURING	INTELLIGENT SYSTEMS	DIVERSIFIED
V/VI SEM	ME23A11-Machine Learning for Intelligent Systems	ME23B11-Reliability and Maintenance Engineering	RO23C31- Marine Robotics	ME 23E155- Additive Manufacturing	RO23E11-Fuzzy Logic and Neural Networks	RO23F11- Basics of Thermal Engineering
V/VI SEM	ME23A12-CAD and CAE	ME23B12-Warehousing Automation	RO23C32-Machine Learning and Cognitive Robotics	ME 23D11-Design for X	MT23F17-Computer Vision and Deep Learning	RO23F12-Object Oriented Programming in C++
V/VI SEM	ME23A13-Numerical heat transfer	ME23B13-Operations Management	RO23C33-Agricultural Robotics and Automation	RO23D41-CNC Machine Tools and Programming	RO23E12-Industrial Network Protocols	RO23F13- Production and Operation Management
VII SEM	ME23A14-Theory on Computation and Visualization	ME23B14-Material Handling Equipment, Repair and Maintenance	RO23C34-Collaborative Robotics	RO23D42- Computer Integrated Manufacturing	RO23E13-Condition Monitoring and Fault Diagnostics	RO23F14- IoT Devices
VII SEM	ME23A15-Computational Bio- Mechanics	ME23B15-Container Logistics	RO23C35-Field and Service Robots	RO23D43-Advanced Manufacturing Systems	RO23E14-Applied Signal Processing	RO23F13-Virtual Instrumentation
VII SEM	ME23A16-Advanced Statistics and Data Analytics	ME23B16-Production Planning and Control	RO23C36-Space Robotics	ME 23E17-Electronics Manufacturing Technology	RO23E15-Applied Image Processing	ME23G12-Industrial Safety
VIII SEM	ME23A17-Noise acoustics & vibration	ME23B17-Operations Research	RO23C37- Micro Robotics	RO23D44-Computer Aided Inspection and Testing	MT23F13-Immersive Technologies and Haptic	ME 23D16-Process Planning and Cost Estimation
VIII SEM	ME23A18-Computational Solid Mechanics	ME23B18-Supply chain and Logistics Management	RO23C38-Medical Robotics	RO23D45-Integrated Product Development	RO23E16-Total Integrated Automation	RO23F14-Project Management
VIII SEM	ME23A19-Computational Fluid Dynamics	ME23B19-Data Science	RO23C39-Parallel Manipulators	ME 23E18-Digital Twin & Industry 4.0	RO23E17-Advanced Optimization Techniques	MT23C13-Medical Mechatronics

SEMESTER I

Course Code	Course Title (Theory Course)	Category	L	T	P	C
HS23111	Technical Communication I	HS	2	0	0	2
Common to all branches of I sem. B.E./ B.Tech. programmes						

Objectives:

•	To facilitate students develop their comprehension skills
•	To enable students to improve their receptive skills
•	To equip learners with better vocabulary and enhance their writing skills
•	To aid students speak effectively in all kinds of communicative contexts.
•	To improve the learners' basic proficiency in workplace communication

UNIT-I	DEVELOPING COMPREHENSION SKILLS	6
Listening: Introduction to Informational listening – Listening to Podcasts, News Reading: Intentional Reading - Short Narratives and Passages. Speaking: Introducing Oneself, Narrating a Story / Incident. Writing: Sequential Writing – connecting ideas using transitional words (Jumbled Sentences), Process Description Grammar: Verbs – Main & Auxiliary: Simple Tenses – Form, Function and Meaning. Vocabulary: Word formation – Prefix, Suffix, Compound Words.		
UNIT-II	LISTENING AND EXTENDED READING	6
Listening: Deep Listening – Listening to Talk Shows and Debates Reading: In-depth Reading - Scanning Passages Speaking: Describing Current Issues, Happenings, etc., Writing: Note Making, Note Taking – Paragraph Writing Grammar: Continuous Tenses, Prepositions, Articles Vocabulary: One Word Substitutes, Phrasal Verbs.		
UNIT-III	FORMAL WRITING AND VERBAL ABILITY	6
Listening: Listening to Lectures and Taking Notes Reading: Interpretation of Tables, Charts and Graphs Speaking: SWOT Analysis on Oneself Writing: Formal Letter Writing and Email Writing Grammar: Perfect Tenses, Phrases and Clauses, Discourse Markers Vocabulary : Verbal Analogy / Cloze Exercise		
UNIT-IV	ENHANCING SPEAKING ABILITY	6
Listening: Listening to eminent voices of one's interest (Martin Luther King, APJ Abdul Kalam, etc.) Reading: Timed Reading, Filling KWL Chart. Speaking: Just a Minute, Impromptu Writing: Check-list, Instructions. Grammar: 'Wh' Questions / 'Yes' or 'No' Questions, Imperatives Vocabulary: Synonyms, Antonyms, Different forms of the same words.		
UNIT-V	LANGUAGE FOR WORKPLACE	6
Listening: Extensive Listening (Audio books, rendering of poems, etc.) Reading: Extensive reading (Jigsaw Reading, Short Stories, Novels) Speaking: Short Presentations on Technical Topics Writing: Recommendations, Essay Writing Grammar: Impersonal Passive, Reported Speech, Concord Vocabulary : Informal Vocabulary and Formal Substitutes		
Total Contact Hours: 30		

Course Outcomes:

On completion of the course students will be able to

•	apply their comprehension skills and interpret different contents effortlessly
•	read and comprehend various texts and audio visual contents
•	infer data from graphs and charts and communicate it efficiently in varied contexts
•	participate effectively in diverse speaking situations
•	to present, discuss and coordinate with their peers in workplace using their language skills

SUGGESTED ACTIVITIES

- Ice breaker
- Just A Minute
- Ship wreck
- Hot seat
- Vocabulary building
- Chinese whispers
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book (s):

1	Effective Technical Communication by M. Ashraf Rizvi (Author) 2 nd Edition Paperback 2017
2	Sylvan Barnet and Hugo Bedau, 'Critical Thinking Reading and Writing', Bedford/st. Martin's: Fifth Edition (June 28, 2004)
3	Meenakshi Upadhyay, Arun Sharma – Verbal Ability and Reading Comprehension.
4	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:

1	Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers 2nd Edition by Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor)
2	Reading Development and Difficulties By Kate Cain
3	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK
4	Everybody Writes: Your Go-To Guide to Creating Ridiculously Good Content Hardcover by Ann Handley (Author)

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS23111.1	1	3	-	2	-	2	1	-	3	3	-	1	1	-	1
HS23111.2	-	-	2	2	1	2	3	3	3	1	-	3	1	-	1
HS23111.3	-	-	-	1	-	1	1	1	3	3	3	3	1	-	1
HS23111.4	-	-	1	-	-	2	2	2	2	2	1	1	1	-	1
HS23111.5	-	-	-	1	-	2	2	-	1	2	3	3	1	-	1
Average	1	3	1.5	1.5	1	1.8	1.8	2	2.4	2.2	3	2.4	1	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MA23112	ALGEBRA AND CALCULUS	BS	3	1	0	4
Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Mechanical Engineering, Mechatronics, Robotics & Automation, Civil Engineering and B.Tech. - Biotechnology, Food Technology & Chemical Engineering						

Objectives:

- To introduce the matrix techniques and to illustrate the nature of the matrix.
- To address data and synthesis of the information to provide valid conclusions.
- To explain techniques of calculus which are applied in the solutions of engineering problems.
- To analyse special types of integrals by analytical methods and numerical techniques.
- To practice the techniques of Integration in finding area and volumes.

UNIT-I	MATRICES	12
Matrices - Eigenvalues and eigenvectors - Diagonalization of matrices using orthogonal transformation - Cayley-Hamilton Theorem(without proof) -Quadratic forms- Reduction to canonical form using orthogonal transformation- Numerical computation of Eigen value using Power method		
UNIT-II	FUNCTIONS OF SEVERAL VARIABLES	12
Partial differentiation–Total derivative–Change of variables–Jacobians–Partial differentiation of implicit functions– Taylor’s series for functions of two variables–Maxima and minima of functions of two variables–Lagrange’s method of undetermined multipliers.		
UNIT-III	INTEGRAL CALCULUS	12
Integral Calculus: Definite Integrals as a limit of sums - Applications of integration to area, volume - Improper integrals: Beta and Gamma integrals - Numerical computation of integrals: Trapezoidal rule - Gaussian Two point quadrature		
UNIT-IV	MULTIPLE INTEGRALS	12
Double integrals – Change of order of integration – Area enclosed by plane curves–Triple integrals–Volume of solids– Numerical computation of double integrals: Trapezoidal rule.		
UNIT-V	REGRESSION	12
Scatter diagram - Karl Pearson coefficient of correlation for raw data –Spearman rank correlation coefficient - Lines of regression - Regression equation X on Y and Y on X- Curve fitting by Principle of least squares - Fitting a straight-line $y = ax+b$ and a parabola $y = ax^2 + bx + c$.		
Total Contact Hours:60		

Course Outcomes:

On completion of the course students will be able to

- Demonstrate the matrix techniques in solving the related problems in engineering and technology.
- Analyse and interpret data, and synthesize information to provide valid conclusions.
- Interpret the problems in Engineering and Technology using the principles of mathematical calculus.
- Apply the analytical methods and numerical techniques to solve the related engineering problems.
- Evaluate multiple integrals to conduct investigations of complex problems.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book (s):	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43 rd Edition, 2014.
2	Gupta S.C. and Kapoor V.K. "Fundamentals of Mathematical Statistics", Sultan and Sons 10 th Edition, 2000.
3	T Veerarajan, "Engineering Mathematics –I", McGraw Hill Education, 2018.
4	I.R. Miller, J.E. Freund and R. Johnson, "Probability and Statistics for Engineers ", 4 th Edition, Pearson, 2018.
5	A. Goon, M. Gupta and B. Dasgupta , "Fundamentals of Statistics ", Vol. I & Vol. II, World Press, 2019.

Reference Books(s) / Web links:	
1	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
2	T Veerarajan , "Fundamentals of Mathematical Statistics", yesdee publications, 2017.
3	Erwin Kreyszig , " Advanced Engineering Mathematics ", John Wiley and Sons, 10 th Edition, New Delhi, 2016.
4	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 2006.
5	N. Draper & H. Smith, "Applied Regression Analysis" 3 rd Edition, Wiley, 1998.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23112.1	3	3	3	3	3	2	-	-	-	-	2	2	2	3	1
MA23112.2	3	3	3	3	3	2	-	-	-	-	2	2	2	3	1
MA23112.3	3	3	3	3	2	1	-	-	-	-	2	2	2	3	1
MA23112.4	3	3	2	2	2	1	-	-	-	-	1	1	2	3	1
MA23112.5	3	3	2	2	2	1	-	-	-	-	1	1	2	3	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	-	-	1.6	1.6	2	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23111	ENGINEERING GRAPHICS	ES	2	2	0	4

Objectives:

- To understand the importance of the drawing in engineering applications
- To develop graphic skills for communication of concepts, ideas and design of engineering products
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply these skill in developing new products.
- To improve their technical communication skill in the form of communicative drawings

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications– Size, layout and folding of drawing sheets– Lettering and dimensioning. Basic Geometrical constructions.

UNIT-I	PLANE CURVES AND PROJECTION OF POINTS	5+12
Curves used in engineering practices: Conics–Construction of ellipse, parabola and hyperbola by eccentricity method – Cycloidal Curves–Construction of cycloid, epicycloid and hypocycloid – Construction of involutes of square and circle–Drawing of tangents and normal to the above curves. Principles of Projection and Projection of points.		
UNIT-II	PROJECTION OF LINES AND PLANE SURFACES	6+12
Projection of straight lines (First angle projection) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		
UNIT-III	PROJECTION OF SOLIDS AND PROJECTION OF SECTIONED SOLIDS	6+12
Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Sectioning of solids in simple vertical position when the cutting plane is inclined to HP and perpendicular to VP – obtaining true shape of the section. Practicing three-dimensional modeling of simple objects by CAD software (Not for examination)		
UNIT-IV	DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS	6+12
Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Principles of isometric projection–isometric scale–Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders and cones Model making of isometric projection of combination of solids as assignment (Not for End semester)		
UNIT-V	FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS	6+12
Free Hand sketching: Freehand sketching of multiple views from pictorial views of objects - Freehand sketching of pictorial views of object from multiple views Perspective projection of simple solids-Prisms, pyramids, cylinder and cone by visual ray method.		
Total Contact Hours: (L=30; P=60) 90 Periods		

Text Book (s):	
1	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50 th Edition, 2010.
2	Natrajan K.V., “A text book of Engineering Graphics”, DhanalakshmiPublishers, Chennai, 2017.

Reference Books(s) / Web links:	
1	Varghese P I., “Engineering Graphics”, McGraw Hill Education (I) Pvt.Ltd., 2013.
2	V.B Sikka “Civil Engineering Drawing”, S.K Kataria & Sons, New Delhi,2022.
3	Venugopal K. and PrabhuRaja V., “Engineering Graphics”, New Age International (P)Limited, 2008.
4	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2017.
5	Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill Publishing Company Limited, New Delhi, 2018.

