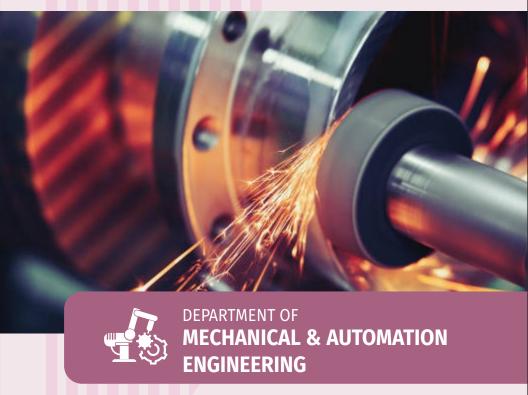# Sri SAI RAM
ENGINEERING COLLEGE
An Autonomous Institution
West Tambaram, Chennai - 44
www.sairam.edu.in

Approved by AICTE, New Delhi
Affiliated to Anna University

DEPARTMENT OF
MECHANICAL & AUTOMATION ENGINEERING

REGULATIONS
2020

Academic Year 2021-22 onwards

AUTONOMOUS
CURRICULUM AND

SYLLABUS
I – VIII
SEMESTERS

SRI SAIRAM ENGINEERING COLLEGE

◉ VISION

To emerge as a "Centre of excellence " offering Technical Education and Research opportunities of very high standards to students, develop the total personality of the individual and instil high levels of discipline and strive to set global standards, making our students technologically superior and ethically stronger, who in turn shall contribute to the advancement of society and humankind.

🚀 MISSION

We dedicate and commit ourselves to achieve, sustain and foster unmatched excellence in Technical Education. To this end, we will pursue continuous development of infra-structure and enhance state-of-the-art equipment to provide our students a technologically up-to date and intellectually inspiring environment of learning, research, creativity, innovation and professional activity and inculcate in them ethical and moral values.

◎ QUALITY POLICY

We at Sri Sai Ram Engineering College are committed to build a better Nation through Quality Education with team spirit. Our students are enabled to excel in all values of Life and become Good Citizens. We continually improve the System, Infrastructure and Service to satisfy the Students, Parents, Industry and Society.

DEPARTMENT OF MECHANICAL & AUTOMATION ENGINEERING

◉ VISION

To develop a daedal mechanical and automation department to cater the ever evolving needs of automation of core engineering based on fundamental and extensive research.

🚀 MISSION

M1 – Prepare the mechanical and automation engineering graduates, for a successful career in engineering and technology through effective teaching-learning.
M2 – Amalgamate core engineering branches with recent trends of automation in vogue for a successful career in the dynamic industrial scenario.
M3 – Promote excellence in engineering and technology by motivating the students for higher studies.
M4 – Empower the learners by importing education that is compatible with the technological needs of the industry and thereby ensuring to contribute to the society.
M5 – Accentuate professionally competent engineers by developing analytical and research abilities, encouraging the culture of continuous learning by adopting new technologies.

AUTONOMOUS CURRICULUM AND SYLLABI
Regulations 2020

SEMESTER I

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS L	WEEK HOURS T	WEEK HOURS P	TOTAL CONTACT HOURS	CREDITS
		THEORY					
1	20BSMA101	Engineering Mathematics-I	3	1	0	4	4
2	20HSEN101	Technical English-I	3	0	0	3	3
3	20BSPH101	Engineering Physics	3	0	0	3	3
4	20BSCY101	Engineering Chemistry	3	0	0	3	3
5	20ESCS101	Problem solving and Programming in C	3	0	0	3	3
6	20ESGE101	Engineering Graphics	1	2	0	3	3
		PRACTICAL					
7	20BSPL101	Physics and Chemistry Lab	0	0	3	3	1.5
8	20ESPL101	Programming in C lab	0	0	3	3	1.5
		VALUE ADDITIONS - I					
9	20TPHS101	Skill Enhancement	0	0	2	2	1
10	20HSMG101	Personal Values	2	0	0	2	0
		TOTAL				29	23

SEMESTER II

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS L	WEEK HOURS T	WEEK HOURS P	TOTAL CONTACT HOURS	CREDITS
		THEORY					
1	20BSMA201	Engineering Mathematics-II	3	1	0	4	4
2	20HSEN201	Technical English-II	3	0	0	3	3
3	20ESIT201	Python Programming with Lab	3	0	2	5	4
4	20BSCY201	Environmental Science and Engineering	3	0	0	3	3
5	20ESEE201	Electrical Technology with Lab	3	0	2	5	4
6	20BSPH202	Physics of Materials	3	0	0	3	3
		PRACTICAL					
7	20ESGE201	Engineering Practices Laboratory	0	0	3	3	1.5
		VALUE ADDITIONS - II					
8	20TPHS201	Skill Enhancement	0	0	2	2	1
9	20HSMG201	Interpersonal Values	2	0	0	2	0
10	20HSTA101	Heritage of Tamils	1	0	0	1	1
		TOTAL				32	24.5

AUTONOMOUS CURRICULUM AND SYLLABI
Regulations 2020

SEMESTER III

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1	20ESCE201	Engineering Mechanics	3	0	0	3	3
2	20MUPC301	Basic Manufacturing Processes	3	0	0	3	3
3	20MEPC302	Engineering Thermodynamics	3	1	0	4	4
4	20MUPW301	Sensors in Automation	3	0	2	5	4
5	20BSMA303	Partial Differential Equations and Probability Theory	3	1	0	4	4
6	20EIPC304	Basic Electronics and Control System	3	0	0	3	3
PRACTICAL							
7	20MEPL301	Manufacturing Processes Laboratory	0	0	3	3	1.5
8	20MEPL302	Computer Aided Drafting Laboratory	0	0	3	3	1.5
VALUE ADDITIONS - III							
9	20MUTE301	Live-in Lab I	0	0	2	2	1
10	20MUTP301	Skill Enhancement	0	0	2	2	1
11	20HSTA201	Tamils And Technology	1	0	0	1	1
		TOTAL	**19**	**2**	**12**	**33**	**27**

SEMESTER IV

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1	20MUPC401	Fluid Power Automation	3	0	0	3	3
2	20MUPC402	Theory of Machines	3	0	0	3	3
3	20MUPC403	CNC Machines and Metrology	3	0	0	3	3
4	20MUPC404	Computer Aided Design	3	0	0	3	3
5	20BSMA403	Statistics and Numerical Methods	3	1	0	4	4
6	20CEPC405	Strength of Materials	3	0	0	3	3
PRACTICAL							
7	20MUPL401	Strength of Materials & Metrology Laboratory	0	0	3	3	1.5
8	20MUPL402	Fluid Power Systems Laboratory	0	0	3	3	1.5
VALUE ADDITIONS - II							
9	20MUTE401	Live-in Lab II	0	0	2	2	1
10	20MUTP401	Skill Enhancement	0	0	2	2	1
		TOTAL	**18**	**1**	**10**	**29**	**24**

AUTONOMOUS CURRICULUM AND SYLLABI
Regulations 2020

SEMESTER V

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1	20MUPC501	Machine Design	3	1	0	4	3
2	20ESEE501	Electrical Drives and Actuators with Laboratory	3	0	2	5	4
3	20MUPC502	Mechanics and Control of Robotic Manipulators	3	0	0	3	3
4	20ESEI501	PLC and Microcontroller	3	0	0	3	3
5	20MUPEXXX	Professional Elective-I	3	0	0	3	3
PRACTICAL							
6	20MUPL501	Mechanics of Robotic elements Laboratory	0	0	3	3	1.5
7	20MUPL502	Automation Laboratory – I	0	0	3	3	1.5
8	20HSPL501	Communication and Soft Skills Laboratory	0	0	2	2	1
VALUE ADDITIONS - V							
9	20MUTE501	Live-in Lab III	0	0	4	4	2
10	20MUTP501	Skill Enhancement	0	0	2	2	1
		TOTAL	15	1	15	32	23

SEMESTER VI

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1	20MUPC601	Additive Manufacturing	3	0	0	3	3
2	20MUPC602	Robots and Systems in Smart Manufacturing	3	0	0	3	3
3	20MUPC603	Industrial Automation for Manufacturing	3	0	0	3	3
4	20MUPEXXX	Professional Elective-II	3	0	0	3	3
5	20MUOEXXX	Open Elective-I	3	0	0	3	3
PRACTICAL							
6	20MUPL601	3D Printing and CNC Laboratory	0	0	3	3	1.5
7	20MUPL602	Modeling and Simulation of Robot Elements Laboratory	0	0	2	2	1.5
8	20MUPJ601	Innovative Design and Fabrication Project	0	0	2	2	1
VALUE ADDITIONS - V							
9	20MUTP601	Skill Enhancement	0	0	2	2	1
10	20MGMC301	Constitution of India	2	0	0	2	0
		TOTAL	17	0	09	26	20

AUTONOMOUS CURRICULUM AND SYLLABI
Regulations 2020

SEMESTER VII

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS L	WEEK HOURS T	WEEK HOURS P	TOTAL CONTACT HOURS	CREDITS
THEORY							
1	20HSMG601	Principles of Engineering Management	3	0	0	3	3
2	20MUPC701	Robotic Vision and Intelligence	3	0	0	3	3
3	20MUPC702	Mechatronics System Design	3	0	0	3	3
4	20XXPEXXX	Professional Elective-III	3	0	0	3	3
5	20MUOEXXX	Open Elective-II	3	0	0	3	3
PRACTICAL							
6	20MUPL701	Automation Laboratory – II	0	0	3	3	1.5
7	20MUPJ701	Project Phase 1	0	0	2	2	2
VALUE ADDITIONS - VII							
9	20MUTP701	Skill Enhancement	0	0	2	2	1
		TOTAL	**15**	**1**	**15**	**31**	**19.5**

SEMESTER VIII

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS L	WEEK HOURS T	WEEK HOURS P	TOTAL CONTACT HOURS	CREDITS
THEORY							
1	20MUPEXXX	Professional Elective - IV	3	0	0	3	3
PRACTICAL							
1	20MUPJ801	Project Phase 1I	0	0	8	8	4
		TOTAL				**11**	**07**

CREDIT DISTRIBUTION

Category	BS	HS	ES	PC+PL	EL	OE	TE	TP	PJ	IS	MC	TOTAL
Credit	29.5	10	27	63.5	12	06	7	4	7	3	Y	169
Percentage	17.46	5.91	15.98	37.58	7.1	3.55	4.14	2.37	4.14	1.78		100

PROFESSIONAL ELECTIVES - I

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			CREDIT	DOMAIN
			L	T	P		
1	20MUPE501	Industry 4.0	3	0	0	3	Smart Manufacturing
2	20MUPE502	Manufacturing System Simulation	3	0	0	3	Smart Manufacturing
3	20MUPE503	Manufacturing Information System	3	0	0	3	Smart Manufacturing
4	20MUPE504	Micro Electro Mechanical Systems (MEMS)	3	0	0	3	
5	20MUPE505	Materials for Engineering	3	0	0	3	
6	20MUPE506	Robot Operating System	3	0	0	3	Robotics
7	20MUPE507	Nano science and Nano Technology	3	0	0	3	
8	20MEPC701	Finite Element Analysis	3	0	0	3	
9	20MEEL606	Product design & development	3	0	0	3	
10	20MEEL604	Non-Destructive Testing & Evaluation	3	0	0	3	
11	20ICEL803	Artificial intelligence for robotics	3	0	0	3	Robotics

PROFESSIONAL ELECTIVES - II

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			CREDIT	DOMAIN
			L	T	P		
1	20MUPE601	Virtual Instrumentation for Automation	3	0	0	3	Smart Manufacturing
2	20MUPE602	Smart mobility and Intelligent Vehicles	3	0	0	3	Smart Manufacturing
3	20MUPE603	Prototyping & Testing	3	0	0	3	Smart Manufacturing
4	20MUPE604	Autonomous Mobile Robots	3	0	0	3	Robotics
5	20MUPE605	Motion Control System	3	0	0	3	Robotics
6	20MUPE606	Microrobotics	3	0	0	3	Robotics
7	20MUPE607	Artificial Intelligence in Industrial Automation	3	0	0	3	
8	20MUPE608	Industrial Internet of Things	3	0	0	3	
9	20MUPE609	Energy Storage and Electric Vehicles	3	0	0	3	
10	20MUPE610	Design for Manufacturing and Assembly	3	0	0	3	
11	20MUPE611	Computer Integrated Manufacturing	3	0	0	3	

PROFESSIONAL ELECTIVES - III

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			CREDIT	DOMAIN
			L	T	P		
1	20MUPE701	Digital Twin and Industry 5.0	3	0	0	3	Manufacturing
2	20MUPE702	Smart farming using Automation principles	3	0	0	3	Manufacturing
3	20MUPE703	Agricultural Robotics And Automation	3	0	0	3	Robotics
4	20MUPE704	Drone Technologies	3	0	0	3	Manufacturing
5	20MUPE705	Robot Path Planning And Programming	3	0	0	3	Robotics
6	20MUPE706	Collaborative Robotics	3	0	0	3	Robotics
7	20MUPE707	Tero technology and Maintenance Management	3	0	0	3	
8	20MUPE708	Engineering Economic Analysis	3	0	0	3	
9	20MEEL810	Entrepreneurship Development	3	0	0	3	
10	20MGEL501	Intellectual Property Rights	3	0	0	3	

PROFESSIONAL ELECTIVES - IV

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			CREDIT	DOMAIN
			L	T	P		
1	20MUPE801	Fundamentals of Machine Learning	3	0	0	3	Manufacturing
2	20MUPE802	Design For X	3	0	0	3	Manufacturing
3	20MUPE803	Industrial Process Automation	3	0	0	3	Manufacturing
4	20MUPE804	Marine Robotics	3	0	0	3	Robotics
5	20MUPE805	Wireless Sensor Networks for Robotics	3	0	0	3	Robotics
6	20MUPE806	Cloud Computing for Industrial Automation	3	0	0	3	Robotics
7	20MUPE807	Medical Robotics	3	0	0	3	
8	20MUPE808	Sustainable Manufacturing	3	0	0	3	
9	20MUPE809	Computer Aided Inspection	3	0	0	3	
10	20MUPE810	Design for Manufacturing and Assembly	3	0	0	3	

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Graduates will have sound technical acumen and leadership to become competent engineers leading to a successful career.

PEO 2: Graduates will pursue lifelong learning in generating innovative engineering solutions using fundamentals in basic science and complex problem-solving skills.

PEO 3: Graduates will strengthen entrepreneurial quality and self-employment in the program adopted..

PEO 4: Graduates will inculcate ethical responsibilities and render service towards peers, society and the nation without compromise.

PEO 5: Graduates will demonstrate commitment towards sustainable development for the betterment of the society ensuring ethical and moral values.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Capable of exhibiting the knowledge and skills in understanding the basic concepts of the Mechanical and Automation Engineering and improving the performance of manufacturing and production systems by implementing the latest technological advancements and excel as entrepreneurs.

PSO 2: Posses sound fundamentals of basic sciences so as to apply them for engineering problem analysis and research in multiple related spheres, showing passion for higher education and research in the chosen field.

COMPONENTS OF THE CURRICULUM (COC)

Course Component	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total Number of credits
Basic Sciences(BS)	17.46	31	29.5
Engineering Sciences(ES)	11.83	25	20
Humanities and Social Sciences (HS)	5.92	12	10
Professional Electives(EL)	7.10	12	12
Program Core+Program Lab (PC+PL)	39.35	80	66.5
Program theory with Lab (PW)	2.37	5	4
Open Electives (OE)	3.55	6	6
Talent Enhancement (TE)	2.37	8	4
Project (PJ)	4.14	14	7
Training & Placement (TP)	4.14	14	7
Internships/Seminars (IS)	1.78	-	3
Mandatory Courses (MC)	NA	06	NA
Total number of Credits		**213**	**169**

PROGRAMME OUTCOMES(POs)

PROGRAM OUTCOME REPRESENTS THE KNOWLEDGE, SKILLS AND ATTITUDES THAT THE STUDENTS WOULD BE EXPECTED TO HAVE AT THE END OF THE 4 YEAR ENGINEERING DEGREE PROGRAM

12 Life-long learning
Recognize the need for, and have the preparation, ability to engage in independent and life-long learning in the context of technological change.

01 Engineering knowledge
Apply the basic principle and knowledge of mathematics, science and engineering principles to solve technical problems.

02 Problem Analysis
Identify and analyze complex engineering problems reaching logical conclusions using the basic principles of mathematics, science and engineering.

11 Project management
Demonstrate knowledge and apply the principles of engineering & management in their own / team projects in multidisciplinary environments.

03 Development of solutions
Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs.

10 Communicate effectively
Communicate effectively amongst the engineering community, being able to comprehend & write effective reports, make presentations & give/receive clear instructions.

04 Investigate complex problems
Perform investigations, use research based knowledge and conduct experiments, analyze and interpret the results to provide valid conclusions.

09 Individual & Teamwork
Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary professional settings.

05 Modern tool usage
Create, select and apply the latest techniques, resources and modern engineering / IT tools to develop appropriate solutions with an understanding of the limitations.

08 Apply ethical principles
Apply ethical principles and commit to professional ethics and responsibilities based on the norms of professional engineering practices.

07 Environment & Sustainability
Demonstrate professional skills, knowledge and contextual reasoning to assess / environmental / societal issues for sustainable development.

06 The Engineer and Society
Apply reasoning based on contextual knowledge to assess societal, legal and cultural issues with competency in professional engineering practices.

ENGINEERING DEGREE

PROGRAM OUTCOMES

SEMESTER - I

20BSMA101	ENGINEERING MATHEMATICS-I	L	T	P	C
SDG NO. 4		3	1	0	4

OBJECTIVES:

The intent of the course is

- To understand and gain the knowledge of matrix algebra.
- To introduce the concepts of limits, continuity, derivatives and maxima and Minima
- To acquaint the concept of improper integrals and the properties of definite integrals.
- To provide understanding of double integration, triple integration and their application.
- To introduce the concept of sequence and series and impart the knowledge of Fourier series.

UNIT I   MATRICES   12

Symmetric, skew symmetric and orthogonal matrices; Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem (excluding proof) – Diagonalization of a Quadratic form using orthogonal transformation - Nature of Quadratic forms.

UNIT II   DIFFERENTIAL CALCULUS   12

Limits, continuity, Differentiation rules - Maxima and Minima of functions of one variable, partial derivatives (first and second order – basic problems), Taylor's series for functions of two variables, Jacobian, Maxima & Minima of functions of several variables, saddle points; Method of Lagrange multipliers.

UNIT III   INTEGRAL CALCULUS   12

Evaluation of definite integrals - Techniques of Integration-Substitution rule - Integration by parts, Integration of rational functions by partial fraction, Integration of irrational functions. Applications of definite integrals to evaluate surface area of revolution and volume of revolution. Evaluation of improper integrals.

UNIT IV   MULTIPLE INTEGRALS   12

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V   SEQUENCES AND SERIES   **12**

Introduction to sequences and series – power series – Taylor's series – series for exponential, trigonometric, logarithmic, hyperbolic functions – Fourier series – Half range Sine and Cosine series – Parseval's theorem.

TOTAL: 60 PERIODS

TEXTBOOKS:

1. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.
2. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 11th Reprint, 2010.

REFERENCES:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic Geometry", 9th Edition, Pearson, Reprint, 2002.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
3. T. Veerarajan, "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
4. N.P. Bali and Manish Goyal, "A text-book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.
5. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 40th Edition, 2014.

WEB REFERENCES:

1. https://math.mit.edu/~gs/linearalgebra/ila0601.pdf
2. http://ocw.mit.edu/ans7870/18/18.013a/textbook/HTML/chapter30/
3. https://ocw.mit.edu/courses/mathematics/18-02sc-multivariable-calculus-fall-2010/2.-partial-derivatives/
4. http://ocw.mit.edu/ans7870/18/18.013a/textbook/HTML/chapter31/

ONLINE RESOURCES:

1. https://www.khanacademy.org/math/linear-algebra/alternate-bases/eigen-everything/v/linear-algebra-introduction-to-eigenvalues-and-eigenvectors
2. https://www.khanacademy.org/math/differential-calculus

OUTCOMES:

Upon completion of the course, the student should be able to

1. Diagonalize the matrix using orthogonal transformation and apply Cayley Hamilton Theorem to find the inverse and integral powers of a square matrix. (K3)
2. Evaluate the limit, examine the continuity and use derivatives to find extreme values of a function. (K3)
3. Evaluate definite and improper integrals using techniques of integration. (K3)
4. Apply double and triple integrals to find the area of a region and the volume of a surface. (K3)
5. Compute infinite series expansion of a function. (K3)

CO - PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	-	1
CO2	3	3	2	1	1	-	-	-	-	-	-	1
CO3	3	3	2	1	1	-	-	-	-	-	-	1
CO4	3	3	2	1	1	-	-	-	-	-	-	1
CO5	3	3	2	1	1	-	-	-	-	-	-	1

SEMESTER - I

20HSEN101 SDG NO. 4	**TECHNICAL ENGLISH – I**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To develop the basic LSRW skills of the students
- To encourage the learners to adapt to listening techniques
- To help learners develop their communication skills and converse fluently in real contexts
- To help learners develop general and technical vocabulary through reading and writing tasks
- To improve the language proficiency for better understanding of core subjects

UNIT I   INTRODUCTION   9

Listening – short texts – formal and informal conversations - **Speaking** – basics in speaking – speaking on given topics & situations – recording speeches and strategies to improve - **Reading –** critical reading – finding key information in a given text – shifting facts from opinions - **Writing –** free writing on any given topic – autobiographical writing - **Language Development** – tenses – voices- word formation: prefixes and suffixes – parts of speech – developing hints

UNIT II   READING AND LANGUAGE DEVELOPMENT   9

Listening - long texts - TED talks - extensive speech on current affairs and discussions -Speaking – describing a simple process – asking and answering questions - **Reading** comprehension – skimming / scanning / predicting & analytical reading – question & answers – objective and descriptive answers –identifying synonyms and antonyms - process description - **Writing** instructions – **Language Development** – writing definitions – compound words.

UNIT III SPEAKING AND INTERPRETATION SKILLS   9

Listening - dialogues & conversations - **Speaking** – role plays – asking about routine actions and expressing opinions - **Reading** longer texts & making a critical analysis of the given text - **Writing** – types of paragraph and writing essays – rearrangement of jumbled sentences - writing recommendations - **Language Development** – use of sequence words - cause & effect expressions - sentences expressing purpose - picture based and newspaper based activities – single word substitutes

UNIT IV   VOCABULARY BUILDING AND WRITING SKILLS   9

Listening - debates and discussions – practicing multiple tasks – self introduction – **Speaking** about friends/places/hobbies - **Reading** -Making inference from the reading passage – Predicting the content of the reading passage - **Writing** – informal letters/e-mails - **Language Development** - synonyms & antonyms - conditionals – if, unless, in case, when and others – framing questions.

UNIT V   LANGUAGE DEVELOPMENT AND TECHNICAL WRITING   9

Listening - popular speeches and presentations - **Speaking** - impromptu speeches & debates - **Reading** - articles – magazines/newspapers **Writing** – essay writing on technical topics – channel conversion – bar diagram/ graph – picture interpretation - process description - **Language Development** – modal verbs - fixed / semi-fixed expressions – collocations

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Board of Editors. Using English: A Coursebook for Undergraduate Engineers and Technologists. Orient Blackswan Limited, Hyderabad: 2015.
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai, 2011.

REFERENCES:
1. Anderson, Paul V. Technical Communication: A Reader – Centered Approach. Cengage, New Delhi, 2008.
2. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason, USA, 2007.
3. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford, 2007.
4. Chauhan, Gajendra Singh and et.al.Technical Communication (Latest Revised Edition). Cengage Learning India Pvt. Limited, 2018.

WEB REFERENCES:
1. https://swayam.gov.in/nd1_noc19_hs31/preview
2. http://engineeringvideolectures.com/course/696

ONLINE RESOURCES:
1. https://www.pearson.com/english/catalogue/business-english/technical-english.html
2. https://www.cambridgeenglish.org/learning-english/free-resources/

OUTCOMES:
Upon completion of the course, the student should be able to
1. Express and explain short texts on different topics with key information applying suitable vocabulary (K2)
2. Interpret and dramatize fluently in informal and formal contexts(K2)
3. Choose and apply the right syntax in comprehending diversified general and technical articles (K3)
4. Analyze and write technical concepts in simple and lucid style (K3)
5. Construct informal letters and e-mails thoughtfully (K2)
6. Demonstrate technical concepts and summaries in correct grammar and vocabulary (K2)

CO - PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	1	-	2	3	1	1
CO2	-	-	-	-	-	-	-	1	2	3	2	1
CO3	-	-	-	-	-	-	-	-	1	3	3	2
CO4	-	2	-	-	-	-	-	1	2	3	1	1
CO5	-	-	-	-	-	-	-	2	-	3	2	1
CO6	-	-	-	-	-	-	3	-	-	3	2	1

SEMESTER - I

20BSPH101 SDG NO. 4	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate and enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology

UNIT I   CRYSTAL PHYSICS   9

Single crystalline, Polycrystalline and Amorphous materials - single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal - Miller indices - Interplanar distance - Powder diffraction method - Debye Scherer formula - Calculation of number of atoms per unit cell - Atomic radius - Coordination number - packing factor for SC, BCC, FCC and HCP structures - Polymorphism and allotropy - Diamond and Graphite structure (qualitative) - Growth of single crystals: Solution and Melt growth Techniques.

UNIT II   PROPERTIES OF MATTER   9

Elasticity - Stress - strain diagram and its uses - Poisson's ratio - Relationship between three moduli of elasticity (qualitative) - Factors affecting elastic modulus and tensile strength - Twisting couple - shaft - Torsion pendulum: theory and experiment - bending of beams - bending moment - cantilever: theory and experiment - uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT III   QUANTUM PHYSICS   9

Black body radiation - Planck's theory (derivation) - Compton effect: theory - wave particle duality - electron diffraction - progressive waves - wave equation - concept of wave function and its physical significance - Schrödinger's wave equation - Time independent and Time dependent equations - particle in a box (one dimensional motion) - Tunneling (qualitative) - scanning tunneling microscope.

UNIT IV   LASERS AND FIBER OPTICS   9

Lasers: population of energy levels, Einstein's A and B coefficients derivation - pumping methods - resonant cavity, optical amplification (qualitative) - three level and four level laser - CO_2 laser - Semiconductor lasers: Homojunction and Heterojunction.

Fiber optics: Principle, Numerical aperture and Acceptance angle - Types of optical fibers (material, refractive index, mode) - Losses associated with optical fibers - Fiber Optical Communication system (Block diagram) - Fiber optic sensors: pressure and displacement.

UNIT V   THERMAL PHYSICS   9

Transfer of heat energy - thermal expansion of solids and liquids - bimetallic strips - thermal conduction, convection and radiation - heat conduction in solids (qualitative) - 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 and solar water heaters.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. D.K. Bhattachary & T.Poonam, "Engineering Physics". Oxford University Press, 2015.
2. R.K. Gaur& S.L. Gupta, "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. B.K. Pandey & S.Chaturvedi, "Engineering Physics", Cengage Learning India, 2017.
4. V. Rajendran, "Engineering Physics", Mc Graw Hill Publications Ltd. New Delhi, 2014.
5. M.N. Avadhanulu& P.G. Kshirshagar, "A textbook of Engineering Physics", S. Chand & Co Ltd. 2016.

REFERENCES:
1.   D. Halliday, . Resnick & J. Walker, "Principles of Physics", Wiley, 2015.

2. R.A. Serway, & J.W. Jewett, "Physics for Scientists and Engineers", Cengage Learning, 2010.
3. N.K. Verma," Physics for Engineers", PHI Learning Private Limited, 2014.
4. P.A. Tipler & G. Mosca "Physics for Scientists and Engineers", W.H.Freeman, 2020.
5. Brijlal and Subramanyam, "Properties of Matter", S. Chand Publishing, 2018.
6. Shatendra Sharma & Jyotsna Sharma, "Engineering Physics", Pearson, 2018.

OUTCOMES :

Upon completion of the course, the student should be able to

1. To understand the crystal systems and elastic properties of Materials (K2)
2. To distinguish different crystal structures and heat conduction in conductor and insulators (K4)
3. To explain powder diffractionmethod-deformation of materials in response to action load,quantum mechanics to understand wave particle dualism (K2)
4. To apply quantum theory to set up one dimensional Schrodinger's wave equation and applications to a matter wave system and principle of laser action (K3)
5. To analyze bending of beams,types of optical fiber and modes of heat transfer (K4)
6. To discuss light propagation in optical fibers and transfer of heat energy in different measures and its applications (K2)

CO - PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	-	-	-	-	-	-	-	1
CO2	3	2	3	3	-	-	2	-	-	-	-	3
CO3	3	3	3	2	-	-	3	-	-	-	-	2
CO4	3	3	3	3	-	-	-	-	-	-	-	3
CO5	3	3	3	3	-	-	3	-	-	-	-	3
CO6	3	3	3	3	-	-	3	-	-	-	-	3

SEMESTER - I

20BSCY101	ENGINEERING CHEMISTRY	L	T	P	C
SDG NO. 4,6&7		3	0	0	3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques
- To illustrate the principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials
- To categorize types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels
- To demonstrate the principles and generation of energy in batteries, nuclear reactors, solar cells, windmills and fuel cells
- To recognize the applications of polymers, composites and nano-materials in various fields

UNIT I   WATER TECHNOLOGY AND SURFACE CHEMISTRY   9

Water Technology : Introduction – Hard water and Soft water. Hardness of water – types – expression of hardness (numerical problems). Boiler troubles – scale and sludge, priming and foaming, caustic embrittlement and boiler corrosion. Treatment of boiler feed water – Internal treatment (carbonate, phosphate, calgon, colloidal and sodium aluminate conditioning). External treatment – Ion exchange process, Zeolite process –Domestic water treatment (break point chlorination) –Desalination of brackish water – Reverse Osmosis.

Surface Chemistry: Adsorption – types – adsorption of gases on solids – adsorption of solutes from solution – applications of adsorption –role of adsorbents in catalysis and pollution abatement.

UNIT II   ELECTROCHEMISTRY AND CORROSION   9

Electrochemistry: Cells – types (electrochemical and electrolytic cell) Redox reaction – single electrode potential (oxidation potential and reduction potential) – measurement and applications –Nernst equation (derivation and problems) – electrochemical series and its significance.

Corrosion: Causes, factors and types – chemical and electrochemical corrosion (galvanic, differential aeration). Corrosion control – material selection and design aspects, cathodic protection methods (sacrificial anodic and impressed current cathodic method) and corrosion inhibitors. Paints: Constituents and its functions. Electroplating of Copper and electroless plating of Nickel.

UNIT III FUELS AND COMBUSTION   9

Fuels: Introduction – classification of fuels – Coal – analysis of coal (proximate and ultimate). Carbonization – manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum – manufacture of synthetic petrol (Bergius process). Knocking – octane number and cetane number – Gaseous fuels – Compressed natural gas (CNG), Liquefied petroleum gases (LPG). Biofuels – Gobar gas and Biodiesel.

Combustion of Fuels: Introduction – calorific value – higher and lower calorific values- theoretical calculation of calorific value – flue gas analysis (ORSAT Method).

UNIT IV ENERGY SOURCES AND STORAGE DEVICES   9

Energy sources: Nuclear fission – nuclear fusion – differences between nuclear fission and fusion – nuclear chain reactions – nuclear energy – light water nuclear power plant – breeder reactor – solar energy conversion – solar cells – wind energy.

Storage devices: Batteries – types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium–ion–battery), fuel cells – H_2 -O_2 fuel cell and super capacitors.

UNIT V POLYMERS AND NANOMATERIALS   9

Polymers: Classification – types of polymerization – mechanism (Free radical polymerization) –Engineering polymers: Nylon–6, Nylon–6,6, Teflon, Kevlar and PEEK – preparation, properties and uses – Plastic and its types - Conducting polymers – types and applications. Composites – definition, types, polymer matrix composites – FRP.

Nanomaterials: Introduction – Nanoparticles, Nanoclusters, Nanorods, Nanotubes (CNT: SWNT and MWNT) and Nanowires – Properties (surface to volume ratio, melting point, optical and electrical), Synthesis (precipitation, thermolysis, hydrothermal, electrodeposition, chemical vapour deposition, laser ablation, sol-gel process) and Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:
1.   S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015.
2.   P. C. Jain and Monika Jain, "Engineering Chemistry" DhanpatRai Publishing Company (P) LTD, New Delhi, 2015.
3.   S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013.
4.   Ravikrishnan A, 'Engineering Chemistry', Sri Krishna Hitech Publishing Company Pvt. Ltd, New Edition 2021.

REFERENCES:
1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

OUTCOMES

Upon completion of the course, the student should be able to

1. Identify the origin of water resources and develop innovative methods to produce soft water for industrial use and potable water at cheaper cost and recognize the basic design of adsorption systems and its industrial applications. (K2)
2. Recognize the basic concepts of electrochemistry and apply the principles of electrochemistry to corrosion process and the applications of protective coatings to overcome the corrosion. (K2)
3. Disseminating the importance of chemistry of fuels and combustion to enhance the fuel efficiency. (K2)
4. Acquire the basics of non-conventional sources of energy and illustrate the principles and the reaction mechanism of batteries and fuel cells. (K2)
5. Explain the synthesis and applications of polymers, composites and nano-materials. (K2)

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	1	2	-	-	-	-	1
CO2	3	2	3	2	2	1	2	-	-	-	-	3
CO3	3	2	3	2	-	1	2	-	-	-	-	1
CO4	3	2	3	2	-	1	2	-	-	-	1	3
CO5	3	2	3	1	2	1	1	-	-	-	1	3

SEMESTER - I

20ESCS101	PROBLEM SOLVING AND	L	T	P	C
SDG NO. 4&9	PROGRAMMING IN C	3	0	0	3

OBJECTIVES:

- To understand about the programming language
- To develop C Programs using basic Programming Constructs, Loops Arrays and Strings
- To develop applications in C using Functions , Pointers and Structures
- To perform I/O operations and File Handling in C

UNIT I INTRODUCTION TO PROGRAMMING AND ALGORITHMS FOR PROBLEM SOLVING   10

The Basic Model of Computation, Programming Paradigms- Program Development Life Cycle - Algorithm –Pseudo Code – Flow Chart - Programming Languages - Compilation - Linking and Loading - Testing and Debugging - Documentation - Control Structures – Algorithmic Problem Solving- Problems Based on Sequential, Decision Making - Branching and Iteration.

UNIT II   BASICS OF C PROGRAMMING   8

Structure of C program - C programming: Data Types – Storage Classes - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions – Input / Output Statements - Assignment Statements – Decision making Statements - Switch Statement - Looping Statements – Pre-Processor Directives - Compilation Process

UNIT III ARRAYS AND STRINGS   9

Introduction to Arrays: Declaration, Initialization – One Dimensional Array – Example Program: Computing Mean, Median and Mode - Two Dimensional Arrays – Example Program: Matrix Operations (Addition, Scaling, Determinant and Transpose) - String Operations: Length, Compare, Concatenate - Copy – Selection Sort - Linear and Binary Search.

UNIT IV FUNCTIONS AND POINTERS   9

Introduction to Functions: Function Prototype, Function Definition, Function Call, Built-in Functions (String Functions, Math Functions) – Recursion – Example Program: Computation of Sine Series - Scientific Calculator using Built-in Functions - Binary Search using Recursive Functions – Pointers – Pointer Operators – Pointer Arithmetic – Arrays and Pointers –

Array of Pointers – Example Program: Sorting of Names – Parameter Passing: Pass by Value - Pass by Reference – Example Program: Swapping of Two Numbers using Pass by Reference.

UNIT V STRUCTURES and FILE PROCESSING   9

Structure - Nested Structures – Pointer and Structures – Array of Structures – Example Program using Structures and Pointers – Self Referential Structures – Dynamic Memory Allocation - Singly Linked List – Typedef.

Files – Types of File Processing: Sequential Access, Random Access – Sequential Access File - Example Program: Finding Average of Numbers stored in Sequential Access File - Random Access File - Example Program: Transaction Processing Using Random Access Files – Command Line Arguments.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2012.

REFERENCES:

1. Paul Deitel and Harvey Deitel, "C How to Program", Seventh edition, Pearson Publication.
2. Jeri R. Hanly & Elliot B. Koffman, "Problem Solving and Program Design in C", Pearson Education, 2013.
3. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009.
4. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
6. Kanetkar Y, "Let us C", BPB Publications, 2007.
7. Hanly J R & Koffman E.B, "Problem Solving and Programme design in C", Pearson Education, 2009.

WEB REFERENCES:

1. https://www.learn-c.org/
2. https://codeforwin.org/
3. https://www.cprogramming.com/

ONLINE RESOURCES:
1. https://www.linuxtopia.org/online_books/programming_books/
   gnu_c_programming_tutorial
2. https://nptel.ac.in/courses/106105171
3. https://swayam.gov.in/nd1_noc19_cs42/preview

OUTCOMES:

Upon completion of the course, the student should be able to
1. Develop efficient algorithms for solving a problem. (K2)
2. Use the various constructs in C to develop simple applications. (K3)
3. Design and Implement applications using Array & Strings. (K3)
4. Develop applications using Functions and Pointers. (K6)
5. Design and Develop applications using Structures. (K3)
6. Design and Develop applications using Files. (K4)

CO- PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	1	1	-	2	2	-	3	2	3
CO2	3	3	3	3	2	-	1	1	2	2	3	3	2	3
CO3	3	3	3	3	2	1	1	1	2	-	3	-	3	2
CO4	3	3	3	3	2	1	-	1	2	2	3	3	1	2
CO5	3	3	3	3	2	1	1	1	2	2	3	3	2	1
CO6	3	3	3	3	2	1	1	1	2	2	3	3	3	2

SEMESTER - I

20ESGE101 SDG NO. 4,6,7, 9, 12,14 &15	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
		1	**2**	**0**	**3**

OBJECTIVES:
- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products
- To visualize the job in three dimensions
- To have a clear conception and appreciation of the shape, size, proportion and design
- To expose the student community to existing national standards related to technical drawings

CONCEPTS AND CONVENTIONS (Not for Examination)   3

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning- Projection of Points

UNIT I   PLANE CURVES AND FREEHAND SKETCHING   6+9

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid on Horizontal Surfaces – construction of involutes of circle for one complete revolution – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II   PROJECTION OF LINES AND PLANE SURFACE   6+9

Orthographic projection- principles-Principal planes- Projection of straight lines (only First angle projections) 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   6+9

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.

**UNIT IV   PROJECTION OF SECTIONED SOLIDS AND
                  DEVELOPMENT OF SURFACES   6+9**

Sectioning of prisms, pyramids, cylinder and cone in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and truncated solids in vertical position – Prisms, pyramids cylinder and cone.

UNIT V   ISOMETRIC AND PERSPECTIVE PROJECTIONS   6+9

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinder, cone- Perspective projection of simple solids-Prisms, pyramids and cylinder by visual ray method.

TOTAL: 78 PERIODS

TEXT BOOKS:
1. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
2. T. Jeyapoovan, "Engineering Graphics using AUTOCAD", Vikas Publishing House Pvt Ltd, 7th Edition.

REFERENCES:
1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
3. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
4. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
5. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
6. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
7. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

WEB REFERENCES:
1. https://nptel.ac.in/courses/112/103/112103019/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/105/104/105104148/

PUBLICATION OF BUREAU OF INDIAN STANDARDS:
1. IS10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods

OUTCOMES:

Upon completion of the course, the student should be able to

1. Relate thoughts and ideas graphically in a neat fashion and ability to perform sketching of engineering curves used in engineering practices, multiple views of objects. (K1)
2. Understand the concepts of orthographic projections for basic geometrical constructions. (K2)
3. Acquire the knowledge of orthographic projection in three dimensional object. (K2)
4. Develop knowledge about Sectioning and apply interior shapes of solids. (K3)
5. Analyze the concepts of design in developing various 3 dimensional projections. (K4)
6. Build a strong foundation to analyze the design in various dimensions. (K4)

CO - PO , PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	2	2	-	2	2	2
CO2	3	2	2	-	-	-	-	-	2	2	-	2	2	2
CO3	3	2	2	-	-	-	-	-	2	2	-	2	2	2
CO4	3	2	2	-	-	-	-	-	2	2	-	2	2	2
CO5	3	2	2	-	-	-	-	-	2	2	-	2	2	2
CO6	3	2	2	-	-	-	-	-	2	2	-	2	2	2

SEMESTER - I

20BSPL101	PHYSICS AND CHEMISTRY	L	T	P	C
SDG NO. 4	LABORATORY	0	0	3	1.5

PHYSICS LABORATORY

OBJECTIVES:

- To acquaint the students with practical knowledge of physics principles in various fields such as optics, thermal physics and properties of matter for developing basic experimental skills
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis

LIST OF EXPERIMENTS (Any 5 Experiments)

1. Determination of Young's modulus by non-uniform bending method.
2. Determination of rigidity modulus –Torsion pendulum.
3. Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
4. (a) Determination of wavelength and particle size using Laser.
    (b) Determination of acceptance angle in an optical fiber.
5. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
6. Determination of specific resistance of a given coil of wire – Carey Foster's bridge.
7. Determination of wavelength of mercury spectrum – spectrometer grating.
8. Determination of band gap of a semiconductor.
9. Determination of Hall coefficient by Hall Effect experiment.
10. Determination of solar cell characteristics.

**LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS /
6 (max.) STUDENTS PER EXPERIMENT**

1. Young's modulus by non-uniform bending method- experimental set-up   – 12 sets
2. Rigidity modulus - Torsion pendulum experimental set-up   – 12 sets
3. Ultrasonic Interferometer to determine velocity of sound and compressibility of liquid   – 6 sets
4. (a) Experimental set-up to find the wavelength of light, and to find particle size using Laser   – 6 sets
    (b) Experimental set-up to find acceptance angle in an optical fiber   – 6 sets
5. Lee's disc method- experimental set up to find thermal conductivity of a bad conductor   – 6 sets
6. Experimental set-up to find specific resistance of a coil of wire-Carey Foster's Bridge   – 6 sets
7. Experimental set-up to find the wavelength of mercury spectrum-spectrometer grating   – 6 sets
8. Experimental set-up to find the band gap of a semiconductor – 12 sets
9. Experimental set-up to find the Hall coefficient by Hall Effect Experiment   – 6 sets
10. Experimental set-up to study characteristics of solar cells   – 6 sets

TEXTBOOKS:

1. J.D. Wilson& C.A. Hernandez Hall "Physics Laboratory Experiments" Houghton Mifflin Company, New York, 2010.
2. M.N. Srinivasan, S. Balasubramanian &R. Ranganathan, "Practical Physics",   S. Chand & Sons educational publications, New Delhi, 2011.
3. R. Sasikumar, "Practical Physics", PHI Learning Pvt. Ltd., New Delhi, 2011.

CHEMISTRY LABORATORY
(Any five experiments to be conducted)

OBJECTIVES:
- To acquaint the students with practical knowledge of the basic concepts of chemistry, the student faces during the course of their study in the industry and engineering field
- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis
- To understand and develop experimental skills for building technical competence

LIST OF EXPERIMENTS (Any five experiments to be conducted)

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water samples.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Determination of strength of given hydrochloric acid using pH meter.
6. Conductometric titration of strong acid vs strong base.
7. Estimation of iron content of the given solution using potentiometer.
8. Estimation of iron content of the water sample using spectrophotometer (1, 10- Phenanthroline / thiocyanate method).
9. Estimation of sodium and potassium present in water using flame photometers.
10. Determination of molecular weights of polymers using Ostwald's Viscometer.

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS / 6 (MAX.) STUDENTS PER EXPERIMENT.

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample - 6 sets

2. Determination of total, temporary & permanent hardness of water by EDTA method - 6 sets

3. Determination of DO content of water sample by Winkler's method - 6sets

4. Determination of chloride content of water sample by argentometric method – 6 sets

5. Determination of strength of given hydrochloric acid using pH meter - 6 sets

6. Conductometric titration of strong acid vs strong base - 6 sets

7. Estimation of iron content of the given solution using potentiometer - 6 sets

8. Estimation of iron content of the water sample using spectrophotometer (1,10- Phenanthroline / thiocyanate method) - 2 sets

9. Estimation of sodium and potassium present in water using flame photometer - 2 sets

10. Determination of molecular weights of polymer using Ostwald's Viscometer. - 6 sets

TOTAL: 30 PERIODS

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

OUTCOMES:

Upon completion of the course, the student should be able to

1. Apply the principles of thermal physics and properties of matter to evaluate the properties of materials and to determine the physical properties of liquid using ultrasonic interferometer. (K1)

2. Understand measurement technique and usage of new instruments in optics for real time application in engineering. (K2)

3. Apply the knowledge of semiconductor materials to evaluate the band gap and Hall coefficient of materials and to study the characteristics of solar cell for engineering solutions. (K3)

4. Interpret quantitative chemical analysis to generate experimental skills in building technical competence. (K3)

5. Analyze the quality of water for domestic and industrial purpose. (K3)

6. Standardize the solutions using volumetric titrations, conductivity, pH, redox potential and optical density measurements. (K3)

CO- PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	3	3	2	2	1	1	3
CO2	3	3	3	3	3	3	3	2	2	2	2	3
CO3	3	3	3	3	3	3	3	2	1	1	2	3
CO4	3	2	3	3	1	1	2	2	2	2	3	2
CO5	3	2	3	3	1	1	2	2	2	2	3	2
CO6	3	2	3	3	1	1	2	2	2	2	3	2

SEMESTER - I

20ESPL101 SDG NO. 4&9	**PROGRAMMING IN C LABORATORY**	L	T	P	C
		0	0	3	1.5

OBJECTIVES:
- To develop programs in C using basic Programming Constructs
- To develop applications in C using Arrays and Strings
- To design and implement applications in C using Functions, Structures
- To develop applications in C using Files

LIST OF EXPERIMENTS
1. Write a program using I/O statements and expressions.
2. Write programs using decision-making constructs.
3. Write a program to find whether the given year is leap year or not? (Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)
4. Write a program to perform the Calculator operations, namely, addition, subtraction, multiplication, division and square of a number.

5.   Write a program to check whether a given number is Armstrong number or not?
6.   Write a program to check whether a given number is odd or even?
7.   Write a program to find the factorial of a given number.
8.   Write a program to find out the average of 4 integers.
9.   Write a program to display array elements using two dimensional arrays.
10.   Write a program to perform swapping using function.
11.   Write a program to display all prime numbers between two intervals using functions.
12.   Write a program to reverse a sentence using recursion.
13.   Write a program to get the largest element of an array using the function.
14.   Write a program to concatenate two string.
15.   Write a program to find the length of String.
16.   Write a program to find the frequency of a character in a string.
17.   Write a program to store Student Information in Structure and Display it.
18.   The annual examination is conducted for 10 students for five subjects. Write a program to read the data and determine the following:
     (a) Total marks obtained by each student.
     (b) The highest marks in each subject and the marks of the student who secured it.
     (c) The student who obtained the highest total marks.
19.   Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
20.   Count the number of account holders whose balance is less than the minimum balance using sequential access file.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler   30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

OUTCOMES:

Upon completion of the course, the student should be able to

1.   Solve some simple problems leading to specific applications. (K3)
2.   Demonstrate C programming development environment, compiling, debugging, linking and executing a program. (K3)
3.   Develop C programs for simple applications making use of basic constructs, arrays and strings. (K4)

4. Develop C programs involving functions and recursion. (K4)
5. Develop C programs involving pointers, and structures. (K6)
6. Design applications using sequential and random access file. (K4)

CO- PO, PSO MAPPING:

CO1	3	3	3	3	2	1	1	1	2	2	3	3	2	3
CO2	3	3	3	3	2	1	-	1	2	2	3	3	1	3
CO3	3	3	-	3	2	-	1	1	-	2	-	3	3	2
CO4	3	3	3	3	2	1	1	1	2	2	3	3	1	3
CO5	3	3	3	-	2	-	1	-	2	2	3	-	2	1
CO6	3	3	3	3	2	1	1	1	2	-	3	3	3	2

SEMESTER - I

20TPHS101 SDG NO. 4&5	SKILL ENHANCEMENT	L	T	P	C
		0	0	2	1

OBJECTIVES:
- To enrich social network ethics
- To develop and enhance browsing culture
- To understand the concepts of networking
- To promote self professionalism
- To acquire knowledge about various digital identification procedures

UNIT I   SOCIAL NETWORK ETIQUETTES   6

Introduction to social network – Social Networking Etiquettes - Pros and Cons - Usage of Facebook, Instagram, WhatsApp , Telegram, Youtube, Evolution of Android and IOS, Introduction to Linkedin & Benefits. (Practicals – Official Mail id- Linkedin Id Creation, Linkedin Profile Bulilding , Facebook Id and Creation and Modifying the existing FB ID)

UNIT II BROWSING CULTURE   6

Introduction to browsing – Search Engines-Google - Bing -Yahoo!-AOL -MSN –DuckDuckGo ,browsers, phishing – Cookies   - URL – https:// extensions , browsing history, Incognito mode- VPN – Pros and Cons – Book mark.

UNIT III NETWORKING   6

Basics of networking - LAN, MAN, WAN, Introduction to network topologies, Protocols , IP Commands (Command line prompt), Define online complier and editor (Practicals – Find Your System IP,Ping Command, Firewall Fortinet, Basic DOS Commands)

UNIT IV PROFESSIONALISM   6

Dress Code, Body Language, Appropriate Attire ,Communication Skills, Interview preparation – Introducing yourself - How to greet Superiors, Importance of Eye Contact During conversation.

UNIT V DIGITAL IDENTIFICATION   6

Introduction to NAD - Importance of Aadhar, PAN Card, Passport, Bank Account, Bar Code, QR scan, Payment Gateway (Gpay, Phone Pe, UPI, BHIM, Paytm), Mobile Banking (Practicals - NAD registration Step by Step, Linking bank account with netbanking , Register for payment gateway).

TOTAL : 30 PERIODS

WEB REFERENCES :

Unit I: Social Network Etiquettes:
1. https://sproutsocial.com/glossary/social-media-etiquette/
2. https://www.shrm.org/resourcesandtools/tools-and-samples/hr-qa/pages/socialnetworkingsitespolicy.aspx
3. https://www.frontiersin.org/articles/10.3389/fpsyg.2019.02711/full
4. https://medium.com/@sirajea/11-reasons-why-you-should-use-telegram-instead-of-whatsapp-ab0f80fbfa79
5. https://buffer.com/library/how-to-use-instagram/
6. https://www.webwise.ie/parents/what-is-youtube/
7. https://www.androidauthority.com/history-android-os-name-789433/
8. https://www.mindtools.com/pages/article/linkedin.htm

Unit II: Browsing Culture:
1. https://sites.google.com/site/bethanycollegeofteacheredn/unit--ict-connecting-with-world/national-policy-on-information-and-communication-technology-ict/accessing-the-web-introduction-to-the-browser-browsing-web
2. https://www.wordstream.com/articles/internet-search-engines-history
3. https://www.malwarebytes.com/phishing/
4. https://www.adpushup.com/blog/types-of-cookies/

5. https://www.eff.org/https-everywhere
6. https://www.sciencedirect.com/topics/computer-science/browsing-history\
7. https://www.vpnmentor.com/blog/pros-cons-vpn/
8. https://www.tech-wonders.com/2016/10/use-hush-private-bookmarking-extension-chrome.html

Unit III:Networking

1. https://www.guru99.com/types-of-computer-network.html
2. https://www.studytonight.com/computer-networks/network-topology-types
3. https://www.cloudflare.com/learning/network-layer/what-is-a-protocol/
4. https://www.howtogeek.com/168896/10-useful-windows-commands-you-should-know/
5. https://paiza.io/en

Unit IV : Professionalism

1. https://career.vt.edu/develop/professionalism.html
2. https://englishlabs.in/importance-dress-code/
3. https://www.proschoolonline.com/blog/importance-of-body-language-in-day-to-day-life
4. https://www.thespruce.com/etiquette-of-proper-attire-1216800
5. https://shirleytaylor.com/why-are-communication-skills-important/
6. https://www.triad-eng.com/interview-tips-for-engineers/
7. https://www.indeed.co.in/career-advice/interviewing/interview-question-tell-me-about-yourself
8. https://toggl.com/track/business-etiquette-rules/

Unit V: Digital Identification

1. https://nad.ndml.in/nad-presentation.html
2. https://www.turtlemint.com/aadhaar-card-benefits/
3. https://www.bankbazaar.com/pan-card/uses-of-pan-card.html
4. https://www.passportindex.org/passport.php
5. https://consumer.westchestergov.com/financial-education/money-management/benefits-of-a-bank-account
6. https://en.wikipedia.org/wiki/QR_code

7. https://www.investopedia.com/terms/p/payment-gateway.asp
8. https://www.paisabazaar.com/banking/mobile-banking/

OUTCOMES:
Upon completion of the course, the student should be able to
1. Learn and apply social network ethics. (K3)
2. Understand the browsing culture. (K2)
3. Analyze the networking concepts . (K4)
4. Develop self professionalism. (K3)
5. Gain hands-on experience in various digital identification procedures. (K2)
6. Analyse and apply the different digital payment gateway methods. (K4)

CO- PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	3	2	-	3	2	3	-	2
CO2	-	-	-	-	3	2	-	3	2	3	-	2
CO3	-	-	-	-	3	2	-	-	1	3	-	2
CO4	-	-	-	-	3	2	-	3	3	3	-	2
CO5	-	-	-	-	3	2	-	-	2	3	-	2
CO6	-	-	-	-	3	2	-	-	2	3	-	2

SEMESTER - I

20HSMG101	**PERSONAL VALUES**	**L**	**T**	**P**	**C**
SDG NO. 4&5		**2**	**0**	**0**	**0**

OBJECTIVES:
● Values through Practical activities

UNIT I SELF CONCEPT   **6**
Understanding self Concept – Identify Yourself – Who am I – an individual, engineer, citizen – Attitude – Measuring Behaviour – Change of Behaviour – Personality – Characteristics in personal, professional life.

UNIT II INDIVIDUAL VALUES   6

Personal Values – Attributes –Courage – Creativity, Honesty, Perfection, Simplicity, Responsibility – Measuring personal values

UNIT III MORAL VALUES   6

Moral – Understanding right and wrong – Positive thoughts – Respect to others – Doing good to society.

UNIT IV PHYSICAL AND MENTAL WELL-BEING   6

Health – Physical fitness –Mental vigour – Diet management – Yoga – Meditation – Peaceful life – Happiness in life

UNIT V DECISION MAKING   6

Goal Setting – Decision making skill – Overcome of Barriers – Success – Mental strength and weakness

TOTAL: 30 PERIODS

Note:

Each topic in all the above units will be supplemented by practice exercises and classroom activities and projects.

REFERENCE BOOKS:

1. Barun K. Mitra, "Personality Development and Soft Skills", Oxford University Press, 2016.
2. B.N.Ghosh, "Managing Soft Skills for Personality Development" McGraw Hill India, 2012.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Become an individual in knowing the self. (K4)
2. Acquire and express Personal Values, Spiritual values and fitness. (K4)
3. Practice simple physical exercise and breathing techniques. (K2)
4. Practice Yoga asana which will enhance the quality of life. (K1)
5. Practice Meditation and get benefitted. (K1)
6. Understanding moral values and need of physical fitness. (K2)

CO – PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Co1	-	-	-	-	-	2	2	3	3	1	1	1
CO2	-	-	-	-	-	2	2	3	3	1	1	1
CO3	-	-	-	-	-	2	2	3	3	1	1	1
CO4	-	-	-	-	-	2	2	3	3	1	1	1
CO5	-	-	-	-	-	2	2	3	3	1	1	1
CO6	-	-	-	-	-	2	2	3	3	1	1	1

SEMESTER - II

20BSMA201 SDG NO. 4	ENGINEERING MATHEMATICS - II	L	T	P	C
		3	1	0	4

OBJECTIVES:

● The objective of this course is to familiarize the prospective engineers with techniques in Vector Calculus, Ordinary differential equations, Complex variables and Laplace transforms. It aims to equip the students to deal with advanced levels of Mathematics and applications that would be essential for their disciplines.

UNIT I   VECTOR CALCULUS   12

Gradient and Directional derivatives - Divergence and Curl- Vector identities - Irrotational and Solenoidal vector fields - Line integral over a plane curve - Surface integral - Volume integral – Gauss divergence, Green's and Stoke's theorems - Verification and application in evaluating line, Surface and volume integrals.

UNIT II   ORDINARY DIFFERENTIAL EQUATIONS   12

Second and higher order linear differential equations with constant coefficients - Method of variation of parameters - Homogeneous equation of Euler's and Legendre's types - System of simultaneous linear differential equations with constant coefficients.

UNIT III   COMPLEX DIFFERENTIATION   12

Analytic functions- Necessary and sufficient conditions for analyticity in cartesian and polar coordinates (without proof) - Properties - Harmonic conjugate - construction of analytic functions- Conformal mapping - Mapping by functions $w = z+a, w=az, w=1/z, w=z^2$ - Bilinear transformation.

UNIT IV   COMPLEX INTEGRATION   12

Contour integrals, Cauchy- Goursat theorem (without proof) - Cauchy Integral formula (without proof)   - Taylor's series - Zeroes of Analytic functions - Singularities - Laurent's Series - Residues – Cauchy Residue theorem (without proof) – Application of Residue theorem for evaluation of real integrals – use of circular contour and semicircular contour(without poles on real axis).

UNIT V   LAPLACE TRANSFORM   12

Existence conditions – Transforms of elementary functions – Transform of Unit step function and Unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Initial and Final value

theorems – Convolution theorem – Transform of Periodic functions – Application of solution of linear second order ordinary differential equations with constant coefficients.

TEXT BOOKS:
1. Erwin Kreyszig, Advance Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill Publishing Company, New Delhi, 2008.

REFERENCES:
1. Dass, H.K., and Er. Rajnish Verma, "Higher Engineering Mathematics", S.Chand Private Ltd., 2011.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2010.
3. Peter V.O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. E.A.Coddinton, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
5. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition, 2014.
6. N.P.Bali and Manish Goyal, "A text Book of Engineering Mathematics", Laxmi Publications, Reprint 2008.

WEB COURSES:
1. https://nptel.ac.in/courses/122107036/
2. https://nptel.ac.in/courses/111105134/
3. https://ocw.mit.edu/courses/mathematics/18-04-complex-variables-with-applications-spring-2018/
4. https://ocw.mit.edu/courses/mathematics/18-02-multivariable-calculus-fall-2007/
5. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/

ONLINE RESOURCES:
1. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/video-lectures/lecture-1-introduction/
2. http://www.nptelvideos.com/course.php?id=90

COURSE OUTCOMES:

Upon completion of the course, the student should be able to

1. Compute the derivatives of scalar and vector point functions. Use vector point function to establish a relation between line, surface and volume integrals. (K3)
2. Solve ordinary differential equations of second and higher order with constant coefficients, variable coefficients and simultaneous linear differential equations. (K3)
3. Construct an analytic function and apply the properties of analytic functions to check for harmonic and orthogonal functions and find the images of circle and straight lines under the standard transformations. (K3)
4. Use Cauchy's integral theorem, formula and Cauchy's Residue theorem to evaluate complex and real integrals, find the Taylor's and Laurent's series expansion. (K3)
5. Apply Laplace and inverse Laplace Transforms to solve the Linear ordinary differential equations with constant coefficients. (K3)

CO - PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	-	-	-	-	-	-	1
CO2	3	3	2	1	-	-	-	-	-	-	-	1
CO3	3	3	2	1	-	-	-	-	-	-	-	1
CO4	3	3	2	1	-	-	-	-	-	-	-	1
CO5	3	3	2	1	-	-	-	-	-	-	-	1

SEMESTER - II

20HSEN201	TECHNICAL ENGLISH - II	**L**	**T**	**P**	**C**
SDG NO. 4		**3**	**0**	**0**	**3**

OBJECTIVES:

● To strengthen the listening skills for comprehending and critically analyzing passages
● To enhance students' ability with multiple strategies and skills for making technical presentations
● To participate in group discussions for developing group attitude
● To develop skills for preparing effective job application
● To write effective technical reports

UNIT I   LANGUAGE DEVELOPMENT   9

Listening – Listening conversations involving two participants – multiple participants – **Speaking** – conversation methods in real life occurrences using expressions of different emotions and imperative usages – **Reading** passages and short stories - **Writing** – preparation of checklist – extended definition – **Language Development** – tenses - subject - verb agreement

UNIT II   VOCABULARY BUILDING   9

Listening – listening formal and informal conversation and participative exercises – **Speaking** - creating greetings/wishes/excuses and thanks – **Reading** – articles/novels-**Writing** summary of articles and concise writing identifying new words – homonyms, homophones, homographs – one-word substitutions – easily confused words - creating SMS and using emoticons - sharing information in social media. **Language Development** - reported speeches – regular and irregular verbs - idioms & phrases

UNIT III   WRITING TECHNICAL REPORTS   9

Listening – listening conversation – effective use of words and their sound aspects, stress, intonation & pronunciation – **Speaking** - practicing telephonic conversations – observing and responding. **Reading** – regular columns of newspapers/magazines - **Writing** – reports – feasibility, accident, survey and progress - preparation of agenda and minutes – **Language Development** - using connectives – discourse markers

UNIT IV   TECHNICAL WRITING   9

Listening – Model debates & documentaries - **Speaking** – expressing agreement/disagreement, assertiveness in expressing opinions – **Reading**

biographies/autobiographies – **Writing** – note-making – formal letters – inviting guests – acceptance/declining letters - **Language Development** – degrees of comparison - numerical adjectives – embedded sentences

UNIT V   GROUP DISCUSSION AND JOB APPLICATION   9

Listening – Listening - classroom lectures – recommending suggestions & solutions – **Speaking** – participating in group discussion – learning GD strategies – **Reading** – journal articles - Writing – Job application – cover letter - résumé preparation – **Language Development** – purpose statement – editing – verbal analogies.

TOTAL: 45 PERIODS

TEXT BOOKS :
1.	Board of editors. Fluency in English: A Course book for Engineering and Technology. Orient Blackswan, Hyderabad 2016.
2.	Ashraf Rizvi. M, Effective Technical Communication. 2nd ed. McGraw Hill, New Delhi, 2018.

REFERENCES
1.	Bailey, Stephen. Academic Writing: A Practical Guide for Students. Routledge, New York,2011.
2.	Raman, Meenakshi and Sharma, Sangeetha. Technical Communication Principles and Practice. Oxford University Press, New Delhi, 2014.
3.	Muralikrishnan& Mishra Sunitha, Communication skills for Engineers 2nd ed. Pearson, Tamilnadu, India 2011. P. Kiranmai and Rajeevan, Geetha. Basic Communication Skills, Foundation Books, New Delhi, 2013.
4.	Suresh Kumar, E. Engineering English. Orient Blackswan, Hyderabad, 2015
5.	Richards, Jack C. Interchange Students' Book – 2. Cambridge University Press, New Delhi, 2015.

WEB REFERENCES :
1.	https://swayam.gov.in/nd1_noc20_hs21/preview
2.	https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/ text/109106122/lec1.pdf
3.	https://freevideolectures.com/course/3250/introduction-to-film- studies/10

ONLINE RESOURCES
1.	https://www.ef.com/wwen/english-resources/

2. https://www.smilesforlearning.org/gclid=EAIaIQobChMI49DF9
    bnd6AIVSY6PCh1d_gV9EAAYASAAEgIBPvD_BwE.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Define technical terms with the correct use of grammar (K1)
2. Identify new words, phrases, idioms and summarize articles/ write ups effectively (K2)
3. Pronounce words correctly, speak fluently and share opinions and suggestions effectively in conversations, debates and discussions (K3)
4. Construct reports convincingly and write official letters emphatically (K3)
5. Communicate confidently while speaking and writing by employing language strategies (K2)
6. Adapt group behavior, execute their role as a contributing team member and prepare winning job applications (K3)

CO - PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	2	3	1	2
CO2	-	2	-	-	-	-	-	-	2	3	1	1
CO3	-	-	-	1	-	-	-	2	2	3	1	1
CO4	-	-	-	-	-	2	-	3	2	3	2	2
CO5	-	-	-	-	-	-	-	-	2	3	2	2
CO6	-	-	-	-	-	-	-	2	2	3	1	2

SEMESTER - II

20ESIT201	PYTHON PROGRAMMING	L	T	P	C
SDG NO. 4	WITH LABORATORY	3	0	2	4

OBJECTIVES:

- To Develop Python Programs with Conditionals and Loops
- To Use Python Data Structures – Lists, Tuples, Dictionaries, Sets
- To Define Python Functions and Work with Modules and Packages
- To Work with Python Classes, Objects and Handling Exceptions

UNIT I   BASICS OF PYTHON PROGRAMMING   9

Python Interpreter and Interactive Mode - Features – History of Python – Literals – Variables and Identifiers – Data Types – Input Operation – Comments – Reserved Words – Indentation – Operators and Expressions – Operator Precedence– Operations on Strings – Other Data types – Type Conversion - Illustrative Programs: Use of various Operators, Evaluation of expressions, String Operations.

UNIT II   DECISION CONTROL STATEMENTS   9

Conditionals: Boolean Values and Operators, Conditional (if) - Alternative (if-else) - Chained Conditional (if-elif-else) - Iteration: state - while - for - break - continue - pass - Illustrative Programs: Exchange the Values of Two Variables - Circulate the values of N Variables - Distance Between Two Points - Square Root - GCD - Exponentiation - Sum and Array of Numbers.

UNIT III   STRING, LISTS, TUPLES, DICTIONARIES, SETS   9

Strings: String Slices - Immutability - String functions and methods - String Module - Lists: List Operations - List Slices - List methods - List Loop - Mutability - Aliasing - Cloning lists - List Parameters - Tuples: Tuple Assignment - Tuple as return value - Dictionaries: Operations and Methods - Advanced List Processing - List Comprehension - Sets: Creating Sets – Operations and Methods – Set Comprehension - Illustrative programs: Linear Search - Binary Search - Selection Sort - Insertion Sort - Merge Sort - Histogram.

UNIT IV   FUNCTIONS, MODULES AND PACKAGES   9

Functions - Function Definition and Use - Flow of Execution - Parameters and Arguments - Fruitful Functions: Return values - Parameters - Local and Global Scope - Function Composition - Recursion - Modules – from-import Statement – Name of Module – Making your own modules - Packages - Standard Library Modules – globals(), locals() and reload() - Illustrative programs: Fibonacci Series using functions - Arithmetic Operations using Module - Area of different shapes using Packages.

UNIT V   CLASSES, OBJECTS AND EXCEPTION HANDLING   9

Classes and Objects – Defining Classes – Creating Objects – Data Abstraction and Hiding through Classes - init() method – Class Variables and Object Variables – Introduction to Errors and Exception Handling – Handling Exceptions – Multiple Except Blocks – else Clause – Raising Exceptions – Built-in and User-defined Exceptions – Finally Block.

LIST OF EXPERIMENTS   15
1.   Write a Python program to perform
       a.   Linear Search
       b.   Binary Search
2.   Write a Python program to perform Selection Sort.
3.   Write a Python program to sort the given numbers using Insertion Sort.
4.   Write a Python program to do sorting using Merge sort.
5.   Write a Python program to find first n prime numbers.
6.   Write a Python program to Multiply two matrices.
7.   Write a Python program to create Student class and instantiate its Object.
8.   Write a Python License verification process using Exception handling.

TOTAL: 60 PERIODS

TEXT BOOKS:
1.   ReemaThareja. "Python Programming Using Problem Solving Approach", Oxford University Press 2018.
2.   Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, O'Reilly Publishers, 2016.

REFERENCES:
1.   Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" Revised and updated for Python 3.2, Network Theory Ltd., 2011.
2.   John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2013.
3.   Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-Disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
4.   Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
5.   Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012.
6.   Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2013.
7.   Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.

WEB REFERENCES:
1.   http://greenteapress.com/wp/think-python/
2.   www.docs.python.org

3.   https://nptel.ac.in/courses/106/106/106106182/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Describe the syntax, semantics and control flow statements of Python programming. (K2)
2. Implement simple programs using control structures in Python. (K3)
3. Explain the methods to create and manipulate strings, lists, dictionaries, tuples and sets. (K2)
4. Articulate the concepts of functions, modules and packages in Python. (K2)
5. Implement simple programs using Python Data types and functions. (K3)
6. Apply the concepts of Exception handling, classes and objects. (K3)

CO - PO MAPPING

CO - PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	2	1	2	-	-	-	1	-	3	3
CO2	1	2	3	3	3	2	1	1	1	1	1	3
CO3	-	1	3	3	2	1	-	-	-	-	1	3
CO4	1	2	3	3	2	-	-	-	-	-	1	3
CO5	2	3	3	3	3	1	1	2	2	1	2	3
CO6	2	3	3	3	3	1	1	2	2	1	2	3

SEMESTER - II

20BSCY201	**ENVIRONMENTAL SCIENCE**	**L**	**T**	**P**	**C**
SDG NO. 1-17	**AND ENGINEERING**	**3**	**0**	**0**	**3**

OBJECTIVES:

- To study the nature and facts about environment
- To find and implement scientific, technological, economic and political solutions to environmental problems
- To study the interrelationship between living organism and environment
- To provide the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I   ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY   9

Definition, scope and importance of environment – need for public awareness – Ecosystem: concept of an ecosystem – structure and functions of an ecosystem – Biotic and abiotic components – Biogeochemical cycle (C, N & P) – energy flow in the ecosystem – food chains, food webs and ecological pyramids – ecological succession - keystone species. Introduction to biodiversity definition: genetic, species and ecosystem diversity – values of biodiversity – IUCN Red list species classification - endemic, endangered, rare, vulnerable, extinct and exotic species – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity – man-wildlife conflicts. Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.   Field study of Terrestrial (Forest, Grassland, Desert) and Aquatic ecosystem (Pond, Lake, River, Estuary and Marine)

UNIT II   ENVIRONMENTAL POLLUTION   9

Definition – causes, effects and control measures of: Air pollution, Water pollution, Soil pollution Marine pollution, Noise pollution, Thermal pollution and Nuclear pollution – solid waste management: causes, effects and control measures of municipal solid wastes (MSW) – role of an individual in prevention of pollution – Case studies related to environmental pollution.

Disaster management: floods, earthquake, cyclone and landslides – nuclear holocaust – Case studies.

UNIT III NATURAL RESOURCES   9

Forest resources: Use and over – exploitation, deforestation – Land resources: land degradation, man induced landslides, soil erosion and desertification – Water resources: Use and over- utilization of surface and groundwater – dams-benefits and problems, conflicts over water – Mineral resources: Environmental effects of extracting and using mineral resources – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – fertilizer – pesticide problems, water logging and salinity. Energy resources: Renewable energy (Solar energy, Wind energy, Tidal energy, Geothermal energy, OTE, Biomass energy) and non renewable energy (Coal, Petroleum, Nuclear energy) sources. – role of an individual in conservation of natural resources. Case studies – timber extraction, mining, dams and their effects on forests and tribal people.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT   10

Atmospheric Chemistry - Composition and structure of atmosphere. Climate change - greenhouse effect- role of greenhouse gases on global warming. Chemical and photochemical reactions in the atmosphere - Formation of

smog, PAN, acid rain (causes, effect and control measures). Oxygen and ozone chemistry - Ozone layer depletion (causes, effect and control measures). environmental ethics: Issues and possible solutions – Green chemistry - 12 principles of green chemistry.

Urbanisation - Urban problems related to energy - Water conservation: rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns - case studies. Environment Legislations and Laws : Environment (protection) act – 1986. Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. Biomedical Waste(Management and Handling rules):1998 and amendments- scheme of labelling of environmentally friendly products (Ecomark) - Issues involved in enforcement of environmental legislation - central and state pollution control boards, role of non-governmental organization – Public awareness - Environmental Impact Assessment (EIA).

UNIT V HUMAN POPULATION AND THE ENVIRONMENT   8

Population growth, variation among nations – population explosion – family welfare programme – women and child welfare environment and human health – HIV / AIDS – Role of Information Technology in environment and Human health – Case studies – human rights – value education – Sustainable Development – Need for sustainable development – concept – 17 SDG goals – 8 Millennium Development Goals(MDG).

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
3. Ravikrishnan A, 'Environmental Science and Engineering', Sri Krishna Hitech Publishing Company Pvt. Ltd, Revised Edition 2020.

REFERENCES :

1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) Pvt Ltd., Hydrabad, 2015.
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India Pvt. Ltd., Delhi, 2014.
4. Rajagopalan. R, "Environmental Studies-From Crisis to Cure", Oxford University Press, 2005.

OUTCOMES:

Upon successful completion of this course, student should be able to

1. Explain the different components of environment, structure and function of an ecosystem, importance of biodiversity and its conservation. (K1)
2. Aware about problems of environmental pollution, its impact on human and ecosystem, control measures and basic concepts in Disaster Management. (K2)
3. Disseminate the need for the natural resources and its application to meet the modern requirements and the necessity of its conservation. (K2)
4. Illustrate the various aspects of atmospheric chemistry with a focus on climate change and recognize the principles of green chemistry. Describe suitable scientific, technological solutions and Protection Acts to eradicate social and environmental issues. (K2)
5. Recognize the need for population control measures and the environmental based value education concepts to achieve the Sustainable Development Goals. (K2)

CO - PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	1	2	-	1	1	-	2
CO2	2	2	2	-	2	2	3	1	2	2	-	2
CO3	1	1	1	1	-	1	1	-	1	2	-	1
CO4	2	2	2	2	1	1	1	-	1	1	1	1
CO5	2	2	1	-	-	1	1	-	-	-	1	-
CO6	1	1	1	1	1	1	1	1	1	1	1	1

SEMESTER - II

20ESEE201	ELECTRICAL TECHNOLOGY	L	T	P	C
SDG NO. 4 & 9	WITH LABORATORY	3	0	2	4

OBJECTIVES:

- To impart knowledge on Electric circuit laws.
- To impart the Construction and working principles of Electrical Machines.
- To introduce about the Electrical drives and its applications.

UNIT I ELECTRICAL CIRCUITS 9

Basic Circuit Components - Ohms Law - Kirchoff's Law – Steady State Solution of DC Circuits - Nodal Analysis, Mesh Analysis - Thevinin's Theorem - Norton's Theorem - Maximum Power Transfer Theorem - Linearity and Superposition Theorem - Introduction to AC Circuits – Single Phase and Three - Phase Circuits - Power and Power Factor

UNIT II TRANSFORMER & DC MACHINE 9

Construction – Principle of Operation – EMF Equation pf Transformer – DC Machine – Construction and Working – Types of DC Motor – Principle and Operations – Types of DC Motor – Torque Equation.

UNIT III AC MACHINES 9

Construction and Principles of Operation of; Synchronous Machines -Three Phase and Single Phase Induction Motors – Torque Equation - Characteristics of Three Phase and Single Phase Induction Motor.

UNIT IV STARTING METHODS & ELECTRICAL BRAKING 9

Need for Starters - Types of DC Motor Starters – Typical Control Circuits for Shunt and Series Motors - Three Phase Squirrel Cage and Slip Ring Induction Motors – Electrical Braking.

UNIT V ELECTRICAL DRIVES 9

Basic Elements – Types of Electric Drives – Factors Influencing the Choice of Electrical Drives – Heating and Cooling Curves – Loading Conditions and Classes of Duty - Applications.

LIST OF EXPERIMENTS: 15
1. Verification of Circuit Laws
2. Verification of Network Theorems
3. Load test on DC Shunt motor
4. Load test on DC Series motor
5. Speed control of DC shunt motor (Armature, Field control)
6. Load test on single phase transformer
7. Load test on three phase squirrel cage Induction motor

TOTAL : 60 PERIODS

TEXT BOOKS:
1. A. E. Fitzgerald, Kingsely Jr Charles, D. Umans Stephen, "Electric Machinery", Tata McGraw Hill, Sixth Edition, 2003.

2. B. L. Theraja, "A Textbook of Electrical Technology", (vol. I), Chand and Company Ltd., New Delhi, 2005.
3. V. K. Mehta, "Basic Electrical Engineering", S. Chand and Company Ltd., New Delhi, 2008.

REFERENCES:
1. William H. Hayt & Jack E. Kemmerly, "Engineering Circuit Analysis", McGraw-Hill Book Company Inc., 2006.
2. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson Education., 5th Edition, 2002.
3. B.R. Gupta ,'Fundamental of Electric Machines' New age International Publishers, 3rd Edition ,Reprint 2015.
4. S.K. Bhattacharya, "Electrical Machines", Mc Graw -Hill Education, New Delhi, 3rd Edition,2009.

WEB RESOURCES:
1. https://www.springerprofessional.de/en/electrical-machines-and-drives/15402586?tocPage=1
2. https://www.academia.edu/37967928/a-textbook_of_electrical_technology_volume_II_ac_and_dc_machines_BL.Theraja.pdf._BUKU_BL.THERAJA_VOL_II

ONLINE RESOURCES:
1. https://swayam.gov.in/nd1_noc19_ee69/preview
2. https://nptel.ac.in/courses/108102146/
3. https://www.coursera.org/lecture/motors-circuits-design/1-course-introduction-EP7KP

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand electric circuits and apply circuit theorems. (K2)
2. Apply the knowledge of electric circuits for engineering application. (K3)
3. Understand the working principles of various electrical machines. (K2)
4. Choose the electrical machines for different applications. (K3)
5. Analyze the performance of electrical machines and electrical circuits in practical. (K4)
6. Build the knowledge to select the starters and braking for electrcial machines. (K2)

CO- PO,PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	-	-	-	-	-	3	3
CO2	3	3	2	2	1	1	1	-	-	-	-	1	3	3
CO3	3	2	1	2	1	1	-	-	-	-	1	-	2	3
CO4	3	2	2	1	-	1	1	-	-	-	1	1	2	3
CO5	3	3	2	1	1	-	-	-	-	-	-	-	3	3
CO6	3	2	1	1	1	-	-	-	-	-	1	-	3	3

SEMESTER - II

20BSPH202 **SDG NO. 4**	**PHYSICS OF MATERIALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:
- To introduce the formation of alloy and phase diagrams
- To interpret the properties of ferrous alloys and its uses
- To familiarize the mechanical properties of materials
- To expose the magnetic, dielectric and superconducting materials properties and application
- To explicate the properties and applications of advanced materials

UNIT I   ALLOY FORMATION AND PHASE DIAGRAMS   9

Types of alloys - Solid solutions - Hume Rothery's rules - the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the Tie-line rule - Lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions - free energy composition curves for binary systems - micro structural change during cooling

UNIT II   FERROUS ALLOYS   9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlite, bainte and martensite transformations - tempering of martensite.

UNIT III   MECHANICAL PROPERTIES 9

Tensile test - plastic deformation mechanisms - slip and twinning - role of dislocations in slip - strengthening methods - strain hardening - refinement of the grain size - solid solution strengthening - precipitation hardening - creep resistance - creep curves - mechanisms of creep - creep-resistant materials - fracture - the Griffith criterion - critical stress intensity factor and its determination - fatigue failure - fatigue tests - methods of increasing fatigue life - hardness - Brinell hardness - Vickers microhardness.

UNIT IV MAGNETIC, DIELECTRIC AND SUPERCONDUCTING
MATERIALS 9

Ferromagnetism - domain theory - types of energy - hysteresis - hard and soft magnetic materials - ferrites - dielectric materials - types of polarization - Langevin-Debye equation - frequency effects on polarization - dielectric breakdown - Insulating materials -Ferroelectric materials - superconducting materials - properties - applications.

UNIT V ADVANCED MATERIALS 9

Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications - shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications – Advanced ceramics –applications – composites: classification, role of matrix and reinforcement – nanomaterials: preparation (bottom up and top down approaches), properties and applications – carbon nanotubes: types.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. W.F.Smith , J. Hashemi , & R.J.Prakash, "Materials Science and Engineering", Tata McGraw Hill Education Pvt. Ltd., 2014.
2. R.Balasubramaniam, "Callister's Materials Science and Engineering", Wiley India Pvt. Ltd., 2014.
3. V.Raghavan, "Physical Metallurgy: Principles and Practice", PHI Learning, 2015.
4. William D. Callister Jr., David G.Rethwisch, "Callister's Materials Science and Engineering", 10th edition, Global edition, John Wiley & Sons, 2019.
5. Donald R Askeland, Wedelin J Wright, "Essentials of Materials Science and Engineering", Cengage Learning India Private Ltd., 2018.

REFERENCES
1. George Dieter, "Mechanical Metallurgy",. McGraw Hill ,2013.
2. James F. Shackelford, " Introduction to Materials Science for Engineers", 8th edition, 8th edition, Pearson, 2015.

3. O.P.Kanna, " Materials science and Metallurgy", Dhanpat Raj Publications, 2nd edition, 2014.
4. Susan Troiler –Mckinstry and Robert E. Newnham, "Materials Engineering: Bonding, Structure, Structure – property relationship" Cambridge University press, 2018.
5. A.Daniel, Brandt, J.C.Warner, " Metallurgy Fundamentals: Ferro and Non Ferrous" 6th edition, Good Heart Wilcox, 2019.

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand the concept of formation of alloys and invariant phase reactions realted to unary and binary system (K2)
2. Demonstrate the practical exposure on microstructure, phase transformation, effect of alloying elements in ferrous alloys and their applications (K2)
3. Explain the phase transformation TTT diagram,various testing procedures for understanding the properties of materials and strengthening methods (K2)
4. Understand the basic knowledge of ferromagnetic and ferrimagnetic materials (K2)
5. Gain knowledge on dielectric, super conducting, composite, ceramic materials,metallic glasses,shape memory alloys,nanomaterials and their properties (K2).
6. Apply the suitable superconducting, ceramic, nano,composite materials and shape memory alloys for specific engineering applications (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	3	-	2	-	-	-	-	1
CO2	3	3	2	-	3	-	2	-	-	-	-	2
CO3	3	3	2	-	3	-	2	-	-	-	-	2
CO4	3	3	2	-	3	-	2	-	-	-	-	2
CO5	3	3	2	-	3	-	2	-	-	-	-	2
CO6	3	3	2	-	3	-	2	-	-	-	-	1

SEMESTER - II

20ESGE201	ENGINEERING PRACTICES	L	T	P	C
SDG NO. 4,9,12	LABORATORY	0	0	3	1.5

OBJECTIVES:
- To provide exposure to the students with hands on experience on various basic engineering practices in Electrical and Electronics Engineering, Civil and Mechanical Engineering

ELECTRICAL ENGINEERING PRACTICE
1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of electrical equipment.

ELECTRONICS ENGINEERING PRACTICE
1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

CIVIL ENGINEERING PRACTICE
Buildings:
Study of plumbing and carpentry components of residential and industrial buildings, safety aspects.

Plumbing Works:
1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
2. Study of pipe connections requirements for pumps and turbines.

3. Preparation of plumbing line sketches for water supply and sewage works.
4. Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
5. Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:
1. Study of the joints in roofs, doors, windows and furniture.
2. Hands-on-exercise: Wood work, joints by sawing, planing and cutting.