Course Outcomes:	
On completion of the course students will be able to	
•	To construct different plane curves and to comprehend the theory of projection
•	To draw the basic views related to projection of lines and planes
•	To draw the projection of simple solids and to draw the projection of development of surfaces of Sectioned solids in simple vertical position
•	To draw the orthographic projection from pictorial objects and Isometric projections of simple solids
•	To visualize Perspective view of simple solids

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23111.1	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.2	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.3	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.4	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
GE23111.5	3	2	2	1	-	1	-	2	2	2	-	2	2	2	1
Average	3	2	2	1	-	1	-	2	3	2	-	2	2	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23111	INTRODUCTION TO MECHANICAL SYSTEMS	ES	2	1	0	3

Objectives:	
•	To understand the basics of mechanics and to solve problems of equilibrium of a Particle in Space.
•	To understand the concept of equilibrium and to solve problems of rigid bodies.
•	To learn about the center of gravity and moment of inertia of surfaces and solids.
•	To learn the concepts in kinematics and kinetics of rigid bodies in plane motion.
•	To know the types of robotics.

UNIT-I	STATICS OF PARTICLES	9
Introduction to Mechanics, Units and Dimensions, Force on a Particle, Resultant of Two Forces, Equilibrium of a Particle, Free body diagram, Newton's First Law of Motion, Equilibrium of a Particle in Space.		
UNIT-II	EQUILIBRIUM OF RIGID BODIES	9
Introduction, External and Internal Forces, Principle of Transmissibility, Moment of a Force about a Point, Varignon's Theorem, Reactions at Supports and Connections for a Two-dimensional Structure, Equilibrium of a Rigid Body in Two Dimensions, Statically Indeterminate Reactions, Equilibrium of Rigid bodies in two dimensions.		
UNIT-III	CENTER OF GRAVITY AND MOMENT OF INERTIA	9
First and second moment of area and mass, radius of gyration, parallel axis theorem, perpendicular axis theorem, product of inertia. Problems- T section, I section, rectangular section, circular section.		
UNIT-IV	DYNAMICS	9
Introduction to Dynamics, Rectilinear and Projectile Motion of particles, Kinetics of particle - Newton's Second Law of Motion and work - Energy Equations, Introduction to Kinematics of Rigid Bodies-Translation, Rotation about a Fixed Axis, Equations Defining the Rotation of a Rigid Body about a Fixed Axis, General Plane Motion-Absolute and Relative Velocity in Plane Motion.		
UNIT-V	INTRODUCTION TO ROBOTICS	9
History and growth of Robotics, Laws of Robotics, types of joints used in robots, degrees of freedom of planar and spatial manipulator, Introduction and application of autonomous mobile robots (AMRs), automated guided vehicles (AGVs), articulated robots, humanoids, cobots.		
		Total Contact Hours
		: 45

Course Outcomes:	
On completion of the course students will be able to	
•	Comprehend and analysis the forces in the system.
•	Solve problems in engineering systems using the concept of static equilibrium.
•	Determine the centroid of objects such as areas and volumes, center of mass of body and moment of inertia of composite areas.
•	Solve problems involving kinematics and kinetics of rigid bodies in plane motion.
•	Select a robot for the application

Text Book (s):	
1	Beer, F.P and Johnston Jr. E.R, Cornwell and Sanghi., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 11 th Edition, McGraw-Hill Publishing company, New Delhi (2017).
2	Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta "Industrial Robotics (SIE):Technology, Programming and Applications", McGraw Hill Education India., 2012

Reference Books(s) / Web links:	
1	Meriam J.L. and Kraige L.G., “Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2”, Third Edition, Wiley India,2017.
2	Hibbeler, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11 th Edition, Pearson Education 2010.
3	Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics” 4 th Edition, Pearson Education 2006.
4	S SBhavikatti, Engineering Mechanics, New Age International Publishers, 2019
5	Vela Murali, “Engineering Mechanics”, Oxford University Press, 2010

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23111.1	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.2	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.3	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.4	3	3	3	1	1	-	1	1	1	1	1	1	3	2	1
RO23111.5	3	3	3	1	1	1	1	1	1	1	1	1	3	2	1
Average	3	3	3	1	1	1	1	1	1	1	1	1	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject Code	Subject Name (Lab oriented Theory Courses)	Category	L	T	P	C
EE23132	BASIC ELECTRICAL ENGINEERING	ES	3	0	2	4

Objectives:						
•	To provide knowledge on the analysis of DC circuits.					
•	To teach methods of analysis of AC circuits.					
•	To impart knowledge on principles of operation of electrical machines.					
•	To teach the basics of electrical safety measures.					
•	To provide hands on experience on electric circuits and machines					

UNIT-I	DC CIRCUITS						9
Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's laws, Mesh and Nodal Analysis, Superposition, Thevenin's, Norton's Theorems and Maximum Power Transfer Theorem							
UNIT-II	AC CIRCUITS						9
Representation of sinusoidal waveforms, Power and Power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations. Three phase balanced circuits.							
UNIT-III	DC MOTORS AND TRANSFORMERS						9
Construction, working and characteristics of DC motors. Construction, principle of operation of single-phase Transformer, EMF Equation.							
UNIT-IV	AC ROTATING MACHINES						9
Construction and basic working of three phase Alternators and Induction motors, Construction and Types of single-phase induction motors- Construction and basic working of Stepper motor, Permanent magnet Brushless Motor (PMBLDC) (Qualitative Treatment Only).							
UNIT-V	ELECTRICAL SAFETY MEASURES						9
Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection - Safety in the use of portable tools - Preventive maintenance- Types of earthing and its importance-Safety precautions for electrical appliances- National electrical Safety code - Indian electricity acts and rules							
					Total Contact Hours	:	45
List of Experiments							
1	Kirchhoff's laws.						
2	Network theorems (Thevenin's , Norton 's and Maximum Power Transfer Theorems)						
3	Determination of Impedance and Current in RL, RC and RLC series circuits						
4	Measurement of voltage and current in three phase balanced star & delta connected loads.						
5	Load test on DC shunt motor (Virtual Lab)						
6	Load test on single-phase transformer (Virtual Lab)						
7	Load test on three phase induction motor (Virtual Lab)						
8	Load test on Single phase induction motor.						
					Contact Hours	:	30
					Total Contact Hours	:	75

Course Outcomes:						
On completion of the course, the students will be able to						
•	analyse DC circuits and apply circuit theorems.					
•	calculate the power and power factor in AC circuits					
•	comprehend the principles of electrical machines.					
•	realise the electrical safety precautions.					
•	experimentally analyze the electric circuits and machines.					
Suggested Activities						
•	Problem solving sessions					
Suggested Evaluation methods						
•	Quizzes					
•	Class Presentation / Discussion					

Text Book(s):	
1	E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
2	J.B.Gupta, “Fundamentals of Electrical Engineering and Electronics” S.K. Kataria & Sons Publications, 2010.
3	K.Venkataratnam, —Special Electrical Machines , Universities Press (India) Private Limited, 2008.
4	John Cadick, P.E. Mary Capelli-Schellpfeffer, M.D., M.P.A. Dennis K. Neitzel, C.P.E. “Al Winfield Electrical Safety Hand Book, fifth edition, The McGraw-Hill 2012

Reference Books(s) / Web links:	
1	Joseph A. Edminister, Mahmood, Nahri, “Electric Circuits” – Schaum Series and Systems”, Schaum’s Outlines, Tata McGraw Hill, Indian. 5 th Edition , 2017
2	D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
3	D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.
4	L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5	https://nptel.ac.in/courses/108108076
6	E G Janardanan, —Special Electrical Machines , Prentice Hall India Limited, 2013.
7	Maxwell Adams. J, “Electrical safety- a guide to the causes and prevention of electric hazards”, The Institution of Electric Engineers, 1994.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EE23132.1	3	3	3	3	-	3	1	1	2	1	1	1	1	1	1
EE23132.2	3	3	3	3	-	3	1	1	2	1	1	1	1	1	1
EE23132.3	3	3	3	3	-	3	1	1	2	1	1	1	2	2	1
EE23132.4	3	3	3	3	-	3	1	1	2	1	1	1	1	2	1
EE23132.5	3	3	3	3	-	3	3	1	2	1	1	1	2	2	1
Average	3	3	3	3	-	3	1.4	1	2	1	1	1	1	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
GE23121	ENGINEERING PRACTICES LABORATORY – Civil and Mechanical	ES	0	0	2	1

Objectives:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.

List of Experiments

CIVIL ENGINEERING PRACTICE

- Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
- Preparation of basic plumbing line sketches for wash basins, water heaters, etc.
- Hands-on-exercise: Basic pipe connections – Pipe connections with different joining components.

Carpentry Works:

- Study of joints in roofs, doors, windows and furniture.
- Hands-on-exercise: Woodwork, joints by sawing, planing and chiselling.

MECHANICAL ENGINEERING PRACTICE

- Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
- Gas welding practice.

Basic Machining:

- Simple Turning and Taper turning
- Drilling Practice

Sheet Metal Work:

- Forming & Bending:
- Model making – Trays and funnels
- Different type of joints.

Machine Assembly Practice:

- Study of centrifugal pump
- Study of air conditioner

Total Contact Hours : 30

Course Outcomes:

On completion of the course students will be able to

- Perform plumbing activities for residential and industrial buildings considering safety aspects while gaining clear understanding on pipeline location and functions of joints like valves, taps, couplings, unions, reducers, elbows, etc.
- Perform wood working carpentry activities like sawing, planing, cutting, etc. while having clear understanding of the joints in roofs, doors, windows and furniture.
- Produce joints like L joint, T joint, Lap joint, Butt joint, etc. through arc welding process while acquiring in depth knowledge in the principle of operation of welding and other accessories
- Perform operations like Turning, Step turning, Taper turning, etc. in lathe and Drilling operation in drilling machine
- Perform sheet metal operations like Forming, Bending, etc. and fabricating models like Trays, funnels, etc.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
GE23121.1	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1
GE23121.2	1	1	1	-	-	-	-	-	-	-	-	-	1	1	1
GE23121.3	2	1	-	2	-	-	2	-	-	-	-	-	1	1	1
GE23121.4	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1
GE23121.5	1	1	1	-	-	2	1	-	2	-	-	2	1	1	1
Average	1.4	1	1	2	-	2	1.2	-	2	-	-	2	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject Code	Subject Name	Category	L	T	P	C
GE23122	ENGINEERING PRACTICES - ELECTRICAL AND ELECTRONICS	ES	0	0	2	1
Objectives:						
<ul style="list-style-type: none"> To provide hands-on experience on various basic engineering practices in Electrical Engineering. To provide hands-on experience on various basic engineering practices in Electronics Engineering. 						
List of Experiments						
A. ELECTRICAL ENGINEERING PRACTICE						
1	Residential house wiring using switches, fuses, indicators, lamp and energy meter.					
2	Fluorescent lamp wiring.					
3	Stair case wiring.					
4	Measurement of electrical quantities – voltage, current, power & power factor in RL circuit.					
5	Measurement of earth resistance using Megger.					
6	Study of Ceiling Fan and Iron Box					
B. ELECTRONICS ENGINEERING PRACTICE						
1	Study of electronic components and equipment – Resistor, colour coding, measurement of AC signal parameters (peak-peak, rms period, frequency) using CRO/DSO.					
2	(a) Measurement of electrical quantities using Multimeter (b) Testing of electronic components.					
3	Study of logic gates : AND, OR, EXOR and NOT.					
4	Generation of Clock Signals.					
5	Soldering practice – Components Devices and Circuits – Using general purpose PCB.					
6	Measurement of ripple factor of Half-wave and Full-wave Rectifiers.					
Total Contact Hours						: 30
Course Outcomes:						
On completion of the course, the students will be able to						
<ul style="list-style-type: none"> fabricate the basic electrical circuits implement the house wiring circuits fabricate the electronic circuits verify the truth table of logic gates design the Half-wave and Full-wave Rectifiers using diodes and passive components 						
SUGGESTED EVALUATION METHODS						
<ul style="list-style-type: none"> Experiment based Viva 						
REFERENCE						
1	Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.					
2	Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.					
3	Jeyapoovan T., Saravanapandian M. &Pranitha S., “Engineering Practices Lab Manual”, Vikas Publishing House Pvt. Ltd, 2006.					
4	Rajendra Prasad A. &Sarma P.M.M.S., “Workshop Practice”, SreeSai Publication, 2002.					

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
GE23122.1	3	3	3	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.2	3	3	2	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.3	3	3	3	2	-	-	2	-	3	2	-	3	1	1	1
GE23122.4	3	3	3	2	-	-		-	3	2	-	3	1	1	1
GE23122.5	3	3	3	2	-	-		-	3	2	-	3	1	1	1
Average	3	3	2.67	2	-	-	2	-	3	2	-	3	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MC23112	ENVIRONMENTAL SCIENCE AND ENGINEERING	MC	3	0	0	0
<p>Common to I sem. B.E. Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering, Mechatronics, and Robotics and Automation and B.Tech. – Biotechnology, Information Technology, Food Technology & Chemical Engineering and Common to II sem. B.E. – Electronics and Communication Engineering, Electrical and Electronics Engineering, Computer Science and Engineering, Computer Science and Design & Computer Science and Engineering (Cyber Security) and B.Tech. – Artificial Intelligence & Machine Learning and Artificial Intelligence & Data Science.</p>						

Objectives:	
•	To develop the understanding of environmental and associated issues
•	To develop an attitude of concern for the environment
•	To promote enthusiasm in participating environmental protection initiatives
•	To nurture skills to solve environmental degradation issues
•	To develop the knowledge about the environmental laws

UNIT-I	AIR AND NOISE POLLUTION	9
<p>Definition –sources of air pollution –chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, ozone depletion, particulate pollutants-Air quality standards-Air quality indices - control of particulate air pollutants-gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP)-catalytic converters. Noise pollution –sources - health effects - standards- measurement and control methods.</p>		
UNIT-II	WATER POLLUTION AND ITS MANAGEMENT	9
<p>Definition-causes-effects of water pollution-point and nonpoint sources of wastewater-marine pollution - thermal pollution - Control of water pollution by physical, chemical and biological methods – wastewater treatment-primary, secondary and tertiary treatment-sources and characteristics of industrial effluents- zero liquid discharge.</p>		
UNIT-III	SOLID WASTE AND HAZARDOUS WASTE MANAGEMENT	9
<p>Solid waste – types- municipal solid waste management: sources, characteristics, collection, and transportation-sanitary landfill, recycling, composting, incineration, energy recovery options from waste - Hazardous waste – types, characteristics, and health impact - hazardous waste management: neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal. E-waste-definition-sources-effects on human health and environment- E-waste management- steps involved - Role of E-waste management within the initiatives of the Govt. of India- Swachh Bharat Mission.</p>		
UNIT-IV	SUSTAINABLE DEVELOPMENT	9
<p>Sustainable development- concept-dimensions-sustainable development goals - value education- gender equality – food security - poverty – hunger - famine - Twelve principles of green chemistry - Green technology - definition, importance - Cleaner development mechanism - carbon credits, carbon trading, carbon sequestration, eco labeling- International conventions and protocols-Disaster management.</p>		
UNIT-V	ENVIRONMENTAL MANAGEMENT AND LEGISLATION	9
<p>Environmental Management systems - ISO 14000 series- Environmental audit-Environmental Impact Assessment-life cycle assessment- human health risk assessment - Environmental Laws and Policy- Objectives - Polluter pays principle, Precautionary principle - The Environment (Protection) Act 1986 - Role of Information technology in environment and human health.</p>		
Total Contact Hours:		45

Course Outcomes:	
On completion of the course students will be able to	
•	Associate air and noise quality standards with environment and human health.
•	Illustrate the significance of water and devise control measures for water pollution.
•	Analyze solid wastes and hazardous wastes.
•	Outline the goals of sustainable development in an integrated perspective
•	Comprehend the significance of environmental laws.

SUGGESTED ACTIVITIES	
•	Continuous assessment tests
•	Assignments
•	Case studies, class room presentations (or) site visit

Text Book (s):	
1	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
2	Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6 th Edition, New Age International Publisher, 2018.
3	Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi

Reference Books(s) / Web links:	
1	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
2	Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3	Fowler B, Electronic Waste – 1 st Edition (Toxicology and Public Health Issues), 2017 Elsevier
4	NPTEL course URL https://onlinecourses.nptel.ac.in/noc19_ge22/NPTEL https://news.mit.edu/2013/ewaste-mit
5	For downloading text/reference books the weblink is given below can be used http://libgen.rs/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC23112.1	3	2	3	2	1	3	3	2	1	1	1	2	1	1	1
MC23112.2	3	2	3	2	1	3	3	2	1	1	2	2	1	1	1
MC23112.3	3	2	3	1	1	3	3	2	1	1	1	1	1	1	1
MC23112.4	3	2	3	1	2	2	3	2	2	2	1	2	1	1	1
MC23112.5	3	2	2	1	1	2	3	1	1	2	1	1	1	1	1
Average	3	2	2.8	1.4	1.2	2.6	3	1.8	1.2	1.4	1.2	1.6	1	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23117	தமிழர் மரபு	ES	1	0	0	1

அலகு I	மொழி மற்றும் இலக்கியம்:	3
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமய சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழிக் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		
அலகு II	மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை:	3
நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		
அலகு III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:	3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.		
அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்:	3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:	3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.		
Total Contact Hours		: 15

TEXT-CUM-REFERENCE BOOKS

Reference Books(s) / Web links:	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருறை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9	Keeladi – ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER II

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MA23212	DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	BS	3	1	0	4
Common to II Sem. B.E. –Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering, Mechanical Engineering, Mechatronics & Robotics & Automation and B. Tech. – Biotechnology, Food Technology & Chemical Engineering						

Objectives:	
•	To provide students with an introduction to the theory of ordinary differential equations through applications, methods of solution, and numerical approximations.
•	To introduce students to how to solve linear Partial Differential with different methods.
•	To enable the students to study the Laplace Transforms, properties of Laplace Transform, inverse Laplace Transform and some applications to solve the differential equations and integral equations.
•	To explain the concept of a vector integration in a plane and in space.
•	To describe basic properties of complex variables and to have the ability to compute complex integrals.

UNIT-I	ORDINARY DIFFERENTIAL EQUATIONS	12
Second and higher order Linear differential equations with constant coefficients - Method of variation of parameters – Legendre’s linear equations – Numerical solution of ODE - Single Step methods: Taylor’s series method, Euler’s method.		
UNIT-II	PARTIAL DIFFERENTIAL EQUATIONS	12
Formation of partial differential equations - Classification of PDE – Solutions of standard types of first order partial differential equations - Lagrange’s linear equation –Linear homogeneous partial differential equations of second and higher order with constant coefficients.		
UNIT-III	LAPLACE TRANSFORM	12
Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse functions, periodic functions. Inverse Laplace transform – Problems using Convolution theorem – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques		
UNIT-IV	VECTOR CALCULUS	12
Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green’s theorem in a plane, Gauss divergence theorem and Stokes’ theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepipeds.		
UNIT-V	COMPLEX VARIABLES	12
Analytic functions — Construction of analytic function - Bilinear transformation –Singularities – Cauchy’s integral theorem (without proof) - Residues – Residue theorem (without proof) - Simple problems - Contour integral over $ z =1$.		
Total Contact Hours: 60		

Course Outcomes:	
On completion of the course students will be able to	
•	Apply the methods as a potent tool in the solution of a variety of problems in the natural sciences and technology.
•	Develop specific methodologies, techniques and resources in Partial differential equations to conduct research and produce innovative results in the area of specialization.
•	Use Laplace transform and inverse transform techniques to solve the complex problems in engineering and technology.
•	Apply the concepts in multivariable analysis, including space curves; directional derivative; gradient; multiple integrals; line and surface integrals; vector fields; divergence, curl; the theorems of Green and Stokes, and the divergence theorem in different fields of engineering.
•	Demonstrate the concept of Analytic functions, conformal mapping and complex integration in solving Engineering problems.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book (s):

1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2	Veerarajan. T, Engineering Mathematics –II, Mc Graw Hill Education, 2018.
3	Erwin Kreyszig, " Advanced Engineering Mathematics ", John Wiley and Sons, 10 th Edition, New Delhi, 2016.
4	Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4 th Edition, New Delhi, 2011.
5	Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5 th Edition, New Delhi, 2017.

Reference Books(s) / Web links:

1	Ramana. B.V., "Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2	T. Veerarajan, Transforms and Partial Differential Equations, Third Edition, 2018.
3	Bali, N.P. and Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications Pvt. Ltd., New Delhi, 4 th Edition 2006.
4	Peter V.O Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi, 2012.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23212.1	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23212.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23212.3	3	3	3	3	2	1	-	-	1	1	2	2	3	2	1
MA23212.4	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
MA23212.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	1	1	1.6	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
CY23131	CHEMISTRY FOR ELECTRONICS ENGINEERING	BS	3	0	2	4
Common to I sem. B.E. – Electronics and Communication Engineering, Biomedical Engineering and Electrical and Electronics Engineering And Common to II sem. B.E. - Mechatronics and Robotics & Automation						

Objectives:

•	To understand the principles of electrochemical processes
•	To explore the functioning of sensors and their applications in industries and health care
•	To get familiarized with the functioning of batteries and fuel cells
•	To acquire knowledge on polymeric materials used in electronics
•	To develop proficiency in nanomaterials

UNIT-I	DYNAMIC ELECTROCHEMISTRY	9
Applied Electrochemistry: Electrode Potential - EMF series - Corrosion- Causes, Consequences and Prevention. Surface Preparation- electropolishing -Electroplating of copper, electrophoretic deposition - Electrochemical machining, electrochemical etching - electrochemical etching of Cu from PCB.		
UNIT-II	ELECTROCHEMICAL SENSORS	9
Electrodes - reference electrodes - ion-selective electrode, determination of electrode potential- Galvanic and concentration cells - potentiometric, amperometric and conductometric methods of analysis - potentiometric sensor, optical sensor, thermal sensor, chemical biosignals- sensors for health care – glucose and urea sensors, gas sensors for CO ₂ , O ₂ and NH ₃ sensing- blood oxygen sensor.		
UNIT-III	ELECTROCHEMICAL ENERGY SYSTEMS	9
Batteries- types - characteristics-fabrication and working of lead-acid battery- NICAD battery – Nickel metal hydride batteries -lithium-ion battery - Supercapacitors- introduction - types - electrochemical double layer capacitor - activated carbon - carbon aerogels. Fuel cells - classification – principle, working and applications of hydrogen-oxygen fuel cell - solid oxide fuel cell - direct methanol fuel cell and proton exchange membrane fuel cells-biofuel cells.		
UNIT-IV	POLYMERS IN ELECTRONICS	9
Conducting polymers - conducting mechanisms- polyaniline, Poly pyrrole - photonic polymers - photo resists - Introduction, Liquid crystalline phases, Identification of the mesophases, Lyotropic main chain liquid crystalline polymers, Thermotropic main chain liquid crystal polymers, Applications of liquid Crystals in Displays (LCDs) - Organic LEDs- functioning-advantages and disadvantages over conventional LEDs- commercial uses.		
UNIT-V	NANO MATERIALS	9
Introduction-Types of nanomaterials-Emergence and challenges in nanotechnology- Synthesis routes for nanomaterials: Bottom-up and top-down approaches- Sol-gel, precipitation, Hydrothermal, Solvothermal, Microwave irradiation, Chemical Vapour Deposition (CVD), Electro deposition- Properties of nanomaterials- Mechanical properties, Chemical, Optical, Electrical and Magnetic properties-applications of nanomaterials.		
Total Contact Hours: 45		

Description of the Experiments	
1.	Construction and determination of EMF of simple electrochemical cells and concentration cells
2.	Estimation of acids by pH metry
3.	Determination of corrosion rate on mild steel by weight loss method
4.	Estimation of mixture of acids by conductometry
5.	Estimation of extent of corrosion of iron pieces by potentiometry
6.	Estimation of copper / ferrous ions by spectrophotometry
7.	Estimation of DO by using sensors
8.	Estimation of concentration of ions in the given sample solution.
9.	Determination of molecular weight of a polymer by viscometry method
10.	Synthesis of nanomaterials by simple precipitation method
Total Contact Hours: 30	

Course Outcomes:	
On completion of the course students will be able to	
●	Apply the knowledge of electrochemistry in exploring electrochemical processes.
●	Associate the knowledge of sensors in health care and in pollution abatement
●	Recognize the types of batteries and fuel cells
●	Employ advanced materials in industrial applications and display techniques
●	Develop nano and biomaterials for medical applications

Suggested Activities	
●	Electroplating process by group of students
●	Ceramic coating on implant materials
●	Electro polishing of metals and alloys
Suggested Evaluation methods	
●	Continuous assessment tests
●	Assignments
●	Model lab examination
●	End semester examination
Text Book(s):	
1	P. C. Jain and Monika Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015
2	O.G.Palanna, "Engineering Chemistry", McGraw Hill Education (India) Pvt, Ltd, New Delhi, 2017
3	Shikha Agarwal "Engineering Chemistry-Fundamentals and applications", Cambridge University Press, New Delhi, 2015
Reference Books(s) / Web links:	
1	Gowarikar V. R., Viswanathan N.V. and Jayadev Sreedhar, —Polymer Science, New Age International (P) Ltd., New Delhi, 2011
2	Sujata V Bhat, "Biomaterials", Narosa Publishing House, New Delhi, 2002
3	PradeepT, "A Text Book of Nanoscience and Nanotechnology", Tata McGraw Hill, New Delhi, 2012
4	Asim K DAS, Mahua Das, "An Introduction to Nanomaterials and Nanoscience", CBS publishers and distributors Pvt. Ltd., 2020
5	NPTEL course Elementary Electrochemistry course url https://onlinecourses.nptel.ac.in/noc23_cy19/preview
6	1.For downloading text/reference books the weblink is given below can be used http://libgen.rs/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CY23131.1	3	2	2	2	1	1	2	1	1	1	1	2	2	1	1
CY23131.2	3	2	2	1	2	1	2	1	2	1	2	2	2	1	1
CY23131.3	3	2	2	2	2	1	1	-	1	1	1	1	2	1	1
CY23131.4	2	1	1	1	1	-	-	-	1	-	-	1	2	1	1
CY23.131.5	3	2	2	2	2	1	2	1	1	1	2	2	2	1	1
Average	2.8	1.8	1.8	1.6	1.6	1	1.75	1	1.2	1	1.5	1.6	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
PH23131	PHYSICS OF MATERIALS	BS	3	0	2	4
Common to I sem. B.E. – Aeronautical Engineering, Automobile Engineering, Civil Engineering, Mechanical Engineering and Common to II sem. B.E. Mechatronics and Robotics & Automation						

Objectives:	
•	To enhance the fundamental knowledge of elasticity and its applications relevant to engineering streams.
•	To become proficient in crystal growth and crystal systems.
•	To introduce the essential of phase transformation in materials.
•	To impart knowledge on the structure, properties, treatment, testing and applications of metals and alloys.
•	To familiarize students with thermal properties and applications.