MECHANICAL ENGINEERING PRACTICE

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

Basic Machining:
1. Simple Turning and Taper turning.
2. Drilling Practice.

Sheet Metal Work:
1. Forming & Bending.
2. Model making – Trays and funnels.
3. Different type of joints.

Machine assembly practice:
1. Study of centrifugal pump.
2. Study of air conditioner.

Demonstration on:
1. Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
2. Foundry operations like mould preparation for gear and step cone pulley.
3. Fitting – Exercises – Preparation of square fitting and V – fitting models.

Total : 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Electrical

1	Assorted electrical components for house wiring	15 Sets
2	Electrical measuring instruments	10 Sets
3	Study purpose items:	
	Iron box, fan and regulator, emergency lamp	1 Each
4	Megger (250V/500V)	1 No
5	Power Tools:	
	Range Finder	2 Nos
	Digital Live-wire detector	2 Nos

2. Electronics

1	Soldering guns	10 Nos
2	Assorted electronic components for making circuits	50 Nos
3	Small PCBs	10 Nos
4	Multimeters	10 Nos

3. Civil

1	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets
2	Carpentry vice (fitted to work bench)	15 Nos
3	Standard woodworking tools	15 Sets
4	Models of industrial trusses, door joints, furniture joints	5 each
5	Power Tools:	
	Rotary Hammer	2 Nos
	Demolition Hammer	2 Nos
	Circular Saw	2 Nos
	Planer	2 Nos
	Hand Drilling Machine	2 Nos
	Jigsaw	2 Nos

4. Mechanical

1	Arc welding transformer with cables and holders	5 Nos
2	Welding booth with exhaust facility	5 Nos
3	Welding accessories like welding shield, chipping hammer, wire brush, etc	5 Sets
4	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos

5	Centre lathe	2 Nos
6	Hearth furnace, anvil and smithy tools	2 Sets
7	Moulding table, foundry tools	2 Sets
8	Power Tool: Angle Grinder	2 Nos
9	Study-purpose items: centrifugal pump, air-conditioner	1 each

OUTCOMES:

Upon completion of the course, the students should be able to

1. Elaborate on the components, gates, soldering practices. Calculate electrical parameters such as voltage, current, resistance and power. (K1)
2. Design and implement Rectifier and Timer circuits (K2)
3. Measure the electrical energy by single phase and three phase energy meters. (K2)
4. Prepare the carpentry and plumbing joints. (K2)
5. Perform different types of welding joints and sheet metal works (K2)
6. Perform different machining operations in lathe and drilling. (K2)

CO - PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	1	-	-	1	1	1	1
CO2	3	2	1	1	2	1	-	-	1	1	1	1
CO3	2	2	1	1	1	1	-	-	1	1	1	1
CO4	1	1	1	-	-	2	-	-	1	1	1	2
CO5	2	1	1	-	-	1	1	1	1	1	1	2
CO6	2	1	1	-	-	1	-	1	1	1	1	2

SEMESTER - II

20TPHS201	SKILL ENHANCEMENT	L	T	P	C
SDG NO. 4&5		0	0	2	1

OBJECTIVES:
- To understand the nuances in resume building
- To explore various virtual meeting tools
- To gain knowledge about online certification courses
- To develop knowledge in Google Suite products
- To enhance presentation skills

UNIT I   RESUME BUILDING   6
Your Strength, Projects, Internship, Paper Presentation, uploading your coding in github, Introduction to HackerRank, HackerEarth virtual online assessment (Auto Proctored) (Practicals - Construct a resume, Register for a online Mock Assessment / Contest)

UNIT II   VIRTUAL MEETINGS   6
Basic Etiquette of virtual meeting – Introduction to Skype - Zoom - Webex - Google Meet - Gotowebinar - Jio meet – Screen Share - Jamboard - Feedback polling - Chatbox
(Practicals - Accept and Register for a mock class to attend - How to host a meeting).

UNIT III ONLINE LEARNING   6
Online Certification - Coursera – Udemy – Edx – Cisco – Online Practice Platforms - SkillRack – Myslate - FACEprep - BYTS - aptimithra - Contest Registrations - TCS Campus Commune - HackwithInfy, InfyTQ - Virtusa NurualHack - Mindtree Osmosis – Online assessment - AMCAT-PGPA.
(Practicals - Campus Commune Registration , Coursera registration - Mock Registration (KAAR Technologies as sample).

UNIT IV   GOOGLE SUITE   8
Define google suite - Benefits of google suite - Google Search - Sheet - Docs - Forms - Calender - Drive - Slide - Translate - Duo - Earch - Maps - Hangouts- Sites - Books - Blogger
(Practicals – Create google sheets and share - Create google Forms and share, Create Google Slide and share , Google drive creation and share (Knowledge of Rights), Create poll and share.

UNIT V PRESENTATION SKILLS 4

Email Writing – Group Discussion - Power Point Presentation
(Practicals- Create a self SWOT Analysis report. A PowerPoint Slide Preparation)

TOTAL : 30 PERIODS

WEB REFERENCES :
Unit I: Resume Building:
1. https://zety.com/blog/resume-tips
2. https://resumegenius.com/blog/resume-help/how-to-write-a-resume
3. https://www.hackerearth.com/recruit/
4. https://www.hackerrank.com/about-us

Unit – II:Virtual Meetings
1. https://www.claphamschool.org/our-community/blog/online-learning-etiquette-guide-14-principles-to-guide-students
2. https://online.hbs.edu/blog/post/virtual-interview-tips?c1=GAW_SE_NW&source=IN_GEN_DSA&cr2=search__-__nw__-__in__-__dsa__-__general&kw=dsa__-__general& cr5=459341920955&cr7=c&gclid=Cj0KCQjw8fr7BRDSARIsAK0Qqr4dRRbboL3kltrwDsr7hm8oIHtN5dfjD3NIFZULuzNwEXxhjpNFQ2caApn5EALw_wcB
3. https://hygger.io/blog/top-10-best-group-meeting-apps-business/
4. https://www.zdnet.com/article/best-video-conferencing-software-and-services-for-business/

Unit – III:Online Learning
1. https://www.coursera.org/browse
2. https://support.udemy.com/hc/en-us/articles/229603868-Certificate-of-Completion
3. https://www.edx.org/course/how-to-learn-online
4. https://www.cisco.com/c/en/us/training-events/training-certifications/certifications.html
5. https://campuscommune.tcs.com/en-in/intro
6. https://www.freshersnow.com/tcs-campus-commune-registration/
7. https://www.infosys.com/careers/hackwithinfy.html
8. https://www.mindtree.com/blog/osmosis-2013-my-experiences
9. https://www.myamcat.com/knowing-amcat
10. https://www.admitkard.com/blog/2020/02/06/amcat/

Unit IV: Google Suite
1. https://www.inmotionhosting.com/blog/what-is-g-suite-and-why-should-i-consider-using-it/
2. https://en.wikipedia.org/wiki/G_Suite
3. https://blog.hubspot.com/marketing/google-suite
4. https://kinsta.com/blog/g-suite/

Unit V: Presentation Skills
1. https://www.mindtools.com/CommSkll/EmailCommunication.htm
2. https://www.grammarly.com/blog/email-writing-tips/
3. https://business.tutsplus.com/articles/how-to-write-a-formal-email--cms-29793
4. https://www.softwaretestinghelp.com/how-to-crack-the-gd/
5. https://www.mbauniverse.com/group-discussion/tips
6. https://slidemodel.com/23-powerpoint-presentation-tips-creating-engaging-interactive-presentations/
7. https://business.tutsplus.com/articles/37-effective-powerpoint-presentation-tips--cms-25421
8 https://blog.prezi.com/9-tips-on-how-to-make-a-presentation-a-success/
9. http://www.garrreynolds.com/preso-tips/design/

OUTCOMES:

On completion of this course, the student should be able to
1. Construct a suitable resume and registration procedure for online mock assessments. (K1)
2. Handle various virtual meeting tools. (K3)
3. Acquire exposure about online certification courses. (K4)
4. Get involved and work in a collaborative manner. (K2)
5. Gain knowledge in various presentation methodologies. (K1)
6. Apply knowledge to practice Google suite features and SWOT analysis. (K3)

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	3	2	-	3	2	3	-	2
CO2	-	-	-	-	3	2	-	3	2	3	-	2
CO3	-	-	-	-	3	2	-	-	1	3	-	2
CO4	-	-	-	-	3	2	-	3	3	3	-	2
CO5	-	-	-	-	3	2	-	-	2	3	-	2
CO6	-	-	-	-	3	2	-	-	2	3	-	2

SEMESTER - II

20HSMG201 SDG NO. 4 & 5	INTERPERSONAL VALUES	L	T	P	C
		2	0	0	0

OBJECTIVES:
- Values through Practical activities

UNIT I INTERPERSONAL VALUES   **6**
Interpersonal Relationships and Values – Importance and Barriers – Building and maintain relationships – Mutual understanding – Respect to others.

UNIT II EFFECTIVE COMMUNICATION   **6**
Communication skills –Importance and Barriers - Impressive formation and management – Public speaking

UNIT III GROUP DYNAMICS   **6**
Group formation –Teamwork – Identify others attitude and behaviour – Formation of relationship – Personal and professional.

UNIT IV MUTUAL RELATIONSHIP   **6**
Building mutual understanding and cooperation – Enhancing decision making skills – Problem solving skills – Comparative Appraisal – Interpersonal needs.

UNIT V POSITIVE ATTITUDE 6

Fostering trust and cooperation – Developing and maintain positive attitude – Improving socialization – Development of security and comfort.

TOTAL: 30 PERIODS

Note: Each topic in all the above units will be supplemented by practice exercises and classroom activities and projects.

REFERENCE BOOKS:
1. Barun K. Mitra, "Personality Development and Soft Skills", Oxford University Press, 2016.
2. B.N.Ghosh, "Managing Soft Skills for Personality Development", McGraw Hill India, 2012.

OUTCOMES:
Upon completion of the course, the student should be able to
1. Develop a healthy relationship & harmony with others. (K1)
2. Practice respecting every human being. (K3)
3. Practice to eradicate negative temperaments. (K3)
4. Acquire Respect, Honesty, Empathy, Forgiveness and Equality. (K4)
5. Manage the cognitive abilities of an Individual. (K5)
6. Understanding the importance of public speaking and teamwork. (K2)

CO – PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	3	3	1	1	1
CO2	-	-	-	-	-	2	2	3	3	1	1	1
CO3	-	-	-	-	-	2	2	3	3	1	1	1
CO4	-	-	-	-	-	2	2	3	3	1	1	1
CO5	-	-	-	-	-	2	2	3	3	1	1	1
CO6	-	-	-	-	-	2	2	3	3	1	1	1

SEMESTER - II

20HSTA101	HERITAGE OF TAMILS	L	T	P	C
SDG NO. 4		1	0	0	1

UNIT I   LANGUAGE AND LITERATURE   3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II   HERITAGE - ROCK ART PAINTINGS TO MODERN
**   ART – SCULPTURE   3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III   FOLK AND MARTIAL ARTS   3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS   3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V   CONTRIBUTION OF TAMILS TO INDIAN NATIONAL
**   MOVEMENT AND INDIAN CULTURE   3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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. பொருநை - 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.

தமிழர் மரபு

அலகு I   மொழி மற்றும் இலக்கியம்: 3
இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் 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 வளர - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - கதர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் 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, ஓயிலொட்டம், தொல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திறைக் கோட்பாடுகள்: 3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்கொப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்ப்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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. பொருநை - 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 - III

20ESCE201 SDG NO. 4 & 5	ENGINEERING MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I   STATICS OF PARTICLES 10

Introduction – Units And Dimensions – Laws of Mechanics – Newton's Laws - lami's Theorem- Parallelogram, Triangular Law and Polygon Law of Forces- principle of Transmissibility - Vectorial Representation of Forces – Fundamental Vector Operations of Forces – Free Body Diagram - Equilibrium of a Particle in 2 D – Forces in Space – Equilibrium of a Particle in Space – Equivalent Systems of Forces.

UNIT II EQUILIBRIUM OF RIGID BODIES 10

Moments And Couples - Vectorial Representation – Scalar Components of a Moment – Varignon's Theorem- Moment of a Force About a Point and About an Axis- Single Equivalent Force - Types of Supports – Action and Reaction Forces – Types of Equilibrium - Equilibrium of Rigid Bodies in Two and Three Dimensions.

UNIT III FRICTION 7

Friction Force – Types of Friction - Laws of Coulomb Friction – Simple Contact Friction - Two Bodies in Contact - Wedge Friction, Ladder Friction - Rolling Resistance.

UNIT IV PROPERTIES OF SURFACES AND SOLIDS 9

Centroids and Centre of Mass and Volume – Simple and Composite Areas and Solids - Theorems of pappus - Area Moments of Inertia of Composite Areas – Parallel Axis Theorem and Perpendicular Axis Theorem – Polar Moment of Inertia - Radius of Gyration - Product of Inertia - Principal Moments of Inertia of Plane Areas and Composite Areas – Principal Axes of Inertia - Mass Moment of Inertia – Prismatic, Cylindrical and Spherical Solids from First Principle.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9

Displacement, Velocity and Acceleration – Relative Motion -Curvilinear Motion - Newton's Laws of Motion – D' Alembert's Principle, Work Energy

Principle - Impulse and Momentum – Impact of Elastic Bodies. Rigid Body Motion - Translation and Rotation – General Plane Motion of Simple Rigid Bodies such as Cylinder, Disc / Wheel and Sphere.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 12th Edition, Tata McGraw-Hill Publishing company, New Delhi, 2004.
2. Dubey, N.H, "Engineering Mechanics – Statics and Dynamics", McGraw Hill Education (India) Pvt Ltd.

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 14thEdition, Pearson Education 2010.
3. Irving H. Shames and Krishna MohanaRao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
5. Kottiswaran. N, Engineering Mechanics (Statics and Dynamics), Sri Balaji Publications, Erode.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/105/112105164/
2. https://nptel.ac.in/courses/112/103/112103109/

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112/106/112106286/
2. https://nptel.ac.in/courses/112/103/112103108/
3. https://nptel.ac.in/courses/112/106/112106180/
4. https://www.coursera.org/learn/engineering-mechanics-statics

OUTCOMES:
Upon completion of the course, the students should be able to

1. Apply the Fundamental concepts of Mechanics and operation of forces to solve equilibrium of particles in 2D and 3D (K3)
2. Apply Varignon's theorem to equilibrium of rigid bodies in 2D & 3D (K3)
3. Apply coulombs law of friction to calculate contact friction, wedge friction, ladder friction and rolling resistance. (K3)

4. Calculate the centroid, centre of mass, volume and area of simple, composite solids using Theorem of Pappus. (K2)
5. Calculate the moment of inertia, product of inertia, radius of gyration of plane & composite areas and mass moment of inertia of prismatic, cylindrical and spherical solids (K2)
6. Determine relative and curvilinear motion using equations of motion and impulse, momentum, impact of elastic bodies, general plane motion of rigid bodies.(K3)

CO – PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	-	-	-	-	-	-	-	-	1	1
CO2	3	2	-	1	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	1	-	-	-	-	-	-	-	-	1	1
CO4	2	1	-	1	-	-	-	-	-	-	-	-	1	1
CO5	2	1	-	1	-	-	-	-	-	-	-	-	1	1
CO6	3	2	-	1	-	-	-	-	-	-	-	-	1	1

SEMESTER - III

20MUPC301	**BASIC MANUFACTURING**	L	T	P	C
SDG NO. 4,9,12,13	**PROCESSES**	3	0	0	3

OBJECTIVES:

- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and metal cutting.
- To understand the working of standard machine tools such as lathe, milling, drilling and allied machines, grinding and allied machines.
- To transform Raw Material into a Finished Product using various Manufacturing Processes.
- To identify appropriate Manufacturing process for producing a component in a least expensive possible way

UNIT I   METAL CASTING AND WELDING   9

Sand Casting Mould – Type of Patterns - Pattern Materials – Pattern Allowances – Moulding Sand Properties and Testing – Cores – Types and Applications – Moulding Machines– Types and Applications – Special Casting Techniques; Defects in Casting. Welding: Fusion Welding - Operating Principle, Basic Equipment, Merits and Applications: Gas Welding - Types – Flame Characteristics; Manual Metal Arc Welding – Gas Tungsten Arc Welding- Gas Metal Arc Welding – Submerged Arc Welding – Electro Slag Welding, Friction Stir Welding, Plasma, Laser Welding; Resistance Welding - Brazing and Soldering; Weld Defects.

UNIT II METAL FORMING PROCESSES   9

Hot Working and Cold Working of Metals – Forging Processes – Open, Impression and Closed Die Forging – Forging Operations. Rolling of Metals– Types of Rolling – Flat Strip Rolling – Shape Rolling Operations – Defects in Rolled Parts. Principle of Rod and Wire Drawing – Tube Drawing – Principles of Extrusion – Types – Hot and Cold Extrusion. Sheet Metal Characteristics –Shearing, Bending and Drawing Operations – Stretch Forming Operations.

UNIT III THEORY OF METAL CUTTING AND TURNING MACHINES   9

Mechanism of Metal Cutting, Cutting Forces, Merchant's Circle, Cutting Tool Nomenclature, Types of Chips, Tool Materials and Cutting Fluids, Taylor's Equation, Machining Variables, Machinability.

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: Semiautomatic – Single spindle: Swiss Type, Automatic Screw Type – Multi Spindle.

UNIT IV DRILLING, MILLING AND GEAR CUTTING MACHINES   9

Drilling, Tapping, Reaming and Boring, Milling Operations - Types of Milling Cutter and Nomenclature. Gear Cutting – Forming and Generation Principle and Construction of Gear Milling, Hobbing and Gear Shaping Processes – Finishing of Gears.

UNIT V ABRASIVE PROCESSES   9

Abrasive Processes: Grinding Wheel – Specifications and Selection, Types of Grinding Process– Cylindrical Grinding, Surface Grinding, Centreless Grinding and Internal Grinding - Typical Applications Concepts of Surface Integrity.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India, 8thEdition, 2019.
2. HajraChoudhary S.K and HajraChoudhary. A.K., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008.

REFERENCES:
1. Paul Degarmo E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" 9thEdition, Prentice – Hall of India, 2003.
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 45thEdition, TMH-2018
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006
4. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2019.
5. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 4thEdition, Tata McGraw-Hill, New Delhi, 2018.

WEB RESOURCES:
1. https://nptel.ac.in/courses/112/107/112107144/
2. https://nptel.ac.in/courses/112/105/112105127/
3. https://nptel.ac.in/courses/112/107/112107084/
4. https://nptel.ac.in/courses/112/106/112106153/
5. http://web.mit.edu/2.810/www/files/lectures/lec5-machining-2018.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/107/112107145/
2. https://nptel.ac.in/courses/112/105/112105126/
3. https://nptel.ac.in/courses/112/104/112104195/
4. https://nptel.ac.in/courses/112/107/112107219/
5. https://nptel.ac.in/courses/112/107/112107083/
6. https://nptel.ac.in/courses/112/107/112107215/
7. https://nptel.ac.in/courses/112/103/112103248/
8. https://nptel.ac.in/courses/112/103/112103250/
9. https://nptel.ac.in/courses/112/107/112107089/
10. https://www.mooc-list.com/course/fundamentals-manufacturing-processes-edx

OUTCOMES:

Upon completion of the course, the students should be able to

1. Explain different Metal casting & Joining processes, associated defects, merits and demerits. (K2)
2. Summarize various hot working and cold working methods of metals and explain various sheet metal making processes. (K2)
3. Interpret metal cutting theory based on cutting force and power consumption. (K2)
4. Describe the constructional and operational features of centre lathe and other special purpose lathes.(K2)
5. Discuss the working construction of various milling, drilling and gear cutting machines.(K2)
6. Explain the types of various abrasive process.(K2)

CO – PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	-	-	-	1	2	2	2
CO2	3	2	2	2	1	1	1	-	-	-	1	2	2	2
CO3	3	2	2	2	1	1	1	-	-	-	1	2	2	2
CO4	3	2	2	2	1	1	1	-	-	-	1	2	2	2
CO5	3	2	2	2	1	1	1	-	-	-	1	2	2	2
CO6	3	2	2	2	1	1	1	-	-	-	2	2	2	2

SEMESTER - III

20MEPC302 SDG NO. 4,7,12,15	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	1	0	4

(Use of Standard and approved Steam Table, Mollier Chart, Compressibility Chart and Psychrometric Chart are permitted)

OBJECTIVES:

- Enable students to analyze and evaluate various thermodynamic cycles used for energy production - work and heat within the natural limits of conversion

- To enable student to understand the concepts of system, entropy and availability.
- To impart the concepts of ideal, real gases and the various gas relations associated with it.
- To make student understand about the concepts of Gas mixtures and psychrometry.

UNIT I   BASIC CONCEPTS AND FIRST LAW   9

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach - Path and point functions - Intensive and extensive properties. System and their types. Thermodynamic Equilibrium State, path and process - Quasi-static, reversible and irreversible processes - Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work, p-V diagram - Zeroth law of thermodynamics – concept of temperature and thermal equilibrium – relationship between temperature scales –new temperature scales - First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND AVAILABILITY ANALYSIS   9

Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump - Statements of second law and its corollaries - Carnot cycle ,Reversed Carnot cycle, Performance. Clausius inequality - Concept of entropy, T-s diagram, T-ds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy - Space applications of II Law - High and low grade energy - Available and non-available energy of a source and finite body - Energy and irreversibility - Expressions for the energy of a closed system and open systems - Energy balance and entropy generation - Irreversibility.

UNIT III   PROPERTIES OF PURE SUBSTANCE AND STEAM
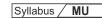##   POWER CYCLE   9

Formation of steam and its thermodynamic properties: p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surface - Use of Steam Table and Mollier Chart - Determination of dryness fraction - Application of I and II law for pure substances - Ideal and actual Rankine cycles, Cycle Improvement Methods -Reheat and Regenerative cycles, Economiser, pre heater, Binary and Combined cycles.

UNIT IV IDEAL, REAL GASES AND THERMODYNAMIC
RELATIONS   9

Properties of Ideal gas - Ideal and real gas comparison- Equations of state for ideal and real gases Reduced properties - Compressibility factor - Principle of Corresponding states – Generalised Compressibility Chart and its use-

Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY   9

Mole and Mass fraction, Dalton's and Amagat's Law - Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function - Psychrometric properties, Psychrometric charts - Property calculations of air vapour mixtures by using chart and expressions - Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing - Simple Applications

TOTAL: 45 PERIODS

TEXT BOOKS:
1. R.K.Rajput, "A Text Book Of Engineering Thermodynamics", Fifth Edition,2017.
2. Yunus A. Cengel& Michael A. Boles, "Thermodynamics", 8th edition 2015.

REFERENCES :
1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Borgnakke & Sonnatag, "Fundamental of Thermodynamics", 8th Edition , 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", 8th Edition.
5. Nag.P.K., "Engineering Thermodynamics", 5th Edition, Tata McGraw-Hill, New Delhi, 2013

WEB RESOURCES:
1. https://nptel.ac.in/courses/112/104/112104113/
2. https://nptel.ac.in/courses/112/108/112108148/
3. https://www.mcgoodwin.net/pages/thermodynamics.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/102/112102255/
2. https://nptel.ac.in/courses/112/105/112105123/
3. https://nptel.ac.in/courses/101/104/101104063/
4. https://nptel.ac.in/courses/101/104/101104067/
5. https://nptel.ac.in/courses/112/105/112105220/

6.   https://nptel.ac.in/courses/112/105/112105266/
7.   https://nptel.ac.in/courses/112/103/112103275/

OUTCOMES:

Upon completion of the course, the students should be able to

1.   Describe the various thermodynamics systems and its associated laws (K1)
2.   State and apply the laws of thermodynamics for various thermal systems (K2)
3.   Illustrate the concept of available and unavailable energies for different thermodynamic systems (K3)
4.   Identify the suitable thermodynamic cycle for power developing and cooling systems (K3)
5.   Derive the thermodynamic relations for real and ideal gases and gas mixtures (K3)
6.   Make use of Thermodynamic charts and tables to obtain the properties for various processes (K3)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO2	3	3	-	-	-	-	-	2	-	-	-	1	3	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	3	-	-	-	-	-	-	-	-	-	1	3	3
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO6	3	3	-	-	-	-	-	2	-	-	-	-	3	3

SEMESTER - III

20MUPW301	SENSORS IN AUTOMATION	L	T	P	C
SDG NO. 4,9		3	0	2	4

OBJECTIVES:
- To understand the concepts of measurement technology
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal data acquisition and communication systems used in automation system development.

UNIT I   INTRODUCTION **9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS **9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS **7**

Strain Gauge, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS **11**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V DAQ SYSTEMS AND APPLICATIONS **9**

Data Acquisition: Single channel and multi-channel data acquisition – Data logging - Applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL : 45 PERIODS

LABORATORY EXPERIMENTS: **PERIODS: 15HRS**

1. Displacement versus output voltage characteristics of a potentiometric transducer.
2. Characteristics of Strain gauge and Load cell.
3. Characteristics of LVDT and Photoelectric transducer.
4. Characteristic and Step response of RTD.
5. Characteristic and Step response of Thermocouple.
6. Characteristic and Thermistor.
7. Measurement of Angular displacement using resistive and capacitive transducer.

TEXTBOOKS

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 7th Edition, 2009.
2. Sawney A K and PuneetSawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, DhanpatRai& Co, New Delhi, 2013

REFERENCE BOOKS

1. Sujatha, C., Dyer, S.A., "Survey of Instrumentation and Measurement", John Wiley & Sons, Canada, 2004.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015

WEB RESOURCES:

1. https://swayam.gov.in/nd1_noc19_ee41/preview
2. https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf

ONLINE RESOURCES:

1. https://instrumentationtools.com/tag/sensors-and-transducers-nptelpdf/
2. https://electronics-tutorials.ws/io/io

OUTCOMES:

Upon completion of the course, the student should be able to

1. Familiar with various calibration techniques and signal types for sensors (K1)
2. Explain the various sensors used in Automotive and Mechatronics applications (K2)
3. Describe the working principle and characteristics of force, magnetic and heading sensors (K1).
4. Understand the basic principles of various pressure and temperature, smart sensors (K1)
5. Understand the basic principles of various optical and smart sensors (K1)
6. Ability to implement the DAQ systems with different sensors for real time applications (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	1	-	-	-	1	-	-	-	-	-	1	1
CO2	1	1	2	1	-	1	1	1	-	-	-	-	1	2
CO3	1	-	-	1	1	-	-	-	-	-	-	-	1	1
CO4	1	-	-	-	2	1	1	1	-	-	-	1	1	1
CO5	1	-	-	-	2	1	1	1	-	-	-	1	1	2
CO6	1	1	2	1	2	1	1	1	1	-	1	2	1	2

SEMESTER - III

20BSMA303 SDG NO. 4	PARTIAL DIFFERENTIAL EQUATIONS AND PROBABILITY THEORY	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To introduce Fourier Transform techniques for applications in engineering problems.
- To provide necessary basic concepts in probability theory and random variables.

● To understand the basic concepts of probability, one dimensional and two-dimensional random variables. Introduce some standard distributions applicable to engineering which can describe real life phenomenon.

UNIT I   PARTIAL DIFFERENTIAL EQUATIONS   12

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS   12

Classification of Partial Differential Equations – Method of separation of variables – Fourier Series Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction.

UNIT III 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.

UNIT IV   PROBABILITY AND RANDOM VARIABLES   12

Probability – Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT V TWO – DIMENSIONAL RANDOM VARIABLES   12

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

TOTAL: 60 PERIODS

TEXT BOOKS:

1.   Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
2.   Veerarajan. T., "Transforms and Partial Differential Equations", Tata Mc-Graw Hill Education Pvt. Ltd., New Delhi, Third print, 2016.

REFERENCES:
1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
2. Trivedi K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2nd Edition, 2002.
3. Ray Wylie. C and Barrett L.C, "Advanced Engineering Mathematics" Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012
4. Ramana B.V., "Higher Engineering Mathematics", Tata Mc Graw Hill Publishing Company Limited, NewDelhi, 2008.
5. Yates R.D. and Goodman D. J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.
6. Ibe O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.
7. Veerarajan T., "Probability,Statistics and Random Processes", Tata McGraw Hill   Education Pvt. Ltd., New Delhi, Third print, 2016.
8. Narayanan S., Manicavachagom Pillay T.K. and Ramanaiah G., "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt. Ltd.1998.

WEB RESOURCES:
1. https://ocw.mit.edu/courses/mathematics/18-600-probability-and-random-variables-fall-2019/lecture-notes/index.htm
2. https://nptel.ac.in/courses/122103012/

ONLINE RESOURCES:
1. https://youtu.be/vEt3eqihm80
2. https://www.youtube.com/watch?v=bjybXMwWjjc

OUTCOMES:
Upon completion of the course, the students should be able to
1. Solve first, higher order linear and nonlinear partial differential equations with constant coefficients and find the variable separable solution of partial differential equations. (K3)
2. Find the Fourier series solution of one-dimensional wave equation, one dimensional and two-dimensional heat equations. (K3)
3. Compute the Fourier and Inverse Fourier Transform, Sine and Cosine Transform of simple functions. (K3)
4. Calculate the probability, conditional probability and statistical averages of one dimensional discrete and continuous random variables and corresponding probability distributions. (K3)

5. Find the relation between two-dimensional random variables and their transformations. (K3)

CO- PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	-	-	1
CO2	3	3	3	2	-	-	-	-	-	-	-	1
CO3	3	3	3	2	-	-	-	-	-	-	-	1
CO4	3	3	3	2	-	-	-	-	-	-	-	1
CO5	3	3	3	2	-	-	-	-	-	-	-	1

SEMESTER - III

20EIPC304	**BASIC ELECTRONICS & CONTROL**	L	T	P	C
SDG NO. 4,8,9,12,16	**SYSTEM**	3	0	0	3

OBJECTIVES:

- To understand the concepts of Electronics devices and Circuits.
- To understand concepts related to analog and digital signal conditioning.
- To understand various systems and derive mathematical model of a system.
- To study time response of closed loop control systems.

UNIT I ELECTRONIC DEVICES 9

Types of Materials - Silicon & Germanium- N type and P type materials - Structure, Operation and Characteristics of Diodes - PN, Zener. Transistors - Bipolar Junction Transistor (NPN and PNP in CE,CB, CC configuration) - Field Effect Transistors - JFET, MOSFET, Thyristors - SCR and UJT

UNIT II ELECTRONIC CIRCUITS 9

Amplifier – Transistor as Amplifier, Ideal Opamp –Block diagram, Inverting and Non-inverting amplifier, Instrumentation Amplifier, Differentiator, Integrator, Oscillator- Wein Bridge, Hartley and Crystal Oscillators

UNIT III ELECTRONIC SIGNAL CONDITIONING 9

Standard analog signals, Signal Level and bias changes, filtering and impedance matching, sampled data system and linearization, sample and hold

circuit, peak detector, ADC (Successive Approximation, Flash, Ramp, dual slope) and DAC (R/2R, Weighted resistors) their types and specifications

UNIT IV SYSTEMS AND REPRESENTATION   9
Basic elements in control systems- Open and closed loop system, Transfer function and Electrical analogy of mechanical translational and rotational systems- Block diagram reduction and Signal Flow graph.

UNIT V   TIME RESPONSE ANALYSIS OF SYSTEMS   9
Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants

TOTAL : 45 PERIODS

TEXTBOOKS:
1. Gupta S, "Electronic Devices & Circuits", DhanpatRaiPublicaions.
2. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.

REFERENCE BOOKS:
1. Boylestad and Nashelsky, "Electronic Devices and Circuit", Pearson Publisher, 2015
2. RamakantGayakwad, "Op-amp and Linear Integrated Circuits" , Fourth edition, PHI Pearson Education
3. Roy Choudhry, D,Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 2018, Fifth Edition
4. Salivahanan, S & V.S. KanchanaBhaskaran, —Linear Integrated Circuits‖, TMH,2nd Edition,4th Reprint, 2016
5. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014.

WEB RESOURCES:
1. https://www.newworldencyclopedia.org/entry/Electronic_engineering
2. https://www.tutorialspoint.com/control_systems/control_systems_useful_resources.htm

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/117103063
2. https://nptel.ac.in/courses/107106081

OUTCOMES:

Upon completion of the course, the students should be able to

1. To describe the characteristics of various semiconductor devices such as diodes, Transistors and Thyristor (K2)
2. To illustrate the working of various configurations operational amplifiers and oscillator circuits (K2)
3. To explain the concepts related to analog and digital conditioning.(K2)
4. Derive the mathematical model of electrical, mechanical systems and determine/reduce the transfer function for the system using block diagram reduction and signal flow graph methods (K3).
5. Derive the time domain behavior of I &II order systems (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	1	-	-	1	1	2
CO2	3	2	1	-	2	-	-	-	1	-	-	1	1	2
CO3	3	2	1	-	-	-	-	-	1	-	-	1	1	2
CO4	3	3	2	-	1	-	-	-	1	-	-	1	2	3
CO5	3	3	2	-	1	-	-	-	1	-	-	1	2	3

SEMESTER - III

20MEPL301	MANUFACTURING PROCESSES	L	T	P	C
SDG NO. 4,9,12,13	LABORATORY	0	0	3	1.5

OBJECTIVES:

- To operate arc welding and gas welding equipments.
- To prepare moulds in foundry.
- To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling and special purpose machines etc.
- To equip the student with practical knowledge required in the core industries

LIST OF EXPERIMENTS

1. Fabrication of simple structural shapes using Gas Metal Arc Welding
2. Joining of plates and pipes using Gas Metal Arc Welding/ Arc Welding /Submerged arc welding
3. Preparation of green sand moulds

4. Manufacturing of simple sheet metal components using shearing and bending operations.
5. Manufacturing of sheet metal components using metal spinning on a lathe
6. Taper Turning and Knurling
7. Thread cutting – External and Internal
8. Eccentric Turning
9. Head Shaping – Square and Hexagonal
10. Contour milling using vertical milling machine
11. Spur gear cutting in milling machine
12. Helical Gear Cutting in milling machine
13. Gear generation in hobbing machine
14. Gear generation in gear shaping machine
15. Grinding – Plain Surface and Cylindrical
16. Tool angle grinding with tool and Cutter Grinder
17. Measurement of cutting forces in Milling / Turning Process

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Arc welding transformer with cables and holders	2 Nos
2.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	1 No
3.	Moulding table, Moulding equipments	2 Nos
4.	Sheet metal forming tools and equipments	2 Nos
5.	Centre Lathes	7 Nos
6.	Horizontal Milling Machine	1 No
7.	Vertical Milling Machine	1 No
8.	Shaper	1 No.
9.	Surface Grinding Machine	1 No
10.	Cylindrical Grinding Machine	1 No
11.	Radial Drilling Machine	1 No
12.	Lathe Tool Dynamometer	1 No
13.	Milling Tool Dynamometer	1 No
14.	Gear Hobbing Machine	1 No
15.	Gear Shaper	1 No
16.	Tool Cutter and Grinder	1 No.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Join two metals using arc welding. (K1)
2. Use sheet metal fabrication tools and make simple tray and funnel. (K1)

3. Use different moulding tools, patterns and prepare sand moulds. (K1)
4. Make the work piece as per given shape and size using Lathe, Milling, Drilling and Special Purpose Machines. (K2)
5. Use different machine tools to manufacture gears and finishing operations.(K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	-	-	-	-	2	-	-	2	2	2
CO2	2	2	2	-	-	-	-	-	2	-	-	2	2	2
CO3	2	2	2	-	-	-	-	-	2	-	-	2	2	2
CO4	2	2	2	-	-	-	-	-	2	-	-	2	2	2
CO5	2	2	2	-	-	-	-	-	2	-	-	2	2	2

SEMESTER - III

20MEPL302	**COMPUTER AIDED DRAFTING**	L	T	P	C
SDG NO. 4,8,9,12	**LABORATORY**	0	0	3	1.5

OBJECTIVES:
- To comprehend the absolute, relative and polar coordinate systems
- To learn the procedure to Create, edit, annotate and plot drawings using basic AutoCAD commands.
- To Visualize and graphically reproduce complex layouts in drafting and design areas
- To calculate part features using math skills

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELLING
1. Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views.

6. Drawing of a plan of residential building (Two bed rooms house.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

LIST OF EQUIPMENTS:
1. Pentium IV computer or better hardware, with suitable graphics facility.
2. Licensed software for Drafting and Modelling. – 30 Licenses
3. Laser Printer or Plotter to print / plot drawings.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Comprehend the absolute, relative and polar coordinate systems. (K1)
2. Create, edit, annotate and plot drawings using basic AutoCAD commands. (K1)
3. Visualize and graphically reproduce complex layouts in drafting and design areas. (K2)
4. Create 3D Models and Plotting of Simple objects.(K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	-	1	-	2	-	-	-	1	2	1	2	2	2
CO2	2	-	3	-	3	-	-	-	1	2	1	2	2	2
CO3	2	-	3	-	3	-	-	-	1	2	1	2	2	2
CO4	3	1	3	2	3	-	-	-	1	2	1	2	2	2

SEMESTER - III

20MUTE301 SDG NO. 4,11,15	**LIVE-IN-LAB – I**	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students face reviews and viva voce examination.

GUIDELINES TO BE FOLLOWED:

The student individually works on a specific topic may be selected from published data or from the creative ideas approved by project supervisor who is familiar in the area of interest (Design/ Manufacturing/ Automation/Mechatronics) and head of the department. The selected topic may be analytical or experimental. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners. The student would apply the knowledge gained from theoretical and practical courses, so as to give confidence to the students to be creative, well planned, organized, coordinated in their Live-in Lab Project-II.

The progress of the project is reviewed and evaluated with a minimum of three reviews with the guidance of Project Coordinator. The review committee may be constituted by the Head of the Department. The student must submit a project report at the end of the semester for evaluation.

EVALUATION: Project work evaluation is based on Regulations of Credit system of Autonomous Regulatory Body

OUTCOMES:
Upon completion of the course, the students should be able to

1. Comprehend an industrial or real life problem and identify right/ real issue with solution. (K1)
2. Complete the necessary studies and review the literature, design a setup of equipment, complete the analysis. (K2)
3. Write a project report based on the findings. (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - III

20MUTP301 SDG NO. 4,11,15	**SKILL ENHANCEMENT**	L	T	P	C
		0	0	2	1

APTITUDE & COGNITIVE SKILLS - PHASE I

OBJECTIVES:
- Improve their quantitative ability.
- Improve the ability of arithmetic reasoning
- Enhance their verbal ability through vocabulary building and grammar
- Equip with creative thinking and problem-solving skills

UNIT I   QUANTITATIVE ABILITY – I   6
Problems on Trains, Time and Distance, Height and Distance, Time and Work

UNIT II   QUANTITATIVE ABILITY – II   6
Problems on Ages, Alligation or Mixture, Chain Rule, Simple Interest, Simple Equation, Theory of Equation

UNIT III   REASONING ABILITY – I   6
Analytical Reasoning, Pipes and Cistern, Logical Problems, Logical Games, Logical Deduction, Data Sufficiency, Arithmetic Reasoning

UNIT IV   VERBAL ABILITY – I   6
Idioms & Phrases, Synonyms, Antonyms, Classification

UNIT V   CREATIVITY ABILITY – I   6
Venn Diagrams, Cube and Cuboids, Dice, Cubes and Dice, Figure Matrix

REFERENCES:

1. R. S. Agarwal, "Quantitative Aptitude for Competitive Exams".
2. Sarvesh Verma, "Quantum CAT".
3. R. S. Agarwal, "A Modern Approach to Logical Reasoning".
4. Arun sharma, "Verbal Ability and Reading Comprehension".

Problem Solving Using C Programming & Geometric Tolerances– Phase 2

OBJECTIVES:

The course aims to provide exposure to problem-solving through programming. It aims to train the student to the basic concepts of the C-programming language, define the geometry for parts, assemblies and geometrical requirements of the drawings. This course involves a lab component which is designed to give the student hands-on experience with the concepts.

UNIT I   INTRODUCTION TO PRINCIPLES OF PROGRAMMING   6

Introduction to Programming, Programing Domain:Artificial Intelligence, Systems Programming, Assembly Level Languages,Problem solving using Algorithms and Flowcharts

UNIT II   INTRODUCTION TO C PROGRAMMING   6

Features of C and its Basic Structure, Simple C programs, Constants, Integer Constants, Real Constants, Character Constants, String Constants Floating-point Numbers, The type cast Operator, Interactive Programming. Operators Expressions and Control statement,Thegoto statement, The if statement, The if-else statement, Nesting of if statements, The conditional expression,The break statement and continue statement.

UNIT III   ARRAYS, STRINGS AND POINTERS   6

Arrays, Multidimensional Arrays, Strings, Basics of Pointers,Pointer Arithmetic, Similarities between Pointers and One-dimensional ArraysStructures, Unions And Functions,Basics of Structures, Arrays of Structures, Pointers to Structures,Function Basics, Function Prototypes, and Passing Parameters,Structures and Functions Recursion.

UNIT IV   BASICS OF GEOMETRIC TERMINOLOGY   6

Basics of Geometric Dimensioning and Tolerances-Terminology & basic tools-Symbols of Geometric Dimensioning and Tolerances.

UNIT V   REPRESENTATION OF GD&T   6

Adding GD&T to drawing/Design-DatumTolerances-Form, Orientation, Profile.