UNIT-I	PROPERTIES OF MATTER	9
Elasticity–Hooke’s law–stress–strain–modulus of elasticity–stress–strain diagram–Poisson’s ratio–rigidity modulus–twisting couple on a cylinder–moment of inertia - torsional pendulum method. Bending of beams -bending moment–cantilever depression–theory and experiment - Young’s modulus determination–uniform and non-uniform bending-I–shape girders. Viscosity–flow of motion–Reynolds number.		
UNIT-II	THERMAL PHYSICS	9
Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation –rectilinear heat flow – thermal conductivity - Forbe’s and Lee’s disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.		
UNIT-III	PHASE DIAGRAMS	9
Solid solutions - Hume-Rothery’s rules –Gibb’s phase rule – unary phase diagram- binary phase diagrams - isomorphous systems - tie-line and lever rule - eutectic, eutectoid, peritectic, peritectoid, monotectic and syntectic systems - formation of microstructures-homogeneous and non-homogenous cooling – nucleation (Qualitative)– iron-carbon phase diagram - eutectoid steel – hypo-eutectoid and hyper-eutectoid steel – diffusion - Fick’s laws – T-T-T diagrams.		
UNIT-IV	CRYSTAL PHYSICS	9
Basis – lattices – unit cell-crystal systems – Bravais lattices –number of atoms, atomic radius, co-ordination number and packing fraction - SC, BCC, FCC, HCP lattices and diamond structure - polymorphism and allotropy-graphite structure - Miller indices – determination of d-space-crystal growth techniques-solution growth –melt growth– Bridgmann and Czochralski - crystal defects.		
UNIT-V	ADVANCED MATERIALS & TESTING	9
Metallic glasses – preparation, properties and applications - Composites – types and properties - Shape memory alloys – properties and applications - Nano-materials – top down and bottom up approaches –sol-gel method-pulsed laser deposition-ball milling- properties-applications - Tensile strength – Hardness – Fatigue - Impact strength – Creep - Fracture – types of fracture.		
Total Contact Hours:		45

List of Experiments		
1	Determination of Young’s modulus of given material by non-uniform bending method.	
2	Determination of moment of inertia of a disc and rigidity modulus of a given wire using Torsional pendulum.	
3	Determination of Young’s modulus of given beam by cantilever method.	
4	Determination of viscosity of the given liquid using Poiseuille’s method.	
5	Determination of Thermal conductivity of a bad conductor – Lee’s Disc method.	
6	Determination of Velocity of ultrasound and compressibility of given liquid – Ultrasonic interferometer.	
7	Determination of the wavelength of Laser and particle size of given powder.	
8	Determination of the Hysteresis loss of ferromagnetic material by B-H curve experiment.	
9	Find the thickness of a given thin wire – Air wedge method.	
10	Study the characteristics of solar cell parameters.	
		Contact Hours
		: 30
		Total Contact Hours
		: 75

Course Outcomes:	
On completion of the course, students will be able to	
•	apply the elastic nature of materials and determine the elastic moduli of different materials.
•	apply the basic knowledge of crystal structure in solids.
•	analyse and measure the properties of alloys.
•	analyse various material testing methods and use them in suitable applications.
•	understand the concepts of heat transfer in various applications.

SUGGESTED ACTIVITIES
• Problem solving sessions

SUGGESTED EVALUATION METHODS
• Quizzes
• Class Presentation / Discussion

Text Book(s):	
1.	Bhattacharya, D.K. & Poonam, T. “Engineering Physics”, Oxford University Press, 2018.
2.	Gaur, R.K. & Gupta, S.L. “Engineering Physics”, Dhanpat Rai Publishers, 2018.
3.	Raghavan V. “Physical Metallurgy: Principles and Practice”, PHI Learning, 2019.

Reference Books(s) / Web links:	
1.	Balasubramaniam, R. “Callister's Materials Science and Engineering”. Wiley India Pvt. Ltd., 2017
2.	Resnick, R., Halliday, D., & Walker, J. “Principles of Physics”, Wiley India Pvt., 2018.
3.	Raghavan, V. “Materials Science and Engineering: A First course”. PHI Learning, 2019.
4.	https://nptel.ac.in/courses/113104068
5.	https://archive.nptel.ac.in/courses/115/105/115105099/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PH23131.1	3	2	1	1	2	1	-	1	1	1	1	2	2	1	1
PH23131.2	3	2	1	1	2	2	1	-	1	1	1	2	2	1	1
PH23131.3	3	2	1	1	2	1	2	-	1	1	1	2	2	1	1
PH23131.4	3	2	1	1	2	2	2	1	1	1	1	2	2	1	1
PH23131.5	3	2	1	1	2	2	2	2	1	1	1	2	2	1	1
Average	3	2	1	1	2	1.6	1.4	1.33	1	1	1	2	2	1	1

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab Oriented Theory Course)	Category	L	T	P	C
GE23233	PROBLEM SOLVING AND PYTHON PROGRAMMING	ES	2	0	4	4

Objectives:
• To know the basics of algorithmic problems solving
• To develop Python programs with conditionals and loops
• To define Python functions and call them
• To use Python data structures—lists, tuples, dictionaries
• To do input/output with files in Python

UNIT-I ALGORITHMIC PROBLEM SOLVING	6
Introduction to computers-characteristics-basic organization of a computer– algorithms-building blocks of algorithms (instructions / statements, state, control flow, functions)-notation (pseudo code, flow chart, programming language) - algorithmic problem solving - simple strategies for developing algorithms (iteration,recursion).	
UNIT-II DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW	6
Python interpreter and interactive mode - values and types - data types – variables – keywords – expressions and statements- python I/O - operators- precedenceof operators– comments. Conditionals:conditional(if)-alternative(if-else)-chained conditional (if- elif- else)–nested conditional.	
UNIT-III CONTROL FLOW – II AND FUNCTIONS	7
Iteration: while – for - break – continue – pass. Illustrative programs: exchange the values of two variables- circulate the values of n variables-test for leap year. Function calls – type conversion– math function– composition- definition and use - flow of execution - parameters and arguments. Fruitful functions: return values – parameters - scope: local and global - recursion.	
UNIT-IV STRINGS	5
Strings: string slices – immutability - string functions and methods – string comparison. Illustrative programs: square root– GCD– exponentiation-sum the array of numbers linear search- binary search.	
UNIT-V LISTS, TUPLES AND DICTIONARIES	6
Lists - list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists - listparameters. Tuples – immutable - tuple assignment - tuple as return value. Dictionaries: operations and methods– dictionaries and tuples– dictionaries and lists. Advanced list processing- list comprehension. Illustrative programs: Sorting.	
	Contact Hours : 30

List of Experiments			
1	Introduction to Python Programming and Python IDLE/Anaconda distribution.		
2	Experiments based on Variables, Data types and Operators in Python.		
3	Coding Standards and Formatting Output.		
4	Algorithmic Approach: Selection control structures.		
5	Algorithmic Approach: Iteration control structures.		
6	Experiments based on Strings and its operations.		
7	Experiments based on Lists and its operations.		
8	Experiments based on Tuples and its operations.		
9	Experiments based on Sets and its operations.		
10	Experiments based on Dictionary and its operations.		
11	Functions: Built-in functions.		
12	Searching techniques: Linear and Binary.		
13	Sorting techniques: Bubble and Merge Sort.		
	Contact Hours	:	60
	Total Contact Hours	:	90

Course Outcomes:	
On completion of the course, students will be able to	
•	Understand the working principle of a computer and identify the purpose of a computer programming language and ability to identify an appropriate approach to solve the problem.
•	Write, test, and debug simple Python programs with conditionals and loops.
•	Develop Python programs step - wise by defining functions and calling them.
•	Use Python lists, tuples, dictionaries for representing compound data.
•	Apply searching, sorting on data and efficiently handle data using flat files.

TextBooks:	
1.	Allen B. Downey, Think Python:How to Think Like a Computer Scientist, Second edition,UpdatedforPython3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2.	Guido Van Rossum and Fred L. Drake Jr, An Introduction to Python-Revised and updated for Python3.2, Network Theory Ltd., 2011.

ReferenceBooks:	
1.	JohnVGutttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press,2013.
2.	Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt.Ltd., 2016.
3.	Timothy A.Budd, Exploring Python, Mc-Graw Hill Education(India)PrivateLtd.,2015.
4.	Kenneth A. Lambert, Fundamentals of Python: First Programs, CengageLearning,2012.
5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem Solving Focus, Wiley India Edition,2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer Science using Python3, Second edition, Pragmatic Programmers, LLC, 2013.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
GE23233.1	2	2	2	2	1	-	-	-	1	1	1	1	2	2	2
GE23233.2	2	1	1	1	1	-	-	-	-	-	1	1	2	2	2
GE23233.3	1	1	2	1	2	-	-	-	-	-	1	1	2	2	2
GE23233.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
GE23233.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	1.8	1.6	2.2	1.6	1.8	-	-	-	1	1	1.4	1	2	2	2

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS 23221	TECHNICAL COMMUNICATION II	HS	0	0	2	1
Common to all branches of II sem. B.E./ B.Tech. programmes						

Objectives:	
•	To facilitate students to improve their vocabulary for a better communication
•	To enable learners to understand and reproduce language
•	To aid students to write technical reports in a convincing manner
•	To expose students to different sentence structures
•	To equip learners to present their ideas in an efficient manner

UNIT-I	VOCABULARY FOR BETTER COMMUNICATION	6
Listening: Telephonic Conversations and TV News Reading: Newspapers and Magazines Speaking: Conversational Practice: Speaking in a given situation, Asking permission and requesting etc., Writing: Job Application Letter and Resume Grammar: Reference words: pronouns and determiners Vocabulary: Guessing meanings of words in different contexts.		
UNIT-II	FUNCTIONAL LANGUAGE ASPECTS	6
Listening: Motivational listening – listening to real life challenges Reading: Articles and Technical reports Speaking: Using Polite Expressions, Indirect Questions Writing: Paraphrasing a Text, Poem Grammar: Purpose Statements, Cause and Effect Expressions Vocabulary: Neologisms.		
UNIT-III	TECHNICAL REPORTWRITING	6
Listening: Empathetic Listening – Giving Solutions to Problems Reading: Inferential Reading Speaking: Dialogues – Interviewing Celebrities / Leaders / Sportspersons, etc., Writing: Report Writing Grammar: Functional Usage of Expressions – used to, gone / been, etc., Vocabulary: Words Often Confused		
UNIT-IV	STRUCTURAL GRAMMAR	6
Listening: Comprehension (IELTS practice tests) Reading: Intensive Reading for specific information Speaking: Pick and Talk Writing: Proposals Grammar: Sentence Structures – Simple, Compound, Complex Sentences Vocabulary: Replacing dull words with vivid ones		
UNIT-V	PRESENTATION SKILLS	6
Listening: Discriminative listening – sarcasm, irony, pun, etc., Reading: Practice of chunking – breaking up reading materials Speaking: Mini presentation on some topic Writing: Minutes of the meeting Grammar: Correction of Errors Vocabulary: Advanced vocabulary – fixing appropriate words in the given context.		
Total Contact Hours: 30		

Course Outcomes:	
On completion of the course, students will be able to	
•	communicate effectively using appropriate vocabulary
•	use the acquired language skills to comprehend various types of language contents
•	evaluate different texts and write effective technical content
•	use appropriate sentence structures to convey their thoughts in varied contexts
•	present their concepts and ideas in an effective manner

SUGGESTED ACTIVITIES

- Story Lines
- One truth and two lies
- Hang Man
- Pictionary
- Word Scramble
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):

1.	Raymond Murphy, "Intermediate English Grammar," Second Edition , Cambridge University Press, 2018
2.	Meenakshi Raman & Sangeeta Sharma, "Technical Communication" Third Edition, Oxford University Press, 2015
3.	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine ChuenMeng Goh, Cambridge University Press

Reference Books(s) / Web links:

1.	Michael McCarthy (Author), Felicity O'Dell (Author), John D. Bunting (Contributor), "Basic Vocabulary in Use: 60 Units of Vocabulary Practice in North American English With Answers" 2 nd Edition
2.	Dale Carnegie, "The Art of Public Speaking," Insight Press
3.	Jack C. Richards & Theodore S. Rodgers, " Approaches and Methods in Language Teaching, Second Edition, Cambridge University Press

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS 23221.1	1	3	-	2	-	2	1	-	3	3	-	1	1	-	1
HS 23221.2	-	-	2	2	1	2	3	3	3	1	-	3	1	-	1
HS 23221.3	-	-	-	1	-	1	1	1	3	3	3	3	1	-	1
HS 23221.4	-	-	1	-	-	2	2	2	2	2	1	1	1	-	1
HS 23221.5	-	-	-	1	-	2	2	-	1	2	3	3	1	-	1
Average	1	3	1.5	1.5	1	1.8	1.8	2	2.4	2.2	3	2.4	1	-	1

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
HS23222	ENGLISH FOR PROFESSIONAL COMPETENCE	HS	0	0	2	1
Common to all branches of II sem. B.E./ B.Tech. programmes						

Objectives:						
•	To facilitate the learners in acquiring listening and reading competence					
•	To enable the learners to communicate effectively through written and oral medium					
•	To assist the learners in preparing for competitive examinations					
•	To train the students in acquiring corporate skills					
•	To inculcate professional standards among the students and make them realize their responsibility in addressing the challenges					

UNIT-I	RECEPTIVE SKILLS	6
Listening – Comprehensive Listening – Watching the news – Listening to a peer giving presentation, etc. – Critical Listening – Watching a televised debate, Listening to poems – Reading – Extensive Reading – Short stories and One-act Plays – Intensive Reading – Articles or Editorials in Magazines, Blog posts on topics like science and technology, arts, etc.		
UNIT-II	PRODUCTIVE SKILLS	6
Speaking – Demonstrative Speaking – Process description through visual aids – Persuasive Speaking – Convincing the listener with the speaker’s view – Writing – Descriptive Writing - Describing a place, person, process – Subjective Writing – Autobiography, Writing based on personal opinions and interpretations.		
UNIT-III	ENGLISH FOR COMPETITIVE EXAMS	6
An introduction to International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service, Indian Economic Service Examination, Indian Statistical Service Examination, Combined Defence Services Examination, Staff Selection- (Language Related) – Aptitude tests.		
UNIT-IV	CORPORATE SKILLS	6
Critical Thinking and Problem Solving – Case Study, Brainstorming, Q & A Discussion – Team work and Collaboration – Activities like Office Debates, Perfect Square, Blind Retriever, etc. – Professionalism and Strong Work Ethics – Integrity, Resilience, Accountability, Adaptability, Growth Mind set.		
UNIT-V	PROJECT WORK	6
Case Study based on the challenges faced by the employers and the employees – Devise Plan, Provide Solution		
Total Contact Hours: 30		

Course Outcomes:	
On completion of the course students will be able to	
•	interpret and respond appropriately in the listening and reading contexts.
•	express themselves effectively in spoken and written communication
•	apply their acquired language skills in writing the competitive examinations
•	exhibit their professional skills in their work place
•	identify the challenges in the work place and suggest strategies solutions

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> • Online Quizzes on Vocabulary • Online Quizzes on grammar • Communication Gap Exercises • Presentations • Word Building Games • Case study

SUGGESTED EVALUATION METHODS
<ul style="list-style-type: none"> • Assignment topics • Quizzes • Class Presentation/Discussion • Continuous Assessment Tests

Text Book(s):	
1.	How to Read Better & Faster, Norman Lewis, Goyal Publishers
2.	Teaching Speaking: A Holistic Approach, Book by Anne Burns and Christine Chuen Meng Goh, Cambridge University Press
3.	The Official Cambridge Guide To IELTS by Pauline Cullen, Cambridge University Press
4.	The 7 Habits of Highly Effective People by Stephen Covey, Simon and Schuster, UK

Reference Books(s) / Web links:	
1.	Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.
2.	Hartley, Mary. "The Power of Listening," JaicoPublishing House; First Edition (2015).
3.	Chambers, Harry. "Effective Communication Skills for Scientific and Technical Professionals," Persues Publishing, Cambridge, Massachusetts, 2000.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HS 23222.1	1	3	-	2	-	2	1	-	3	3	-	1	1	-	1
HS 23222.2	-	-	2	2	1	2	3	3	3	1	-	3	1	-	1
HS 23222.3	-	-	-	1	-	1	1	1	3	3	3	3	1	-	1
HS 23222.4	-	-	1	-	-	2	2	2	2	2	1	1	1	-	1
HS 23222.5	-	-	-	1	-	2	2	-	1	2	3	3	1	-	1
Average	1	3	1.5	1.5	1	1.8	1.8	2	2.4	2.2	3	2.4	1	-	1

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23221	COMPUTER AIDED MODELING LABORATORY	ES	0	0	2	1

Objectives:

- To introduce the engineering drawing symbols and abbreviation used on the drawing.
- To provide hands on experience to develop 2D and 3D models of engineering components.
- To provide knowledge to use Drawing/Modeling software.

List of Experiments

1	Creating Sketched Geometry
2	Practice the additional sketching tools-Edit, Move, Copy and Pattern,
3	Constructing Features-planes, axis and points
4	Perform Additional Features and Operations-shell, draft, rib, split face, thread, sweep and loft
5	Perform Detailing Drawings- Dimensions Other Annotations Parts List and Balloons Annotation and Dimension Settings Drawing Output.
6	prepare assembly models - Plummer Block
7	prepare assembly models -Flange Coupling
8	prepare assembly models - Screw Jack
9	prepare assembly models -Robot gripper
10	prepare assembly models -2R manipulator
Total Contact Hours	
: 30	

Course Outcomes:

On completion of the course students will be able to

- Develop engineering drawing and dimensioning for the industrial component
- Use CAD software for drafting machine components.
- Develop 2D and 3D models of the component using software.
- Perform assembly modeling using software.
- Perform Detailing of assembly drawings using software.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23221.1	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.2	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.3	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.4	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
RO23221.5	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1
Average	1	1	1	1	3	1	-	1	2	1	1	3	2	2	1

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
GE23217	தமிழரும் தொழில்நுட்பமும்	MC	1	0	0	1

அலகு I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்:	3
சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பண்டங்களில் கீறல் குறியீடுகள்		
அலகு II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:	3
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரம் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ - சாரோசெனிக் கட்டிடக் கலை.		
அலகு III	உற்பத்தித் தொழில் நுட்பம்:	3
கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:	3
அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குழுமித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கல்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.		
அலகு V	அறிவியல் தமிழ் மற்றும் கணித்தமிழ் :	3
அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.		
Total Contact Hours		: 15

Reference Books(s) / Web links:	
1	தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ் - முனைவர் இல. சந்திரம். (விகடன் பிரசுரம்).
3	கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருறை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5	Social Life of Tamils (Dr. K. K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils – The Classical Period (Dr. S. Singaravelu)(Published by: International Institute of Tamil Studies).
7	Historical Heritage of the Tamils (Dr. S. V. Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9	Keeladi – ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Code	Course Title (Theory Course)	Category	L	T	P	C
MC23111	INDIAN CONSTITUTION AND FREEDOM MOVEMENT	MC	3	0	0	0
<p>Common to I sem. B. E. – Computer Science and Engineering, Electronics and Communication Engineering, Electrical and Electronics Engineering & Computer Science and Design & Computer Science and Engineering (Cyber Security)</p> <p>and</p> <p>B.Tech. - Computer Science and Business Systems, Artificial Intelligence and Machine Learning and Artificial Intelligence & Data Science</p> <p>and</p> <p>Common to II sem. B.E. – Aeronautical Engineering, Automobile Engineering, Biomedical Engineering, Civil Engineering, Mechanical Engineering, Mechatronics and Robotics & Automation</p> <p>and</p> <p>B.Tech. - Chemical Engineering, Food Technology & Information Technology</p> <p>and</p> <p>IV sem. - B.Tech. – Biotechnology.</p>						

Objectives:

•	To apprehend the sacrifices made by the freedom fighters.
•	To inculcate the values enshrined in the Indian constitution.
•	To in still a sense of responsibility as the citizens of India.
•	To familiarise about the functions of the various levels of Government.
•	To be informed about Constitutional and Non- Constitutional bodies.

UNIT-I	INDIAN FREEDOM MOVEMENT	9
British Colonialism in India-Colonial administration till 1857- Revolt of 1857- Early Resistance to British Rule-Rise of Nationalism in India- Indian Freedom Struggle under Mahatma Gandhi -Non- Cooperation Movement-Civil Disobedience Movement- Quit India Movement-British Official response to National movement- Independence of India Act 1947-Freedom and Partition.		
UNIT-II	CONSTITUTION OF INDIA	9
Historical Background – Indian Constitution: Constitution’ meaning of the term, Sources and constitutional history, Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens.		
UNIT-III	STRUCTURE AND FUNCTIONS OF CENTRAL GOVERNMENT	9
Union Government – Structure of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.		
UNIT-IV	STRUCTURE AND FUNCTION OF STATE GOVERNMENT AND LOCAL BODY	9
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts- Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati Raj: Introduction, Elected officials and their roles, Village level: Role of Elected and Appointed officials.		
UNIT-V	CONSTITUTIONAL FUNCTIONS AND BODIES	9
Indian Federal System – Centre – State Relations – President’s Rule – Constitutional Functionaries – Assessment of working of the Parliamentary System in India- CAG, Election Commission, UPSC, GST Council and other Constitutional bodies-. NITI Aayog, Lokpal, National Development Council and other Non –Constitutional bodies.		
Total Contact Hours: 45		

Course Outcomes:

On completion of the course students will be able to

•	appreciate the sacrifices made by freedom fighters during freedom movement.
•	be responsible citizens and abide by the rules of the Indian constitution.
•	be aware of the functions of the Indian government.
•	be knowledgeable about the functions of the state Government and the Local bodies.
•	apply the knowledge on constitutional functions and role of constitutional bodies and non-constitutional bodies.

SUGGESTED ACTIVITIES

- Famous speeches from around the world relating to independence
- Case study
- Quiz on Portfolio and Cabinet
- Discussions on International Associations like the UN, BRICS, QUAD
- Presentation on issues around the world

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous assessments (CAT)

Text Book(s):

1.	M. Laxmikanth , “Indian Polity:, McGraw-Hill, New Delhi.
2.	Durga Das Basu, “Introduction to the Constitution of India “, Lexis Nexis, New Delhi. 21 st ed 2013.
3.	P K Agarwal and K N Chaturvedi, Prabhat Prakashan, New Delhi, 1 st ed , 2017.

Reference Books(s) / Web links:

1.	Sharma, Brij Kishore, “Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2.	U.R.Gahai, “Indian Political System “, New Academic Publishing House, Jalaendhar
3.	Bipan Chandra, India’s Struggle for Independence, Penguin Books, 2016.
4.	Maciver and Page, “Society: An Introduction Analysis “, Mac Milan India Ltd., New Delhi.2 nd ed, 2014.
5.	Bipan Chandra, History of Modern India, Orient Black Swan, 2009.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC23111.1	-	-	-	-	-	-	2	2	1	1	-	1	-	-	-
MC23111.2	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1
MC23111.3	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1
MC23111.4	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1
MC23111.5	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1
Average	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1

1: Slight (Low)

2: Moderate (Medium) 3: Substantial (High)

SEMESTER III

Course Code	Course Title	Category	L	T	P	C
MA23311	TRANSFORMS AND APPLIED PARTIAL DIFFERENTIAL EQUATIONS	BS	3	1	0	4
Common to III sem. B.E. – Aeronautical Engineering, Mechatronics, Robotics & Automation and – Biotechnology, Food Technology and Chemical Engineering						B.Tech.

Objectives:	
•	To express Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
•	To show continuous function arising in wave and heat propagation, signals and systems using Fourier Transforms.
•	To obtain solution of one dimensional wave equation with finite difference techniques.
•	To solve one and two dimensional heat flow equations using finite difference methods and numerical techniques.
•	To make use of Z-transform to illustrate discrete function arising in wave and heat propagation, signals and systems.

UNIT-I	FOURIER SERIES	12
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis.		
UNIT-II	FOURIER TRANSFORMS	12
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.		
UNIT-III	WAVE EQUATION	12
Solution of one dimensional wave equation - Finite difference techniques for the solution for PDE- One Dimensional Wave Equation by Explicit method		
UNIT-IV	HEAT EQUATION	12
One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges)- Numerical computation :One dimensional heat flow equation by implicit and explicit methods		
UNIT-V	Z-TRANSFORMS	12
Z- transforms - Elementary properties – Inverse Z - transform (using residues) - Formation of difference equations – Solution of difference equations using Z- transform.		
Total Contact Hours: 60		

Course Outcomes:	
On completion of the course, students will be able to	
•	Demonstrate Fourier series to study the behaviour of periodic functions and their applications in engineering problems such as system communications, digital signal processing and field theory.
•	Apply the shifting theorems, Fourier integral theorems, Inverse Fourier sine and cosine transforms appropriate problems in engineering and technology.
•	Evaluate solution of one dimensional wave equation arising in various field of engineering using finite difference techniques.
•	Apply the numerical techniques of differentiation to solution of heat flow equations arising in various branches of engineering.
•	Use Z-transform to illustrate discrete function arising in wave and heat propagation, signals and systems.

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> • Problem solving sessions • Activity Based Learning • Online MATLAB session can be implemented

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Books:

1	Erwin Kreyszig, "Advanced Engineering Mathematics", 10 th Edition, Wiley India, 2015.
2	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
3	Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
4	Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
5	P. Kandasamy, K. Gunavathy, Thilagavathy., "Engineering Mathematics Transforms and Partial Differential Equations", S.Chand & Company, 2002.