REFERENCES:

1. E. Balagurusamy, "Programming in ANSI C", Tata McGraw-Hill Education, 2008
2. Stephen G. Kochan, "Programming in C" (3rdEdition), Sams, 2004
3. Stephen G. Kochan, "Programming in C", 3rdEdition, Pearson Education.
4. Geometric Dimensioning and Tolerancing by P.S.Gill, S.K.Kataria& Sons, Edition 2013.
5. Fundamentals of Geometric Dimensioning and Tolerancing by Alex Krulikowski, 2012, 3rdEdition, Delmar Cengage Learning Publications.

ONLINE RESOURCES:

1. https://www.coursera.org/learn/introduction-cad-cam-practical-cnc-machining.
2. https://nptel.ac.in/courses/112105211

WEB RESOURCES:

1. https://www.helmancnc.com/cnc-programming-for-beginners-a-simple-cnc-programming-example/.
2. https://www.steckermachine.com/blog/g-code-and-m-code-programming.

OUTCOMES:

Upon completion of this course, the students should be able to:

1. Analyze their quantitative ability. (K4)
2. Understand the ability of arithmetic reasoning along with creative thinking and problem-solving skills. (K2)
3. Create their verbal ability through vocabulary building and grammar. (K6)
4. Evaluate the situations to analyse the computational methods in order to identify and abstract the programming task involved. (K5)
5. Understanding the basics of geometric dimensioning and tolerance. (K2)
6. Identify the symbols of GD&T. (K1)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO2	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO3	-	-	-	-	3	2	-	-	1	3	-	2	-	-
CO4	-	-	-	-	3	2	-	3	3	3	-	2	2	2
CO5	-	-	-	-	3	2	-	-	2	3	-	2	2	2
CO6	-	-	-	-	3	2	-	-	2	3	-	2	2	2

SEMESTER - III

20HSTA201 SDG NO. 4	**TAMILS AND TECHNOLOGY**	L	T	P	C
		1	0	0	1

UNIT I   WEAVING AND CERAMIC TECHNOLOGY   3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II   DESIGN AND CONSTRUCTION TECHNOLOGY   3
Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III   MANUFACTURING TECHNOLOGY   3
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV   AGRICULTURE AND IRRIGATION TECHNOLOGY   3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT V   SCIENTIFIC TAMIL & TAMIL COMPUTING   3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
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.   பொருநை - 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.

தமிழும் தொழில்நுட்பமும்

அலகு I   நெசவு மற்றும் பானைத் தொழில்நுட்பம்:   3

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க கொலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் ____ சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் கொலத்தில் 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, கண்ணொடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: 3

அணை, ஏரி, குளங்கள், மதகு -சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக 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 நூ லகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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. பொருநை - 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 - IV

20MUPC401 SDG NO. 4,9	FLUID POWER AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.
- To train the students in designing the hydraulic and pneumatic circuits using various design procedures.

UNIT I   INTRODUCTION TO FLUID POWER PRINCIPLES   8

Introduction to Fluid Power Automation: Definition; Basics of Hydraulics – Pascal's Law – Principles of flow; properties of fluids;Benefits and Impact of Automation on Manufacturing and Process Industries. Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.

UNIT II   FLUID POWER GENERATING/UTILIZING COMPONENTS   9

Hydraulic pumps and motor gears, vane, piston -selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators and their types. Pneumatics: Properties of air - Perfect Gas Laws - Types of Actuators and Compressor - Filters, Regulator, Lubricator and Muffler.

UNIT III   FLUID POWER CONTROL ELEMENTS   9

Direction Flow and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications; Air control Valves, Quick Exhaust Valves.

UNIT IV   CIRCUIT DESIGN   9

Basic Hydraulic Circuits: Meter in, Meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits. Pneumatic Circuit Designing: Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 3 cylinders), Design of Pneumatic circuits for Pick and Place applications.

UNIT V ELECTRO PNEUMATICS &ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS 10

Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching. Digital Hydraulics: Introduction, different ways to realize motion control with on/off valves, Benefits and challenges of digital Hydraulics.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications',7th Edition, Pearson Education Limited, 2013.
2. Bolton,W.,"Mechatronics, Electronic control systems in Mechanical and Electrical Engineering", 6th Edition, Pearson Education, 2015.

REFERENCES:

1. Dudbey. A., Peace, "Basic Fluid Power", 2nd Edition, Prentice Hall Inc, 1986.
2. Fitch, E.C., and Suryaatmadyn, J.B., "Introduction to fluid logic", McGraw Hill, 1978.
3. Herbert R. Merritt, "Hydraulic control systems", John Wiley & Sons, Newyork, 1967.
4. Peter Rohner, "Fluid Power Logic Circuit Design", McmelanPrem, 1994.

WEB RESOURCES:

1. http://link.springer.com/content/pdf/bfm%3A978-1-349-16126-3%2F1.pdf
2. https://yuken-usa.com/pdf/special/Basic_Hydraulic_And_Components_(Pub._ES-100-2)_.pdf

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112105206
2. https://www.iitp.ac.in/~athakur/courses/MH501/ModuleIV/Hydraulic%20Systems.pdf
3. https://nptel.ac.in/courses/112105206
4. https://www.haenchen-hydraulic.com/media/pdf/en/en_preview-book-hydraulic-systems.pdf?m=1582719423&

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand basic automation techniques for small manufacturing set-ups. (K1)
2. Illustrate the working principles of fluid power accessories like pumps, motors. (K3)
3. Analyze pneumatic and hydraulic circuits of medium complexity. (K3)
4. Illustrate the working of control and regulation elements used in pneumatic and hydraulic circuits. (K3)
5. Demonstrate the use of electrical and electronics control in pneumatic and hydraulic circuits. (K3)
6. Analyze the benefits and challenges of Digital Hydraulics. (K3)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	-	-	-	-	-	-	-	1	2	2
CO2	1	1	-	-	-	-	-	-	-	-	-	1	2	2
CO3	2	1	-	-	-	-	-	-	-	-	-	1	2	2
CO4	2	-	-	-	-	-	-	-	-	-	-	1	2	2
CO5	2	-	-	-	1	-	-	-	-	-	-	1	2	2
CO6	2	-	-	-	1	-	-	-	-	-	-	1	2	2

SEMESTER - IV

20MUPC402 SDG NO. 4,9	THEORY OF MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the principles in the formation of mechanisms and their kinematics
- To understand the effect of control mechanism in different machine elements
- To understand the importance of balancing and vibration

UNIT I INTRODUCTION   9

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint & motion – Degrees of freedom - Slider crank – single and double – Crank rocker mechanisms – Inversions, applications. Introduction to Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

UNIT II   GEARING AND CAMS   9

Gear terminology, law of gearing- nomenclature of spur & helical gears -– interference – requirement of minimum number of teeth in gears. Simple, Compound and reverted gear trains -determination of speed and torque in epicyclic gear trains.Types of cams, Types of followers. Displacement, Velocity and, acceleration time curve for cam profiles. Follower motions including SHM, Uniform acceleration and retardation and Cycloidal motion.

UNIT III   MECHANISM FOR CONTROL   9

Governors – Types: Centrifugal governors – Gravity controlled and spring controlled governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

UNIT IV   BALANCING   9

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder Inline, V-engines – Partial balancing in engines – Balancing machines.

UNIT V   VIBRATION   9

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

TOTAL: 45 PERIODS

TEXT BOOKS:
1.   Sadhu Singh, "Theory of Machines:Kinematics and Dynamics", Pearson Education, 3rd Edition, 2011.
2.   Rattan S.S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4thEdition, 2014.

REFERENCES:
1. Khurmi, R. S., Gupta, J. K.,"Theory of Machines", S.Chand Publisher, 14th Edition, 2020.
2. John Joseph Uicker, Pennock,G. R., Joseph Edward Shigley, 'Theory of Machines and Mechanisms', Oxford University Press, 2003.
3. Amitabha Ghosh and Mallick, 'Theory of Machines and Mechanisms', East West Press, 3rdEdition 2020.
4. Thomas Bevan, "Theory of Machines", CBS Publication, 3rd Edition,2005.
5. Singh, V.P.,"Mechanical Vibrations", DhanpatRai Publications (P) Ltd, 3rd Edition, 2011.

WEB RESOURCES:
1. http://www.mechanisms.co.
2. http://dynref.engr.illinois.edu
3. https://nptel.ac.in/courses/112/101/112101096/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/101/112101096/
2. http://nitc.ac.in/index.php/?url=users/view/270/12/3
3. https://nptel.ac.in/courses/112/104/112104114/
4. https://nptel.ac.in/courses/112/104/112104121/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Enumerate the basic concepts of various mechanisms. (K1)
2. Understand the concepts of gears and gear trains. (K1)
3. Draw the cam profiles for the given specification. (K2)
4. Study and analyse the characteristics of governors and the gyroscopic effect on automobiles, ships and airplanes. (K3)
5. Understand the balancing of Rotating and Reciprocating Masses. (K1)
6. Compute the parameters of free and forced vibrations. (K3)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	1	2	2
CO2	3	2	2	1	-	-	-	-	-	-	-	1	3	3
CO3	2	2	1	1	-	-	-	-	-	-	-	1	2	2
CO4	2	2	1	1	-	-	-	-	-	-	-	1	2	2
CO5	1	1	1	-	-	-	-	-	-	-	-	1	2	2
CO6	3	3	3	-	-	-	-	-	-	-	-	1	3	2

SEMESTER - IV

20MUPC403	**CNC MACHINES AND METROLOGY**	L	T	P	C
SDG NO. 4,8,9, 12,16		3	0	0	3

OBJECTIVES:

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

UNIT I   INTRODUCTION TO CNC MACHINE TOOLS   9

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways.

UNIT II   DRIVES AND WORK HOLDING DEVICES   9

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

UNIT III   CNC PROGRAMMING   9

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre (controllers such as Fanuc, Heidenhain, Sinumerik), generation of CNC codes from CAM packages.

UNIT IV   LINEAR AND ANGULAR MEASUREMENTS   9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchangeability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT V   ADVANCES IN METROLOGY   9

Basic concept of lasers, Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 22nd Edition, 2022.

REFERENCES:
1. HMT, "Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. Gupta. I.C., "Engineering Metrology",Dhanpatrai Publications, 2018.
3. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education ,6th Edition, 2013.
4. Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.
5. Radhakrishnan P, "Computer Numerical Control Machines and Computer Aided Manufacturer", New Central Book Agency, 2018.

WEB RESOURCES:
1. https://nptel.ac.in/courses/112/106/112106139/
2. https://www.matweb.com

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/106/112106138/
2. https://nptel.ac.in/courses/112/106/112106179/
3. https://nptel.ac.in/courses/112/104/112104250/
4. https://nptel.ac.in/courses/112/103/112103261/
5. https://nptel.ac.in/courses/112/106/112106140/
6. https://nptel.ac.in/courses/112/107/112107242/
7. https://nptel.ac.in/courses/112/107/112107259/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Describe the basics of CNC machines(K1)
2. Discuss various drives and Work holding devices used in CNC Machine tools. (K2)
3. Write simple programs for CNC machine tools(K2)
4. Describe the concepts of linear measurements applicable to various metrological instruments.(K2)
5. Discuss the concepts of angular measurements applicable to various metrological instruments. (K2)
6. Understand about the advancement in metrology.(K1)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	2	3	2	2
CO2	2	1	2	-	-	-	-	-	-	-	1	2	2	2
CO3	2	1	1	-	-	-	-	-	-	-	2	2	1	2
CO4	2	2	1	-	-	-	-	-	-	-	2	2	2	2
CO5	2	2	1	-	-	-	-	-	-	-	2	2	2	2
CO6	2	2	1	-	-	-	-	-	-	-	2	2	2	2

SEMESTER - IV

20MUPC404 SDG NO. 4,8,9,12	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To learn the usage of computers in designing mechanical components.
- To introduce the student to the basic tools of computer-aided design (CAD).
- To expose the student to contemporary computer design tools.
- To prepare the student to be an effective user of a CAD system.

UNIT I   FUNDAMENTALS OF COMPUTER GRAPHICS   9

Product cycle- Design process- sequential and concurrent engineering - Computer aided design – CAD system architecture- computer graphics – co-ordinate systems- 2D and 3D transformations - homogeneous co-ordinates - Line drawing -Clipping- viewing transformation.

UNIT II   GEOMETRIC MODELING   9

Representation of curves- Hermite curve- Bezier curve- B-Spline curves - rational curves. Techniques for surface modeling – surface patch- Coons and Bicubic patches- Bezier and B-Spline surfaces. Solid modeling techniques- CSG and B-rep.

UNIT III   VISUAL REALISM   9

Hidden – Line – Surface - Solid removal algorithms – shading – colouring – computer animation

UNIT IV   ASSEMBLY OF PARTS   9

Assembly modelling – interferences of positions and orientation – tolerance analysis-mass property calculations – mechanism simulation and interference checking.

UNIT V   CAD STANDARDS   9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ibrahim Zeid, "Mastering CAD CAM", Tata McGraw-Hill PublishingCo., 2007.
2. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.

REFERENCES:

1. Chris McMahon and Jimmie Browne, "CAD/CAM Principles", "Practice and Manufacturing management " Second Edition, Pearson Education, 1999.
2. Donald Hearn and M. Pauline Baker, "Computer Graphics"'. Pearson Education India, 2nd Edition, 2002.
3. Foley, Van Dam, Feiner and Hughes, "Computer graphics principles & practice", Pearson Education India, 2013.
4. William M Neumann and Robert F.Sproul, "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/102/112102102/
2. https://nptel.ac.in/courses/112/102/112102103/
3. http://nitc.ac.in/index.php/?url=users/view/270/12/3

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112/104/112104031/
2. https://nptel.ac.in/courses/112/102/112102101/
3. https://nptel.ac.in/courses/112/105/112105211/
4. https://nptel.ac.in/courses/112/104/112104252/
5. http://guides.lib.ua.edu

OUTCOMES:

Upon completion of the course, the students should be able to

1. Acquire the knowledge on fundamentals of Computer Graphics concepts in engineering. (K1)
2. Understand the knowledge of surface modeling techniques in engineering applications. (K1)
3. Understand the knowledge of solidmodeling techniques in engineering applications. (K1)
4. Render and animate the components by applying Line, Surface and Solid removal Algorithms. (K3)
5. Demonstratethe knowledge of assembly techniques. (K3)

6. Interchange CAD documents effectively between cad software's using various standards. (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	1	1	-	-	-	1	1	1	1	2	3
CO2	2	2	2	-	2	1	-	-	-	1	1	2	2	2
CO3	2	2	2	-	2	1	-	-	-	1	1	1	2	2
CO4	1	1	1	-	2	-	-	-	-	3	-	2	2	3
CO5	3	2	2	1	1	-	-	-	1	1	-	2	2	2
CO6	1	-	1	-	3	1	-	-	1	3	1	2	2	2

SEMESTER - IV

20BSMA403	STATISTICS AND NUMERICAL	L	T	P	C
SDG NO. 4	METHODS	3	1	0	4

OBJECTIVES:

- To identify small, large samples and apply testing of hypothesis
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems
- To introduce the basic concepts of solving algebraic and transcendental equations
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines
- To introduce the knowledge of various techniques and methods of solving ordinary differential equations

UNIT I   TESTING OF HYPOTHESIS   12

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F-distributions for mean, variance and proportion - Contingency table (test for independence) - Goodness of fit.

UNIT II   DESIGN OF EXPERIMENTS   12

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 2^2 factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS   12

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices .

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION
AND NUMERICAL INTEGRATION   12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V   NUMERICAL SOLUTION OF ORDINARY AND
PARTIAL DIFFERENTIAL EQUATIONS   12

Single step methods : Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step methods : Milne's and Adams - Bashforth predictor corrector methods for solving first order equations. Solution of   two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by Crank Nicholson method – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.

4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.

5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

WEB RESOURCES:
1. https://www.classcentral.com/course/swayam-numerical-analysis-17709
2. https://online-learning.harvard.edu/course/statistics-and-r?delta=1

ONLINE RESOURCES:
1. https://freevideolectures.com/course/3057/numerical-methods-and-computation
2. https://nptel.ac.in/courses/111107105/
3. https://www.maths.unsw.edu.au/courses/math2089-numerical-methods-and-statistics

OUTCOMES:
Upon completion of the course, the student should be able to
1. Apply statistical techniques for testing of hypothesis of small and large samples. (K3)
2. Perform Analysis of Variance (ANOVA) in the Design of Experiments. (K3)
3. Provide numerical solution for Algebraic equations, Transcendental equations and Eigen value problems. (K3)
4. Apply Numerical techniques to interpolate data and find Numerical Differentiation and Integration. (K3)
5. Solve Ordinary and Partial Differential equations using numerical techniques. (K3)

CO- PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	-	1
CO2	3	3	2	1	1	-	-	-	-	-	-	1
CO3	3	3	2	1	1	-	-	-	-	-	-	1
CO4	3	3	2	1	1	-	-	-	-	-	-	1
CO5	3	3	2	1	1	-	-	-	-	-	-	1

SEMESTER - IV

20CEPC405 SDG NO. 4, 9	STRENGTH OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand the concepts of stress and strain.
- To determine the principal stresses and deformation in cylindrical and spherical shells.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To study the concept of shearing force and bending moment due to external loads in beams and their effect on stress distribution.
- To compute slopes and deflections in determinate beams by various methods.

UNIT I   STRESS, STRAIN & DEFORMATIONS OF SOLIDS   9

Definition of Stress and Strain – Tension, Compression and Shear Stresses. Stress-Strain relationship and Hooke's law. Deformation of simple and compound bars – Thermal stresses – Elastic constants and their relations

UNIT II   ANALYSIS OF STATE OF STRESS AND CYLINDRICAL AND
**   SPHERICAL SHELLS (THIN AND THICK)   9**

Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress. Stresses and deformation in thin and thick cylinders due to internal pressure. Stresses and deformation in thin and thick spherical shells subjected to internal pressure. Lame's theorem.

UNIT III   TORSION AND SPRINGS   9

Torsion Equation - Deformation in solid and hollows shafts – Stepped shafts–shafts fixed at the both ends- Stresses & deflection in open and closed coil helical springs with axial load – Stresses and deflection in carriage springs.

UNIT IV   STRESSES IN BEAMS   9

Beams – types, Transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending–bending stress distribution- Shear stress distribution.

UNIT V   DEFLECTION OF BEAMS & COLUMNS   9

Computation of slopes and deflections in beams - Double Integration method – Macaulay's method – Area moment method - Euler Equation and Rankine Formula for buckling of columns.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ferdinand P. Beer and E. Russell Johnston Jr., "Mechanics of Materials", 8th Edition in S.I. Units, McGraw Hill Education (India) Pvt. Ltd., 2020.
2. Bansal, R.K., "A Text Book of Strength of Materials", Laxmi Publications (P) Ltd. New Delhi, 2018.

REFERENCES:

1. Rajput, R.K., "Strength of Materials", S. Chand Publications, 2018.
2. Jindal U.C., "Strength of Materials", 2nd Edition, Pearson India Education, 2018.
3. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 3rd Edition, 2016.
4. Hibbeler, R.C., "Mechanics of Materials", Pearson India Education, 2017.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/106/112106141/
2. https://nptel.ac.in/courses/112/107/112107146/
3. https://nptel.ac.in/courses/105/102/105102090/
4. http://ocw.mit.edu/courses/mechanical-engineering
5. http://nitc.ac.in/index.php/?url=users/view/270/12/3

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112/107/112107147/
2. https://nptel.ac.in/courses/105/105/105105108/
3. https://nptel.ac.in/courses/105/106/105106116/
4. https://nptel.ac.in/courses/105/104/105104160/
5. https://nptel.ac.in/courses/105/106/105106172/

OUTCOMES:

Upon completion of the course, the students should be able to

1. Perform calculations related to deformation of deformable bodies using the concepts of stress and strain. (K2)
2. Determine the principal stress on a plane and deformation of thin and thick vessels subjected to internal pressure. (K3)

3. Calculate the dimensions and deformation of cylindrical member's subjected to torsional load. (K3)
4. Compute the stresses and dimensions of the structural member subjected to transverse load. (K3)
5. Determine the deflection in structural member subjected to transverse load. (K3)
6. Predict the behaviour of columns subjected to axial loading. (K3)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	-	-	-	-	-	1	2	2
CO2	3	2	2	-	-	1	-	-	-	-	-	1	2	2
CO3	3	2	2	-	-	1	-	-	-	-	-	1	2	2
CO4	3	2	1	-	-	1	-	-	-	-	-	1	2	2
CO5	3	2	1	-	-	1	-	-	-	-	-	1	2	2
CO6	3	2	1	-	-	1	-	-	-	-	-	1	2	2

SEMESTER - IV

20MUPL401	STRENGTH OF MATERIALS &	L	T	P	C
SDG NO. 4,9,12,13	METROLOGY LABORATORY	0	0	3	1.5

OBJECTIVES:
- To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads.
- To enable the students to have a clear understanding of the Design for strength and stiffness.
- To measure various parameters accurately using different measuring instruments for Quality Inspection in Industries
- To identify and classify different measuring tools and explain accuracy and precision
- To conduct, analyse, interpret, and present measurement data from measurements experiments
- To identify sources of variability, error, and uncertainties

LIST OF EXPERIMENTS
STRENGTH OF MATERIALS LABORATORY

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
5. Hardness test on metals - Brinell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.

METROLOGY LABORATORY

1. Calibration and use of measuring instruments – verniercaliper, micrometer, vernier height gauge – using gauge blocks
2. Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge
3. Measurement of linear dimensions using Comparators
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of screw thread parameters – Screw thread Micrometers and Three wire method (floating carriage micrometer)
6. Measurement of gear parameters – gear tooth vernier caliper
7. Measurement of features in a prismatic component using Coordinate Measuring Machine

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Universal Tensile Testing machine with double shear attachment – 40 Ton Capacity
2. Torsion Testing Machine (60 NM Capacity)
3. Impact Testing Machine (300 J Capacity)
4. Brinell Hardness Testing Machine
5. Rockwell Hardness Testing Machine
6. Spring Testing Machine for tensile and compressive loads (2500 N)
7. Micrometer and dial gauges
8. Vernier Height Gauge and Vernier depth Gauge
9. VernierCaliper and Gear Tooth Vernier
10. Sine Bar
11. Floating Carriage Micrometer

12. Mechanical / Electrical / Pneumatic Comparator
13. Bore gauge
14. Surface finish measuring equipment
15. Telescope gauge
16. Coordinate measuring machine

OUTCOMES:

Upon completion of the course, the students should be able to

1. Explain and perform different destructive testing's such as Tension test, Shear test, Impact test, Hardness test to estimate the strength under externally applied loads with due consideration to safety. (K3)
2. Estimate and compare the elastic constants such as Young's modulus and Rigidity modulus of the given specimen through Deflection testing and spring testing with standard values.(K3)
3. Understand the various linear and angular measurements using measurants like comparator, sine bar, floating carriage micrometer etc. and inspect various profiles of mechanical components.(K1)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	2	-	-	-	1	-	-	-	-	-	1	2	2
CO2	3	2	-	-	-	1	-	-	-	-	-	1	2	2
CO3	3	2	-	-	-	1	-	-	-	-	-	1	2	2

SEMESTER - IV

20MUPL402	FLUID POWER SYSTEMS	L	T	P	C
SDG NO. 4,9,12,13	LABORATORY	0	0	3	1.5

OBJECTIVES:
- To enable the students to have a clear understanding of the losses in pipe flow
- To understand the flow measurements.
- To analyses the Performance of various Pumps and Turbines
- To know Microprocessor programming
- To design, model and analyse basic Electrical, Hydraulic & Pneumatic Systems

LIST OF EXPERIMENTS
1. Determination of friction factor for a given set of pipes.
2. Conducting experiments and drawing the characteristic curves of centrifugal pump/submergible pump
3. Conducting experiments and drawing the characteristic curves of reciprocating pump.
4. Conducting experiments and drawing the characteristic curves of Gear pump.
5. Stepper motor interface.
6. Traffic light interface.
7. Speed control of DC motor.
8. Study of various types of transducers.
9. Study of hydraulic, pneumatic and electro-pneumatic circuits.
10. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
11. Study of PLC, Design and Development of Color Sorting Conveyor system, Pick and place conveyor system using sensors and PLC.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:
1. Pipe Flow analysis setup
2. Centrifugal pump/submergible pump setup
3. Reciprocating pump setup
4. Gear pump setup.
5. Basic Pneumatic Trainer Kit with manual and electrical controls/ PLC Control each.

6. Basic Hydraulic Trainer Kit
7. Hydraulics and Pneumatics Systems Simulation Software

OUTCOMES:
Upon completion of the course, the students should be able to
1. Measure the flow rate of fluid using different flow measuring devices and calculate the friction loss and other minor losses in a pipe flow. (K2)
2. Conduct experiments on pumps, turbines and to analyze their performance characteristics. (K2)
3. Demonstrate the functioning of control systems with the help of PLC and microcontrollers. (K3)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	2	-	-	-	1	-	-	-	-	-	1	2	2
CO2	3	2	-	-	-	1	-	-	-	-	-	1	2	2
CO3	3	2	-	-	-	1	-	-	-	-	-	1	2	2

SEMESTER - IV

20MUTE401 SDG NO. 4,6,7,8,9,11, 12,13, 17	LIVE-IN-LAB – II	L	T	P	C
		0	0	2	1

OBJECTIVES:
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students face reviews and viva voce examination.

COURSE METHODOLOGY
The student should continue the Live-in Lab Project-I on the selected topic under the same supervisor selected in Live-in Lab Project-I. The student has to complete design part and design evaluation of the selected project in Live-in Lab Project-I. At the end of the semester, the progress of the project is reviewed and evaluated with a minimum of three reviews with the guidance of Project Coordinator. The students will be evaluated through project report and the viva-voce examination by the panel of members. The review committee may be constituted by the Head of the Department. The student must submit a detailed project report at the end of the semester for evaluation

EVALUATION: Project work evaluation is based on Regulations of Credit system of Autonomous Regulatory Body.

Note: All the three evaluations are mandatory for course completion and for awarding the final grade

OUTCOMES:

Upon completion of the course, the students should be able to

1. Comprehend an industrial or real life problem and identify right/ real issue with solution. (K1)
2. Design a setup of equipment based on review of literature, complete the analysis (K3)
3. Write a project report based on the findings. (K2)

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - IV

20MUTP401 SDG NO. 4	SKILL ENHANCEMENT	L	T	P	C
		0	0	2	1

PROBLEM SOLVING SKILLS - PHASE I

OBJECTIVES:

● Improve their quantitative ability.
● Improve their reasoning ability.
● Enhance their verbal ability through vocabulary building and grammar
● Equip with creative thinking and problem-solving skills

UNIT I   QUANTITATIVE ABILITY – III   **6**

Compound Interest, Profit and Loss, Partnership, Percentage, Set Theory

UNIT II QUANTITATIVE ABILITY – IV   **6**

True Discount, Ratio and Proportion, Simplification, Problems On H.C.F and L.C.M

UNIT III REASONING ABILITY – II   **6**

Course of Action, Cause and Effect, Statement and Conclusion, Statement and Argument, Data Sufficiency (DS), Statement and Assumption, Making Assumptions

UNIT IV VERBAL ABILITY – II   **6**

Change of Voice, Change of Speech, Letter and Symbol Series, Essential Part, Verbal Reasoning, Analyzing Arguments

UNIT V CREATIVITY ABILITY – II   **6**

Seating Arrangement, Direction Sense Test, Character Puzzles, Missing Letters Puzzles, Mirror &Water Images

TOTAL : 30 PERIODS

REFERENCES:
1. R. S. Agarwal, "Quantitative Aptitude for Competitive Exams".
2. Sarvesh Verma, "Quantum CAT".
3. R. S. Agarwal, "A Modern Approach to Logical Reasoning".
4. Arun sharma, "Verbal Ability and Reading Comprehension".

Advanced C Programming & CNC Programming– Phase 2

OBJECTIVES:

The course is oriented to those who want to advance structured and procedural programming understating and to improve C programming skills, aspect of CNC machines. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition using complex data types.

UNIT I   INTRODUCTION TO RECURSION AND GROWTH FUNCTIONS 6

Introduction to Recursion, Recurrence Relation,Deriving time complexity and space complexity using recurrence relation Polynomial Equations, Compare growth functions, Nth Fibonacci Number, Exponent Function, Taylor Series, Tower of Hanoi.

UNIT II   STORAGE CLASSES, THE PREPROCESSOR AND DYNAMIC
              MEMORY ALLOCATION   **6**

Storage Classes and Visibility, Automatic or local variables, Global variables, Macro Definition and Substitution,Conditional Compilation, Dynamic Memory Allocation, Allocating Memory with malloc and callo Allocating Memory with calloc,Freeing Memory, The Concept of linked list, Inserting a

node by using Recursive Programs, Deleting the Specified Node in a Singly Linked List.

UNIT III   FILE MANAGEMENT AND BIT MANIPULATION   6

Defining and opening a file, Closing Files, Input/output Operations on Files, Predefined Streams, Error Handling during I/O Operations, Random Access to Files, Command Line Arguments,the hexadecimal number system, C bitwise operators, how to generate all the possible subsets of a set, Tricks with Bits, Applications of bit operations.

UNIT IV   INTRODUCTION   6

Introduction to NC and CNC machine-types-constructional details.

UNIT V   BASICS OF PROGRAMMING   6

Basics of part programming-G Codes and M Codes-Programming and Machining of a component.

REFERENCES:

1. R. G. Dromey, "How to solve it by computer", Pearson, 1982
2. A.R. Bradley, "Programming for Engineers", Springer, 2011
3. Kernighan and Ritchie, "The C Programming Language", (2nd Edition) Prentice Hall,1988.
4. CNC Programming by Dr. S.K. Sinha.
5. CNC Programming Handbook (3rd Edition) by Peter Smid.
6. CNC Trade Secrets by James Harvery.

OUTCOMES:
Upon completion of this course, the students should be able to:

1. Analyze their quantitative ability. (K4)
2. Understand the ability of arithmetic reasoning along with creative thinking and problem-solving skills. (K2)
3. Create their verbal ability through vocabulary building and grammar. (K6)
4. Evaluate code organization and functional hierarchical decomposition with complex data types. (K5)
5. Understand to improve C programming skills to apply advanced structured and procedural programming. (K2)
6. Write a part program for a given product drawing and demonstrate the program by using a CNC Machine. (K1)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO2	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO3	-	-	-	-	3	2	-	-	1	3	-	2	-	-
CO4	-	-	-	-	3	2	-	3	3	3	-	2	2	2
CO5	-	-	-	-	3	2	-	-	2	3	-	2	2	2
CO6	-	-	-	-	3	2	-	-	2	3	-	2	2	2

SEMESTER - V

20MUPC501 SDG NO. 4, 9, 11, 12	MACHINE DESIGN (Use of Design Data Book is permitted)	L	T	P	C
		3	1	0	3

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements
- To understand the basics of Transmission elements involved in a Mechanical Power Transmission Components
- To design and analyse various forces acting on the Mechanical Power Transmission Components using suitable techniques, Codes and Standards

UNIT I   STEADY STRESSES IN MACHINE MEMBERS   9

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principal stresses for various load combinations, eccentric loading -Factor of safety - theories of failure – Design based on strength and stiffness.

UNIT II   POWER TRANSMITTING ELEMENTS – I   9

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, key ways and splines –Rigid and flexible couplings.

UNIT III   JOINTS and BEARINGS   9

Threaded fasteners, Welded joints and riveted joints for structures. Journal bearings – bearing materials, properties and mechanisms of lubrication, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated and heat dissipated. Numerical examples on Sliding contact and Rolling Contact bearings.

UNIT IV   POWER TRANSMITTING ELEMENTS - II   9

Design of Flat belts and pulleys - Selection of V belts and pulleys –Design of Transmission chains and Sprockets. Gear materials – Design of straight tooth spur & helical gears based on life and wear considerations.

UNIT V   GEAR BOXES   9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout - Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box for machine tool applications – Variable speed gear box.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bhandari V B, Design of Machine Elements‖, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Richard G. Budynas, and J. Keith Nisbett, "Shigley's Mechanical Engineering Design", McGraw- Hill Education, 10th Edition, 2015.

REFERENCES:

1. Design Data Hand Book, PSG College of Technology, Coimbatore, 2013.
2. Ansel C Ugural, "Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2004.
3. Merhyle Franklin Spotts, Terry E. Shoup, and Lee Emrey Hornberger, "Design of Machine Elements", 8th Edition, Printice Hall, 2004.
4. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
5. Sundararajamoorthy T. V. and Shanmugam .N, Machine Design, Anuradha Publications, Chennai, 2003.

WEB RESOURCES:

1. http://library.iiti.ac.in/?page_id=1477
2. https://www.machinedesignonline.com/
3. https://library.stanford.edu/guides/mechanical-engineering
4. https://www.classcentral.com/course/machine-design1-7404
5. http://thegateacademy.com/subject-pack/machine-design

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/112/105/112105124/
2. https://nptel.ac.in/courses/112/106/112106137/

OUTCOMES:

Upon completion of the course, the students should be able to

1. Acquaint with design standards, material selection and static stress in the design of machine components. (K3)

2. Determine the dimensions of torque transmitting elements. (K3)

3. Calculate the dimensions of mechanical joints like riveted, welded joints and springs. (K3)

4. Determine the design parameters for flexible power transmission elements and parallel axis Gears using Design Standards. (K3)

5. Compute the dimensions of a multi-speed gear box for machine tool and automotive applications using Design Standards. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	1	1	-	-	-	-	2	2	2
CO2	3	3	2	-	-	1	1	-	-	-	-	1	2	2
CO3	3	3	2	-	-	1	1	-	-	-	-	1	2	2
CO4	3	3	2	-	-	1	1	-	-	-	-	1	2	2
CO5	3	3	2	-	-	1	1	-	-	-	-	1	2	2

SEMESTER - V

20ESEE501 SDG NO. 4, 9	**ELECTRICAL DRIVES AND ACTUATORS WITH LABORATORY**	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To familiarize a relay and power semiconductor devices.
- To get a knowledge on drive characteristics.
- To obtain the knowledge on DC motors and drives.
- To obtain the knowledge on AC motors and drives.
- To obtain the knowledge on Stepper and Servo motor.
- To impart industry oriented learning.

UNIT I   RELAY AND POWER ELECRONIC DEVICES   9

Study of Switching Devices – Relay and Types, Switching characteristics - SCR, TRIAC, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits.

UNIT II   DRIVE CHARACTERISTICS   9

Electric Drive – Equations Governing Motor Load Dynamics – Steady State Stability – Multi Quadrant Dynamics: Acceleration, Deceleration, Torque, and Direction, Starting and Stopping – Selection of Motor

UNIT III   DC MOTORS AND DRIVES   9

DC Motors, PMDC, BLDC motors and Servomotors – Types, Principle of Operation - EMF Equations - Speed Torque Relationship - Driver Circuits. H Bridge Circuits – Applications.

UNIT IV   STEPPER MOTORS   9

Constructional Features – Principle of Operation – Types Stepper Motors – Position Control - Drive Circuits – Closed Loop Control - Modern Stepper Motors and Drives–Applications.

UNIT V   AC MOTORS AND DRIVES   9

AC Permanent Magnet Synchronous Motors – Linear Electrical Motors – VFD Drives – AC Servo Drives - Overview of Motion Control – Applications.

LIST OF EXPERIMENTS: 15
1. Switching Characteristics of MOSFET and IGBT.
2. Switching Characteristics of SCR and TRIAC.
3. Gate pulsation generation using PWM signals.
4. Speed Control of DC motor using Power Electronic Drive.
5. Speed Control of BLDC motor using Power Electronic Drive.
6. Speed Control of PMDC motor using Power Electronic Drive.
7. VFD control of Three Phase Induction Motor using Power Electronic Drive.

TOTAL: 60 PERIODS

TEXT BOOKS:
1. Bimbhra B.S., "Power Electronics", 6th Edition, Kanna Publishers, New Delhi, 2018.
2. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2010.

REFERENCES:
1. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S. Chand & Co. Ltd., New Delhi, 2016.
2. Vedam Subramanyam, "Electrical Drives, Concepts and Applications", 2nd Edition, Tata McGraw Hill, New Delhi, 2011
3. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
4. Singh M.D. & Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2011.

WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc22_ee94/preview
2. https://www.digimat.in/nptel/courses/video/108104140/L01.html
3. https://www.youtube.com/watch?v=Ub-csHc4VhA
4. https://www.youtube.com/watch?v=EaENkSSUK-k
5. https://www.youtube.com/watch?v=QaLGo0R0SYU

ONLINE RESOURCES:
1. https://www.youtube.com/watch?v=k9miF1KeMr0
2. https://www.youtube.com/watch?v=UHsM3uN0c8g
3. https://www.youtube.com/watch?v=UejGsuDSA-I
4. https://www.youtube.com/watch?v=G3Cwrr_IUtQ
5. https://www.youtube.com/watch?v=nE4o4ANcvKc

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the working principle of relays and power electronic devices. (K2).
2. Explain the concepts of Electric drive characteristics, stability, dynamics and motor selection. (K2).
3. Illustrate the working of different types of DC motor and drives. (K2)
4. Make use of stepper motor and drives for real time applications. (K3)
5. Interpret the performance of AC Motors and Drives. (K2)
6. Analyze the characteristics of Power Electronic Devices. (K4)
7. Analyze the performance of different types of motors using Power Electronic Drive.(K4)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	2	-	-	-	-	-	3	2	2
CO2	3	2	2	-	-	2	-	-	-	-	-	2	2	2
CO3	2	2	1	-	2	2	-	-	-	-	-	3	2	2
CO4	3	3	2	-	2	2	-	-	-	-	-	3	2	2
CO5	2	2	2	-	2	2	-	-	-	-	-	3	2	2
CO6	3	2	-	-	-	2	-	-	-	-	-	2	2	2

SEMESTER - V

20MUPC502 SDG NO. 4, 9, 11, 12	MECHANICS AND CONTROL OF ROBOTIC MANIPULATORS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To analyze and determine the kinematic and dynamic models of robots and control systems design motion and strength
- To understand nonlinearities in control system
- To demonstrate various concepts by working out problems and exercises relevant to real time applications involving innovative mechanisms and robotic chains
- To understand Lagrangean and Hamiltonian mechanics
- To undertake research topics in the field of robot modeling and control Mechanics and Control of Robotic Manipulators

UNIT I   INTRODUCTION   9

Introduction to Robotics - History - Definitions - Law of Robotics – Terminologies – Classifications Overview – Links & Joints - Degrees of Freedom - Coordinate Systems - Work Volume - Precision, Repeatability & Accuracy - Position and Orientation of Objects - Roll, Pitch and Yaw Angles - Joint Configuration – serial manipulators- Wrist Configuration. Overview of end effector - Selection and Application of Serial Manipulators.

UNIT II   FORWARD KINEMATICS   9

Need for forward and Inverse Kinematics Equation – Parameters in Design and Control – Methods of forward and inverse kinematics- Geometrical and Algebraic Approach in Forward Kinematics Solution, 1 DOF - 2 DOF Planar Robot (2P and 2R); 3DOF 2RP Spatial Robot. Representation using the Denavit-Hartenberg (DH) parameters -Degrees of freedom-Direct kinematics - SCARA robots.

UNIT III   INVERSE KINEMATICS   9

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3DOF planar and Spatial robot - Inverse kinematics of 3 axis robot and 6 axis robot -Inverse kinematics Computation-Solution methods - Closed loop solution.

UNIT IV   ROBOT DYNAMICS   9

General Expressions for Kinetic and Potential Energy - Kinetic Energy for an n-Link Robot - Potential Energy for an n-Link Robot - Equations of Motion -

Lagrangean Multiplier - Langrage's Equation - Hamilton Equation - Hamilton vector Field- Euler - Langrage Equation – State Vector and Equation Formulation

UNIT V ROBOT CONTROL SYSTEM 9

The manipulator control problem, Linear second-order model of manipulator. Functions of controller and power amplifier. Joint actuators- stepper motor, servo motor. Control Schemes: PID control scheme – Position and force control schemes. Robotic sensors and its classification - robotic vision system, Description of components of vision system.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Groover M.P., "Industrial Robotics - Technology Programming and Applications", McGraw Hill, 2012.
2. Niku S B, "Introduction to Robotics: Analysis, Systems, Applications", 3rd Edition, Prentice Hall, 2020.

REFERENCES:
1. John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2020
2. Deb S.R., "Robotics Technology and Flexible Automation", 2nd edition, Tata McGraw– Hill, 2010.
3. J. Srinivas, R. V. Dukkipati, K., "Robotics: Control and Programming", Narosa Publishing House, 2009.
4. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G. "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
5. Saeed B. Niku, "Introduction to Robotics: Analysis, Control, Applications", 2nd edition, John Wiley & sons, Inc., 2020

WEB RESOURCES:
1. https://blog.robotiq.com/how-to-calculate-a-robots-forward-kinematics-in-5-easy-steps
2. https://www.sciencedirect.com/topics/engineering/trajectory-planning
3. https://en.wikibooks.org/wiki/Robotics/Navigation/Trajectory_Planning

ONLINE RESOURCES:
1. https://h2t.anthropomatik.kit.edu/pdf/Vahrenkamp2016.pdf
2. https://nptel.ac.in/courses/112105236

3. https://nptel.ac.in/courses/112105249
4. https://archive.nptel.ac.in/courses/112/105/112105249/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the history, classifications and basic terminologies of robotics and various configuration of robots. (K2)
2. Describe forward kinematic model for planar and spatial robot manipulator. (K2)
3. Describe inverse kinematic model for multi-DOF robot manipulators. (K2)
4. Illustrate dynamics of robot using Lagrangean and Hamiltonian mechanics. (K3)
5. Describe the control architecture of robot manipulator. (K2)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	-	1	-	1	1	1	1	-	1	2	2
CO2	3	3	2	2	2	1	-	-	-	-	-	1	2	2
CO3	3	3	2	2	2	1	-	-	-	-	-	1	2	2
CO4	3	3	3	3	2	1	-	-	-	-	-	2	2	2
CO5	1	2	2	3	3	1	-	-	-	-	-	2	2	2

SEMESTER - V

20ESEI501 **SDG NO. 4, 9**	**PLC AND MICROCONTROLLER**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:
- To introduce students with the architecture and operation of typical microcontrollers and PLC.
- To familiarize the students with the programming and interfacing of microcontrollers, PLC, and Control systems.
- To provide strong foundation for designing real-world applications using microcontrollers and PLC.