Reference Books / Web links:

1	N. Subramaniam, K. S. Ramaswami ., "Transforms and Partial Differential Equations", Pearson Education, 2018.
2	Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
3	Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
4	Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), 7 th Edition, New Delhi, 2009.
5	Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi, 2012. https://drspmaths.files.wordpress.com/2020/01/advanced-engineering-mathematics-peter-v.-o-neil.pdf

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23311.1	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23311.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23311.3	3	3	3	3	2	1	-	-	1	1	2	2	3	2	1
MA23311.4	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
MA23311.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	1	1	1.6	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23311	Analog and Digital Electronics	PC	3	0	0	3

Objectives:	
•	To acquire knowledge about Diode & Transistors operation and characteristic.
•	To learn the IC fabrication procedure and applications of op-amp.
•	To impart knowledge on design and implementation of IC 555 timer, VCO, PLL, FVR, VVR, ICL.
•	To learn the basic postulates of Boolean algebra and infer the methods for simplifying Boolean expressions and design of various Combinational circuits.
•	Design of Synchronous and Asynchronous Sequential circuits and its problems.

UNIT-I	INTRODUCTION TO ANALOG CIRCUITS	9
PN junction & Zener diodes: Forward and Reverse bias, VI characteristics- BJT: Input and Output Characteristics of CE, CB and CC - JFET AND MOSFET: Drain and Transfer Characteristics.		
UNIT-II	FUNDAMENTALS AND CHARACTERISTICS OF OP-AMP	9
Fundamentals of monolithic IC technology and fabrication, Inverting and Non-inverting Amplifiers – Voltage follower – Summing amplifier – Difference amplifier –V/I and I/V converter – Differentiator – Integrator – Instrumentation amplifier–log and antilog amplifier- Oscillators- Comparators – Multivibrators.		
UNIT-III	REGULATOR & SPECIAL ICS OF OP-AMP	9
Functional block, characteristics: 555 Timer IC – IC566 Voltage Controlled Oscillator (VCO) – IC 565 Phase Locked Loop (PLL) – LM79XX – Fixed voltage regulators – LM 723 Variable voltage regulators, – SMPS – ICL 8038 function generator IC.		
UNIT-IV	NUMBER SYSTEMS & COMBINATIONAL CIRCUITS	9
Review of number systems, Boolean laws, K maps – simplification and implementation of combinational logic, Binary codes - code converters, adders, subtractors, multiplexers and de-multiplexer, encoders and decoders.		
UNIT-V	SYNCHRONOUS & ASYNCHRONOUS SEQUENTIAL CIRCUITS	9
Sequential logic- SR, JK, D and T flip flops – level triggering and edge triggering – asynchronous and synchronous counters – Shift registers, Analysis of asynchronous sequential logic circuits -Transition table, flow table-race conditions, hazards & errors in digital circuits.		
Total Contact Hours:45		

Course Outcomes:	
On completion of the course, students will be able to	
•	Demonstrate and Developing of Diode & Transistors operation and characteristic.
•	Realize the various applications of OP-AMP & generate a Waveforms.
•	Develop functional systems of various OP-AMP
•	Simplify the Boolean expressions with suitable minimization techniques, Design and Implement Combinational circuits.
•	Design & Construct Synchronous and Asynchronous Sequential circuits and analyse its problems

SUGGESTED ACTIVITIES	
•	Industrial visit
•	Mini Project

SUGGESTED EVALUATION METHODS	
•	Assignment topics
•	Class Presentation/Discussion
•	Continuous Assessment Tests

Text Books:	
1	D. Roy Choudhary, Sheilb.Jani, —Linear Integrated Circuits, fifth edition, New Age, 2018.
2	Morris Mano & Michael D Ciletti, “Digital Design: With an Introduction to Verilog HDL, 5 th Edition, Pearson Education, 2013

Reference Books / Web links:

1	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory," 11 th Edition, Prentice Hall, 2012.
2	D. Neamen , D. Biswas "Semiconductor Physics and Devices," 4/e, Mc Graw-Hill Education, 2012.
3	Ramakant A.Gayakwad, —Op-amps and Linear Integrated Circuits , fourth edition, Pearson Education, 2015.
4	Charles H.Roth. "Fundamentals of Logic Design", 7 th Edition, Thomson Learning, 2014.
5	Thomas L. Floyd, "Digital Fundamentals", 10 th Edition, Pearson Education Inc, 2011.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23311.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23311.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23311.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23311.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23311.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23312	THEORY OF MECHANISMS AND MACHINES-I	PC	3	1	0	4

Objectives:						
●	To understand the basic concepts of mechanisms					
●	To develop the velocity, and acceleration diagram of mechanisms					
●	To understand the fundamentals of lower pair mechanisms					
●	To understand the cam mechanisms					
●	To understand the basic concepts of cam mechanism, gears and gear trains					

UNIT-I	FUNDAMENTALS AND TYPE OF MECHANISMS	12
Introduction to statics, kinematics, kinetics - Classification of mechanisms – Basic kinematic concepts and definitions – Kinematic links. Joints, pairs, chains and its types. Degree of freedom - constrained motion and its types - Mobility – Kutzbach criterion, Gruebler’s criterion – Grashof’s Law- Inversions, Mechanism, Machine and Structure. Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantage – Transmission Angle.		
UNIT-II	VELOCITY AND ACCELERATION ANALYSIS	12
Velocity of a Point on Rotating Rigid Body - Relative Velocity between Two Points on the Same Link - Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – velocity analysis using instantaneous centers - Aronhold-Kennedy's Theorem of Three Centres – kinematic analysis of simple mechanisms – Coincident points – Introduction to linkage synthesis problem.		
UNIT-III	MECHANISMS WITH LOWER PAIRS	12
Offset Slider-Crank Mechanism as a Quick Return Mechanism - The Pantograph - Straight Line Motion Mechanisms. Exact Straight Line Motion Mechanisms - Peaucellier Mechanism, The Hart Mechanism, The Scott-Russel Mechanism. Approximate Straight Line Motion - Watt Mechanism, Grasshopper Mechanism, Roberts Straight Line Motion Mechanism. Davis Steering Gear mechanism - Ackerman Steering Gear mechanism - Hooke's Joint or Universal Coupling - Toggle Mechanism - Scotch Yoke Mechanism.		
UNIT-IV	KINEMATICS OF CAM MECHANISMS	12
Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.		
UNIT-V	GEARS AND GEAR TRAINS	12
Classification of Gears - Nomenclature for Straight Spur Gears – Fundamental Law of toothed gearing – Involute and cycloidal tooth profiles – Length of Path of Contact– Length of arc of Contact - contact ratio – Interference and undercutting. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains - Algebraic Method of Analysing Epicyclic Gear Trains – Tabulation Method for Analysing Epicyclic Gear Train		
		Total Contact Hours
		: 60

Course Outcomes:						
On completion of the course students will be able to						
●	Analyze the mechanisms					
●	Construct the velocity and acceleration diagrams for a given mechanism					
●	Analyze the mechanisms with lower pairs.					
●	Design and analyse the cam mechanisms.					
●	Analyze the given gear trains					

SUGGESTED ACTIVITIES						
●	Industrial visit					
●	Mini Project					

SUGGESTED EVALUATION METHODS						
●	Assignment topics					
●	Class Presentation/Discussion					
●	Continuous Assessment Tests					

Text Books:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., —Theory of Machines and Mechanisms , Oxford University Press, 4 th Edition, Reprint: 2017
2	Rattan, S.S, —Theory of Machines , McGraw-Hill Education Pvt. Ltd., 5 th edition, 2019.

Reference Books(s) / Web links:	
1.	Amitabha Ghosh and Asok Kumar Mallik, —Theory of Mechanisms and Machines , Affiliated East-West Pvt. Ltd., 3 rd edition, 1988.
2.	Rao J.S. and Dukupati. R.V. —Mechanism and Machine Theory, New Age International Pvt. Ltd., 2nd Edition, 2014
3.	Singh.V.P, —Theory of Machine , Dhanpat Rai & Co., 6 th Edition, 2017
4.	Ashok G. Ambedkar – Mechanism and Machine Theory, Prentice-Hall of India Private Limited, New Delhi, 2007
5.	https://nptel.ac.in/courses/112/104/112104121/
6.	https://nptel.ac.in/courses/112105268/
7.	https://nptel.ac.in/courses/112101096/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23312.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23312.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23312.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23312.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23312.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23313	SENSORS IN AUTOMATION	PC	3	0	0	3

Objectives:	
•	To understand the concepts of measurement and various sensors.
•	To Understand the practical approach in design of technology based on different sensors
•	To Learn various sensor materials and technology used in designing sensors.
•	To demonstrate different sensors working principle.
•	To Develop a sense for recognizing bad data and an intuition of how to resolve problems.

UNIT-I	SENSORS FUNDAMENTALS AND CHARACTERISTICS	9
Basics of measurement – Calibration techniques – Errors in measurement – Generalized measurement system – Modules of Measurements - Sensors and Transducers – Classification of transducer – Static and dynamic characteristics of transducer – Sensor calibration techniques.		
UNIT-II	PHYSICAL PRINCIPLES OF SENSING	9
Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.		
UNIT-III	INTERFACE ELECTRONIC CIRCUITS	9
Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.		
UNIT-IV	SENSORS IN DIFFERENT APPLICATION	9
Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors.		
UNIT-V	ADVANCED SENSOR TECHNOLOGY	9
Smart sensors, MEMS based sensors, Innovations in sensor technology Actuators and its selection while designing a robot system. Types of transmission systems.		
Total Contact Hours:45		

Course Outcomes:	
On completion of the course, students will be able to	
•	Familiar with various measurements, calibration techniques and types of transducers
•	Good knowledge of working of different types of sensors
•	Interfacing of electronic circuits with different sensors for its applications in different fields.
•	Select suitable sensors for all applications.
•	Analyze innovations in sensor technology.

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> • Industrial visit • Mini Project

SUGGESTED EVALUATION METHODS
<ul style="list-style-type: none"> • Assignment topics • Class Presentation/Discussion • Continuous Assessment Tests

Text Book(s):	
1.	D. Patranabis, "Sensors and Transducers", PHI Publication, New Delhi, 2019.
2.	Ganesh S. Hegde, "Mechatronics", Laxmi Publication Private Limited, India, 2016.

Reference Books(s) / Web links:	
1.	J. Fraden, "Handbook of Modern Sensors: Physical, Designs, and Applications", AIP Press, Springer.
2.	Jon S. Wilson, "Sensor Technology Handbook", Elsevier, 2005.
3.	Devdas Shetty, Richard A. Kolk, "Mechatronics system design", 2nd Edition, Cengage Learning, 2011.
4.	Sawhney A K and Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation and Control", 12 th edition, Dhanpat Rai & Co, New Delhi, 2013.
5.	Braünl, T., "Embedded robotics: mobile robot design and applications with embedded systems", 3rd edition Berlin; Heidelberg: Springer, 2008. ISBN 9783540705338.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23313.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23313.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23313.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23313.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23313.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23331	ELEMENTS OF MANUFACTURING PROCESSES	PC	3	0	2	4

Objectives:	
•	To understand the basic concepts of sand-casting technique and special casting technique.
•	To learn about the principles of different welding and joining techniques.
•	To study the working principle and applications of Turning machines.
•	To understand the working principles of shaper, milling and gear cutting machines.
•	To know about Unconventional machining processes.

UNIT-I	METAL CASTING	9
Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Vacuum casting- CO2 process Defects in Sand casting.		
UNIT-II	METAL JOINING AND FORMING PROCESSES	9
Operating principle of Fusion welding processes, Gas welding, metal arc welding, Laser welding, Friction Stir welding Brazing and soldering; Weld defects: types, causes and cure– Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling, Extrusion, Principle of rod and wire drawing		
UNIT-III	TURNING MACHINES	9
Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle : Swiss type, automatic screw type – multi spindle, Introduction to CNC machines.		
UNIT-IV	SHAPER, MILLING AND GEAR CUTTING MACHINES	9
Shaper - Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting – forming and generation principle and construction of gear milling, hobbing and gear shaping processes – finishing of gears.		
UNIT-V	INTRODUCTION TO UNCONVENTIONAL MACHINING PROCESS	9
Unconventional machining Process–Need–classification–merits, demerits and applications. Abrasive Jet Machining– Water Jet Machining–Abrasive Water Jet Machining-Ultrasonic Machining, Laser Beam Machining. Working Principles–equipment used–Process parameters–MRR-Applications.		
Total Contact Hours:45		

LIST OF EXPERIMENTS	
1	Preparation of sand mould using single & split piece pattern.
2	Step turning and Taper turning using lathe.
3	Knurling and external thread cutting using lathe.
4	Performing Drilling and tapping.
5	Cube formation using shaper.
6	Hexagonal milling and Spur gear cutting using vertical milling machine.
7	Gear generation in gear hobbing machine
8	Study of Laser cutting
Total Contact Hours: 30	
Total Contact Hours: 60	

Course Outcomes:	
On completion of the course students will be able to	
●	Develop components using special casting processes.
●	Select welding techniques based on applications
●	Perform machining in turning machines
●	Produce Gear components.
●	Select suitable non-conventional machining process.

SUGGESTED ACTIVITIES	
●	Industrial visit
●	Internship
●	Fabrication project
●	Seminar

SUGGESTED EVALUATION METHODS	
●	CAT 1, CAT 2, CAT 3
●	Assignment- 1, Assignment- 2, Assignment- 3.
●	End Semester Examination.

Text Book(s):	
1	HajraChoudhary. S.K and Hajra Choudhary. A.K., "Elements of Workshop Technology", volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 2014.
2	Kalpakjian. S, "Manufacturing Engineering and Technology", 7 th Edition, Pearson Education India Edition, 2018

Reference Books(s) / Web links:	
1	Roy A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2016
2	Black J.T and Ronald A. Kosher, "Degarmos Materials and Processes, in Manufacturing" 12 th Edition, WileyPublishers, 2017.
3	Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2006.
4	Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", Vol 1, 4 th Edition, Mcgraw Hill-2017.
5.	https://nptel.ac.in/courses/112107144/

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
RO23331.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23331.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23331.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23331.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23331.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Lab oriented Theory Course)	Category	L	T	P	C
RO23332	MECHANICS OF MATERIALS	PC	3	0	2	4

Objectives:	
•	To understand the fundamental concepts of stress, strain and elastic constants of solids under external loading
•	To learn about torsion of linearly elastic materials and shell structures like thin cylinders and pressure vessels
•	To learn about the shear force, bending moment and deflection of beams and study about that the analysis plane stress and strain
•	To learn about the deflection of beams and stability of columns and shell structures like thin cylinders, spheres and thick cylinders and study the mechanical properties of materials when subjected to different types of loadings and study the impact strength of given specimen.
•	To study the hardness properties of given specimen and understand the deflection of different beams

UNIT-I	CONCEPT OF STRESS AND STRAIN	9
Deformation of bars: Hooke's law, stress, strain, and elongation; Tensile, compressive and shear stresses in 2D solids; Elastic constants and their relations; Volumetric, linear and shear strains; Principal stresses and strain; Principal planes; Mohr's circle.		
UNIT-II	MECHANICS OF BEAMS	9
Transverse loading on beams, point and distributed loads; Shear force and bend moment diagrams; Type of beam supports – simply supported, over-hanging, cantilevers, fixed and guided beams; Static determinacy and indeterminacy; Theory of bending of beams, pure bending stress distribution and neutral plane, second moment of area; Different cross-sections of beams; Shear stress distribution.		
UNIT-III	DEFLECTION OF BEAMS	9
The elastic curve -slope and displacement by integration- Discontinuity function -Slope and displacement by moment area method -Method of super position- Statically indeterminate beams and shafts- statically indeterminate beams and shafts -Method of integration- statically indeterminate beams and shafts - Moment area method - statically indeterminate beams and shafts -Method of superposition.		
UNIT-IV	COLUMN BUCKLING, TORSION AND TWIST	9
Critical loads using Euler's theory; Different boundary conditions; Eccentric columns. Torsion stresses and deformation of circular and hollow shafts; Polar moment of area, stepped shafts; Deflection of shafts fixed at both ends; Stresses and deflection of helical springs.		
UNIT-V	PRESSURE VESSELS	9
Axial and hoop stresses in cylinders subjected to internal pressure; Deformation of thin and thick cylinders; Deformation in spherical shells subjected to internal pressure; Combined thermomechanical stress; Examples and case studies (boilers).		
Contact Hours :45		

LIST OF EXPERIMENTS	
1	Tension test on a mild steel rod
2	Double shear test on Mild steel and Aluminium rods
3	Torsion test on mild steel rod
4	Impact test on metal specimen (Charpy and Izod test)
5	Hardness test on metals – (Brinell and Rockwell Hardness Number)
6	Deflection test on beams (Simply supported beam)
7	Compression test on helical springs (Closed coil)
8	Beam Deflections using Maxwell Reciprocal Theorem
9	Strain Measurement
10	Deflection Of Continuous Beam.
	Total Contact Hours : 30
	Total Contact Hours : 75

Course Outcomes:

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

- Apply the principal concepts behind stress, strain and deformation of solids for various engineering applications.
- Design beams for various loading conditions
- Calculate the deflection of beams and measure the deflection of a Continuous beam
- Perform Tension, shear test, Torsion, impact test and Hardness test on given material and determine the stiffness and modulus of rigidity of the spring wire.
- Design columns and pressure vessels

Text Books:

1. R.C HIBLER , “ Mechanics of Materials”, 8th edition Pearson Education, India, 2018.
2. Rajput R. K, “Strength of Materials (Mechanics of Solids)”, S.Chand Publishers ,India, 2022

Reference Books:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2015.
2. Egor. P.Popov —Engineering Mechanics of Solids Prentice Hall of India, New Delhi, 2001.
3. Ramamurtham S., "Strength of Materials", Dhanpat rai publishing company, New Delhi , 2011.
4. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill
5. Barry J. Goodno and James M. Gere "Mechanics of Materials", CI-Engineering; 9th Edition., Canada, 2016.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23332.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23332.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23332.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23332.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23332.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title	Category	L	T	P	C
CS23422	Python Programming for Machine learning (with effect from 2023 batch onwards)	ES	0	0	4	2

Objectives:

This course is aimed at enabling the students to:

•	To understand the relationship of the data collected for decision making.
•	To know the concept of principal components, factor analysis and cluster analysis for profiling and interpreting the data collected.
•	Lay the foundation of machine learning and its practical applications and prepare students for real-time problem-solving in data science.
•	Develop self-learning algorithms using training data to classify or predict the outcome of future datasets.
•	Distinguish overtraining and techniques to avoid it such as cross-validation.

List of Experiments			
1.	NumPy Basics: Arrays and Vectorized Computation		
2.	Getting Started with pandas		
3.	Data Loading, Storage, and File Formats		
4.	Data Cleaning and Preparation		
5.	Data Wrangling: Join, Combine, and Reshape		
6.	Plotting and Visualization		
7.	Data Aggregation and Group Operations		
8.	Time Series		
9.	Supervised Learning		
10.	Unsupervised Learning and Pre-processing		
11.	Representing Data and Engineering Features		
12.	Model Evaluation and Improvement		
Contact Hours			: 60

Course Outcomes:

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

•	Develop a sound understanding of current, modern computational statistical approaches and their application to a variety of datasets.
•	Analyze and perform an evaluation of learning algorithms and model selection.
•	Compare the strengths and weaknesses of many popular machine learning approaches.
•	Appreciate the underlying mathematical relationships within and across machine learning algorithms and the paradigms of supervised and unsupervised learning.
•	Design and implement various machine learning algorithms in a range of real-world applications.

Text Books:

1.	Wes McKinney, Python for Data Analysis - Data wrangling with pandas, Numpy, and ipython, Second Edition, O'Reilly Media Inc., 2017.
2.	Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python - A Guide for Data Scientists, First Edition, O'Reilly Media Inc, 2016.

Reference Books:

1.	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media Inc, 2019.
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CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CS23422.1	2	2	2	2	1	-	-	-	1	1	1	1	2	2	2
CS23422.2	2	1	1	1	1	-	-	-	-	-	1	1	2	2	2
CS23422.3	1	1	2	1	2	-	-	-	-	-	1	1	2	2	2
CS23422.4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
CS23422.5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	1.8	1.6	2.2	1.6	1.8	0.0	0.0	0.0	0.2	0.2	1.4	1	2	2	2

SEMESTER IV

Course Code	Course Title	Category	L	T	P	C
RO23411	FLUID POWER SYSTEMS	PC	3	0	0	3

Objectives:

●	To understand the basics of fluid properties and flow characteristics.
●	To learn about losses in fluid flow through pipes.
●	To develop hydraulic circuits and systems.
●	To know the working principles of pneumatic power system and its components.
●	To learn the trouble shooting methods in fluid power systems.

UNIT-I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9
Properties of fluids-Pressure Measurements-U-tube manometer-Single column manometer- Differential manometer - Buoyancy and floatation-Flow characteristics-Eulerian and Lagrangian Principle of fluid flow-concept of control volume and system –Reynolds transportation theorem-continuity equation, energy equation and momentum equation-Applications.		
UNIT-II	FLOW THROUGH PIPES	9
Reynold’s Experiment-Laminar flow through circular conduits-Darcy Welsbach equation –friction factor- minor losses-Hydraulic and energy gradient –Pipes in series and parallel. Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps		
UNIT-III	HYDRAULIC ACTUATORS AND CIRCUIT DESIGN	9
Hydraulic Actuators: Cylinders –Types and construction, Application, Hydraulic cushioning ,Hydraulic motors, Direction Control, Flow control and pressure control valves –Types, Construction and Operation – Accessories ,Fluid Power ANSI Symbols –Problems, Accumulators, Intensifiers, Industrial hydraulic Circuit Design and Analysis, Hydrostatic transmission, Sensors used in Electro hydraulic systems, Electro hydraulic circuits,–Servo and Proportional valves –Applications-Mechanical , hydraulic servo systems.		
UNIT-IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9
Properties of air –Air preparation and distribution –Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification-single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits, PLC-Architecture and types, Electro Pneumatic System – Elements –Ladder diagram –timer circuits-Problems.		
UNIT-V	TROUBLE SHOOTING AND APPLICATIONS	9
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. –Low- cost Automation –Hydraulic and Pneumatic power packs-Case studies of innovative applications of fluid power systems in automation		
Total Contact Hours		: 45

Course Outcomes:

On completion of course students will be able to

●	Understand the behavior of fluids.
●	Calculate losses in fluid flow and design the effective fluid flow system.
●	Design hydraulic circuits and systems for various applications.
●	Design and develop pneumatic and electro pneumatic systems.
●	Select, Install and Maintain fluid power systems.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:

1	Anthony Esposito, “Fluid Power with Applications”, Pearson New International Edition, England, 2014.
2	Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2017.

Reference Books / Web links:

1	Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
2	Joshi.P., Pneumatic Control”, Wiley India, 2008.
3	Majumdar, S.R., “Oil Hydraulics Systems –Principles and Maintenance”, TataMcGraw Hill, 2001
4	Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
5	Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23411.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23411.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23411.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23411.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23411.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23412	INDUSTRIAL AUTOMATION AND CONTROL	PC	3	0	0	3

Objectives:	
•	To introduce the elements of control system and their modeling using various Techniques.
•	To perform frequency domain analysis of control systems required for stability analysis.
•	To design the compensation technique that can be used to stabilize control systems.
•	To study about the hardware and software involved in a PLC
•	To provide the control functions involved in DCS and SCADA

UNIT-I	INTRODUCTION TO CONTROL SYSTEM	9
Basic Elements of Control System – Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram –Signal flow graph – P, PI, PD and PID Compensation, Analysis of Compensation in Mechatronics systems		
UNIT-II	ANALYSIS OF TIME AND FREQUENCY RESPONSE	9
Time response analysis - First Order Systems - Impulse and Step Response - Analysis of second order systems-Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Frequency Domain specifications from the plots. Compensators - Lead, Lag, and Lead-Lag Compensators		
UNIT-III	STABILITY ANALYSIS	9
Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram. – Transfer function from State Variable Representation – Solutions of the state equations - Concepts of Controllability and Observability.		
UNIT-IV	PROGRAMMABLE LOGIC CONTROLLERS	9
Introduction to Programmable Logic Controllers, Architecture of PLC, PLC programming languages, Relay Logic, Ladder logic, Timers and Counters, selection of PLC based on input and output. Application of PLC in automation.		
UNIT-V	SCADA	9
Introduction, Application areas of SCADA, Major elements of SCADA systems, Comparison of SCADA, DCS and PLC, Considerations and benefits of SCADA system. Introduction to field-programmable gate array (FPGA).		
Total Contact Hours:45		

Course Outcomes:	
On completion of the course students will be able to	
•	Write mathematical equations for model mechanical, electrical systems and compute transfer function using block diagram and signal flow graph methods.
•	Perform time domain and frequency domain analysis of control systems required for stability analysis in Robot Control.
•	Design the compensation technique that can be used to stabilize Robot control systems.
•	Program PLC based on applications.
•	Summarize the working of various elements of DCS and SCADA

SUGGESTED ACTIVITIES

- Mini Project
- Industrial visit

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Book(s):

1.	Nagrath J and M.Gopal, “Control System Engineering”, New Age International Publishers, 6 th Edition, 2017.
2.	Levent Güvenç, Bilin Aksun Güvenç, Burak Demirel, Mümin Tolga Emirler, “Control of Mechatronic Systems”, Institution of Engineering and Technology, 2017.

Reference Books(s) / Web links:

1.	Benjamin.C.Kuo, “Automatic control systems”, Prentice Hall of India, 9 th Edition,2014.
2.	Gopal M, “Control System – Principles and Design”, Tata McGraw Hill, 4 nd Edition, 2012.
3.	Stuart A Boyer, “SCADA-supervisory control and data acquisition”, International Society of automation, 3rd edition,2011.
4.	Georg Pelz, “Mechatronic Systems Modeling and Simulation with HDLs”, wiley Publication, 2003.
5.	Richard Zurawski, “Industrial Communication Technology Handbook” 2 nd Edition, CRC Press, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23412.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23412.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23412.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23412.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23412.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23413	MICROCONTROLLERS AND REAL TIME EMBEDDED SYSTEMS	PC	3	0	0	3

Objectives:	
•	To understand architecture of microcontroller and usage of built-in special function blocks.
•	To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
•	To design the interface circuit and programming of I/O devices, sensors and actuators.
•	To impart knowledge on basics of embedded system architecture.
•	To provide essential knowledge on real time embedded operating system.