UNIT I   INTRODUCTION TO PLC   9
Programmable logic Controllers-Introduction, Types of PLC, PLC architecture and block diagram. PLC hardware section- Input/output devices and their

interfacing, Discrete I/O module, Analog I/O module, Special I/O module. CPU-Processor memory organisation. Programming languages for PLC-Bit -level logic instructions-Instruction addressing-Branch instruction-Internal relay instruction-Programming XIC and XIO instruction.

UNIT II   APPLICATIONS OF PROGRAMMABLE LOGIC CONTROLLERS   9

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions –Program control instruction - Data manipulation and math instructions; Applications of PLC –Automatic lubrication of supplier Conveyor belt, Automatic motor control, Automatic car washing machine and Automatic Bottle filling system.

UNIT III   INTRODUCTION TO MICROCONTROLLER   9

8051 Architecture:– Memory map - Addressing modes, I/O Ports –Counters and Timers – Serial data - I/O – Interrupts –Instruction set, Data transfer instructions, Arithmetic and Logical Instructions, Jump and Call Instructions , Assembly Language Programming tools.

UNIT IV   MICROCONTROLLER PROGRAMMING   9

8051 Assembly Language Programming- Block transfer, arithmetic operations, Code conversion, Time delay generation, Interrupt programming, Lookup table techniques

UNIT V   MICROCONTROLLER APPLICATIONS   9

Interfacing and programming of serial communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI Interfacing of 8051 microcontrollers. Simple programming exercises- keyboard and display interface –Control of servo motor, stepper motor - Application to automation systems.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Mandal S. K , "Microprocessors and Microcontrollers", WBUT Series by TMH, 2020.
2. W. Bolton, "Programmable logic controllers", Elsevier Ltd, 2015.

REFERENCES:
1. Ram B, Fundamentals of Microprocessors and Microcontrollers, Dhanpat Rai Publications, 2008.
2. Kenneth J. Ayala, The 8085-micro controller-Architecture, Programming & Applications, Penram Publishing, 1997.

3. Frank D. Petruzella, Programmable Logic Controller, 4 th Edition, The McGraw-Hill, 2011.
4. Frank D Petruzella, Programmable logic controllers, McGraw-Hill, 5th Ed, 2016.
5. John R Hackworth and Fredrick D Hackworth Jr., Programmable Logic Controllers: Programming Methods and Applications‖, Pearson Education, 2015.

WEB RESOURCES:
1. https://www.plcacademy.com/ladder-logic-tutorial/
2. https://www.solisplc.com/tutorials/function-block-programming

ONLINE RESOURCES:
1. https://www.solisplc.com/tutorials/how-to-read-ladder-logic
2. https://nptel.ac.in/courses/108105102
3. https://nptel.ac.in/courses/108105088

OUTCOMES:
Upon completion of the course, the students should be able to
1. Describe the working of PLC and build small programs using bit level instructions. (K2)
2. Develop PLC programs using relay logic and ladder logic for simple automatic applications. (K2)
3. Describe the working of 8051 microcontroller and build small programs using 8051 instruction set. (K2)
4. Develop 8051 microcontroller programs for implementing simple automatic applications. (K2)
5. Discuss the advanced techniques and develop 8051 programs for interfacing microcontroller with industrial automation systems. (K2)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	2	1	1	1	-	-	-	-	-	-	1	2	2
CO3	3	1	-	-	-	-	-	-	-	-	-		2	2
CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	2
CO5	3	1	1	1	1	-	-	-	-	-	-	1	2	2

SEMESTER - V

20MUPL501 SDG NO. 4, 9, 12	MECHANICS OF ROBOTIC ELEMENTS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To model and simulate a robot and verify its kinematics
- To model and simulate a robot and generate a trajectory plan.
- To model and simulate a robot and verify its dynamics

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELLING

1. Kinematic Analysis of 2R planar robot for varying trajectories using Robo analyzer
2. Kinematic Analysis of 6 DOF robot for varying trajectories using Robo analyzer
3. Inverse Dynamic Analysis of 6 DOF robot for varying trajectories using Robo analyzer
4. Forward and Inverse Dynamics of 2R planar robot using Robo analyzer
5. Programming and working of Simple pick and place operations using a 3dof articulated arm robot
6. Programming of SCARA industrial robots for drilling and welding operations
7. Programming and working of palletizing and packaging robot
8. Analysis and Simulation of assembly operations using a four axis robot
9. Analysis and simulation of polar robot for terrestrial applications
10. Implementation of trajectory planning algorithm for straight line motion of two axis planar articulated robot
11. Implementation of trajectory planning algorithm for curved path of two axis planar articulated robot
12. Design and control of wall climbing robot
13. Design and control of mobile robot

LIST OF EQUIPMENTS:

1. PC workstation - 25 No's
2. Robot analyzer (open source) installed on computer - 25 No's
3. Articulated robot for pick and place application - 1 No
4. Robotic Manipulator for welding applications - 1 No
5. Accessories for palletizing and packaging robot

6. Accessories for articulated robot
7. Accessories for designing wall climbing robots
8. Accessories for designing mobile robots

OUTCOMES:
Upon completion of the course, the students should be able to
1. Design and simulate the forward and inverse kinematics of the robots (K5)
2. Perform the kinematic & dynamic simulation using MATLAB software. (K4)
3. Operate various robot for industrial applications. (K4)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	-	3	2	-	-	-	-	-	2	3	3
CO2	1	-	2	1	3	2	2	1	3	2	2	3	3	2
CO3	1	1	-	3	3	1	1	1	2	2	2	3	2	2

SEMESTER - V

20MUPL502 SDG NO. 4, 9, 12	AUTOMATION LABORATORY – I	L	T	P	C
		0	0	3	1.5

OBJECTIVES:
- Identify the components and performance characteristics of PLC, Signal and Communication Modules.
- To design and execute pneumatic circuits in automation systems.
- To simulate the hydraulic circuits for automation systems
- To apply PLC for different applications.

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELLING
1. Design of pneumatic circuits and show the operation using basic pneumatic trainer kit
2. Design of pneumatic circuits and show the operation using electro pneumatic trainer kit
3. Design of pneumatic circuits and show the operation using PLC electro pneumatic trainer kit
4. Design of pneumatic circuits and show the operation using basic hydraulic trainer kit

5. Design of pneumatic circuits and show the operation using PLC electro hydraulic trainer kit
6. Design and Simulation of hydraulic circuits using Automation studio software
7. Design and Simulation of pneumatic circuits using Automation studio software
8. PLC control circuit design and simulation using Automation studio software
9. Motor control using PLC (Servo, Stepper, DC & AC Motors)
10. Applications using PLCs (Traffic light, Bottle filling, Lift etc.)
11. Closed loop control of a variable speed drive using PLC, SCADA

LIST OF EQUIPMENTS:

1. Hydraulic Trainer Kit with Pump and Valves – 2 Nos
2. Pneumatic Trainer Kit with Compressor and Valves – 1 No
3. Electro Pneumatic Trainer Kit – 1 No
4. Electro Pneumatic Trainer Kit with PLC – 1 No
5. Electro Hydraulic Trainer Kit with PLC – 1 No
6. Hydraulics and Pneumatics Simulation Software – 5 licenses
7. System Controlled DC Motor with Feedback Setup - 1 No
8. System Controlled AC Motor with Feedback Setup - 1 No
9. System Controlled Stepper Motor Setup – 2 Nos
10. PLC application modules - 1 set
11. Automation Studio Software - 5 Licenses
12. Personal Computers -10 No's

OUTCOMES:
Upon completion of the course, the students should be able to
1. Design and execute pneumatic circuits in automation systems. (K5)
2. Simulate the hydraulic circuits for automation systems. (K4)
3. Apply PLC for different applications. (K5)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	2	1	2	-	2	2	-	-	-	-	-	2	3	3
CO2	1	-	2	1	3	2	2	1	2	2	2	2	3	2
CO3	1	1	-	3	3	1	1	1	2	2	2	2	2	2

SEMESTER - V

20HSPL501 SDG NO. 4, 8	COMMUNICATION AND SOFT SKILLS LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:
- To develop effective communication and presentation skills
- To enhance the employability and career skills of the learners
- To enable the learners for preparing job application and e-portfolio
- To make the learners use soft skills efficiently
- To develop their confidence and help them in attending interviews successfully

UNIT I LISTENING AND SPEAKING SKILLS   6

Conversational skills participate in formal and informal talks – general, – group discussion– time management – group dynamics – GD strategies - making effective presentations - listening/watching   interviews conversations, documentaries - listening to lectures, discussions from social media – improving articulation.

UNIT II ADVANCED READING AND WRITING SKILLS   6

Reading different genres of texts - writing job applications – cover letter – resume – emails – memos - writing abstracts – summaries – interpreting visual texts.

UNIT III SKILLS FOR COMPETITIVE EXAMS   6

Reading passages for competitive exams – language focus exercise – building vocabulary tasks - FAQs related to competitive exams – current affairs - improving global reading skills – elaborating ideas – summarizing – understanding arguments – identifying opinion/attitude and making inferences - critical reading.

UNIT IV SOFT SKILLS   6

Motivation – emotional intelligence – managing changes – stress management – leadership straits – team work – career planning – intercultural communication – creative and critical thinking.

UNIT V INTERVIEW SKILLS   6

Different types of interview – personal interview – panel interview – telephone/online interview - interview etiquette - answering questions – offering information – mock interviews – FAQs related to job interviews.

TOTAL: 30 PERIODS

TEXT BOOKS:
1. Business English Certificate Materials, Cambridge University Press.
2. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge, 2011.
3. International English Language Testing System Practice Tests, Cambridge University Press
4. Personality Development (CD-ROM), Times Multimedia, Mumbai.

WEB RESOURCES:
1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. http://www.oxforddictionaries.com/words/writing-job-applications
3. http://www.skillsyouneed.com/ips/interview-skills.html
4. http://www.personalitydevelopment.org/
5. https://nptel.ac.in/courses/109/107/109107121/
6. https://swayam.gov.in/nd1_noc19_hs33/preview
7. https://ict.iitk.ac.in/courses/enhancing-soft-skills-and-personality/

ONLINE RESOURCES:
1. https://www.britishcoucil.my/english/courses-adults/learningtips/importance-of- soft-skills
2. https://www.skillsoft.com/content-solutions/business-skillstraining/soft-skills- training/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Give oral presentations effectively.
2. Use technology to communicate effectively in various settings and context.
3. Develop skills required for workplace environment.
4. Communicate in forums like debate, group discussion and interviews confidently.
5. Develop skills required for workplace environment.

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	1	3	-	-
CO2	-	-	-	-	-	1	-	-	1	3	1	-
CO3	-	-	-	-	1	-	-	-	-	2	-	-
CO4	-	-	-	-	-	-	-	1	-	3	-	-
CO5	-	-	-	-	-	-	-	1	-	3	1	-

SEMESTER - V

20MUTE501 SDG NO. 4,6,7,8,9, 11,12,13, 17	LIVE-IN-LAB – III	L	T	P	C
		0	0	2	1

OBJECTIVES:
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students face reviews and viva voce examination.

COURSE METHODOLOGY

The student should continue the Live-in Lab Project-II on the selected topic under the same supervisor. The student has to complete the analysis portion and validation of the project done in Live-in Lab Project-II. The students are asked submit as a product if the project involves fabrication. At the end of the semester, the progress of the project is reviewed and evaluated with a minimum of three reviews with the guidance of Project Coordinator. The students will be evaluated through based on the report and the viva-voce examination by the panel of members. The review committee may be constituted by the Head of the Department. The student must submit a detailed project report at the end of the semester for evaluation.

EVALUATION: Project work evaluation is based on Regulations of Credit system of Autonomous Regulatory Body.

Note: All the three evaluations are mandatory for course completion and for awarding the final grade

COURSE OUTCOMES:

Upon completion of the course, the students should be able to

1. Comprehend an industrial or real life problem and identify right/ real issue with solution. (K1)
2. Complete the necessary studies and review the literature, design a setup of equipment, complete the analysis (K2)
3. Write a project report based on the findings. (K2)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Co1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - V

20MUTP501 SDG NO. 4	SKILL ENHANCEMENT	L	T	P	C
		0	0	2	1

PROBLEM SOLVING SKILLS – PHASE 1

OBJECTIVES:

- Improve their quantitative ability.
- Improve their reasoning ability.
- Enhance their verbal ability through vocabulary building and grammar.
- Equip with creative thinking and problem solving skills.

UNIT I   QUANTITATIVE ABILITY – V   6

Square Root and Cube Root, Logarithm, Volume and Surface Area, Permutation and Combination.

UNIT II   QUANTITATIVE ABILITY – VI   6

Probability, Averages, Area, Odd Man Out, Crypt Arithmetic, Flowcharts.

UNIT III   REASONING ABILITY – III   6

Data Interpretation Table Charts, Data Interpretation Bar Charts, Blood Relationship, Puzzles.

UNIT IV   VERBAL ABILITY – III   6

Spellings, Selecting Words, Spotting Errors, Ordering of Words, Logical Sequence of Words.

UNIT V   CREATIVITY ABILITY – III   6

Logical Puzzles, Playing Cards Puzzles, Clock Puzzles, Number Puzzles, Sudoku.

TOTAL : 30 PERIODS

REFERENCES:
1. R. S. Agarwal, "Quantitative Aptitude for Competitive Exams"
2. Sarvesh Verma, "Quantum CAT"
3. R. S. Agarwal, "A Modern Approach to Logical Reasoning"
4. Arunsharma, "Verbal Ability and Reading Comprehension"

COURSE OUTCOMES:
Upon completion of the course, the students should be able to
1. Analyze their quantitative ability. (K4)
2. Understand the ability of arithmetic reasoning along with creative thinking and problem solving skills. (K2)
3. Create their verbal ability through vocabulary building and grammar. (K6)

PROBLEM SOLVING USING BASIC DATA STRUCTURES
MATLAB AND SIMULINK – PHASE 2

COURSE OBJECTIVE:
- Analyze simple algorithms and data structures.
- Design of computer algorithms, as well as analysis of sophisticate algorithms.
- Familiar with the CST Studio Suite interface
- Perform basic tasks in terms of modeling, setup of simulation, and analyzing pre and post processing results

UNIT I   LINKED LIST & STACK, QUEUE & HEAP   `10

Linked List - Doubly Linked List Traversal, Circular Linked List, Structure, Node creation, Traversal Stack, Stack –Time Complexities of the Operations, Infix to Postfix/Prefix Conversation, Histogram Problem, Implementation - Using Array, Using Linked List, Queue Implementation - Queue using Stack

UNIT II   BINARY TREE AND HASHING   10

Binary Tree - Types of Binary Tree, Balanced Tree, Degenerate or pathological Tree, Binary Search Tree, Inorder , Preorder , Post Order and Level Order Traversal, Hashing, Linear Probing for Collision Handling, Union and Intersection of two Linked Lists

UNIT III   TREES AND GRAPH   10

AVL Tree -Right-Left Imbalance, Left and Right Rotation, - Red Black Tree, Rules of coloring Left and Right Rotation, Graph terminology –Representation of graphs –Path matrix –Graph Traversal –BFS (breadth first search) –DFS (depth first search) –Minimum spanning Tree –Kruskal's Algorithm & Prim's Algorithm –Warshall's algorithm (shortest path algorithm).

UNIT IV   SIMULINK   8

Basics of matlab programming - simulink - computer programming - application of simulink for automotive field.

UNIT V   MATLAB   7

Simulation software in Matlab - Experimentation with matlab - scripting - plotting - Applications.

                                              TOTAL : 45 PERIODS

REFERENCES:
1. Weiss, Mark. A. (2012), Data structures and algorithm analysis in Java. 3 edition. Harlow, Essex: Pearson (632 p).
2. Zobel, Justin (2014), Writing for Computer Science. 3 edition. Springer Verlag London Ltd (270 p).

WEB RESOURCES:
1. http://users.isr.ist.utl.pt/~alex/micd0506/simulink.pdf
2. https://in.mathworks.com/products/simulink.html

OUTCOMES:
Upon completion of the course, the students should be able to
1. Data abstraction and information hiding. (K2)
2. Explain linear data structures and their applications in problem solving and programming. (K2)
3. Explain Nonlinear data structures and their applications in problem solving and programming. (K2)

4. Explain Internal and external sort and search techniques. (K2)
5. Implementing statistical analysis using matlab and simulink software.(K3)
6. Applying Simulink Tool for Design and Analysis. (K4)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	-	-
CO4	1	1	-	2	2	-	-	-	-	1	-	1	2	2
CO5	-	2	1	2	1	-	-	-	-	-	-	1	2	2
CO6	1	2	1	-	2	-	-	-	-	-	1	1	2	2

SEMESTER - VI

20MUPC601 SDG NO. 4,8,9,12	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

● To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
● To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
● To be acquainted with vat polymerization and material extrusion processes.
● To be familiar with powder bed fusion and direct energy deposition.
● To gain knowledge on applications of binder jetting, material jetting and laminated object manufacturing processes.

UNIT I   INTRODUCTION   9

Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing - Printing Electronics. Business Opportunities and Future Directions.

UNIT II   DESIGN FOR ADDITIVE MANUFACTURING (DFAM)   9

Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation - Model Slicing - Tool Path Generation – Data formats, slicing algorithms: - uniform flat layer slicing, adaptive slicing and rasterization.

UNIT III   VAT POLYMERIZATION AND MATERIAL EXTRUSION   9

Photo polymerization: Stereo lithography Apparatus (SLA) - Materials - Process –Advantages - Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process-Materials - Applications and Limitations.

UNIT IV   POWDER BED FUSION AND DIRECT ENERGY DEPOSITION   9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application.

Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS) - Process -Material Delivery - Process Parameters -Materials -Benefits -Applications.

UNIT V   OTHER ADDITIVE MANUFACTURING PROCESSES   9

Binder Jetting: Three Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: Multijet Modeling- Materials - Process - Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM) - Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015.
2. Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", 2nd edition, Springer., United States, 2015.

REFERENCES:

1. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011.
3. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States, 2006.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011.
5. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016.

WEB RESOURCES:

1. https://www.sculpteo.com/en/3d-printing/3d-printing-technologies/
2. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/
3. https://3dprinting.com/what-is-3d-printing/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/107/103/107103081/
2. https://www.coursera.org/learn/3d-printing-software
3. https://nptel.ac.in/courses/112/104/112104225/

OUTCOMES:

Upon completion of the course, the students should be able to
1. Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities. (K2)
2. Acquire knowledge on process of transforming a concept into the final product in AM technology. (K2)
3. Elaborate the vat polymerization and material extrusion processes and its applications. (K2)
4. Acquire knowledge on process and applications of powder bed fusion and direct energy deposition. (K3)
5. Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	-	-	-	-	-	1	-	1	2	2
CO2	2	3	3	2	2	-	-	-	-	1	-	1	2	3
CO3	3	3	3	3	2	-	-	-	-	1	-	1	2	3
CO4	2	2	2	1	2	-	-	-	-	1	-	1	2	2
CO5	1	1	1	2	2	-	-	-	-	-	-	1	1	1

SEMESTER - VI

20MUPC602 SDG NO. 4,9,11,12	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To get a knowledge of working on Industrial robots and their load handling capacity
- To enlist with an application of robots in various operation
- To familiar with a material handling system
- To impart the knowledge on robotic welding
- To obtain the knowledge on various type of robot welding operation.

UNIT I   INTRODUCTION   8

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell.

UNIT II   SELECTION OF ROBOTS AND OTHER APPLICATIONS   9

Factors influencing the choice of a robot - robot performance testing - economics of robotisation - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT III   MATERIAL HANDLING   12

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design softwares.

UNIT IV   ROBOTIC WELDING   8

Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.

UNIT V   APPLICATIONS OF ROBOTS   8

Application of robot in manufacturing: Robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Richard D Klafter, Thomas Achmielewski, Mickael Negin , "Robotic Engineering – An Integrated Approach", Prentice Hall India, New Delhi, 2006.
2. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2021.

REFERENCES:
1. Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.

2. Parmar R S, "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.

3. John A. piotrowski, William T. Randolph, "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.

4. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, Ashish Dutta, "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2017.

5. Yoram Koren, "Robotics for Engineers", McGraw-Hill, 1987.

WEB RESOURCES:
1. https://www.manufacturingtomorrow.com/article/2018/05/5-ways-robotics-are-being-used-in-smart-manufacturing/11568
2. https://robotnik.eu/smart-factories-robots/
3. https://www.slideshare.net/nabil130290/selection-of-robot
4. https://www.automationworld.com/factory/robotics/article/21133266/robots-how-to-choose-the-right-one
5. https://www.motoman.com/en-us/applications

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112107298
2. https://nptel.ac.in/courses/112107289
3. https://nptel.ac.in/courses/112104293

OUTCOMES:
Upon completion of the course, the students should be able to
1. Learn about the basic concepts of Industrial Robot. (K2)
2. Ability in selecting the required robots (K2)
3. Apply their knowledge in handling the materials. (K3)
4. Learn about the Welding operation and also related to Programming. (K2)
5. Know the various applications of robots. (K2)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	-	-	-	-	-	1	-	1	1	1
CO2	2	2	3	1	1	-	-	-	-	1	-	1	2	2
CO3	2	2	3	2	1	-	-	-	-	2	-	1	2	2
CO4	2	2	2	1	1	-	-	-	-	1	-	1	2	1
CO5	1	1	1	2	2	-	-	-	-	-	-	1	1	1

SEMESTER - VI

20MUPC603 SDG NO. 4,9,11,12	INDUSTRIAL AUTOMATION FOR MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To impart the basic knowledge in automation of industrial processes.
- To learn the different automated flow lines in manufacturing industries.
- To explore the material handling and part identification techniques.
- To learn about control system, assembly system and testing in modern manufacturing industries.

UNIT I   INTRODUCTION   9

Introduction- Automation in production system, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers.

UNIT II   MANUFACTURING SUPPORT SYSTEM AND SIMULATION   9

Process planning–Computer Aided Process planning, types. Production Planning- Master production schedule, bill of material, inventory record, working of material requirements planning and its outputs. Shop floor control – phases of shop floor control, factory data collection system. Simulation - classification of simulation language, Building of simulation models using General Purpose Simulation System (GPSS) – Simulation of manufacturing shop and super market using GPSS.

UNIT III   AUTOMATION FOR MANUFACTURING SYSTEM   9

Group technology– Part classification and coding, cellular manufacturing, production flow analysis- Rank Order Clustering and Hollier method. Flexible Manufacturing System (FMS) and its planning and implementation, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine

UNIT IV   AUTOMATION IN PROCESS INDUSTRIES – I   9

Introduction to computer based industrial automation- Direct Digital Control (DDC), Distributed Control System (DCS) and supervisory control and data acquisition (SCADA) based architectures. SCADA for process industries includes understanding of RTUs, Pumping stations, Evacuation processes, Mass Flow Meters and other flow meters, Leak-flow studies of pipelines, Transport Automation.

UNIT V   AUTOMATION IN PROCESS INDUSTRIES – II   9

Distributed Control System- Local Control Unit (LCU) architecture, LCU Process Interfacing Issues, Block diagram and Overview of different LCU security design approaches, Networking of DCS. Introduction to communication protocols- Profibus, Field bus, HART protocols. Data gathering, Data analytics, Real-time analysis of data stream from DCS.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th Edition, Pearson Education, 2009.
2. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.

REFERENCES:
1. Curtis D. Johnson, "Process Control Instrumentation Technology", 8th Edition, Pearson New International, 2013.
2. Lukas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
3. N. Viswanandham, Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", 1st Edition, 2009.
4. H K Shivanand, —Flexible Manufacturing Systems‖, New Age International, 1st Edition, 2006.
5. Frank Lamb, Industrial Automation: Hands-On, 1st Edition, McGraw-Hill Education, 2013

WEB RESOURCES:
1. https://www.accessengineeringlibrary.com/content/book/9780071816458
2. https://nikarifblog.files.wordpress.com/2017/12/jm608-industriial-automation-textbook.pdf
3. https://www.iare.ac.in/sites/default/files/IARE_IAC_PPT_0.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/syllabus/108108098/
2. https://onlinecourses.nptel.ac.in/noc21_me67/preview
3. https://nptel.ac.in/courses/112103293

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand the basics of automation and analyze the cost effective of automated system. (K2)
2. Explain the working principles of different manufacturing support systems. (K2)
3. Explain the Concept of Group Technology and FMS. (K2)
4. Differentiate various control aspects of automation. (K2)
5. Apply the distributed control system for automation. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	-	-	-	-	-	1	-	1	2	2
CO2	2	3	3	2	2	-	-	-	-	1	-	1	2	3
CO3	3	3	3	3	2	-	-	-	-	1	-	1	2	3
CO4	2	2	2	1	2	-	-	-	-	1	-	1	2	2
CO5	1	1	1	2	2	-	-	-	-	-	-	1	1	1

SEMESTER - VI

20MUPL601 SDG NO. 4,9,11,12	3D PRINTING AND CNC LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:
- To expose and train the students on different 3D printing technologies and enable them to produce the physical components for different industrial applications.
- To understand the concepts G and M codes and manual part programming.
- To understand the applications of various CNC machines and to expose students to modern CNC application machines.

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELLING

3D Printing exercises:
1. Introduction to Additive Manufacturing.
2. Generating STL files from the CAD Models & Working on STL files.
3. Processing the CAD data in open source software.
4. Simulation in Catalyst Software for optimizing build-time and material consumption.
5. Fabricating physical part on FDM 3D printer for the automotive applications.
6. Fabricating physical part on FDM 3D printer for manufacturing applications.
7. Removing the supports & post processing (cleaning the surfaces).
8. Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy.

CNC Exercises:
9. Develop CNC Program for simple Facing operation with its tool simulation.
10. Develop CNC Program for Step turning operation with its tool simulation.
11. Develop CNC Program for Tapper turning operation with its tool simulation.
12. Develop CNC Program for Grooving and threading operation along with its tool simulation.
13. Develop a manual CNC Program for Contour milling with simulation.
14. Develop CNC Program for Profile milling operation.

15. Develop CNC Program for Profile milling and circular pocket operation with simulation.
16. Develop CNC Program for profile milling and drilling operations using CAM Package.

LIST OF EQUIPMENTS:

1. FDM technology Single/Dual Extruder 3D printer – 3 Nos.
2. Personal Computers with open source printing software – 25 Nos
3. CNC Lathe – 1 No
4. CNC Milling – 1 No

OUTCOMES:

Upon completion of the course, the students should be able to

1. Apply the knowledge gained on AM for various manufacturing industries. (K3)
2. Build the physical part using 3D printers. (K3)
3. Create part programming on CNC lathe and CNC milling machine for the machine component. (K4)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	-	-	-	-	1	1	2	-	1	3	2
CO2	1	1	3	1	3	-	1	1	2	3	-	2	3	3
CO3	1	1	3	1	3	-	1	1	2	3	-	2	3	3

SEMESTER - VI

20MUPL602 SDG NO. 4,9,12	**MODELING AND SIMULATION OF ROBOT ELEMENTS LABORATORY**	**L**	**T**	**P**	**C**
		0	0	3	1.5

OBJECTIVES:

- To develop the student's skills in proper modeling, meshing, and setting up material properties, loads, and constraints for computer simulation and analysis.
- To expose the students to different applications of simulation and analysis tools
- To provide the analysis skills to interpret and draw conclusion the results of computer analysis
- To give exposure to software tools needed to analyze engineering Problems

LIST OF EXERCISES USING SOFTWARE CAPABLE OF MODELLING and SIMULATION

1. 3D Modelling Mounting clamp for motor.
2. 3D Modeling of pulley and belt drive system.
3. 3D Modelling Ball Screw and Nut assembly.
4. 3D Modelling and motion simulation of Rotational Joint assembly.
5. 3D Modelling and motion simulation of Prismatic Joint assembly.
6. 3D modelling and simulation of Cartesian Robot.
7. 3D modelling and simulation of Articulated / Spherical / Cylindrical Robot.
8. 3D modelling and motion simulation of 2 fingered gripper assembly.
9. Modeling and Simulation of Conveyors for Material Handling.
10. Modeling and Simulation of Manufacturing Control Systems.
11. Modeling and Simulation of Assembly line.
12. Modeling and Simulation of packaging line.

LIST OF EQUIPMENTS:

1. Personal Computers – 30 Nos
2. Simulink Software – 5 Licenses
3. Modeling software like Solidworks, Catia, …

OUTCOMES:

Upon completion of the course, the students should be able to

1. Develop the basic components of a robot in CAD software. (K3)
2. Model the some common joints, links and transmission assembly for a robot in CAD software. (K3)
3. Model and simulate the assembly lines of manufacturing industry. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	2	2	-	-	1	-	-	2	3	2
CO2	2	3	2	-	2	2	-	-	2	-	-	2	3	2
CO3	1	1	1	-	2	2	-	-	2	-	-	2	3	2

SEMESTER - VI

20MUPJ601 SDG NO. 4, 6, 7, 8, 9, 11, 12, 13, 17	**INNOVATIVE DESIGN AND FABRICATION PROJECT**	L	T	P	C
		0	0	2	1

OBJECTIVES:

● The main objective is to give an opportunity to the students to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them

GUIDELINES TO BE FOLLOWED:

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/ component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

COURSE OUTCOMES:
Upon completion of the course, the students should be able to

1. Conceptualize the societal needs and acquire design ability. (K3)
2. Manufacture the component/equipment to meet the specific needs of the society with appropriate consideration for public health, safety and environmental context for sustainable development. (K4)
3. Demonstrate the working of model fabricated by them and write a detailed report on project. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	3	3	3	3	3	3	3	3
CO2	2	2	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	1	-	-	3	-	2	3	3	3	1	3	3	3

SEMESTER - VI

20MUTP601 SDG NO. 4	SKILL ENHANCEMENT	L	T	P	C
		0	0	2	1

APTITUDE & COGNITIVE SKILLS – PHASE 1

COURSE OBJECTIVE:
- Improve their quantitative ability.
- Improve their reasoning ability.
- Enhance their verbal ability

UNIT I   QUANTITATIVE ABILITY – VII   6
Races And Games, Boats and Streams, Surds and Indices, Pipes and Cistern, Alligations And Mixtures.

UNIT II QUANTITATIVE ABILITY – VIII   6
Numbers, Problems on Numbers, Pick Wrong Number, Missing Number, Areas, Shapes, Perimeter.

UNIT III   REASONING ABILITY – IV   6
Data Interpretation Pie Charts, Data Interpretation Line Charts, Data Sufficiency (DS), Data Arrangements, LR – Arrangements, LR – Ranking.

UNIT IV VERBAL ABILITY – IV   6
Sentence Correction, Sentence Improvement, Completing Statements, Sentence Formation, Paragraph Formation.

UNIT V CREATIVITY ABILITY – IV   6
Dot Situation, Rule Detection, Embedded Images, Grouping Of Images, Image Analysis.

TOTAL : 30 PERIODS

REFERENCES:
1.   Quantitative Aptitude for Competitive Exams by R. S. Agarwal
2.   Quantum CAT by Sarvesh Verma
3.   A Modern Approach to Logical Reasoning by R. S. Agarwal
4.   Verbal Ability and Reading Comprehension by Arun Sharma

PROBLEM SOLVING USING C PROGRAMMING AND DATA SCIENCE USING R PROGRAMMING - PHASE 2

COURSE OBJECTIVE:

- The course aims to provide exposure to problem-solving through programming. It aims to train the student to the basic concepts of the C programming language.
- This course involves a lab component which is designed to give the student hands-on experience with the concepts.
- This course aims at learning new tools for data science using open source software- R.
- This course is oriented towards familiarizing the concepts of data analysis and statistical modelling

UNIT I   INTRODUCTION TO PRINCIPLES OF PROGRAMMING   6

Introduction to Programming, Programing Domain: Artificial Intelligence, Systems Programming, Assembly Level Languages, Problem solving using Algorithms and Flowcharts.

UNIT II   INTRODUCTION TO C PROGRAMMING   6

Features of C and its Basic Structure, Simple C programs, Constants, Integer Constants, Real Constants, Character Constants, String Constants Floating point Numbers, The type cast Operator, Interactive Programming. Operators Expressions and Control statement, The goto statement, The if statement, The if-else statement, Nesting of if statements, The conditional expression, The break statement and continue statement.

UNIT III   ARRAYS, STRINGS AND POINTERS   6

Arrays, Multidimensional Arrays, Strings, Basics of Pointers, Pointer Arithmetic, Similarities between Pointers and One-dimensional Arrays Structures, Unions And Functions, Basics of Structures, Arrays of Structures, Pointers to Structures, Function Basics, Function Prototypes, and Passing Parameters, Structures and Functions Recursion.

UNIT IV   R PROGRAMMING FUNDAMENTALS   6

Overview of Data Science- Downloading and installing R and RStudio- R Basics- Data Types- Vector- Matrix-Arrays- Data frame- packages- R charts and Graphs.

UNIT V   DATA SCIENCE USING R   6

Importing and exporting data using R- Working with open source datasets from Kaggle- Data cleaning- Exploration Analysis and Visualization for real time data sets- Case studies.

TOTAL : 30 PERIODS

REFERENCES:
1. Programming in ANSI C - Balagurusamy - Tata McGraw-Hill Education, 2008
2. Programming in C (3rd Edition), by Stephen G. Kochan, Sams, 2004
3. Programming in C - Stephen G. Kochan, III Edition, Pearson Education.
4. Nathan Metzler, R Programming for Beginners, First Edition
5. Hadley Wickham,Garrett Grolemund, "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data",O'Reilly Publications,2017.
6. Kaelen Medeiros, R Programming Fundamentals, First Edition

OUTCOMES:
Upon completion of the course, the students should be able to
1. Analyze their quantitative ability. (K4)
2. Understand the ability of arithmetic reasoning along with creative thinking and problem solving skills. (K2)
3. Create their verbal ability through vocabulary building and grammar. (K6)
4. Evaluate the situations to analyse the computational methods in order to identify and abstract the programming task involved. (K5)
5. Understand the basics of data science and R programming fundamentals. (K2)
6. Apply R programming language concepts such as data types, vectors, matrix arrays, structures, functions, and boolean operators by writing R programs and through examples. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO2	-	-	-	-	3	2	-	3	2	3	-	2	-	-
CO3	-	-	-	-	3	2	-	-	1	3	-	2	-	-
CO4	-	-	-	-	3	2	-	3	3	3	-	2	2	2
CO5	3	2	2	2	3	2	-	-	-	3	-	2	-	-
CO6	2	2	3	2	3	2	-	-	-	3	-	2	-	-

SEMESTER - VI

20MGMC301 SDG NO. 4,8,9,12	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

OBJECTIVES:
- To know about Indian constitution
- To know about central government functionalities in India
- To know about state government functionalities in India
- To know about Constitution function
- To Know about Constitutional remedies

UNIT I   INTRODUCTION   6
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties.

UNIT II   STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT   6
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India.

UNIT III   STRUCTURE AND FUNCTION OF STATE GOVERNMENT   6
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

UNIT IV   CONSTITUTION FUNCTIONS   6

Indian Federal System – Centre – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries.

UNIT V   CONSTITUTIONAL REMEDIES   6

Enforcement of fundamental rights - Power of parliament to modify the rights the conferred by this part in their application to forces.

TOTAL:30 PERIODS

TEXT BOOKS:
1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
2. R.C. Agarwal, (1997) "Indian Political System", S. Chand and Company, New Delhi.
3. M.V. Pyle (2019), "An Introduction to The Constitution of India, 5/e", Vikas Publishing, New Delhi.
4. P.M. Bakshi, (2018), "Constitution of India", Universal Law Publishing, New Delhi.

REFERENCES:
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, Jalandhar.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the Constitution and Fundamental rights of citizens. (K2)
2. Discuss the structure, hierarchy and functions of Central Government. (K2)
3. Explain the functions of Supreme Court and Judiciary Systems in the state. (K2)
4. Discuss the structure, hierarchy and functions of State Government (K2)
5. Recall the Centre-State relationship, constitutional amendments and functionaries (K1)
6. Discuss the remedies and rights available to India Citizens (K2)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	1	1	-	-	-	-	-	-	-
CO2	-	-	-	-	-	1	1	-	-	-	-	-	-	-
CO3	-	-	-	-	-	1	1	-	-	-	-	-	-	-
CO4	-	-	-	-	-	1	1	-	-	-	-	-	-	-
CO5	-	-	-	-	-	2	1	3	-	-	-	-	-	-
CO6	-	-	-	-	-	2	1	2	3	-	-	-	-	-

SEMESTER - VII

20HSMG601	PRINCIPLES OF	L	T	P	C
SDG NO. 4,8,9,10,12	ENGINEERING MANAGEMENT	3	0	0	3

OBJECTIVES:
- To enable the students to study the evolution of Management, to study the functions and principles of management.
- To learn the application of the principles in an organization

UNIT I   INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS   9

Management – Science or Art – Manager Vs Entrepreneur – types of managers – Engineers as Managers. Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization – Sole proprietorship, partnership, company-public and private sector enterprises – Organization culture and Environment – Current issues and future trends in Management; Industry 4.0 – Engineering management in modern business.

UNIT II   PLANNING   9

Planning, Technology Planning - Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – MBO – process - Principles and functions of engineering management – Planning Tools and Techniques – Decision making steps and process.

UNIT III   ORGANISING   9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority –departmentalization – delegation of authority – centralization and decentralization – Job Design – Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV   DIRECTING AND CONTROLLING   9

Foundations of individual and group behaviour – Motivation – theories and techniques–Leadership – Level 5 leadership - theories – Leadership as a determinant of Engineering management - Communication – process and barriers – effective communication – Communication and IT - System and process of controlling – budgetary and non-budgetary control techniques.

UNIT V INNOVATION AND TECHNOLOGY MANAGEMENT   9

Innovation management of Product and Services, Role of R & D in Entrepr eneurship, Breakthrough Innovation, Disruptive Innovation – Modern approa ches in Engineering management – Green management, Lean management, Managing diversity. IPR – Principles of Ethics for Engineering Managers.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Tripathy.P.C , Reddy.P.N, and Asish Bajpai"Principles of Management", Tata McGraw Hill, 7th Edition, 2021.
2. Peter Eichhorn, Ian Towers, "Principles of Management", Springer Texts in Business and Economics, Springer, 2018.

REFERENCES:

1. Stephen P. Robbins and Mary Coulter, "Management", Prentice Hall (India) th Pvt. Ltd., 10 Edition, 2009.
2. JAF Stoner, Freeman R.E and Daniel R Gilbert, "Management", Pearson th Education, 6 Edition, 2004.
3. Stephen A. Robbins and David A. Decenzo and Mary Coulter, th "Fundamentals of Management", Pearson Education, 7 Edition, 2011.
4. Robert Kreitner and Mamata Mohapatra, "Management", Biztantra, 2008.
5. Harold Koontz and Heinz Weihrich, "Essentials of Management", Tata McGraw Hill, 11th Edition, 2020.

WEB RESOURCES:

1. https ://www.managementstudyguide.com/organizationmanagement. htm
2. https://nptel.ac.in/courses/110/105/110105034/
3. https://courses.lumenlearning.com/boundless-management/ chapter/principles-of-management/

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/110/105/110105033/

OUTCOMES:

Upon completion of the course, the students should be able to

1. Get a clear idea on the practical implications of the management concepts in engineering with emphasis on the need for innovation in every sphere. (K2)
2. Manage functions like planning on international aspect of management. (K2)

3. Understand basic knowledge about organizing, staffing on international aspect of management. (K2)
4. Understand the concepts and principles of management viz., Directing, and Controlling in the changing business scenario. (K3)
5. Get through knowledge on the Efficient and Effective management of Men, Money and Technology towards developing the industrial system. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	3	3	1	1	1
CO2	-	-	-	-	-	2	2	3	3	1	1	1
CO3	-	-	-	-	-	2	2	3	3	1	1	1
CO4	-	-	-	-	-	2	2	3	3	1	1	1
CO5	-	-	-	-	-	2	2	3	3	1	1	1

SEMESTER - VII

20MUPC701 SDG NO. 4,9,11,12	ROBOTIC VISION AND INTELLIGENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics concepts of optics and vision systems.
- To learn and understand the fundamentals of image processing
- To impart knowledge on object recognition and feature extraction.
- To understand algorithms in image processing.
- To demonstrate the various applications of machine vision system.

UNIT I   IMAGE ACQUISITION   9

The Nature of Vision- Robot vision – Need, Applications - image acquisition – Physics of Light – Interactions of light – Refraction at a spherical surface – Thin Lens Equation - Illumination techniques - linear scan sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

UNIT II   IMAGE PROCESSING FUNDAMENTALS   9

Introduction to Digital Image Processing - Image sampling and quantization - Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features,

Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.

UNIT III   OBJECT RECOGNITION AND FEATURE EXTRACTION   9

Image segmentation- Edge Linking-Boundary detection-Region growing-Region splitting and merging- Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition structural methods- Recognition procedure, mahalanobic procedure.

UNIT IV   COLLISION FRONTS ALGORITHM   9

Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

UNIT V   ROBOT VISION APPLICATION   9

Case study-Automated Navigation guidance by vision system – vision based de palletizing- line tracking. Automatic part Recognition. Image processing techniques implementation through Image Processing software.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Rafael C. Gonzales, Richard. E. Woods, "Digital Image Processing Publishers", Fourth Edition, Pearson, 2008.
2. Forsyth, Ponce "Computer Vision, A modern approach", Pearson Education Limited, second edition, 2016.

REFERENCES:
1. Trucco Emanuele, Verri Alessandro, "Introductory Techniques For 3D Computer Vision", First Edition, 2009
2. Fu .K.S, Gonzalez .R.S, Lee .C.S.G, "Robotics – Control Sensing, Vision and Intelligence", Tata McGraw-Hill Education, 2008.
3. Rafel C.Gonzalez, Richard E.Woods, Steven L.Eddins, "Digital Image Processing using MATLAB", 2nd edition, Tata McGraw Hill, 2010.
4. Milan Sonka, Vaclav Hlavac & Roger Boyle, "Image Processing, Analysis, and Machine Vision" 3rd Edition, Cengage Learning, 2008.
5. Alexander Hornberg, "Handbook of Machine Vision", Wiley-VCH, USA, 2017

WEB RESOURCES:
1. https://dl.icdst.org/pdfs/files4/01c56e081202b62bd7d3b4f8545 775fb.pdf

2. https://www2.informatik.uni-hamburg.de/wtm/publications/2013/ YTVMWCW13/Yan_chap_garcia-rodriguez_book.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/117105079
2. https://nptel.ac.in/courses/106105216

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize the various types of sensors, lightings, hardware and concept of machine vision. (K2)
2. Identify the image by the appropriate use of sensors, lightings and hardware. (K2)
3. Apply the various techniques of image processing in real time applications. (K3)
4. Explain various Collision fronts algorithm.(K2)
5. Apply the vision techniques in Robot vision system. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	3	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	3	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	3	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	3	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	3	2

SEMESTER - VII

20MUPC702 SDG NO. 4,8,9	MECHATRONICS SYSTEM DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To impart thorough knowledge in system modeling, system identification and simulation of mechatronics system.
- To get a glimpse of content about mechatronic design and optimization.

UNIT I INTRODUCTION TO MECHATRONICS 7

Mechatronics system overview – Recent advancements – application – key elements – mechatronics system design process.

UNIT II   SYSTEM MODELING   9

Need for modeling – systems overview – representation of systems (block diagram, signal flow graphs, transfer function and state space) -Modeling technique (analytical and identification techniques) – direct method-analogue approach – bond graph approach – modeling of electrical, mechanical, thermal, fluid and hybrid systems – system identification methods overview – Least square method.

UNIT III   OVERVIEW OF SIMULATION   9

Simulation fundamentals – simulation life cycle – Monte Carlo simulation – solution for model equations and their interpretations zeroth and first and second order system and its response – scaling – validation – hardware in loop simulation (HIL) - Controller prototyping – simulation systems in software environment.

UNIT IV   DESIGN OPTIMIZATION   11

Optimization – problem formulation - constraints – over view of linear and nonlinear programming techniques – other optimization techniques- optimal design of mechatronics system with case studies.

UNIT V   CASE STUDIES ON BUILDING A MECHATRONICS SYSTEM   9

Modeling and simulation of automotive system - power window, engine timing, building clutch look up - antilock braking system ABS and automatic transmission controller -modeling of Stewart platform with actuators.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Devadas Shetty, Richard A.Kolk, "Mechatronics System Design", Cengage Learning, 2010.
2. Nagrath.I.J and Gopal.M, "Control System Engineering", New Age international (P) Ltd., Seventh Edition, 2021.

REFERENCES:
1. Bolton, "Mechatronics – Electronic Control Systems in Mechanical and Electrical Engineering", Addison Wesley Longman Ltd., 4th Edition, 2010.
2. Rajput, R.K., "A text book of Mechatronics", S.Chand & Company Private Limited, Fourth Edition, 2016.
3. West Cott, Gupta,A.K., and Arora, "Industrial Automation and Robotics", Lakshmi Publications Pvt Ltd., 3rd Edition, 2023.
4. Patrick O. J. Kaltjob, "Control of Mechatronic Systems: Model-Driven Design and Implementation Guidelines", Wiley publications, December 2020.

5. William Bolton, "Mechatronics: Electronic control systems" Pearson Education, Seventh edition, 2018.

WEB RESOURCES:
1. https://pdfkeys.com/download/2537297-Mechatronic-Systems-Design-Methods.pdf
2. https://www.mathworks.com/solutions/mechatronics.html
3. https://courseware.cutm.ac.in/courses/mechatronics-system-design-sfs/

ONLINE RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc21_me129/preview
2. https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-ph16/
3. https://archive.nptel.ac.in/courses/107/106/107106081/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize various mechatronics elements in the system modeling.(K1)
2. Use the modeling technique for the mechatronics system design. (K3)
3. Explain simulation of mechatronics system (K2)
4. Explain various design optimization techniques for mechatronics systems. (K2)
5. Apply mechatronics concept for various applications (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	3	1	-	-	-	1	1	1	2	2
CO2	2	2	2	3	2	-	-	-	-	1	1	1	2	2
CO3	3	3	2	2	2	-	-	-	-	1	1	1	2	2
CO4	2	2	2	2	2	-	-	-	-	1	-	-	2	2
CO5	3	3	2	2	3	-	-	-	-	1	-	-	2	2

SEMESTER - VII

20MUPJ701 SDG NO. 4,, 6, 7, 8, 9, 11, 12, 13, 17	PROJECT PHASE 1	L	T	P	C
		0	0	2	2

OBJECTIVES:
- To train the Students for Project Work Phase-II
- To improve the student research and development activities
- To identify industrial problem and solve them
- To develop good written and oral communication skills and leadership skills
- To train the students in preparing the project reports and to face reviews
- To develop the ability to solve a specific Industrial problem
- To accelerate the learning process

GUIDELINES TO BE FOLLOWED:

Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work. Each Group of students are required to select their area of interest either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.

TOTAL : 30 PERIODS

COURSE OUTCOMES:
Each student, under the guidance of a Faculty, is required to
1. Present the seminar on the selected project orally and/or through power point slides.
2. Answer the queries and involve in discussion.
3. Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Undertake problem identification, formulation and solution. (K2)
2. Communicate with engineers and the community at large in written an oral forms. (K2)
3. Demonstrate the knowledge, skills and attitudes of a professional engineer.

(K3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - VII

20MUPL701 SDG NO. 4,9,12	AUTOMATION LABORATORY – II	L	T	P	C
		0	0	3	1.5

OBJECTIVES:
- To impart knowledge on architecture of PLC, SCADA and DCS.
- To introduce students on how to program using all ive IEC-61131-3 programming languages
- To impart knowledge on working with industrial automation systems
- To introduce students on how to interface Field devices (Conventional/ Smart) with PLC and DCS.

LIST OF EXERCISES:
1. Study of PLC field device interface modules (AI,AO,DI,DO modules)
2. Programming Logic Gates Function in PLC
3. Implementing Mathematical Operations in PLC
4. Programming Jump-to-subroutine & return operations in PLC
5. PLC Exercises: - 1. Trafic Light Control.
6. PLC Exercises: - 2. Filling/Draining Control Operation.
7. PLC Exercises: - 3. Reversal of DC Motor Direction.
8. PLC Exercises: - 4. ON/OFF Controller for Thermal Process.
9. PC based control of Level Process
10. On-line Monitoring and Control of a Pilot plant using DCS
11. PLC based Control of Flow Process

LIST OF EQUIPMENTS:
1. Programmable Logic controller - 5 Nos
2. Programmable Logic controller Software - 10 User License
3. DAQ card - 2 Nos.
4. Filling /Draining System - 1 No.
5. Traffic Light Controller

6. DC Motor – 5 Nos
7. Personal Computer – 10 Nos.
8. DCS along with Interface module – 1 set
9. Thermal Process, Level Process and Flow Process sections - 1 set each
10. Smart Transmitter – 1 No

TOTAL : 30 PERIODS

OUTCOMES:
Upon completion of the course, the students should be able to
1. To understand connecting hardware modules to PLC (K1)
2. Acquire knowledge on working with industrial automation system (K2)
3. Design and implement control schemes in PLC & DCS. (K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	1	-	-	-	-	-	2	3	3	2
CO2	3	3	1	3	1	-	-	-	-	-	2	3	3	2
CO3	3	3	1	3	1	-	-	-	-	-	2	3	3	2

SEMESTER - VII

20MUTP701 SDG NO. 4	SKILL ENHANCEMENT	L	T	P	C
		0	0	2	1

Aptitude & Technical Refresher & Company Specific Training – Finite Element Analysis and CFD

OBJECTIVES:
- Enhance their quantitative ability.
- Enhance their reasoning ability
- Enhance their verbal ability.
- Enhance the knowledge of Finite Element Analysis
- Know about Computational Fluid Dynamics

UNIT I   Product Company Specific Training – I   10
Product Specific Training for Amazon, Microsoft, IBM, ThoughtWorks, Juspay, Paypal, Mu Sigma, Zoho Corporation, VM Ware, Directi, Oracle, Wells Fargo, Goldman Sachs, Chargebee, Coda Global, Temenos, Freshworks, Adobe Systems., Ernst and Young, BA Continuum, Standard Chartered, AON Hewitt, Soliton Technologies, Payoda Technologies, Infoview Technologies, Athena Health Technology.

UNIT II   Product Company Specific Training – II   10

Product Specific Training for TCS,Wipro,TechMahindra, InfoView, RobertBosch, , NTT Data, Verizon, Payoda Technologies. CTS, Accenture, MindTree, MPhasis, Odessa Technologies, Vuram Technologies, Hewlett Packard, HCL.

UNIT III   Service Company Specific Training - I   10

Capgemini, Infosys, IBM, UGAM Solutions, Skava Systems, L&T Infotech, BahwanCybertech, DhyanInfotech.

UNIT IV   BASICS OF FINITE ELEMENT ANALYSIS   8

Basic concepts of the Finite Element Method - Boundary, Initial and Eigen Value problems- One Dimensional Second Order Equations –Second Order 2D Equations involving Scalar Variable Functions . Overview of simulation software.

UNIT V   COMPUTATIONAL FLUID DYNAMICS   7

Introduction to flow analysis, Essential need for CFD modeling, Applications of CFD modeling. Classifications of Fluid Flow. Discretization Using the Finite-Difference Method, Assembly of Discrete System and Application of Boundary Conditions, Solution of Discrete System. Overview of CFD simulation software.

TOTAL : 45 PERIODS

REFERENCES:

1. Quantitative Aptitude for Competitive Exams by R. S. Agarwal
2. Quantum CAT by SarveshVerma
3. A Modern Approach to Logical Reasoning by R. S. Agarwal
4. Verbal Ability and Reading Comprehension by Arun Sharma
5. Nam.H.Kim, Bhavani.V.Sankar, and Ashok V.Kumar, "Introduction to Finite Element Analysis and Design" Wiley, 2nd Edition, 2018.
6. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
7. Versteeg, H.K. and Malalasekara, W. Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint), Pearson Education. 2008.

WEBSITE LINKS

1. http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/ 03/502_06_Montgomery-Design-and-analysis-of-experiments-2012.pdf
2. https://www.ctanujit.org/uploads/2/5/3/9/25393293/_a.dean_ d.voss_-_design_and_analysis_of_experiments.pdf

3. https://www.statease.com/software/design-expert/
4. https://archive.nptel.ac.in/courses/112/105/112105308/
5. https://archive.nptel.ac.in/courses/112/104/112104193/
6. https://archive.nptel.ac.in/courses/112/104/112104205/

OUTCOMES:

Upon completion of the course, the students should be able to

1. Enhance their quantitative ability. (K2)
2. Enhance their reasoning ability. (K2)
3. Enhance their verbal ability. (K2)
4. Understand the basics of finite element formulation (K1)
5. Apply flow field to determine various quantities of interest using flow visualization and analysis tools.(K3)

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	1	-	2	1	-	2	1	-
CO2	-	-	-	-	1	1	1	1	-	1	-	1	-	-
CO3	3	2	2	3	2	2	1	-	2	1	-	2	2	-
CO4	2	2	2	3	1	1	1	-	-	2	3	3	2	2
CO5	2	2	2	3	1	1	1	-	-	2	3	3	2	2

SEMESTER - VIII

20MUPJ801 SDG NO. 4,6,7, 8, 9,11,12,13,17	**PROJECT PHASE-II**	L	T	P	C
		0	0	8	4

OBJECTIVES:
- To develop the ability to solve a specific problem right from its identification and literature review till finding successful solution for the same.
- To train the students face technical reviews boldly and viva voce examination.

GUIDELINES TO BE FOLLOWED:

The students may be grouped into 3 to 4 members and work under a project supervisor (faculty member) for preparing a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report should be checked jointly by external and internal examiners constituted by the Head of the Department. The Project Work Phase-II will have the following Sequence:

I.   Problem Identification
1.   A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
2.   List of possible solutions including alternatives and constraints
3.   Cost benefit analysis
4.   Time Line of activities

II. A report highlighting the design finalization [based on functional requirements and standards (if any)]

III. A presentation including the following:
1.   Implementation Phase (Hardware / Software / both)
2.   Testing and Validation of the developed system
3.   Learning in the Project

IV. Consolidated report preparation

TOTAL: 120 PERIODS

OUTCOMES:

Upon completion of the course, the students should be able to

1. Comprehend an industrial or real time problem and identify exact / real issue with solution.
2. Complete the necessary studies and review the literature, design a setup of equipment, complete the analysis.
3. Write a project report based on the findings.

CO-PO & PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2

PROFESSIONAL ELECTIVE - I

20MUPE501 SDG NO. 4,8,9,11,12	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Learn about an introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world.
- Will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

UNIT I INTRODUCTION   **9**

The various industrial revolutions, digitalization and the networked economy, comparison of industry 4.0 factory and today's factory, trends of industrial big data and predictive analytics for smart business transformation - Nine pillars of Industry 4.0 - Internet of Things (IoT), Big data, Value chains in Manufacturing companies, Smart factories, Smart Devices and Products, Smart Logistics, Smart Cities, smart services, Predictive Analytics, Case studies.

UNIT II CYBER PHYSICAL SYSTEM   **7**

Cyber Physical System –Cyber world and Physical world - Concepts of embedded systems, Wireless sensor networks, Mobile networks, Satellite networks and RFID & IoT.

UNIT III AI, MACHINE LEARNING AND BIG DATA AND ANALYTICS   **10**

Definition of AI – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems. Machine learning and its types. Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs. Reporting.

UNIT IV DESIGN PRINCIPLES   **10**

Introduction to Industry 4.0 design principles – Interoperability, Communication systems and standards for Industry 4.0, virtualization, Decentralization, Modularity, real time capability, information transparency. System Structure of Augmented Reality. Key Technology in AR, Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality.

UNIT V CLOUD COMPUTING, SYSTEM INTEGRATION AND
CYBER SECURITY 9

Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications, Horizontal and vertical system integration – Need of cyber security-Types of attack.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bruno S.Sergi, Elena G.Popkova, Aleksei V. Bogoviz and Tatiana N. Litvinova, "Understanding Industry 4.0: AI, The internet of things, and the future of work", Emerald publishing limited, 2019.

2. Christoph Jan Bartodziej, "The Concept Industry 4.0", Springer Gabler, 2017.

REFERENCES:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.

2. Kaushik kumar, DivyaZindani, J. Paulo Davim, "Digital manufacturing and assembly systems in Industry 4.0", CRC Press, Taylor and Francis group, 2020.

3. Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Kindle Edition, 2017.

4. Perry Lea, "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Kindle Edition, 2018.

5. Ustundag, Alp, Cevikcan, Emre, "Industry 4.0: Managing the Digital Transformation", Springer, 2018.

WEB RESOURCES:

1. https://library.oapen.org/bitstream/handle/20.500.12657/43836/external_conten t.pdf?sequence=1&isAllowed=y

2. https://www.i-scoop.eu/industry-4-0/

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106105195

2. https://nptel.ac.in/courses/112104319

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand different components and concepts of Industry 4.0. (K2)
2. Understand cyber physical system and the emerging applications. (K2)
3. Understand the importance of AI and Big data analytics in modern industry. (K2)
4. Enumerate different design principles of Industry 4.0 and Visualize the complete factory layout and processes by simulation, AR/VR. (K2)
5. Explain about Cloud technology and its benefits. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO2	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO3	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO4	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO5	2	1	1	-	1	-	-	-	-	-	1	1	2	1

PROFESSIONAL ELECTIVE - I

20MUPE502 **SDG NO. 4,8,9,11,12**	**MANUFACTURING SYSTEM SIMULATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To discuss the importance and advantages of applying simulation and modelling techniques
- To teach various random number generation techniques, its use in simulation
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.

UNIT I INTRODUCTION   **9**

Systems and its types, Types of Modelling, Principles used in Modeling, simulation as a decision making tool, types of simulation, advantages and

disadvantages of simulation, Steps in simulation model building - statistical models in simulation -discrete and continuous system.

UNIT II RANDOM NUMBERS 9

Random number generation -Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers.

UNIT III RANDOM VARIATES 9

Random variate generation - Inverse Transform Technique – Direct Transform Techniques, Convolution Method - Acceptance Rejection Technique– Routines for Random Variate Generation, Testing -Analysis of simulation data.

UNIT IV ANALYSIS OF SIMULATION DATA 9

Input modelling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.

UNIT V SIMULATION LANGUAGES AND CASE STUDIES 9

Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK Simulation based optimization-Modelling and Simulation with Petrinets -Case studies in manufacturing and material handling system-Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2020.
2. Jerry Banks & John S. Carson, Barry L Nelson, "Discrete event system simulation", Prentice Hall, 2000.

REFERENCES:
1. Law A.M, "Simulation Modelling and Analysis", Fifth edition, Tata Mc Graw Hill, 2014.
2. Narsingh Deo, "System Simulation with Digital Computer", Fith edition, Prentice Hall, 2014.
3. Pidd, M, "Computer Simulation in Management Science", Fifth edition, John Wiley & Sons, Inc, 2016.
4. Altiok, T., and Benjamin, M., (2011), "Simulation Modelling and Analysis with ARENA", Academic Press, Elsevier, 2011.

5. Feldman, R.M., and Valdez-Flores, C., "Applied Probability & Stochastic Processes", Second Edition, Springer-Verlag, Berlin, 2010.

WEB RESOURCES:
1. https://www.plm.automation.siemens.com/global/en/our- story/ glossary/manufacturing-simulation/27068.
2. https://www.informs-sim.org/wsc97papers/0086.PDF.
3. https://dl.acm.org/doi/pdf/10.1145/268437.268454

ONLINE RESOURCES:
1. https://archive.nptel.ac.in/courses/112/107/112107220/
2. https://nptel.ac.in/courses/123105007
3. https://nptel.ac.in/courses/110107116
4. https://nptel.ac.in/courses/112104188

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the Manufacturing Models of Discrete event systems. (K2)
2. Solve the Uncertainty using Random numbers and Random Variates. (K3)
3. Explain the Analysis of simulation data. (K2)
4. Demonstrate the concepts of modeling layers of society's critical infrastructure networks. (K3)
5. Make use of tools to view and control simulations. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO2	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO3	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO4	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO5	2	1	1	-	1	-	-	-	-	-	1	1	2	1

PROFESSIONAL ELECTIVE - I

20MUPE503 SDG NO. 4,9,11,12	MANUFACTURING INFORMATION SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an importance of databases and its application in manufacturing systems.
- To prepare students for their engineering practice by organization by conversant with order policies and data base terminologies.
- To acquire the knowledge on designing and manufacturing considerations.

UNIT I   INTRODUCTION   9

Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioral approach. Use of information systems in manufacturing functions, organizations, and strategy, ethical and social issue in information systems. The Evolution of order policies, from MRP to MRP II to ERP. Manufacturing Database Integration.

UNIT II   DATABASE   9

Terminologies – Entities and attributes – Data models, schema and subschema - Data Independence – ER Diagram – UML notation for describing the enterprise–wide data objects - Trends in database.

UNIT III   DESIGNING DATABASE   9

Hierarchical model – Network approach- Relational Database concepts, principles, keys,– functional dependency – Normalization types – relational operations- Query Languages-Case Studies.

UNIT IV   MANUFACTURING CONSIDERATION   9

The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database.

UNIT V   INFORMATION SYSTEM FOR MANUFACTURING   9

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems,

Computer based production management system, computerized manufacturing information system –RFID- Telecommunication– case study.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Franjo C, "Manufacturing Information & Data Systems Analysis, Design & Practice", Butterworth-Heinemann, 2002.
2. Date C.J, "An Introduction to Database Systems", Addison Wesley", 8th Edition, 2003.

REFERENCES:
1. K. Laudon and J. Laudon, "Management Information Systems", 14th edition, Pearson Higher Education, 2016.
2. F. Cecelja, "Manufacturing Information and Data Systems", 1st edition, Butterworth- Heinemann, 2002.
3. Orlicky G, "Material Requirements Planning", McGraw-Hill, 1994.
4. Kerr R, "Knowledge based Manufacturing Management", Addison-Wesley, 1991.
5. Sartori, L.G., "Manufacturing Information Systems", Addison-Wesley Publishing Company, 1988.

WEB RESOURCES:
1. www.ist.psu.edu
2. www.cse.wustl.edu

ONLINE RESOURCES:
1. https://archive.nptel.ac.in/courses/112/107/112107220/
2. https://nptel.ac.in/courses/123105007
3. https://nptel.ac.in/courses/110107116
4. https://nptel.ac.in/courses/112104188

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain framework and process for aligning and organization's information technology objectives with manufacturing strategy. (K2)
2. Discuss organization's information systems and technology decision making processes. (K2)
3. Identify ways of designing database for manufacturing information systems. (K2)

4. Define the utilization of data base management for manufacturing activities. (K2)
5. Define what an engineer should be able to expect from an IT department in a manufacturing organization. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	-	-	-	3	1	-	2	1	1
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	2
CO3	2	-	-	-	1	-	-	-	1	2	-	-	1	1
CO4	1	1	3	-	-	-	-	-	-	-	-	1	1	1
CO5	1	-	-	2	2	3	-	-	1	-	-	-	1	2

PROFESSIONAL ELECTIVE - I

20MUPE504 SDG NO. 4,8,9,11,12	**MICRO ELECTRO MECHANICAL SYSTEMS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices
- To educate on the rudiments of micro fabrication techniques
- To introduce various micro sensors, actuators and different materials used for MEMS

UNIT I   INTRODUCTION   9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices –Polymers in MEMS– Polyamide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon.

UNIT II   SENSORS   9

Characteristics of sensors - Electrostatic sensors – Parallel plate capacitors – Piezo resistive sensors – Piezo resistive sensor materials - Stress and strain analysis – Flexural beam bending - Torsional deflection– Applications to

Inertia, Pressure, Tactile and Flow sensors –Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials.

UNIT III   ACTUATORS   9

Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications –Magnetic Actuators – Micro magnetic components – Case studies of MEMS in magnetic actuators -Actuation using Shape Memory Alloys.

UNIT IV   MICRO MACHINING   9

Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching– Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Anti restriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V   APPLICATIONS OF MEMS   9

Application to Acceleration, Inertia, Acoustic, Lenses and Mirrors -Actuators for Active Optical MEMS – RF MEMS and Microfluidics. Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2014, 2nd Edition.
2. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2008.

REFERENCES:

1. Stephen D Senturia, "Microsystem Design", Springer Publication, 2001.
2. James J. Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
3. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD, 2013.
4. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC press Baco Raton, 2005.
5. Thomas M. Adams and Richard A. Layton, "Introduction MEMS, Fabrication and Application", Springer, 2014.

WEB RESOURCES:
1. https://www.lboro.ac.uk/microsites/mechman/research/ipm-ktn/pdf/Technology_review/an-introduction-to-mems.pdf.
2. https://www.techtarget.com/iotagenda/definition/micro-electromechanical-systems- MEMS.
3. https://inup.cense.iisc.ac.in/mems.
4. http://www.memsnet.org/mems/
5. http://www.people.cornell.edu/pages/akt1/memsmain.html
6. http://mems.sandia.gov/scripts/index.asp
7. http://www.ulg.ac.be/ltas-vis/research/recherche_MEMS.pdf
8. http://www.memsoptical.com/techinfo/memstut1.htm

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/117/105/117105082/
2. https://nptel.ac.in/courses/112/104/112104181/
3. https://nptel.ac.in/courses/108/108/108108113/
4. https://onlinecourses.nptel.ac.in/noc23_ee109/preview
5. https://onlinecourses.nptel.ac.in/noc22_ee76/preview
6. https://nptel.ac.in/courses/108107142
7. https://onlinecourses.nptel.ac.in/noc21_ee86/preview
8. https://onlinecourses.nptel.ac.in/noc23_ee120/preview
9. https://nptel.ac.in/courses/103/106/103106075/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand MEMS Energy Domains and Transducers, Sensors and Actuators. (K2)
2. Analyse Various MEMS sensors and its Stress and strain. (K2)
3. Apply various MEMS actuators in Real time system. (K2)
4. Understand various micro machining processes, Structural and Sacrificial Materials. (K2)
5. Apply various MEMS inertial, tactile, pressure and flow sensors in real time system. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO2	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO3	2	1	1	-	1	-	-	-	-	-	1	1	2	1
CO4	2	1	1	-	1	-	-	-	-	-	1	1	2	2
CO5	2	1	1	-	1	-	-	-	-	-	1	1	2	1

PROFESSIONAL ELECTIVE - I

20MUPE505 SDG NO. 4,8,9,11,12	MATERIALS for ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the various structural features of metallic materials.
- To desire the various ferrous and nonferrous alloys and their applications.
- To illustrate the role of heat treatment and surface modification of materials.
- To review non-metallic materials and composites with their applications
- To enable student to select material for applications including the modern materials

UNIT I   ALLOYS AND PHASE DIAGRAM   9

Atomic structure and interatomic bonding the structure of crystalline and non-crystalline materials. Constitution of alloys- Solid solution, substitutional and interstitial- phase diagrams, Isomorphous, eutectic, eutectoid, peritectic and peritectoid reactions, iron – carbon equilibrium diagram.

UNIT II   FERROUS AND NON FERROUS METALS   9

Classifications of the steels – effect of alloying addition of steel-stainless and tool steel- HSLA. Cast iron- Gray, White, Malleable and Spheroidal – alloy cast iron, Copper and Copper alloys, Brass, Bronze and Cupronickel – Aluminium alloys and AI-Cu –precipitation strengthening treatment – Alloys of Aluminium, Titanium and Magnesium.

UNIT III HEAT TREATMENT AND SURFACE MODIFICATION 9

Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Types and stages of annealing, stress relief, recrystallization and spheroidizing – normalizing, hardening and tempering of steel – Introduction to case hardening, Thermal spraying, CVD, PVD and non-metallic coatings.

UNIT IV NON METALLIC MATERIALS AND COMPOSITES 9

Polymers- Thermo, Thermoset Polymers, PE, PS, PVS PMMA, PC, PET, ABS- Engineering Polymers, PA, PPS, PI, PFE- Natural and Synthetic rubbers, Elastomers - Adhesives – Ceramics - Natural and Synthetic Ceramic - Composites – classification - structural composites and applications of composites.

UNIT V FUNCTIONAL MATERIALS 9

Introduction to smart materials, principles of piezoelectricity, piezoelectric polymers. Magnetostrictive materials - Magneto resistance effect, Introduction to Electro active polymers, Ionic polymer matrix composite. Shape memory alloys - Bulk Metallic glasses and nano crystalline materials.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. David G Rethwisch, Callister's 'Materials Science and Engineering', Wiley India Pvt. Limited, 2021.
2. Kenneth G. Budinski and Michael K. Budinski ,"Engineering Materials", 9th Indian Reprint, Prentice-Hall of India Private Limited, 2016.

REFERENCES:
1. Donald R. Askeland, Pradeep P. Fulay and Wendelin J. Wright, "The Science and Engineering of Materials", 7 th Edition, Cengage Learning, Inc. 2017.
2. Sidney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2017.
3. Ashby M.F., Material Selection in Mechanical Design, 5thEdition, Butter Worth 2017.

WEB RESOURCES:
1. http://materialstandard.com/wp-content/uploads/2019/06/Ashby Engineering-Materials-1.pdf
2. https://doc.lagout.org/electronics/Materials%20for%20engineering %20%5Bby%20John%20Martin%5D.pdf
3. https://sedyono.files.wordpress.com/2015/10/ch-02.pdf

4. https://www.academia.edu/6042047/Introduction_to_Engineering_Material_and_their_Applications

ONLINE RESOURCES:
1. https://archive.nptel.ac.in/courses/113/102/113102080/
2. https://archive.nptel.ac.in/courses/112/108/112108150/
3. https://onlinecourses.nptel.ac.in/noc20_me78/preview
4. https://onlinecourses.nptel.ac.in/noc23_me78/preview

OUTCOMES:
Upon completion of the course, the students should be able to
1. Identify the various structural features of metallic materials. (K2)
2. Recognize the various ferrous and nonferrous alloys with their applications. (K2)
3. Relate the heat treatment, Coating, microstructure and properties. (K2)
4. Explain the various non-metallic materials and composites with their applications. (K2)
5. Suggest suitable materials for a given application. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	2
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	2
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	2
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	1

PROFESSIONAL ELECTIVE - I

20MUPE506 SDG NO. 4,8,9,11,12	ROBOT OPERATING SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To introduce the basics of Robot Operating Systems and its architecture.
- To provide knowledge on the hardware interfacing aspects.
- To understand the applications of ROS in real world complex applications.

UNIT I   Introduction   10
Introduction – ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases. UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables.

UNIT II   Architecture of Operating System   9
File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands.

UNIT III   Computation Graph Level   8
Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.

UNIT IV   Debugging and Visualization   9
Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS.

UNIT V   Case Studies: Using ROS in Real World Applications   9
Navigation stack-creating transforms -odometer – IMU – laser scan – base controller – robot configuration – cost map – base local planner – global planner – localization – sending goal– the low cost mobile robot.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018
2. Aaron Martinez, Enrique Fernandez, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013

REFERENCES:
1. Jason M O'Kane, "A Gentle Introduction to ROS", Create Space, 2013.
2. Anis Koubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
3. Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.
4. Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press, 2017.
5. Patrick Gabriel, "ROS by Example: A do it yourself guide to Robot Operating System", Lulu, 2012.

WEB RESOURCES:
1. http://robotics.stanford.edu/~ang/papers/icraoss09-ROS.pdf
2. https://stanfordasl.github.io/aa274a/pdfs/notes/lecture2.pdf
3. http://wiki.iranros.com/wp-content/uploads/2019/10/Lentin-Joseph-Robot-Operating-SystemROSfor-Absolute-Beginners_IRANROS.COM2018.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112105236
2. https://nptel.ac.in/courses/112105249
3. https://nptel.ac.in/courses/112103280
4. https://nptel.ac.in/courses/107106090
5. https://nptel.ac.in/courses/106105217
6. https://nptel.ac.in/courses/112101304
7. https://nptel.ac.in/courses/112106304

OUTCOMES:
Upon completion of the course, the students should be able to
1. Describe the need for ROS and Linux commands used in robotics. (K2)
2. Discuss about the concepts behind navigation through file system. (K2)
3. Explain the concepts of Node debugging. (K2)
4. Analyze the issues in hardware interfacing. (K3)
5. Discuss about the applications of ROS. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	-	-	-	-	-	-	1	2	1
CO2	2	1	1	-	1	-	-	-	-	-	-	1	2	2
CO3	2	1	1	-	1	-	-	-	-	-	-	1	2	1
CO4	2	1	1	-	1	-	-	-	-	-	-	1	2	2
CO5	2	1	1	-	1	-	-	-	-	-	-	1	2	1

PROFESSIONAL ELECTIVE - I

20MUPE507 SDG NO. 4,8,9,11,12	**NANO SCIENCE AND NANO TECHNOLOGY**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to understand the science of nanomaterials.
- To enable students to understand properties of nanomaterials.
- To understand various nanostructuring techniques.
- To apply the nanoscience concept for various applications to improve to efficiency.

UNIT I   OVER VIEW 0F NANOTECHNOLOGY   9

Background to Nano science: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nano science and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties.

UNIT II   NANOSTRUCTURE AND PROPERTIES OF NANOMATERIALS   9

One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.

UNIT III   NANODEFECTS, NANOPARTICLES AND NANOLAYERS   9

Nanodefects in crystals, applications, Nuclear Track nano defects. Fabrication of nano particles, Epitaxy and ion implantation, formation of Silicon oxide-chemical composition, doping properties, optical properties.

UNIT IV   NANOSTRUCURING   9

Nano photolithography, techniques, optical, electron beam, ion beam, X-ray and Synchrotron, Nano lithography for microelectronic industry, nano polishing of Diamond, Etching of Nano structures, Nano imprinting technology, Focused ion beams, LASER interference Lithography nanoarrays, Near-Field Optics - case studies and Trends.

UNIT V   APPLICATION OF NANOTECHNOLOGY   9

Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nano toxicology. Use of nanoparticles for environmental remediation and water treatment. Case studies and Regulatory needs.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. C. N. R. Rao, Achim Müller, Anthony K. Cheetham , "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", Wiley-VCH Publications, 2004.
2. G. Schmidt, "Nanoparticles: From theory to applications", Wiley Publications, 2006.

REFERENCES:
1. Leon L. Shaw, C. Suryanarayana, Rajiv S. Mishra, "Processing & properties of structural naonmaterials" Wiley, 2003.
2. Cao G., "Nanostructures and Nanomaterials Synthesis, Properties, and Applications", Imperial College Press, 2004.
3. Goddard III W.A., Handbook of Nanoscience, Engineering, and Technology, Taylor & Francis Group, 2007.
4. B.P.S. Chauhan, "Hybrid Nanomaterials: Synthesis, Characterization, and applications", Wiley- VCH, 2011.
5. Juyoung Kim, "Advances in Nanotechnology and the Environment", Jenny Stanford Publishing, 2011.

WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc23_me127/preview
2. https://onlinecourses.nptel.ac.in/noc23_me128/preview
3. https://onlinecourses.nptel.ac.in/noc23_mm37/preview

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112107283
2. https://nptel.ac.in/courses/113107081
3. https://nptel.ac.in/courses/113106093

OUTCOMES:

Upon completion of the course, the students should be able to
1. Describe the outline of nanoscience and nanotechnology of the materials. (K2)
2. Discuss the various dimensional nanostructured materials and its properties. (K2)
3. Explain nano-defects on fabrication of nano particles and its properties (K2)
4. Describe various nanostructuring techniques. (K2)
5. Apply the concepts of nano technology in various applications. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	1	-	-	-	-	-	2	2	2	2
CO2	2	1	2	1	2	-	-	-	-	-	2	2	2	2
CO3	2	1	2	1	1	-	-	-	-	-	2	2	2	2
CO4	2	2	1	1	1	-	-	-	-	-	2	2	2	2
CO5	2	2	2	1	2	-	-	-	-	-	2	1	1	2

PROFESSIONAL ELECTIVE - I

20MEPC701 SDG NO. 4, 9, 12	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand the concepts of mathematical modelling and engineering fundamentals for solving complex engineering problems
- To analyze one and two dimensional elements
- To analyze the heat transfer and vibration in simple and complex geometries
- T o understand the concepts of iso-parametric and higher order elements

UNIT I   INTRODUCTION   9

Basic Concepts – History, Relevance and Scope of Finite Element Methods - FEM Procedure - Natural and Essential boundary conditions - Concepts of Potential Energy - Rayleigh Ritz – Weighted Residual Method- Gaussian Elimination Methods – Solved Problems.

UNIT II   ONE-DIMENSIONAL ELEMENTS   9

Coordinate Systems -Global, Local and Natural - Shape function, Finite element formulation - Stiffness Matrix, Load Vector, Boundary Condition and Assembly of Global Equation, Temperature Effects for 1D bar, Truss and Beam Element – Solved Problems.

UNIT III   TWO-DIMENSIONAL ELEMENTS   9

Shape function for linear triangular element-Finite element formulation - Constant Strain Triangular (CST) element -Plane Stress, Plane Strain conditions – Axisymmetric Elements formulation – Solved Problems

UNIT IV   HEAT TRANSFER AND VIBRATION   9

Shape function for 1D and 2D Triangular Element - Stiffness Matrix, Load vector and Assembly of Global Equation - Heat Conduction, Convection and Internal heat Generation for Linear element - Longitudinal and Transverse Vibrations for Bar and Beam Elements.

UNIT V   HIGHER ORDER AND ISOPARAMETRIC ELEMENT   9

Higher order Elements, Serendipity elements, Shape function formulation - Isoparametric, Sub parametric, Super parametric Elements, Iso parametric Transformation, Jacobian formulation and Stress Strain relations for Isoparametric elements. Gaussian Quadrature. Introduction to CFD.

TOTAL:45 PERIODS

TEXT BOOKS:

1. J.N. Reddy, "An Introduction to the Finite Element Method" Third Edition, McGraw-Hill Mechanical Engineering, Reprint, 2015.
2. Singuresu S. Rao, "Finite Element method in Engineering", Fourth edition, Elsevier Science & Technology Books, Reprint 2015.

REFERENCES:

1. Tirupathi R. Chandrupatla, Ashok D. Belagundu, "Introduction to Finite Elements in Engineering", Third Edition, Reprint, Prentice Hall, 2012.
2. R. D. Cook, D. S. Malkus, and M. E. Plesha, "Concepts and Applications of Finite Element Analysis", Third Edition, John Wiley and Sons, New York, Reprint 2010.

3. O. C. Zienkiewicz and R. L. Taylor, "The Finite Element Method: Volume 1, The Basis", 5th Edition, Butterworth-Heinemann, Oxford. Reprint 2011.

4. Daryl L. Logan A, "First Course in the Finite Element Method", Fourth Edition, Cengage Learning, 2007.

5. K. J. Bathe, "Finite Element Procedures", Second Edition, Prentice-Hall Inc., Englewood Cliffs, New Jersey, Reprint 2012.

6. S. Bhavikati, "Finite Element Analysis", New Age International Publishers, 2015.

WEB RESOURCES:
1. https://www.simscale.com/blog/2016/11/learn-finite-element-analysis-fea/
2. https://nptel.ac.in/courses/112/104/112104116/
3. https://nptel.ac.in/courses/105/105/105105041/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112/104/112104205/
3. https://nptel.ac.in/courses/105/106/105106051/
4. https://nptel.ac.in/courses/112/106/112106135/
5. https://nptel.ac.in/courses/112/104/112104115/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand the knowledge of mathematical modeling and engineering fundamentals to solve complex engineering problems by finite element methods. (K2)
2. Analyze the one dimensional elements for bar, truss and beam elements. (K3)
3. Interpret the results for complex two dimensional CST and axisymmetric elements. (K3)
4. Compute the heat transfer and Vibration problems for various elements. (K3)
5. Evaluate the solution for iso-parametric elements and to learn basics of CFD. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	-	2	-	-	-	-	-	2	3	2
CO2	3	3	1	-	-	2	-	-	-	-	-	2	3	2
CO3	3	3	1	-	-	2	-	-	-	-	-	2	3	2
CO4	3	3	1	-	-	2	-	-	-	-	-	2	3	2
CO5	3	3	1	2	2	2	-	-	2	2	-	3	3	2

PROFESSIONAL ELECTIVE - I

20MEEL606 **SDG NO. 4,9,12**	**PRODUCT DESIGN AND DEVELOPMENT**	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To provide basic concepts of product design, product features and its architecture
- To gain basic knowledge about the common features of a product
- To develop qualities and characteristics of products
- To design a product that is easily and economically manufactured

UNIT I INTRODUCTION   **9**

Need for Innovation and design, User Innovation, Introduction to product and Product design. Difference between Product development and product design, Need: Problem Identification, User study by contextual enquiry, Questionnaire study, Interview techniques, Persona and scenario mapping, Product Study and market study, Design Brief

UNIT II CONCEPTS GENERATION AND EVALUATION   **9**

Importance of Human factors in product design, Physical Ergonomics principles and issues, Ergonomic assessment tool, Cognitive issues in product design, Creative techniques and tools for Concept generation, concept evaluation, Product prototyping model making work flow, tools and techniques for model making and prototyping, introduction to prototype driven innovation, Overview of materials and processes, Evaluation tools and techniques for User- Product interaction.

UNIT III PRODUCT ARCHITECTURE   9

Implications, Product change , variety, Component Standardization , Product performance, manufacturability – product development management , Establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV INDUSTRIAL DESIGN AND CASE STUDIES   9

Integrate process design – Managing costs, Robust design, Integrating CAE, CAD, CAM tools, Simulating product performance and manufacturing processes electronically , Need for industrial design – impact – design process – investigation of industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user driven products – assessing the quality of industrial design. Case Studies.

UNIT V DESIGN FOR MANUFACTURING   9

Design for Manufacturing: Over the wall design, most in influential phase in design, best practices in injection molding and sheet metal working, Design for additive manufacturing, single point and multipoint tools, Design for Assembly: Boothroyd Dewhurst method, theoretical minimum number of parts, Xerox producibility index (XPI) method, Do's and dont's in manual assembly, assembly time estimation, design for robotic assembly considerations. Design for sustainability.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Karl T. Ulrich, Steven D.Eppinger and Maria C. Yang, "Product Design and Development", McGraw-Hill, 7th Edition, 2020.
2. Kevin Otto and Kristin Wood, "Product Design Techniques in Reverse Engineering and New Product Development", Pearson, 1st Edition, 2003.