UNIT-I	INTRODUCTION TO MICROCONTROLLER	9
Introduction to 8085 Architecture-,addressing mode - instruction set, Architecture of 8051 – Memory organization - I/O Ports - Instruction set - Addressing modes - Assembly language programming, PIC Architecture – Programming Techniques – PIC Development Systems – Application Design – Program Debugging - Introduction to Arduino microcontroller, Raspberry Pi		
UNIT-II	PROGRAMMING AND COMMUNICATION	9
Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.		
UNIT-III	PERIPHERAL INTERFACING	9
I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light.		
UNIT-IV	INTRODUCTION TO EMBEDDED SYSTEMS	9
Embedded system Architecture - Design Process in Embedded system- Classification of Embedded system, Timer and Counting devices - Watchdog Timer - Real Time Clock - In circuit emulator - Target Hardware Debugging		
UNIT-V	REAL TIME OPERATING SYSTEM	9
Introduction to basic concepts of RTOS – Tasks and Data – Threads – Multiprocessing and Multitasking – Semaphores – Priority Inversion - Priority Inheritance – Queues – Pipes, Washing machines - Cruise control - antilock braking systems - Automatic chocolate vending machine – Automatic lubrication of supplier Conveyor belt.		
Total Contact Hours:45		

Course Outcomes:	
On completion of the course students will be able to	
•	Design and implement the programs of 8051.
•	Recognize the role of each functional units in microcontroller, processors and system- on chip based on the features and specifications.
•	Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing.
•	Construct the basic architecture and components of embedded system.
•	Develop embedded system in real time for simple applications.

SUGGESTED ACTIVITIES
<ul style="list-style-type: none"> • Industrial visit • Mini Project

SUGGESTED EVALUATION METHODS
<ul style="list-style-type: none"> • Assignment topics • Class Presentation/Discussion • Continuous Assessment Tests

Text Book(s):	
1.	Muhammad Ali Mazidi and Janice GillispicMazdi, “The 8051 Microcontroller and Embedded Systems”, Pearson Education, 2006.
2.	Muhammad Ali Mazidi, Rolin D. McKinlay and Danny Causey, “PIC Microcontroller and Embedded Systems: Using Assembly and C For Pic 18”, Pearson Education, 2016

Reference Books(s) / Web links:	
1.	James W. Stewart, “The 8051 Microcontroller Hardware, Software and Interfacing”, Regents Prentice Hall, 2003.
2.	Santanu Chattopadhyay, “Embedded system Design” 2nd Edition, PHI Learning Private Limited, 2013
3.	K C Wang, “Embedded and Real time Operating systems” Springer, 2017
4.	Subrata Ghoshal, “8051 Microcontroller: Internals, Instructions, Programming and Interfacing” Pearson Education, 2010
5.	Raj Kamal, “Embedded Systems: Architecture, Programming and Design” Tata Mc Graw-Hill, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23413.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23413.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23413.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23413.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23413.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Theory Course)	Category	L	T	P	C
RO23414	ROBOT KINEMATICS	PC	3	1	0	4

Objectives:

•	To understand the Robot types and its end effectors.
•	To introduce the concept of homogenous transformation matrices.
•	To understand the industrial robot kinematics.
•	To impart knowledge on singularity Analysis.
•	To learn the kinematics and dynamics of mobile robots.

UNIT-I	BASICS OF INDUSTRIAL ROBOTICS	12
Robot classifications, work envelope, Internal Grippers and External Grippers; Selection and Design Considerations, resolution, accuracy and repeatability of robot, applications, robot teaching, specification.		
UNIT-II	SPATIAL DESCRIPTIONS AND TRANSFORMATIONS	12
Representation of objects in 3-D space-position and orientation, Frame transformations-translation-rotation-translation and rotation combined- translation operator-rotation operator, composite rotation matrix, representation of position in cylindrical, spherical coordinate system, representation of orientation using roll, pitch and yaw angles, representation of orientation using Euler angles. Forward and inverse kinematics of 2R planar robot using Geometry.		
UNIT-III	ROBOT KINEMATICS	12
Denavit-Hartenberg (D-H) notations- link and joint parameters-rules for coordinate assignments, forward and inverse kinematics using D-H representation - 2R planar robots - SCARA robot - Stanford arm. Introduction to Robot Kinematics with Screw-Based Mechanics - Rotation about a Screw Axis -Homogenous Transformations about a General Screw Axis Successive Screw-Based Transformations - Forward and Inverse Position Analysis of an Articulated Robot.		
UNIT-IV	SINGULARITY ANALYSIS	12
Manipulator Jacobians, Jacobian of Revolute-Revolute (RR) Manipulator, finding singularities of the 2-Link Manipulator, Introduction to parallel mechanisms and manipulators, Inverse and Forward Kinematics -RPR Planar Parallel Mechanism - Stewart–Gough Platform - General Parallel Mechanisms, Differential Kinematics- Stewart–Gough Platform - General Parallel Mechanisms, Singularities.		
UNIT-V	MOBILE ROBOT KINEMATICS	12
Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion, Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots.		
Total Contact Hours		: 60

Course Outcomes:

On completion of the course students will be able to

•	Select the robot and its grippers based on application.
•	Calculate transformation and translation movements for spatial robots.
•	Develop DH parameters for robots.
•	Perform singularity analysis of serial and parallel manipulators.
•	Model mobile robots based on kinematics.

SUGGESTED ACTIVITIES

- Industrial visit
- Mini Project

SUGGESTED EVALUATION METHODS

- Assignment topics
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:

1. John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education India, 2021
2. Siegwart, R Nourbakhsh, and Scaramuzza, —Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.

Reference Books / Web links:

1. Groover Mikell. P, "Industrial Robotics -Technology Programming and Applications", McGraw Hill, 2014
2. Deb S.R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Book Co., 2013.
3. Koren Y., "Robotics for Engineers", McGraw Hill Book Co., 1992
4. Maja J Mataric, "The Robotics Primer", Universities Press. 2013.
5. Fu. K.S, Gonzalez. R.C, Lee. C.S.G —Robotics –Control, Sensing, Vision, and Intelligence, McGraw Hill, 2015.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23414.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23414.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23414.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23414.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23414.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title	Category	L	T	P	C
MA23432	STATISTICS AND NUMERICAL METHODS	BS	3	0	2	4
Common to IV sem. B.E. – Aeronautical Engineering, Mechatronics and Robotics & Automation						

Objectives:	
•	To apply numerical methods to obtain approximate solutions to mathematical problems.
•	To derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear equations, and the solution of differential equations.
•	To analyse statistical experiments leading to reliability modelling and to identify reliability testing components for assessment of reliability in engineering design.
•	To solve the problems those are faced in testing of a hypothesis with reference to the errors in decision making.
•	To analyse the different mathematical models with the help of statistical designs and appropriate data and made valuable conclusions by proper evaluation.

UNIT-I	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEM	9
Newton Raphson method – Secant method – Gauss Jordan method – Iterative method of Gauss Seidel –Eigen value of a matrix by Jacobi method for symmetric matrix.		
UNIT-II	INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION	9
Lagrange’s interpolations – Newton’s forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical integration – Simpsons 1/3 rule – Gaussian three point quadrature.		
UNIT-III	RELIABILITY	9
Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve - Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions - Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model- Distribution functions and reliability analysis.		
UNIT-IV	STATISTICAL TESTING	9
Maximal Likelihood estimation – Parameters of Binomial and Poisson distribution - Tests of significance – Z test: Single mean, difference of means- Chi square - F test.		
UNIT-V	ANOVA	9
Design of Experiments - Completely randomized design – Randomized block design –Latin square design.		
Total Contact Hours: 45		

S.No	List of Experiment (using R Software)	Total Contact Hours: 30
1	Basic Functions in R and plotting	
2	Mathematical functions in R – Integration	
3	Control flow – Loops in R	
4	Probability Distributions using R- PDF, CDF for Binomial and Poisson.	
5	Testing of Hypothesis – Z, F and chi-square testing	
6	ANOVA – one way and two way	
7	Reliability – MTTF, MTBF	
8	Solution of equations – system of linear equations, Newton Raphson method	
9	Linear regression and cubic spline interpolation	
10	Reading, writing data in R and working with inbuilt data sets in R	

Course Outcomes:

On completion of the course students will be able to

•	Demonstrate common numerical methods and used to obtain approximate solutions of linear and system of equations.
•	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear equations, and the solution of differential equations.
•	Illustrate the basic concepts and techniques of modern reliability engineering tools.
•	Apply the different testing tools like t-test, F-test, chi-square test to analyse the relevant real life problems.
•	Analyse the different mathematical models with the help of statistical designs and appropriate data and made valuable conclusions by proper evaluation.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Smart Class room sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS

- Problem solving in Tutorial sessions
- Assignment problems
- Quizzes and class test
- Discussion in classroom

Text Book(s):

1.	Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks', Mc Graw Hill, 2016
2.	Burden, R.L and Faires, J.D, "Numerical Analysis", 9 th Edition, Cengage Learning, 2016.
3.	Kandasamy P., Thilagavathi and K. Gunavathi., "Statistics and Numerical Methods", S. Chand & Company Ltd. (2010).
4.	Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice- Hall of India PVT. LTD., 4 th Edition, New Delhi, 2006.

Reference Books(s) / Web links:

1.	Johnson R.A., "Miller and Freund's Probability and Statistics for Engineers", 11 th Edition, Pearson Education, Asia, 2011.
2.	Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8 th Edition, Pearson Education, Asia, 2007.
3.	Spiegel M.R., Schiller. J., and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 2004.
4.	Grewal B.S., and Grewal. J.S., "Numerical Methods in Engineering and Science", 9 th Edition, Khanna.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MA23432.1	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23432.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
MA23432.3	3	3	3	3	2	1	-	-	1	1	2	2	3	2	1
MA23432.4	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
MA23432.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	3	2.6	2.6	2.4	1.4	-	-	1	1	1.6	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23421	MECHANISMS AND ROBOTICS LABORATORY	PC	0	0	4	2

Objectives:

- To study the kinematic analysis of mechanisms.
- To study the transformation matrix usage.
- To study the robot application for pick and place.
- To understand Trajectory Control.
- To calculate the joint torque of a robot.

List of Experiments

1.	Simulation of four bar mechanism and analyze motion of the mechanism
2.	Simulation of slider crank mechanism and analyze motion of the mechanism
3.	Simulation of toggle mechanism and analyze motion of the mechanism
4.	Determination of maximum and minimum position of links.
5.	Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
6.	Estimation of accuracy, repeatability and resolution.
7.	Robot programming and simulation for pick and place
8.	Robot programming and simulation for Colour identification
9.	Robot programming and simulation for Shape identification
10.	Robot programming and simulation for assembly process
11.	Trajectory Control Modeling with Inverse Kinematics
12.	Check for Environmental Collisions with Manipulators
13.	Robot programming for joint torque calculation.
Total Contact Hours	
: 60	

Course Outcomes:

On completion of the course students will be able to

- Design and analyze mechanisms
- Calculate robot position and orientation.
- Develop optimal trajectory and path planning of robots.
- Determine joint torques and forces in a robot.
- Select sensors and actuators for any robotic system.

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23421.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23421.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23421.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23421.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23421.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
RO23422	INDUSTRIAL AUTOMATION LABORATORY-I	PC	0	0	4	2

Objectives:

- To provide exposure to the students with hands on experience to control motors, conveyors using PLC

List of Experiments

1.	Sequential start-up of multiple machines with chain electric latching			
2.	Controlling a machine from multiple different locations			
3.	Palindrome movement of worktable with memory			
4.	PLC Program to Control Lights in a Sequence using Bit Shift Registers			
5.	PLC Program to Control motor in a Sequence using Timers			
6.	PLC Program to Perform Pulse Width Modulation			
7.	PLC Program to Operate multiple Outputs Simultaneously with Time Delay			
8.	PLC Program to Control speed of Conveyor on sensor values			
9.	PLC program to perform bottle labeling automatically			
10.	PLC program to perform bottle capping automatically			
11.	PLC program to control motors based on (level, torque & load) sensors			
12.	Study of SCADA system			
		Total Contact Hours	:	60

Course Outcomes:

On completion of the course students will be able to

- Design Automation circuits using electrical components
- Control the machines using automation circuits
- Program PLC using Ladder diagram method
- Interface PLC with sensors and actuators
- Control, collect data from all inputs and monitor all devices in an automation system

CO/PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
RO23422.1	3	2	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23422.2	3	3	3	3	3	2	-	-	1	1	2	2	3	2	1
RO23422.3	3	3	3	3	2	2	-	-	1	1	1	2	3	2	1
RO23422.4	3	3	3	2	2	2	-	-	1	1	1	1	3	2	1
RO23422.5	3	3	2	2	2	1	-	-	1	1	1	1	3	2	1
Average	3	2.6	2.8	2.6	2.4	1.8	-	-	1	1	1.4	1.6	3	2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)