REFERENCES:

1. Kenneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates,26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, "Tool Design – Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New York, NY.

WEB RESOURCES:

1. https://ocw.mit.edu/courses/15-783j-product-design-and-development-spring-2006/pages/lecture-notes/
2. https://www.iea.lth.se/tillmek/Lectures/08.a%20-%20Intro%20Product%20Development.pdf
3. https://nzifst.org.nz/resources/creatingnewfoods/documents/CreatingNewFoodsCh5.pdf

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/107/103/107103082/
2. https://nptel.ac.in/courses/107/101/107101086/
3. https://nptel.ac.in/courses/107/101/107101088/
4. https://nptel.ac.in/courses/112/107/112107258/
5. https://nptel.ac.in/courses/112/106/112106249/
6. https://nptel.ac.in/courses/107/104/107104076/
7. https://onlinecourses.nptel.ac.in/noc23_de11/preview

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand basic concepts of Product Design, Development and Innovation. (K2)
2. Generate concepts and selection for the design of a product. (K2)
3. Describe the Product Architecture. (K3)
4. Know the Industrial Design procedure. (K2)
5. Explain the Design for Manufacturing for Product development. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	2	2	3	3	1	2	3	3	3	3	1	2
CO2	2	2	1	2	2	-	-	1	3	3	3	3	1	2
CO3	2	2	3	3	2	1	1	3	2	3	3	3	2	3
CO4	2	3	2	3	3	1	-	2	3	3	3	3	2	3
CO5	-	2	1	3	2	1	1	1	3	3	3	3	1	3

PROFESSIONAL ELECTIVE - I

20MEEL604 SDG NO. 4,8,9,11,12	NON DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To imbibe the students the basic principles of various NDT techniques, its applications, limitations, codes and standards
- To equip the students with proper competencies to locate a flaw in various materials
- To make the students to be ready to use NDT techniques for in-situ applications
- To inculcate the knowledge of selection of the right NDT technique for a given application

UNIT I   INTRODUCTION AND VISUAL INSPECTION METHODS   9

NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT. Visual Inspection -Unaided, Aided- Borescopes -Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography, Case study.

UNIT II   LIQUID PENETRANT TESTING AND MAGNETIC PARTICLE TESTING   9

LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipments, Advantages and limitations, Inspection and Interpretation, Applications and case study. MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation– need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting, Case study.

UNIT III   THERMOGRAPHY AND EDDY CURRENT TESTING   9

Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography approaches, IR detectors, Instrumentation and methods and applications, Case study. Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications, Case study.

UNIT IV ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING 9

Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B- Scan & C-Scan, Phased Array Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications, Case study. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications, Case study.

UNIT V RADIOGRAPHY AND REMOTE FIELD INSPECTION 9

Introduction, Principle, X-ray Production, Gamma ray sources, tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, geometric factors, inverse square law, characteristics of film, graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography – Film Digitisation, Direct Radiography &Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X-ray and Gamma Ray radiography, Case study. Radiation Safety Measures.

RFI: Introduction, Theory-Zones, probes, Instrumentation, Signal Interpretation and Reference Standards.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers, 1st revised edition, 2010.

REFERENCES:
1. J. Prasad and C.G.K. Nair, "Non-destructive Test and Evaluation of Materials", Mc Graw Hill Publication, 2017.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
3. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd edition New Jersey, 200
4. G. Gaussorgues, "Infrared Thermography", Chapman & Hall, University Press, Cambridge, 1994.

5. Lari and Kumar, "Basics of Non-Destructive Testing", S.K. Kataria & Sons, 2013.

WEB RESOURCES:
1. https://www.nde-ed.org/index_flash.htm
2. https://ndtlibrary.asnt.org/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/113/106/113106070/
2. https://nptel.ac.in/courses/112/107/112107259/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Compare the differences between the various visual inspection techniques and apply the same to the components to be inspected. (K2)
2. Understand the procedures involved in the penetration methods and magnetic particle inspection. (K2)
3. Interpret the images obtained from the thermographic technique and results from the eddy current testing. (K2)
4. Evaluate and interpret the results obtained in the ultrasonic inspection and acoustic emission technique. (K3)
5. Explain the techniques involved in the radiographic testing and the various advancements in radiography. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	-	1	-	-	-	1	1	2	2	2
CO2	3	3	2	1	-	1	-	-	-	1	1	2	3	2
CO3	3	3	2	1	-	1	-	-	-	1	1	2	3	2
CO4	3	3	2	1	-	1	-	-	-	1	1	2	3	2
CO5	3	3	2	1	-	2	-	-	-	1	1	2	3	2

PROFESSIONAL ELECTIVE - I

20ICEL803 SDG NO. 4, 9	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and Machine learning.

UNIT I   PROBLEM SOLVING   9

History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. Solving problems by searching - Informed search and exploration - Constraint satisfaction problems - Adversarial search, knowledge and reasoning- knowledge representation - First order logic.

UNIT II   PLANNING   9

Planning with forward and backward State space search - Partial order planning - Planning graphs - Planning with propositional logic - Planning and acting in real world.

UNIT III   REASONING   9

Uncertainty - Probabilistic reasoning - Filtering and prediction - Hidden Markov models - Kalman filters - Dynamic Bayesian Networks, Speech recognition, making decisions.

UNIT IV   LEARNING   9

Forms of learning - Knowledge in learning - Statistical learning methods - reinforcement learning, communication, perceiving and acting, Probabilistic language processing, and perception.

UNIT V   AI IN ROBOTICS   9

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approach", Pearson Education, India, 2016.
2. Negnevitsky, M, "Artiicial Intelligence: A guide to Intelligent Systems", Harlow: Addison Wesley, 2002.

REFERENCES:
1. David Jefferis, "Artiicial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992.
2. Robin Murphy, Robin R. Murphy, Ronald C. Arkin, "Introduction to AI Robotics", MIT Press, 2000.
3. Francis.X.Govers, "Artiicial Intelligence for Robotics", Packt. Publishing, 2018.
4. Huimin Lu, Xing Lu, "Artiicial Intelligence and Robotics", Springer, 2017.
5. Michael Brady, Gerhardt, Davidson, "Robotics and Artificial Intelligence", Springer, 2012.

WEB RESOURCES:
1. https://www.simplilearn.com/tutorials/artificial-intelligence tutorial/what-is-artificial-intelligence1

ONLINE RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc21_ge20
2. https://onlinecourses.nptel.ac.in/noc20_de11

OUTCOMES:
Upon completion of the course, the students should be able to
1. Identify problems that are amenable to solution by AI methods (K1)
2. Identify appropriate AI methods to solve a given problem (K1)
3. Formalize a given problem in the language/framework of different AI methods (K2)
4. Summarize the learning methods adopted in AI (K2)
5. Design and perform an empirical evaluation of different algorithms on a problem formalization (K4)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	2	-	-	-	1	-	2	2	2
CO2	3	1	1	1	-	2	-	-	-	1	-	2	2	2
CO3	2	2	2	1	-	2	-	-	-	-	2	2	2	2
CO4	2	2	2	1	-	2	-	-	-	-	2	2	2	2
CO5	2	3	3	3	2	2	-	-	-	-	3	3	3	3

PROFESSIONAL ELECTIVE - II

20MUPE601 SDG NO. 4, 9, 17	VIRTUAL INSTRUMENTATION FOR AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the concepts of virtual instrumentation.
- To apply concepts of Lab VIEW in developing graphical programs.
- To develop skills in data acquisition, instrumentation and control.

UNIT I   INTRODUCTION TO VIRTUAL INSTRUMENTATION   9

Virtual instrumentation: Virtual instrument and traditional instrument, hardware and software in VI, VI for test, control and design, VI in engineering process, virtual instruments beyond personal computer, graphical system design using LabVIEW. Introduction to LabVIEW: Advantages, software environment, creating and saving VI, front panel and block diagram toll bar, palettes, controls and indicators, block diagram, data types, data flow program.

UNIT II   DATA-FLOW TECHNIQUES   9

Graphical programming in data low - Comparison with conventional programming - Software in virtual instrumentation - VI programming techniques – VIS & Sub VIS - loops and charts – arrays – clusters – graphs - case - sequence structures - formula nodes - local and global variable - string and file functions

UNIT III   DATA ACQUISITION BASICS   9

DAQ cards for VI applications – DAQ modules with serial communication. ADC, DAC, DIO, Counters and timers, RS232C/ RS485, GPIB, PC Hardware structure, DMA software and hardware installation.

UNIT IV   USE OF ANALYSIS TOOLS   9

Advanced analysis tools such as Fourier transforms, Power spectrum, Correlation methods, Windowing and filtering and their applications in signal and image processing, Motion Control.

UNIT V   APPLICATIONS OF VIRTUAL INSTRUMENTATION   9

Celsius to Fahrenheit conversion – Oscilloscope - Digital multimeter - Application in Process Control Projects - DC voltage measurement using DAQ - Virtual instrument design for robotics - machine vision – automation

TOTAL: 45 PERIODS

TEXT BOOKS:
1. "Virtual Instrumentation using LabVIEW", S. Gupta and J. John, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
2. "Virtual Instrumentation using LabVIEW", J. Jerome, Prentice Hall of India, 2010.

REFERENCES:
1. J. Travis, J. Kring, "Lab VIEW for Everyone: Graphical Programming Made Easy and Fun", 3 rd Edition, Prentice Hall, 2006.
2. R. H. Bishop, "Learning with LabVIEW", 1st edition, Pearson Publishing, 2014.
3. B. Mihura, "Lab VIEW for Data Acquisition", Prentice Hall of India, 2013.
4. R. Bitter, T. Mohiuddin, M. Nawrocki, "LabVIEW: Advanced Programming Techniques", CRC Press, 2007.
5. G.W. Johnson, R. Jennings, "LabVIEW Graphical Programming", 3 rd Edition, McGraw-Hill Professional Publishing, 2006.

WEB RESOURCES:
1. https://www.ni.com/en-in/shop/labview/virtual-instrumentation.html
2. https://mindmajix.com/dataflow-programming-and-data-types-in-labview

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/103105064
2. https://nptel.ac.in/courses/103103037
3. https://nptel.ac.in/courses/108106074
4. https://nptel.ac.in/courses/108105064

OUTCOMES:
Upon completion of the course, the students should be able to
1. Describe various aspects of VI. (K2)
2. Explain the various types of structures used in LabVIEW (K2)
3. Analyze and design different type of programs based on data acquisition (K4)
4. Demonstrate the use of LabVIEW for signal processing, image processing etc (K3)
5. Design and develop programs for different Applications (K4)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	-	-	-	-	-	1	-	1	2	2
CO2	2	3	3	1	2	-	-	-	-	1	-	1	2	3
CO3	3	3	3	3	2	-	-	-	-	1	-	1	2	3
CO4	2	2	2	1	-	-	-	-	-	1	2	1	2	2
CO5	1	1	1	1	-	-	-	-	-	-	-	1	1	1

PROFESSIONAL ELECTIVE - II

20MUPE602 SDG NO. 4, 9	**SMART MOBILITY AND INTELLIGENT VEHICLES**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
- To learn the Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, and other sensors for automobile vision systems.
- To learn Basic Control System Theory applied to Autonomous Automobiles.
- To produce the overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
- To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I   INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES   9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles

UNIT II   SENSOR TECHNOLOGY FOR SMART MOBILITY   9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT III   CONNECTED AUTONOMOUS VEHICLE   9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy.

UNIT IV   VEHICLE WIRELESS TECHNOLOGY & NETWORKING   9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks.

UNIT V   CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY   9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer
2. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board.

REFERENCES:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roult edge", Taylor & Francis Group, 5th Edition, 2018.
2. Turban E.,"Decision Support and Export Systems Management Support Systems", Maxwell Macmillan, 1998.
3. Sitausu S. Mittra, "Decision Support Systems – Tools and Techniques", John Wiley, New York, 1986.
4. Papacostas C.S., Prevedouros, "Transportation Engineering and Planning", 3rd Edition, Prentice Hall of India, New Delhi, 2002.
5. Drew, D.R., "Traffic Flow Theory and Control", McGraw Hill, NewYork, 1968.

WEB RESOURCES:

1. https://www.udemy.com/course/cooperative-intelligent-transportation-systems-cits-its/

2. https://ieee-itss.org/courses/introduction-to-intelligent-transportation

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/105107210
2. https://nptel.ac.in/courses/105105204

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles. (K2)
2. Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing.(K2)
3. Relate with the concept of fully autonomous vehicles. (K2)
4. Apply the basic concepts of wireless communications and wireless data networks.(K3)
5. Analyze the concept of the connected vehicle and its role in automated vehicles.(K4)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE603 SDG NO. 4, 9	PROTOTYPING AND TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To product and functionality testing of new designs they can also be used to obtain customer feedback for new products.
- To visualize product and its features and analysis for new product development.

UNIT I   PRODUCT DEVELOPMENT CYCLE   9

Impact on economy, export competitiveness, design as a strategy to win international market and Innovation process - virtual prototyping and testing technology, Physical Prototyping and Rapid Manufacturing technologies and Synergic Integration Technologies.

UNIT II   VIRTUAL PROTOTYPING   9

Geometric modeling: Types of Geometric models and Solid Models, Reverse engineering: Acquiring Point Data, Constructing 3D model and Applications. Virtual augmented reality: Requirement of devices and technologies Design for X: Design for manufacture and design for assembly and other facets of DFX.

UNIT III   PHYSICAL PROTOTYPING   9

Computer Numerical Control: Comparison between NC and conventional machines, features of CNC Machine Tool and programming Robotics: classification, programming, sensors and applications Computer Aided Process Planning: Methodology, evaluation, types, CAD/CAM Integration and CAPP Features.

UNIT IV   SYNERGIC INTEGRATION   9

Concurrent Engineering: Benefits, methodology, integration and transactions Product Data Management: Product data classifications, Process Management and benefits Computer Integrated Manufacturing: Components, barriers to CIM. Implementation, case study, development and research.

UNIT V   RAPID PROTOTYPING AND RAPID TOOLING   9

Rapid Prototyping: dawn of slice age, benefits, applications, important issues and popular RP process Methods, Stereo-lithography, Fused-deposition modeling, Selective laser sintering, Laminated-object manufacturing, Ballistic particle Manufacturing, Solid base curing - Rapid Tooling: Indirect rapid tooling process.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K. P. Karunakaran, V. P. Bapat, Sreenath Babu Akula P. D. Solanki Gaurav Gupta, V.R. Prasanth, Saket Anand, Arnab Sarkar and S. Venkatkrishnan, "Rapid Product Development- Synergic integration of time-compression technologies", 2003.
2. Serope Kalpakjion and Steven R. Schmid,, "Manufacturing Processes for Engineering Materials", Pearson Education, 2018.

REFERENCES:

1. Kevin N. Otto, Kristin L. Wood, "Product Design", Pearson Education, 2004.
2. Ali K. Kamrani and Emad Abouel Nasr, "Engineering Design and Rapid Prototyping", Springer, 2010.
3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
4. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015.
5. Andreas Gebhardt, Understanding Additive Manufacture: Rapid Prototyping, Rapid Tooling and Rapid Manufacture, Hanser Publishers, 2013.

WEB RESOURCES:

1. https://en.wikipedia.org/wiki/Rapid_prototyping
2. http://www.factoryoffactories.com/rapidprotot.htm

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108108115
2. https://nptel.ac.in/courses/108105186
3. https://nptel.ac.in/courses/113106070

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand the virtual prototyping and testing of technology. (K2)
2. Outline the importance of Physical Prototyping. (K2)
3. Apply the Rapid Manufacturing technologies and Synergic Integration Technologies in the present technological era. (K3)
4. Relate the importance of Concurrent Engineering and its implementation. (K2)
5. Apply the importance of Rapid tooling and its processes.(K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	2	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	2	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	2	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	2	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE604 SDG NO. 4, 9	**AUTONOMOUS MOBILE ROBOTS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT I   INTRODUCTION TO AUTONOMOUS MOBILE ROBOTICS   9

Introduction – fundamentals of mobile robotics - Classification of mobile robots - Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles – Teleportation and Control.

UNIT II   KINEMATICS   9

The Basics of Autonomy (Motion, Vision and PID) - Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots – Open Loop and Feedback Motion Control – Humanoid Robot - Kinematics Overview.

UNIT III   PERCEPTION   9

Sensors for mobile robots - Classification, performance, uncertainty in sensors, wheel sensor, heading sensor, accelerometers, inertial measurement, motion sensor, range sensors. Vision sensor- Basics of computer vision, image processing techniques, feature extraction - image, range data location recognition.

UNIT IV   LOCALIZATION   9

Major challenges, localization based navigation. Belief representation, map representation, probabilistic Map. Examples of localization systems. Autonomous map building - Stochastic Map Technique - Other Mapping Techniques. Simultaneous Localization and Mapping (SLAM).

UNIT V   PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS   9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Modularity for Code Reuse and Sharing - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MIT Press, Cambridge, 2004.
2. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.

REFERENCES:
1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP Lambert Academic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions", Intec Press, 2009.
5. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013.

WEB RESOURCES:
1. https://www.edx.org/course/autonomous-mobile-robots
2. https://www.edx.org/learn/autonomous-robotics

3. https://www.classcentral.com/course/edx-autonomous-mobile-robots-1564
4. https://www.coursera.org/learn/robotics-flight

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112106298
2. https://nptel.ac.in/courses/112104316
3. https://nptel.ac.in/courses/112104308
4. https://nptel.ac.in/courses/112107289

OUTCOMES:
Upon completion of the course, the students should be able to
1. Evaluate the appropriate mobile robots for the desired application. (K3)
2. Develop the kinematics for given wheeled and legged robot. (K3)
3. Analyze the sensors for the intelligence of mobile robotics. (K3)
4. Create the localization strategies and mapping technique for mobile robot. (K2)
5. Create collaborative mobile robotics for planning, navigation and intelligence for desired applications. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE605 SDG NO. 4, 9	MOTION CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understanding of fundamental issues in motion control systems, the usage of a sophisticated set of tools for analysis and design of motion control systems.
- To engagement in realistic case studies in order to introduce students to real design problems.

UNIT I   BASICS OF MOTION CONTROL   9

Basics of robotic system's kinematics and dynamics: Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes. Symbolic Modelling of Robots for Direct Kinematic Model and inverse kinematics.

UNIT II   STABILITY METHODS AND ANALYSIS   9

System Stability and Types of Stability - Lyapunov stability analysis, both direct and indirect methods. - Lemmas and theorems related to stability analysis.

UNIT III   CONTROL TECHNIQUES   9

Joint Space and Task Space Control Schemes - Position control, velocity control, trajectory control and force control. Description of Force Control tasks, Force Control Strategies, Hybrid Position / Force Control, Impedance Force / Torque Control.

UNIT IV   ROBUST CONTROL   9

Nonlinear Control Schemes Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer based control and robust control.

UNIT V   OPTIMAL CONTROL   9

Optimal Control: Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti's equation – Application examples. Nonlinear Observer Schemes: Design based on acceleration, velocity and position feedback. Numerical simulations using software packages.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. R K Mittal, I J Nagrath, Robotics and Control, TMGH Publishing Co Lmt, 2003.
2. A Sabanovic and K Ohnishi, "Motion Control Systems", John Wiley & Sons (Asia), 2011.

REFERENCES:
1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
2. R M Murray, Z. Li and SS Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.
3. J J Craig, "Introduction to Robotics: Mechanics and Control", Prentice Hall, 2004.
4. Carlos, Bruno, Georges Bastin, "Theory of Robot Control", Springer, 2012.
5. J J E Slotine and W Li, "Applied Nonlinear Control", Prentice Hall, 1991.

WEB RESOURCES:
1. https://www.udemy.com/course/siemens-s71200-motion-control-training/
2. https://www.udemy.com/course/plc-programming-motion-control-with-plcopen/
3. https://www.youtube.com/watch?v=H8KxrQePTJo

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/108106024
2. https://nptel.ac.in/courses/108103007
3. https://nptel.ac.in/courses/108103008
4. https://nptel.ac.in/courses/115108104
5. https://nptel.ac.in/courses/101108047

OUTCOMES:
Upon completion of the course, the students should be able to
1. Demonstrate non-linear system behavior by phase plane and describing function methods. (K2)
2. Perform the stability analysis nonlinear systems by Lyapunov method. (K3)
3. Derive discrete-time mathematical models in both time domain and z domain. (K2)

4. Analyze transient and steady-state responses, stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems. (K3)
5. Develop the knowledge of state space and state feedback in optimal control systems. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE606 **SDG NO. 4, 9**	**MICRO-ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To make the students learn the basic concepts and this course focuses on the design, construction, analysis, and control of state-of-the-art micro/nano-robotic systems for MEMS, nanotechnology, biotechnology, and robotics fields.
- To train the students in designing the micro/nanoscale physics, sensors, actuators, manipulators, power sources, interfacing, robotic design, and control issues.

UNIT I   INTRODUCTION TO MICRO/NANO-PHYSICS   9

Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro-robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots - Scaling Effects in the Physical Parameters - Micro/Nano-Robotic System Examples. Around the World - Micro/Nanoforces: Van der Waals, Capillary, Electrostatic, Double Layer, Hydration, etc. Forces - Adhesion and Surface Energy - Micro/Nano Scale Contact Mechanics: Hertz, DMT, JKR, and MD Contact Mechanics Approaches - Micro/Nano tribology.

UNIT II   MICRO/NANO SENSORS   9

Imaging Sensors (Far-Field and Near-Field) - Optical Microscopy: Reflective, Inverted, Stereo, etc., Position Sensors: Capacitive Sensors, Linear Variable Differential Transformer, Interferometric Sensors - Force and Pressure Sensors: Strain Gauges, Deflection Based: AFM, etc., Visual Force Sensing: Bending Imaging, etc., Capacitive Force/Tactile Sensors - Accelerometers, Gyroscopes, Chemical Sensors, Flow Sensors.

UNIT III   IMPLEMENTATION OF MICROROBOTS   9

Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators - Piezoelectric Actuators - Bending Type: Unimorph and Bimorphs - Stack Type: Piezotubes, Thin-Film Type: ZnO, etc. - Electrostatic, Thermal, Ultrasonic, Electro/Magnetostrictive, and Shape Memory Alloy Based Actuators - Polymer Actuators, Dielectric Elastomers, Carbon Nanotube (CNT) Actuators - Biomolecular Motors.

UNIT IV   MICRO-ROBOTICS DEVICES   9

Micro-grippers and other micro-tools - Manipulators - SPM Probes and Micro/Nanogrippers - Optical Tweezers, (Di)Electrophoresis - Micro-conveyors - Walking MEMS Micro-robots – Multi-robot system: Micro-robot powering - Lithium Thin Film Batteries, Solar Cells, Micro Fuel Cells, (Electro)Magnetic Energy, Molecular Energy (ATP) - Micro-robot communication.

UNIT V   MICROFABRICATION AND MICRO ASSEMBLY   9

Micro-fabrication principles - Design selection criteria for micromachining - Packaging and Integration aspects – Micro/Nanofabrication, Micro/Nanoassembly, Self-Assembly, Hybrid Integration, etc. - Micro-assembly platforms and manipulators. -

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Yves Bellouard, ―Microrobotics Methods and Applications, CRC Press, Massachusetts, 2011.
2. Metin Sitti, " Microrobotics", MIT Press, 2017

REFERENCES:

1. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, ―Principles of Robot Motion-Theory, Algorithms, and Implementation, MIT Press, Cambridge, 2005.

2. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
3. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.
4. A Kelly, Mobile Robotics, Mathematics, Models, and Methods, Cambridge University Press, USA, 2013.
5. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.

WEB RESOURCES:
1. https://edu.epfl.ch/coursebook/en/micro-nano-robotics-ME-436
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9871318/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112105249
2. https://onlinecourses.nptel.ac.in/noc23_me67/preview
3. https://www.coursera.org/learn/robotics-mobility?specialization =robotics

OUTCOMES:
Upon completion of the course, the students should be able to
1. Identify and design a suitable manufacturing process for micro robots. (K3)
2. Select the characteristics of various flexures, actuators and sensor systems. (K2)
3. Outline the various methods of implementation of micro robots. (K2)
4. Summarize a task specification of micro robots and its applications based on the knowledge about micro robots. (K3)
5. Build the principles of microsystems and micromachining. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE607 SDG NO. 4, 9	ARTIFICIAL INTELLIGENCE IN INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To identify potential areas for automation and justify need for automation
- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Apply the concepts of AI to attain industrial automation

UNIT I   INTRODUCTION   9

Introduction to Industrial Automation - Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations.

UNIT II   INTELLIGENT AGENTS   9

Introduction to Artificial Intelligence -Introduction-Foundations of AI- History of AI Intelligent agents: Agents and Environment- Reactive agent- deliberative- goal-driven, utility driven, and learning agents -Artificial Intelligence programming techniques. Introduction to ML and DL Concepts.

UNIT III   KNOWLEDGE REPRESENTATION   9

Knowledge Representation and Reasoning -Ontologies-foundations of knowledge representation and reasoning-representing and reasoning about objects-relations- event sactions- time- and space- predicate logic-situation calculus-description logics-reasoning with defaults,-reasoning about knowledge-sample applications- Representing Knowledge and reasoning in an Uncertain Domain- Bayes rule-bayesian networks-probabilistic inference sample applications- Planning: planning as search- partial order planning- construction and use of planning graphs.

UNIT IV   EXPERT SYSTEMS   9

Expert systems -Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON.

UNIT V   AI APPLICATIONS   9

Industrial AI applications and Case studies - Applications of Industrial AI in Monitoring, optimization and control. Introduction to Deep learning. Deep learning for Industrial Automation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rich and Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2014.
2. S.G. Tzafestas, H. B. Verbruggen, "Artificial Intelligence in Industrial Decision Making, Control and Automation (Intelligent Systems, Control and Automation: Science and Engineering", 1st Edition, Springer, 2012.

REFERENCES:

1. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 2nd Edition, Prentice Hall, 2003.
3. Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House, 2018.
4. Robert J. Schalkeff, Artificial Intelligence: An Engineering Approach, PHI, Second edition, 1990.
5. Ashutosh Kumar Dubey, Abhishek Kumar, S. Rakesh Kumar, N. Gayathri, Prasenjit Das, "AI and IoT-Based Intelligent Automation in Robotics", Scrivener Publishing LLC, 2021.

WEB RESOURCES:

1. https://www.ambitautomation.in/courses/industrial-automation/
2. https://www.automationprogram.com/automation-technician-program-outline
3. https://www.coursera.org/specializations/roboticprocessautomation
4. https://www.learnvern.com/industrial-automation-with-scada
5. https://www.edx.org/learn/automation

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/112101098
3. https://nptel.ac.in/courses/108105063
4. https://archive.nptel.ac.in/courses/108/105/108105088/
5. https://nptel.ac.in/courses/108105062

OUTCOMES:
Upon completion of the course, the students should be able to

1. Extend the basics of Industrial Automation. (K2)
2. Identify appropriate AI methods to solve a given problem. (K2)
3. Acquire knowledge about AI/ ML/DL techniques in Industrial automation. (K3)

4. Summarize the levels of automation. (K2)
5. Select the basic AI algorithms. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO2	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO3	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO4	3	2	1	3	-	2	-	-	-	-	-	2	2	2
CO5	3	2	1	3	-	2	-	-	-	-	-	2	2	2

PROFESSIONAL ELECTIVE - II

20MUPE608 SDG NO. 4, 9	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To focus on basics of Industrial Internet
- To modify the various existing industrial systems
- To get an idea about IIoT Architectures
- To acquire the knowledge about various Network Protocols
- To extract the backend Middleware Protocols

UNIT I   INTRODUCTION TO INDUSTRIAL INTERNET   9

Innovation and IIoT – Intelligent Devices – Industrial Internet – Health care –Oil and Gas Industry – Smart Office – Logistics – IoT Innovations in Retail.

UNIT II   TECHNICAL AND BUSINESS INNOVATORS OF INDUSTRIAL INTERNET   9

Miniaturization – Cyber Physical Systems – Wireless technology – IP Mobility – Network Functionality Virtualization – Cloud and Fog - Big Data and Analytics – M2M Learning and Artificial Intelligence.

UNIT III   IIOT REFERENCE ARCHITECTURE   9

Industrial Internet Architecture Framework – Functional Viewpoint – Operational Domain, Information Domain, Application Domain, Business Domain – Implementation View point – Architectural Topology – Three Tier Topology – Data Management.

UNIT IV INDUSTRIAL INTERNET SYSTEMS   9

Introduction-Proximity Network Protocols – WSN Edge Node – Legacy Industrial Protocols – RS232 Serial Communications, 4-20mA Current Loop, Field Bus Technologies – Modern Communication Protocols – Industrial Ethernet – Industrial Gateways.

UNIT V   MIIDDLEWARE TRANSPORT PROTOCOL   9

TCP/IP, UDP, RTP, CoAP –Middleware Software patterns –Software Design patterns – Application Programming Interface (API) – CAN Protocol-Web Services – Middleware IIoT – Securing the IIoT- Identity Access Management.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press, 2020.
2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.

REFERENCES:
1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
2. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Development Copyrights ,2014
3. Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press, ISBN-10: 1138316849.
4. Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing.
5. Krishna P. Venkata, Sasikumar Gurumoorthy, Mohammad S.Obaidat, Internet of Things and Personalized Healthcare Systems, Springer-2019.

WEB RESOURCES:
1. https://www.classcentral.com/course/swayam-introduction-to-industry-4-0-and-industrial-internet-of-things-12941
2. https://www.coursera.org/learn/industrial-internet-of-things
3. https://freevideolectures.com/course/4638/nptel-introduction-internet-things
4. https://www.henryharvin.com/blog/iot-courses-online/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/106105195
2. https://archive.nptel.ac.in/courses/106/105/106105195/
3. https://nptel.ac.in/courses/106105166

OUTCOMES:
Upon completion of the course, the students should be able to
1. Enhance the company's performance using IoT. (K2)
2. Demonstrate the different styles of technical and business innovators. (K3)
3. Examine various IIoT Architectures related to data management system. (K2)
4. Organize the design of Industrial Internet Systems. (K2)
5. Construct a Middleware software system related to proximity edge networks. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	2	-	-	-	-	-	1	2	2
CO2	3	2	1	2	-	2	-	-	-	-	-	1	2	2
CO3	3	2	1	2	-	2	-	-	-	-	-	1	2	2
CO4	3	2	1	2	-	2	-	-	-	-	-	1	2	2
CO5	3	2	1	2	-	2	-	-	-	-	-	1	2	2
CO6	3	2	1	2	-	2	-	-	-	-	-	1	2	2

PROFESSIONAL ELECTIVE - II

20MUPE609 SDG NO. 4, 9	**ENERGY STORAGE AND ELECTRIC VEHICLES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:
- To present a comprehensive overview of Electric and Hybrid Electric Vehicles
- To deliver and discuss the about architecture, power electronics based drive control systems, battery management systems and grid integration issues of Electric and Hybrid vehicles

UNIT I   ELECTRIC VEHICLES   9

Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design.

UNIT II   BATTERY   9

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries.

UNIT III   DC & AC ELECTRICAL MACHINES   9

Motor and Engine rating, Requirements, DC machines, Three phase A/c machines, Induction machines, permanent magnet machines, switched reluctance machines.

UNIT IV   ELECTRIC VEHICLE DRIVE TRAIN   9

Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.

UNIT V   HYBRID ELECTRIC VEHICLES   9

Types – series, parallel and series, parallel configuration – Design – Drive train, sizing of components.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

REFERENCES:
1. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2000.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2004.
4. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998.
5. Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013.

WEB RESOURCES:
1. https://elearn.nptel.ac.in/shop/nptel/electric-vehicles-and-renewable-energy/
2. https://collegedunia.com/courses/hybrid-electric-vehicle

ONLINE RESOURCES:
1. http://nptel.ac.in/courses/108103009/
2. https://archive.nptel.ac.in/courses/108/103/108103009/
3. https://nptel.ac.in/courses/108106170
4. https://archive.nptel.ac.in/courses/108/102/108102121/
5. https://archive.nptel.ac.in/courses/108/106/108106182/
6. https://archive.nptel.ac.in/courses/108/106/108106170/
7. https://nptel.ac.in/courses/108103009/41

OUTCOMES:
Upon completion of the course, the students should be able to
1. Summarize the working of different configurations of electric vehicles. (K2)
2. Understand the hybrid vehicle configuration and its components, performance analysis. (K2)
3. Identify the properties of batteries and its types. (K2)
4. Outline the electric vehicle drive systems. (K2)
5. Select the hybrid electric vehicles based on configuration. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	1	3	-	-	-	-	-	2	2
CO2	3	3	2	2	3	-	3	-	-	-	-	-	2	2
CO3	2	3	2	2	2	2	3	-	-	-	-	-	2	2
CO4	3	3	3	3	3	1	2	-	-	-	-	-	2	2
CO5	2	3	2	2	2	2	3	-	-	-	-	-	2	2

PROFESSIONAL ELECTIVE - II

20MUPE610 SDG NO. 4, 9	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the concept and application for Design for manufacturing and assembly and its impact on product cost and quality.
- Be able to optimize tolerances to enhance manufacturability.
- Be able to optimize various manufacturing processes to enhance manufacturability.
- Be able to discuss various fundamentals of assembly and design recommendations for product development.

UNIT I   INTRODUCTION   9

Group technology, Value engineering, development and evaluation of alternative solutions, Tolerance analysis - Introduction to materials and material selection: Classification of engineering materials, Material selection for product design. Classification of the manufacturing process, Basic manufacturing processes, Mechanical properties of the material.

UNIT II   FACTORS INFLUENCING FORM DESIGN   9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice – Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III   DESIGN FOR CASTING   9

Introduction to casting - Sand casting, Die-casting, Injection moulding – Design recommendation, suitable materials.

UNIT IV   DESIGN FOR METAL JOINING AND ADDITIVE
**   MANUFACTURING   8**

Design for Matal Joining: Various weld joint designs, Minimizing distortion, Design for Brazing, Soldering and Adhesive bonding. Design for Additive Manufacturing: General Part and Feature Design, Part Design – Product Enclosure, Optimization of Path Planning

UNIT V   DESIGN FOR WELDING AND ASSEMBLY   10

Design for welding: Design for the recommendation for welding process, Design for solder and brazed assembly, Design for adhesively bonded constructions - Suitable materials, Design recommendations Design for

Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, "Product Design for Manufacture and Assembly", Second Edition, CRC Press, Taylor & Francis, Florida, USA, 2010.
2. O. Molloy, S. Tilley and E.A. Warman, "Design for Manufacturing and assembly", First Edition, Chapman &Hall, London, UK, 1998.

REFERENCES:

1. D.E. Whitney, "Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development", Oxford University Press, New York, 2005.
2. A.K. Chitale and R.C. Gupta, "Product Design and Manufacturing", Prentice Hall of India, New Delhi, 2013.
3. James G.Bralla, "Design for Manufacturability Handbook", Second Edition, McGraw-Hill companies, New York, USA, 2020.
4. Geoffrey Boothroyd, "Assembly Automation and Product Design", Second Edition, CRC Press, Taylor & Francis, Florida, USA, 2005.
5. G. Q. Huang, "Design for X, Concurrent Engineering Imperatives", First Edition, Chapman &Hall, London, UK, 1996.

WEB RESOURCES:

1. https://www.classcentral.com/course/youtube-design-for-quality-manufacturing-and-assembly-47428
2. https://www.londontfe.com/course/mechanical-engineering/DESIGN-FOR-MANUFACTURING---ASSEMBLY/

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/107103012
2. https://nptel.ac.in/courses/112107258
3. https://nptel.ac.in/courses/112106249
4. https://nptel.ac.in/courses/112104230
5. https://archive.nptel.ac.in/courses/107/103/107103012/
6. https://archive.nptel.ac.in/courses/112/101/112101005/

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand the fundamentals, material selection process, cost implications of the Design and manufacturability of various products. (K2)

2. Understand the factors influencing design. (K2)
3. Apply design guidelines for manufacturing processes like casting and moulding. (K3)
4. Apply design guidelines for Metal joining process and additive manufacturing. (K3)
5. Identify the concepts of design for welding and design for assembly. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	1	-	-	-	-	-	-	2	2
CO2	3	3	2	2	3	1	-	-	-	-	-	-	2	2
CO3	2	3	2	2	2	2	-	-	-	-	-	-	2	2
CO4	3	3	3	3	3	1	-	-	-	-	-	-	2	2
CO5	2	3	2	2	2	2	-	-	-	-	-	-	2	2

PROFESSIONAL ELECTIVE - II

20MUPE611 SDG NO. 4,8,9,12	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide the overview of evolution of automation, CIM and its principles.
- To learn the various Automation tools, include various material handling system.
- To familiarize the AGV and IOT.
- To introduce to basics of data transaction, information integration and control of CIM.

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In Time Production.

UNIT II   CAD AND CAM INTEGRATION   9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Product life cycle management (PLM).

UNIT III   CAD AND CAM FOR MANUFACTURING PROCESSES   9

Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine.

UNIT IV   AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) AND IOT   9

Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety. Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station.

UNIT V   PROCESS CONTROL AND DATA ANALYTICS   9

Introduction to process model formulation – linear feedback control systems – Optimal control – Adaptive control –Sequence control and PLC & SCADA. Computer process control – Computer process interface – Interface hardware – Computer process monitoring –Overview of Automatic identification methods – Bar code technology –Automatic data capture technologies. - Quality management (SPC) and automated inspection.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

REFERENCES:

1. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, Tata McGraw-Hill, 2015.
2. P.M. Agarwal and V.J.Patel, "CNC Fundamentals and Programming", Charotar Publishing House Pvt. Ltd., Second Edition, 2014.
3. Hindustan Machine Tool Ltd., "Mechatronics", Tata McGraw Hill, 2000.

4. Jerry Banks and Barry L. Nelson, "Discrete Event System Stimulation", Pearson Education, 2006.
5. H. K. Shivanand and M.M. Benal, "Flexible Manufacturing System", New Age International Pvt Ltd Publishers, 2006.

WEB RESOURCE:
1. https://lecturenotes.in/search/computer%20integrated%20manu facturing

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112/104/112104289/
2. https://nptel.ac.in/courses/112/104/112104288/
3. https://nptel.ac.in/courses/110/106/110106044/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts. (K2)
2. Describe the application of computer in CAPP, MRP, ERP and PLM. (K2)
3. Explain the use of advanced manufacturing processes interfaced with CNC machine. (K2)
4. Understanding the modern trends in Manufacturing like AGV System and applications of IoT leading to Smart Manufacturing. (K2)
5. Illustrate the performance in process control and data analytics. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1	-	-	-	1	1	1	2
CO2	2	2	1	2	1	-	-	-	1	1	1	2
CO3	2	2	1	2	1	-	-	-	1	1	1	2
CO4	2	2	1	2	1	-	-	-	1	1	1	2
CO5	2	2	1	2	1	-	-	-	1	1	1	2

PROFESSIONAL ELECTIVE - III

20MUPE701 SDG NO. 4,9	DIGITAL TWIN AND INDUSTRY 5.0	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics concepts in digital twin
- To Introduce the concepts in digital twin in a discrete Industry
- To Introduce the concepts in digital twin in a process Industry
- To obtain the knowledge in industry 5.0
- To know about the advantages in industry 5.0

UNIT I   INTRODUCTION   9

Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems.

UNIT II   DIGITAL TWIN IN A DISCRETE INDUSTRY   9

Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise

UNIT III   DIGITAL TWIN IN A PROCESS INDUSTRY   9

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise

UNIT IV   INDUSTRY 5.0   9

Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0

UNIT V   ADVANTAGES OF DIGITAL TWIN   9

Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019

REFERENCES:
1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018
2. Manisha Vohra, "Digital Twin Technology: Fundamentals and Applications", Scrivener Publishing LLC, 2023, Wiley publications.
3. Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.
4. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
5. Ulrich Sendler, "The Internet of Things, Industries 4.0 Unleashed", Springer., Germany, 2018

WEB RESOURCES:
1. https://www.udemy.com/course/digital-twin-a-comprehensive-overview/
2. https://uu.diva-portal.org/smash/get/diva2:1770202/FULLTEXT01.pdf

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/106105195
2. https://nptel.ac.in/courses/112104319
3. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the basics concepts in digital twin (K2)
2. Recognize the concepts in digital twin in a discrete Industry(K2)

3. Review the requirements and various concepts of digital twin in a process Industry (K2)
4. Describe the concepts of Industry 5.0 (K2)
5. Apply the advantages in industry 5.0 with various applications (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	2	1	-	-	-	-	-	1	2	1	2
CO2	1	2	1	2	1	-	-	-	-	-	1	2	1	2
CO3	1	2	1	2	1	-	-	-	-	-	1	2	1	2
CO4	1	2	1	2	1	-	-	-	-	-	1	2	1	2
CO5	1	2	1	2	1	-	-	-	-	-	1	2	1	2

PROFESSIONAL ELECTIVE - III

20MUPE702 SDG NO. 8,9,11	SMART FARMING USING AUTOMATION PRINCIPLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the principle, design and application of various measurement and assisted devices for the sustainable farming
- Provides knowledge of the agriculture devices and their functions

UNIT I INTRODUCTION AND SENSORS IN AGRICULTURE 9

Overview of smart agriculture: Nature and origin of soil; soil minerals, classification and composition, soil properties including structure, PH, surface tension and soil nutrients. Standards for agriculture, need for agriculture digitalization. Smart sensors, Colorimetry based detection, MEMS Electrochemical Sensors, Dielectric Soil Moisture Sensors, ISFET, Weather sensors, Proximity Sensors, Air flow sensors, Thermal camera, Image processing.

UNIT II ACTUATORS & CONTROLS IN AGRICULTURE AND TELEMETRY 9

AC & DC Motors, Stepper motor, Solenoid actuators, Piezoelectric motors, Electric drives, Hydraulic and Pneumatic actuators. Wireless communication modules and topology, Zig-bee, Bluetooth, LORA, Zero power devices, Energy Harvesting technology, GIS enabled smart technology.

UNIT III   PLANT HEALTH MONITORING   9

Measurement of leaf health, chlorophyll detection, ripeness level, crop mapping, fertilizing, Drone technology for soil field analysis and assistive operations. Case study.

UNIT IV   TECHNOLOGIES FOR FARMING   9

Water quality monitoring, smart water management, micro-irrigation system, solar pump and lighting system, Fencing, Android based automation, AI and IOT in farming. Case study.

UNIT V   CASE STUDIES   9

Case studies on sorting, seeding and weeding machine, fruit picking robots, Autonomous unmanned ground vehicles and Drones

TOTAL:45PERIODS

TEXT BOOKS:

1. Ramesh C. Poonia, Xiao-Zhi Gao, Linesh Raja, Sugam Sharma and Sonali Vyas, Smart Farming Technologies for Sustainable Agricultural Development, IGI Global, 2018.
2. Pradeep Tomar and Gurjit Kaur, Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, IGI Global, 2021.

REFERENCES:

1. Annamaria Castrignano, Gabriele Buttafuoco, Raj Khosla, Abdul Mouazen, Dimitrios Moshou and Olivier Naud, Agricultural internet of things and decision support for precision smart farming, Elsevier, 2020.
2. J Bruce Ralphin Rose, N R Rajalakshmi, Narayanan Prasanth, Saravanan Krishnan,Cloud IoT Systems for Smart Agricultural Engineering Hardcover –CRC Press Chapman and Hall Book, 2022.
3. Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021
4. Amitava Choudhury, Arindam Biswas, T. P. Singh, Santanu Kumar Ghosh, "Smart Agriculture Automation Using Advanced Technologies" , Springer series, 2021

WEB RESOURCES:

1. https://www.cstaricalcutta.gov.in/images/CTS%20IoT%20Tech. %20(Smart%20Agriculture)_CTS_NSQF-4.pdf
2. https://farmlabor.ucdavis.edu/sites/g/files/dgvnsk5936/files/inline-files/Paper%20Vougioukas%20Fountas.pdf

3. https://www.biz4intellia.com/blog/5-applications-of-iot-in-agriculture/
4. https://openaccess.city.ac.uk/id/eprint/28838/1/1-s2.0-S2772427122000791-main.pdf
5. https://easternpeak.com/blog/iot-in-agriculture-technology-use-cases-for-smart-farming-and-challenges-to-consider/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/126104005
2. https://nptel.ac.in/courses/102104069

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand Smart farming techniques and various sensors for smart farming (K2)
2. Discuss different actuators for farming tools, data acquisition and telemetry. (K2)
3. Demonstrate Plant health monitoring systems. (K2)
4. Review advanced technologies for farming. (K2)
5. Develop a machine for smart irrigation system. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	2	1	-	-	-	-	-	2	1	2
CO2	1	2	2	-	2	1	-	-	-	-	-	2	1	2
CO3	1	2	2	-	2	1	-	-	-	-	-	2	1	2
CO4	1	2	2	-	3	2	-	-	-	-	-	2	1	2
CO5	1	2	3	-	2	1	-	-	-	-	-	2	1	2

PROFESSIONAL ELECTIVE - III

20MUPE703 SDG NO. 8,9,11,12	AGRICULTURAL ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about Farming related Machines.
- To understand the global position and information system in machines.
- To know about traction and testing
- To familiarize the concept on weed management
- To learn about machinery selection.

UNIT I   INTRODUCTION   9

History of Mechanized Agriculture – Farming Operations and Related Machines – Tillage, Planting Cultivation, and Harvesting, Agricultural Automation – Agricultural Vehicle Robot.

UNIT II   PRECISION AGRICULTURE   9

Sensors – types and agricultural applications, Global Positioning System (GPS) – GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks.

UNIT III   TRACTION AND TESTING   9

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

UNIT IV   SOIL TILLAGE AND WEED MANAGEMENT   9

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation

UNIT V   MACHINERY SELECTION   9

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.

TOTAL:45PERIODS

TEXT BOOKS:
1. Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2. Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.

REFERENCES:
1. Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2. Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3. R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4. Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.
5. Avital Bechar, "Innovation in Agricultural Robotics for Precision AgricultureA Roadmap for Integrating Robots in Precision Agriculture", Springer series.

WEB RESOURCES:
1. https://www.mdpi.com/2077-0472/13/5/1005//ef aidnbmnnnibpcajp cglclefindmkaj/
2. https://www.fao.org/3/cb218 6en/cb2186en.pdf
3. https://builtin.com/robotics/farming-agricultural-robots

ONLINE RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc24_bt30/preview
2. https://www.udemy.com/course/modern-farming-techniques/
3. https://www.edx.org/learn/agriculture

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize the areas in agricultural process where robotics can be applied. (K2)
2. Integrate sensor and system for a required specific process in agricultural applications. (K2)
3. Apply Mechanics to the design various robot parameters (K3)

4. Convert various mechanisms into robot by providing actuation at specific links and joints of the mechanism.(K3)
5. Develop suitable robotic system for specific agricultural tasks.(K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	-	2	1	-	-	-	-	-	2	1	2
CO2	1	2	3	-	3	1	-	-	-	-	-	2	1	2
CO3	1	2	3	-	2	1	-	-	-	-	-	2	1	2
CO4	1	2	3	-	2	3	-	-	-	-	-	2	1	2
CO5	1	2	3	-	2	1	-	-	-	-	-	2	1	2

PROFESSIONAL ELECTIVE - III

20MUPE704 **SDG NO. 4,9**	**DRONE TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To introduce students to the accessories of drones and its functionality.
- To describe the students about mathematical model of quad copter drone.
- To make the students design and development of drone model using Simulink.
- To discuss the implementation models of different drone-based case studies.

UNIT I   INTRODUCTION TO DRONES   8

Introduction - Unmanned Aerial Systems (UAS), Basics of drones, different body materials used for drone, different types of drones, Laws of Motion, Bernoulli's Principle, four forces of Flight, three axes of Flight.

UNIT II   DRONE ACCESSORIES   10

Sensors & Motors, its types and specifications, design constraints, Estimation of pay load - Test and measurement methods for drone sensors and actuators, Batteries - Understand different specifications and their significance of batteries. Propellers, Concept of propulsion, Forces working on a Flight, Principle axes and rotation of aerial systems, Role of GPS navigation and telemetry model, interfacing of GPS module to navigation drone.

UNIT III   DRONE CONTROL SYSTEMS AND DEVELOPMENT   9

Control system architecture, Quadcopter with actuator & propellers functionality block, Sensing & estimation functionality block, controller functionality block.

UNIT IV   MODELLING, SIMULATION & FLIGHT CONTROL DESIGN   9

Dynamic quad copter system Model, flight control design, 3D visualization, testing & tuning the model, Flight operations, Applicable software for data collection, processing, and analysis

UNIT V   APPLICATIONS OF DRONE TECHNOLOGY   9

Drones in delivering mail, parcels and other cargo, Drones in agriculture, Drones in inspection of transmission lines and power distribution, Drones in disaster management (Flood, Fire etc), Case Study: Eagle Eye drone.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Garvit Pandya, "Basics of Unmanned Aerial Vehicles : Time to start working on Drone Technology", Notion Press , 2021
2. Ben Rupert, Drones (The ultimate guide), Create Space Independent Publishing Platform, 1stEdition,2017

REFERENCES:
1. Muhammad Usman, Quadcopter modeling and control with Matlab/Simulink implementation LAB University of Applied Sciences, 1stEdition, 2020.
2. R.K.Mittal , I.J.Nagrath, Robotics and control, Tata McGraw-Hill, 1stEdition,2005.
3. Sachi Nandan Mohanty, JVR Ravindra, Surya Narayana, Drone Technology: Future Trends and Practical applications, Wiley, 2023.
4. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
5. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.

WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc20_ae04/preview
2. https://onlinecourses.nptel.ac.in/noc19_ae06/preview
3. https://www.iitram.ac.in/dt

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/101104073
2. https://nptel.ac.in/courses/101104083
3. https://nptel.ac.in/courses/105107218

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand the basic concepts and the principles of drone technology. (K2)
2. Describe the specifications and requirements of customized drone design.(K2)
3. Analyze the different Drone control system as per applications.(K3)
4. Design and evaluate the Drone control systems and apply the various software to control and analysis.(K3)
5. Apply the autonomous and controlled Drones for various industrial and domestic applications.(K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	-	-	-	-	-	1	-	1	2	2
CO2	2	3	3	1	2	-	-	-	-	1	-	1	2	3
CO3	3	3	3	3	2	-	-	-	-	1	-	1	2	3
CO4	2	2	2	1	-	-	-	-	-	1	2	1	2	2
CO5	1	1	1	1	-	-	-	-	-	-	-	1	1	1

PROFESSIONAL ELECTIVE - III

20MUPE705 SDG NO. 7,8,9	ROBOT PATH PLANNING AND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:
- Introduce basic trajectory planning problems.
- Provide a basic review of various path planning theory of manipulator.
- Provide a basic review of various path planning theory of mobile robot.
- Introduction to the most widely used classical motion planning algorithms.
- Introduce sufficient terminology and concepts in ROS for robot programming

UNIT I TRAJECTORY PLANNING APPROACHES 9

Definitions – Task planning and Trajectory planning – Representation of end-effector: Cartesian and joint space schemes. Workspace Analysis: work envelope of a multi DOF manipulator. Applications: Point to point motion and continuous path motion.

UNIT II TRAJECTORY PLANNING OF MANIPULATOR 9

Joint space techniques – Motion profiles – Cubic polynomial, Linear Segmented Parabolic Blends and cycloidal motion - Cartesian space technique – Straight line and circular trajectories.

UNIT III PATH PLANNING OF MOBILE ROBOT 9

Introduction - Representation of the Robot's Environment - Review of configuration spaces - Visibility Graphs - Voronoi diagrams - Potential Fields – Attractive and Repulsive – Cell Decomposition - Planning with moving obstacles - Probabilistic Roadmaps - Random trees - Execution of the Quadtree- Based Path Planner Program.

UNIT IV PATH PLANNING ALGORITHMS 9

Planning - A* Algorithm - the D* algorithm - Path control. Graph search and discrete planning algorithms. - Sensor-Based Motion Planning Algorithms – the "Bug" algorithms – the Tangent Bug algorithm.

UNIT V ROS PROGRAMMING 9

Robot language classification - Programming methods: Lead through method, teach pendent method - Syntax features and applications of various programming languages – Examples - Inter locking commands - Safety features - Introduction to Robot Operating System (ROS) - ROS examples - Introduction to programming using ROS - Industrial ROS - ROS examples - Programming for point to point /continuous – operations - Case Study

TOTAL:45PERIODS

TEXT BOOKS:

1. Niku S B, "Introduction to Robotics, Analysis, Control, Applications", John-Wiley & Sons Inc, 3rd edition, 2019.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, Sebastian Thrun , "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005

REFERENCES:

1. Steve LaValle, Planning Algorithms, Cambridge Univ. Press, New York, 2006.

2. Patnaik, Srikanta , "Robot Cognition and Navigation An Experiment with Mobile Robots",   Springer-Verlag Berlin and Heidelberg, 2007.
3. Reza N Jazar , "Theory of Applied Robotics", Springer, 2010.
4. Neil Wilkins, Robotics, Bravex Publications, 2019.
5. Morgan Quigley, Brian Gerkey, William D. Smart, Programming Robots with Ros: A Practical Introduction to the Robot Operating System, First Edition, 2016.

WEB RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc21_me76/preview
2. https://archieve.nptel.ac.in/courses/112/105/112105249/

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090
3. https://onlinecourses.nptel.ac.in/noc20_me03/preview

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize various trajectory planning and path planning for mobile robot and manipulator. (K2)
2. Classify trajectory planning and path planning for mobile robot and Manipulator. (K2)
3. Choose appropriate Path and Trajectory planning algorithm for various Industrial Applications. (K3)
4. Plan the path and trajectory for various Industrial robots and mobile robots for specific Applications. (K3)
5. Program the developed path and trajectory into real time robot applications(K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	2	2
CO2	3	2	1	1	-	-	-	-	-	-	-	1	2	2
CO3	3	2	1	1	-	-	-	-	-	-	-	1	2	2
CO4	3	2	1	1	-	-	-	-	-	-	-	1	2	2
CO5	3	2	1	1	-	-	-	-	-	-	-	1	2	2

PROFESSIONAL ELECTIVE - III

20MUPE706 SDG NO. 4,8,9	COLLABORATIVE ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To know the fundamentals of Cobotics
- To introduce Swarm robot and trajectory planning for Swarm
- To introduce Modular Robotics and its Mechanics
- To learn about various Natural models of robot collaboration
- To introduce the concept of Reconfigurable robot.

UNIT I INTRODUCTION TO COBOTICS 9

Collaborative Robotics- Properties – Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators-Current Challenges.

UNIT II SWARM ROBOTICS 9

Introduction, mapping, kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios-aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

UNIT III PROGRAMMING FOR COBOTS 9

Manual programming- lead through- walk through- powered Lead through- teach pendant. Interpolation techniques- Linear- Circular- Point to Point- Controlled motion- Motion Interpolation techniques- High level text Languages- Cobots programs.

UNIT IV NATURALLY INSPIRED COLLABORATION 9

Collective Decision-Making. Group Decision Making in Animals, Collective Motion as Decision Process, Models for Collective Decision-Making Processes, Urn Models, Voter Model ,Majority Rule , Hegselmann and Krause , Kuramoto Model , Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Sociophysics and Contrarians .

UNIT V RECONFIGURABLE ROBOTS 9

V-Shaped Formation Control for Robotic Swarms Constrained by Field of View – formation of reconfigurable virtual linkage – Reconfigurable Formation

Control of Multi-Agents – Self-Assembly Modular Robot Platform for swarm robot– Swarm Dynamics Emerging from Asymmetry.

TOTAL:45PERIODS

TEXT BOOKS:
1. Peter Matthews, Steven Greenspan, "Automation and Collaborative Robotics: A Guide to the Future of Work", Apress; 1st Edition, 2020.
2. V. Daniel Hunt, "Smart Robots- A Handbook of Intelligent Robotic Systems", Chapman and Hall Advanced Industrial Technology Series, Springer-Verlag New York Inc., 2011.

REFERENCES:
1. Heiko Hamann, "Collective Decision-Making in Swarm Robotics: A Formal Approach", Springer, 2019.
2. Angelo Cangelosi and Minoru Asada, "Cognitive Robotics", 2022, The MIT Press
3. Aude Billard, SinaMirrazavi and Nadia Figueroa, "Learning for Adaptive and Reactive Robot Control- A Dynamical Systems Approach", 2022, The MIT Press
4. George A. Bekey, "Autonomous Robots: From Biological Inspiration to Implementation and Control (Intelligent Robotics and Autonomous Agents series)", Bradford Books; Reprint edition, 2017.
5. Angelo Cangelosi and Matthew Schlesinger," Developmental Robotics: From Babies to Robots", Book, 2015, The MIT Press.
6. Giandomenico Spezzano, "Swarm Robotics", Applied Sciences, MDPI, 2019.

WEB RESOURCES:
1. https://www.coursera.org/learn/collaborative-robot-safety
2. https://www.uts.edu.au/industry/corporate-training/courses/basic-programming-and-use-collaborative-robots-cobots

ONLINE RESOURCES:
1. https://onlinecourses.nptel.ac.in/noc22_me38/preview
2. https://archive.nptel.ac.in/courses/112/107/112107289/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Recognize the fundamentals of Collaborative Robotics. (K2)
2. Apply Swarm robots technology in real time applications. (K3)

3. Analyze and select the suitable concept of Modular Robotics and its program for modelling a collaborative robot. (K3)
4. Create various Natural models for robot collaboration. (K3)
5. Develop collaborative robots for various requirement in industrial tasks. (K3)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	1	1	-	-	-	-	2	2	2	1
CO2	1	1	2	1	1	1	-	-	-	-	2	2	2	1
CO3	1	1	2	2	2	2	-	-	-	-	2	2	2	1
CO4	1	2	1	2	1	2	-	-	-	-	1	2	2	1
CO5	1	2	1	1	2	1	-	-	-	-	2	1	2	1

PROFESSIONAL ELECTIVE - III

20MUPE707 SDG NO. 4,7,8,9, 11,12	**TEROTECHNOLOGY AND MAINTENANCE MANAGEMENT**	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To understand basic maintenance concepts and latest trends
- To know various maintenance policies for maximizing the profit.
- To diagnose and analyze maintenance problems.
- To know effective spare parts management strategies
- To learn strategies for improving the overall Equipment Effectiveness

UNIT I   INTRODUCTION   9
Maintenance definition – Maintenance objectives - Maintenance challenges – Tero Technology Maintenance costs - Scope of maintenance department. –Latest Trends in MaintenanceComputerized Maintenance Management Software (CMMS)- Role of IoT in Maintenance- Digital Twins in Maintenance.

UNIT II   MAINTENANCE MODELS   9
Proactive/reactive maintenance - Maintenance policies – Imperfect maintenance Preventive / breakdown maintenance – Optimal PM schedule and product characteristics – Inspection decisions - Maximizing profit - Minimizing downtime – Replacement decisions.

UNIT III   MAINTENANCE QUALITY   9

Five zero concept – FMEA- FMECA – Root cause analysis – Repair time distribution – Analysis of downtime – Maintainability prediction – Design for maintainability – Reliability Centered Maintenance.

UNIT IV   MAINTENANCE MANAGEMENT   9

Human factors – Maintenance staffing - Learning curves – Simulation – Optimal size of service facility– Optimal repair effort – Spare parts management – Maintenance planning – Maintenance scheduling.

UNIT V   TOTAL PRODUCTIVE MAINTENANCE   9

TPM philosophy – Chronic and sporadic losses – Equipment defects – Six major losses – Overall equipment effectiveness –TPM pillars –Autonomous maintenance.

TOTAL:45PERIODS

TEXT BOOKS:

1. Andrew K.S.Jardine& Albert H.C. Tsang, "Maintenance, Replacement and Reliability-Theory and Applications" Taylor and Francis, 2021.
2. Mishra R C and Pathak K., "Maintenance Engineering and Management", 2nd Edition. PHI, 2012.

REFERENCES:

1. Bikas Badhury & S.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
2. Seichi Nakajima, "Total Productive Maintenance", Cambridge, MA: Productivity Press, 2015.
3. Borris, S, "Total Productive Maintenance", 1st Ed. New York: McGraw Hill, 2006.
4. Matthew P. Stephens, "Productivity and Reliability-Based Maintenance Management", Purdue University Press, 2nd Edition, 2022.
5. Charles E. Ebling., "An Introduction to Reliability and Maintability Engineering", Tata McGraw Hill, 2013.

WEB RESOURCES:

1. https://archive.nptel.ac.in/courses/127/105/127105234/
2. https://archive.nptel.ac.in/courses/105/108/105108128/
3. https://archive.nptel.ac.in/courses/110/105/110105088/
4. https://archive.nptel.ac.in/courses/110/104/110104080/

5. https://archive.nptel.ac.in/courses/110/104/110104085/
6. https://archive.nptel.ac.in/courses/110/101/110101010/

ONLINERESOURCES:
1. https://www.udemy.com/course/master-in-predictive-maintenance/
2. https://books.google.co.in/books?id=TYktpq1dRUEC&printsec=copyright&redir_esc=y#v=onepage&q&f=false
3. https://nibmehub.com/opac-service/pdf/read/Handbook%20of%20Maintenance%20Management%20and%20Engineering%20Haroun.pdf
4. https://onlinelibrary.wiley.com/doi/10.1002/9781118926581.ch17
5. https://www.accessengineeringlibrary.com/content/book/9780071826617

OUTCOMES:
Upon completion of the course, the students should be able to
1. Describe basic maintenance concepts and latest trends in maintenance. (K1)
2. Extract maintenance policies for maximizing the profit. (K2)
3. Diagnosis of maintenance problems. (K2)
4. Improve uptime of machines by effective spare parts management. (K2)
5. Improve the overall Equipment Effectiveness. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	2	2	1	1	1	-	1	3	2	2	2
CO2	2	2	1	2	2	1	1	-	-	1	3	2	2	2
CO3	1	1	2	2	1	1	2	1	-	1	3	2	2	2
CO4	1	1	2	2	2	1	1	1	-	1	3	2	2	2
CO5	1	2	2	2	3	1	2	-	-	1	3	2	2	2

PROFESSIONAL ELECTIVE - III

20MUPE708 SDG NO. 4,8,9,17	ENGINEERING ECONOMIC ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the fundamentals of cost analysis and economics.
- To learn about the basics of economics and cost analysis related to engineering so as to take economically sound decisions.
- To make the students to understand capital market, break-even point analysis and depreciation.
- To learn the techniques of incorporating the inflation factor in economic decision-making.

UNIT I   INTRODUCTION TO ECONOMICS   9

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics - Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

UNIT II   VALUE ENGINEERING   9

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

UNIT III   CASH FLOW   9

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT IV   REPLACEMENT AND MAINTENANCE ANALYSIS   9

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset,

Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely

UNIT V   DEPRECIATION   9

Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset

TOTAL:45 PERIODS

TEXT BOOKS:
1. R. Panneer Selvam, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2nd Edition, 2013.
2. Donald G. Newnan, Ted G. Eschenbach, Jerome P. Lavelle, "Engineering Economic analysis", Oxford University press, 12th Edition, 2015.

REFERENCES:
1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
2. Donald. G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, NewYork,2011.
4. Don Newnan, Ted Eschenbach, Jerome Lavelle, and Neal Lewis, "Engineering Economic Analysis", Oxford University Press, 14th Edition, 2019.
5. Paul Samuelson, William Nordhaus, "Economics", Tata McGraw Hill, New Delhi, 2010.
6. Zahid A. Khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012

WEB RESOURCES:
1. https://www.hzu.edu.in/engineering/engineering%20economy.pdf
2. https://www.aboutcivil.org/engineering-economics.html
3. https://openpress.usask.ca/engecon/

ONLINE RESOURCES:
1.   https://archive.nptel.ac.in/courses/112/107/112107209/
2.   https://nptel.ac.in/courses/110105067

OUTCOMES:

Upon completion of the course, the students should be able to
1.   Analyze to financial functions to model and solve engineering economic analysis. (K2)
2.   Define and provide examples of the time value of money. (K2)
3.   Demonstrate the effects of cash flow, revenue generation. (K2)
4.   Solve economic problems involving comparison and variety analytical techniques. (K3)
5.   Demonstrate and solve the effects of depreciation, income taxes, and price change in engineering economic analysis problems. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	1	-	-	-	-	1	-	1	1	2
CO2	2	1	2	-	2	-	-	-	-	1	-	1	2	2
CO3	3	-	1	1	2	-	-	-	-	1	-	1	2	2
CO4	2	1	1	-	1	-	-	-	-	1	-	1	1	1
CO5	1	1	-	-	1	-	-	-	-	-	-	1	1	1

PROFESSIONAL ELECTIVE - III

20MEEL810 SDG NO. 4,8,9, 16,17	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:
●   To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
●   To write a business plan the project report
●   To learn the steps involved in starting and running a business
●   To gain knowledge and skills needed to run a business successfully.

UNIT I   INTRODUCTION TO ENTREPRENEURSHIP   9

Entrepreneur and Entrepreneurship - Concepts and Definition, Role of Entrepreneur in Economy, Types of Entrepreneurs. Entrepreneur Personality and Behaviour, Entrepreneurial Skills, Factors affecting Entrepreneurial growth, Manager vs Entrepreneur, Steps in Entrepreneurial Process.

UNIT II   OPPORTUNITY IDENTIFICATION AND PRODUCT SELECTION 9

SWOT Analysis. Entrepreneurial Opportunity Search and Identification, Criteria to select a Product for business, Feasibility Study – Economic and Market Feasibility, Entry Strategies, IPR, Negotiation and Conflict Management.

UNIT III   ENTREPRISE LAUNCHING & PROJECT REPORT PREPARATION9

Small Scale Business – Definition, Role of SME in Economy, Registration Procedure, Rules of Pollution Board for NOC, Machinery and Location selection. Specimen of Project Report, Project Planning and Scheduling, Project Appraisal Methods –Liabilities under different Statutory Laws.

UNIT IV   TRENDS IN ENTREPRENEURSHIP   9

Women Entrepreneurship – Role, Challenge, Trends and Benefits. Rural Entrepreneurship –Need, Challenges, Government support, Opportunities and Benefits. Social Entrepreneurship – Emergence and Pioneers, Social Entrepreneurs vs Business Entrepreneurs, Challenges. Technology Driven Entrepreneurship – Types of Technological venture, Challenges, International Entrepreneurship – Opportunities and Challenges.

UNIT V   ROLE OF SUPPORT INSTITUTIONS   9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL:45 PERIODS

TEXT BOOKS:
1. Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9thEdition, Cengage Learning, 2014.
2. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

REFERENCES:
1. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers:
2. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGrawHill, 2013.
3. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech, 2005.
4. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
5. Raj Shankar, Text Books Entrepreneurship - Theory and Practice , TMGH.
6. K Ramchandran: Entrepreneurship – Indian Cases on Change Agents, TMGH
7. Kuratko, D.F. & Hodgetts, R.M: Entrepreneurship: Theory, Process and Practice by Cengage Press.

WEB RESOURCES:
1. https://www.ediindia.org/
2. https://nptel.ac.in/courses/110/101/110101004/
3. https://www.editn.in/pages/view/edp-course-materials
4. https://www.startupindia.gov.in/content/sih/en/governmentscheme s.html
5. https://inc42.com/buzz/startup-scheme-indian-government-startups

ONLINE RESOURCES:
1. https://www.coursera.org/learn/entrepreneurship-development?
2. https://www.coursera.org/specializations/wharton-entrepreneurship
3. https://www.coursera.org/learn/wharton-entrepreneurship opportunity
4. https://www.coursera.org/learn/entrepreneurship-strategy
5. https://www.coursera.org/specializations/start-your-own-business
6. https://www.udemy.com/course/intro-to-entrepreneurship-getstarted-as-an-entrepreneur/
7. https://www.udemy.com/course/launch-your-idea-idea-to-mvp-withno-cto-and-no-coding/
8. https://www.udemy.com/course/entrepreneurship-start-a-businessfrom-scratch/
9. https://www.udemy.com/course/entrepreneurship-101-from-idea-tolaunch-and-beyond/
10. https://swayam.gov.in/nd1_noc20_hs66/preview
11. https://swayam.gov.in/nd1_noc20_mg46/preview

OUTCOMES:

Upon completion of the course, the students should be able to

1. Instil knowledge and spirit of entrepreneurship among students. (K2)
2. Impart competencies required to become an entrepreneur. (K2)
3. Provide insights into feasibility study and procedures of starting business. (K3)
4. Have awareness of recent trends in entrepreneurship. (K2)
5. Understand the support system for entrepreneurship in India. (K2)
6. Understand the step by step procedure of starting and running the business(K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	3	1	3	3	2	3	3	2	1	2	2
CO2	1	1	1	3	1	2	3	2	3	2	3	1	2	2
CO3	1	1	1	3	1	3	3	3	2	3	3	1	2	2
CO4	1	1	1	2	1	2	3	2	2	2	2	2	2	2
CO5	1	1	1	2	1	3	3	2	3	3	3	3	2	2
CO6	2	2	2	2	3	3	3	3	3	3	3	3	3	3

PROFESSIONAL ELECTIVE - III

20MGEL501 SDG NO. 4,7,8,9, 11,12	**INTELLECTUAL PROPERTY RIGHTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To get an introductory insight about the IPR in national and international context
- To understand the procedures for IPR, registration and its enforcement.
- To encourage innovation and to provide incentives for innovation by granting protection to inventors that will allow them to recover research and development investments
- To protect inventors or creators of intellectual products with moral and commercial value.

UNIT I   INTRODUCTION   9

Intellectual property: Introduction, Meaning, Nature and significance types of intellectual property, importance of intellectual property rights, Protection of

human innovations by IPR such as Patents, Trademarks, Copyright, Industrial Designs Geographical Indications, and Trade Secrets.

UNIT II AGREEMENTS AND TREATIES   9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, General agreement on trade and tariff (GATT), Ben convention, Rome convention, Role of WTO and WIPO.

UNIT III PATENTS   9

Concept of Patent – Historical view of Patent system in India and International Scenario, patent searching process, ownership rights and transfer, compulsory licenses, Procedure for filing of patents, Grants of patent, Benchmarks for patentability of inventions, Recent key changes and development.

UNIT IV TRADEMARKS AND COPYRIGHTS   9

Concept of Trademarks and copyrights – Rationale behind the protection Purpose, function and acquisition, ownership issues, Procedure for Registration, Industrial design and integrated circuits, protection of geographical indications and plant varieties, Recent Trends in copyrights and Trademark., Trade secrets -liability for misappropriations of trade secrets.

UNIT V LEGAL ASPECTS AND NEW DEVELOPMENTS   9

Infringements of patents– Criteria of Infringement – Modes of Infringement - remedies and modification - Protection against unfair competition, enforcement of intellectual property rights, Intellectual property audits, New developments of intellectual property, Impact of international instruments relating to the protection of intellectual properties Future of IPR in National and International levels.

TOTAL:45 PERIODS

TEXT BOOKS:

1. S.V. Satarkar, Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi, 2002.
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
3. P.Narayanan, Intellectual property rights Eastern law house-2018 3rd Edition (revised and updated)
4. Deborah, E. Bouchoux, Intellectual property right, Cengage learning2018 5th Edition

REFERENCES:
1. Sterling, J. L. A., World copyright law, (2008) 3rd Edition, London, Sweet & Maxwell
2. GP Reddy, Intellectual property rights & other laws, Gogia law agency
3. Barrett, Margreth, Intellectual Property, (2009) 3rd Edition, New York Aspen publishers.
4. Inventing the Future: An introduction to Patents for small and medium sized Enterprises; WIPO publication
5. Cornish, William Intellectual Property: Patents, Copyright, Trademarks and allied rights, (2010) 7th Edition, London Sweet & Maxwell.
6. Kankanala and Kalyan.C : Indian Patent Law and Practice (2010), India, Oxford University Press

WEBRESOURCES:
1. https://www.wipo.int/edocs/lexdocs/laws/en/ws/ws020en.pdf
2. http://caaa.in/Image/34_Hb_on_IPR.pdf
3. http://www.ipindia.nic.in/patents.htm
4. http://www.ipindia.nic.in/trade-marks.htm
5. https://assets.publishing.service.go v.uk/government/uploads/system/ uploads/ attachment_data/ file/627956/IP-Rights-in-India.pdf
6. https://economictimes.indiatimes.com/small-biz/resources/startup handbook/intellectual-property-rights-registration/ articleshow/ 59126802.cms?from=mdr

ONLINERESOURCES:
1. https://www.coursera.org/learn/introduction-intellectual-property
2. https://www.edx.org/course/intellectual-property-law-and-policy part-1
3. https://www.classcentral.com/tag/intellectual-property
4. https://swayam.gov.in/nd1_noc19_mg58/preview

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand the concepts of Intellectual property rights. (K2)
2. Demonstrate the agreements and treaties of Intellectual property rights(K2)
3. Explore needs and avenues for patents (K2)
4. Explore the necessity of Trademarks and Copy rights (K2)

5. Understand the legal context and developments of Intellectual property rights(K2)
6. Understand the systems and procedures for IPR (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	-	1	1	1	1	1	-	-	1	2	1
CO2	3	1	3	1	2	-	1	1	-	-	-	1	2	1
CO3	1	1	2	2	2	-	1	1	-	-	-	1	1	1
CO4	2	1	1	2	2	-	1	1	-	-	-	1	1	2
CO5	1	1	1	2	2	2	1	1	-	-	-	1	2	2
CO6	1	1	1	2	2	2	1	1	2	2	2	1	2	2

PROFESSIONAL ELECTIVE - IV

20MUPE801 SDG NO. 4,8,9	FUNDAMENTALS OF MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts and techniques of Machine Learning.
- To implement the concepts of Supervised and Unsupervised learning techniques
- To study the various probability based learning techniques
- To understand graphical models of machine learning algorithms

UNIT I   INTRODUCTION   9

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Regression.

UNIT II   LINEAR AND GRAPHICAL MODEL   9

Multi-layer Perceptron –Deriving Back-Propagation– Radial Basis Functions and Splines – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines- Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution - Graphical Models –Bayesian Networks – Markov Random Fields – Hidden Markov Models.

UNIT III   TREE AND PROBABILISTIC MODELS   9

Learning with Trees – Decision Trees – Classification and Regression Trees –Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods –Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

UNIT IV   DIMENSIONALITY REDUCTION   9

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization

UNIT V EVOLUTIONARY MODELS   9

Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms –Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, "Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)", Third Edition, MIT Press,2014

REFERENCES:

1. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
3. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series,2014.
4. Jorge Brasil, "Before Machine Learning Volume 1 - Linear Algebra for A.I: The fundamental mathematics for Data Science and Artificial Inteligence", , Asia- Pacific holdings, Pvt ltd.

WEB RESOURCES:

1. http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid
2. http://www.amazon.com/Machine-Learning-AlgorithmicPerspective Recognition/dp/1420067184
3. http://research.microsoft.com/en-us/um/people/cmbishop/prml/
4. http://www.cs.cmu.edu/~tom/mlbook.html

ONLINE RESOURCES:

1. http://calla.rnet.missouri.edu/cheng_courses/mlbioinfo/heckerman _bn.pdf
2. https://link.springer.com/chapter/10.1007/3-540-26888-X_5

OUTCOMES:

Upon completion of the course, the students should be able to

1. Understand the concept of machine learning fundamentals (K1)

2. Apply the appropriate machine learning strategy for linear and graphical model (K2)
3. Apply the tree and probabilistic approach in learning (K2)
4. Apply the dimensional reductionality techniques (K2)
5. Analyze the evolutionary model in machine learning (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	3	2	0	0	1	1	1	1	0	2	1
CO2	1	2	1	2	2	0	0	1	1	1	1	0	2	2
CO3	1	2	2	2	2	0	0	1	1	1	1	2	2	1
CO4	1	2	2	2	2	0	0	1	1	1	1	2	2	2
CO5	1	2	2	2	2	0	0	1	1	1	1	2	2	1

PROFESSIONAL ELECTIVE - IV

20MUPE802 SDG NO. 4,8,9,11	**DESIGN FOR X**	L	T	P	C
		3	0	0	3

OBJECTIVES:

● To introduce the selection principles of general design, manufacturing development, design products for various engineering applications.
● To learn the design consideration principles of forming in the design of extruded, stamped, and forged products and casting in the design of cast products.
● To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
● To learn design consideration principles of welding in the design of welded products.
● To learn design consideration principles in additive manufacturing

UNIT I   INTRODUCTION   9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances - Assembly limits -Datum features - Tolerance stacks. Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice –Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV COMPONENT DESIGN – CASTING CONSIDERATION 9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.

UNIT V DESIGN FOR ADDITIVE MANUFACTURING 9

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings / numbers.

TOTAL:45 PERIODS

TEXTBOOKS:
1. James G. Bralla, "Design for Manufacturability Handbook", McGraw Hill Professional, 1999.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 2012

REFERENCES:
1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.

3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994
6. Ulrich, K.T, & Eppinger, S. D.: Product Design & Development. McGraw Hill. Robust design, Chapter 13, 5th Edition. 2012.

WEB RESOURCES:
1. 1. https://sixsigma study guide.com/design-for-x-dfx/
2. 2. https://fractory.com/design-for-x-dfx/.
3. 3. https://pmstudycircle.com/design-for-x-dfx/.
4. 4. https://vpitechnology.com/design-for-x/.

ONLINE RESOURCE:
1 onlinecourses.nptel.ac.in/noc23_me/24.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Understand the design principles for manufacturability (K2)
2. Interpret the factors influencing in form design (K2)
3. Apply the component design features of various machine (K3).
4. Construct the design consideration principles of welding in the design of welded products. (K3)
5. Build the design consideration principles of additive manufacturing. (K3)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	-	-	1	2	-	1	1	2	1	1	1
CO2	1	2	3	-	-	1	2	-	1	2	2	2	1	1
CO3	1	2	3	-	-	1	2	-	1	3	2	1	1	1
CO4	1	2	3	-	-	1	2	2	1	2	2	2	1	1
CO5	1	2	3	-	-	1	2	-	1	3	2	2	1	1

PROFESSIONAL ELECTIVE - IV

20MUPE803 SDG NO. 4,7,8,9, 11,12	INDUSTRIAL PROCESS AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate on design of signal conditioning circuits for various applications.
- To Introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses used in automation industries

UNIT I   INTRODUCTION   8

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

UNIT II   AUTOMATION COMPONENTS   9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

UNIT III   COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation

UNIT IV   PLC and SCADA   10

Programmable logic controllers - Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries. SCADA – Architecture – Elements, block diagram of SCADA: Types of SCADA, MTU and RTU functions.

UNIT V   DISTRIBUTED CONTROL SYSTEM   9

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

TOTAL:45PERIODS

TEXT BOOKS:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., 2003.
2. Politeknik Port Dickson, Industrial Automation: An Engineering Approach - 2013

REFERENCES:

1. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
2. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
3. Gary Dunning, Thomson Delmar, "Programmable Logic Controller", CeneageLearning, 3 rd Edition, 2005.
4. Viswanandham N & Narahari Y, Performance Modeling of Automated Manufacturing Systems, PHI,   1st Edition, 2009.

WEB RESOURCES:

1. https://nikarifblog.files.wordpress.com/2017/12/jm608-industriial-automation-textbook.pdf
2. https://industlabs.com/news/industrial-automation
3. https://www.machinemetrics.com/blog/industrial-automation
4. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L01 (SM)(IA&C)%20((EE)NPT EL).pdf

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/108105088
2. https://nptel.ac.in/courses/108105062
3. https://nptel.ac.in/courses/108105063

OUTCOMES:

Upon completion of the course, the students should be able to

1. Illustrate the various requirements for Industrial process automation. (K2)
2. Explain various components required for Automation (K2)

3. Understand the basics and Importance of communication in applied automation Engineering. (K2)
4. Explain to design PLC and SCADA system. (K2)
5. Extend the detailed knowledge on data acquisition system interface and DCS system. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	-	-	3
CO2	3	2	2	1	2	1	-	-	-	-		-	-	2
CO3	3	2	2	2	2	1	-	-	-	-	-	-	-	3
CO4	3	2	2	2	1	1	-	-	-	-	-	-	-	2
CO5	3	3	2	2	2	1	-	-	-	-	-	-	-	2

PROFESSIONAL ELECTIVE - IV

20MUPE804 SDG NO. 4, 6, 9, 14	**MARINE ROBOTICS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the principles of underwater vehicle construction
- To create a kinematic model with respect to global coordinates
- To explain the working of various sensors
- To describe controllability and stability about a point, trajectory
- To discuss the feedback control design for various robots

UNIT I   FUNDAMENTALS OF MOBILE ROBOT   9

Introduction to mobile robots - principle of locomotion - types of mobile robots: ground robot, aerial robot, underwater robot and water-surface robot - principles of underwater vehicle construction

UNIT II   KINEMATICS OF UNDERWATER VEHICLE   9

Equations for moving frame - rigid motion in a plane - representation of a rotated frame - holonomic and non-holonomic systems - kinematic modeling with respect to global coordinates.

UNIT III   SENSORS FOR ROBOT NAVIGATION   9

Types of sensors - magnetic and optical position sensor - gyroscope - accelerometer - magnetic compass inclinometer - tactile and proximity sensor - ultrasound range finder - laser scanner, infrared range finder - visual and motion sensing systems.

UNIT IV   MOTION PATH PLANNING, CONTROL AND STABILITY   9

Path planning algorithms - collision-free path planning - sensor-based obstacle avoidance - motion control methods: kinematic control, dynamic control, controllability and stability about a point and trajectory.

UNIT V   ROBUST FEEDBACK CONTROL DESIGN   9

Based on kinematic model: input uncertain control model - robust control by the Lyapunov Redesign method - Based on dynamic model: robust back stepping: unmatched uncertainty - robust control: matched uncertainty - both matched and unmatched uncertainty.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Sabiha Wadoo, Pushkin Kachroo, Autonomous Underwater Vehicles, 1st Edition, CRC Press, 2011.
2. Yu Junzhi, Visual Perception and Control of Underwater Robots, 1st Edition, CRC Press, 2018.

REFERENCES:
1. Gerald Cook, Feitian Zhang, Mobile Robots: Navigation, Control and Sensing, Surface Robots and AUVs, 2nd Edition, Wiley Publication, 2020.
2. Nikolaus Correll, Introduction to Autonomous Robots, 1st edition, April 23, 2016.
3. R.K.Mittal , I.J.Nagrath, Robotics and control, Tata McGraw-Hill, 1st Edition, 2005.
4. Steven W Moore, Harry Bohn, Vickie Jensen, Underwater Robotics – Science, Design & Fabrication', Marine advanced Technical Education, NSF Pub., 2010.
5. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.

WEB RESOURCES:
1. www.iee.ras.org/marinerobotics
2. www.oceans.mit/edu/research/ocean-engineering
3. https://www.sciencedirect.com/topics/engineering/marine-robotics

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/114105005

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the principle of locomotion and describe different types of mobile robots. (K2)
2. Develop the degree of freedom to maneuverability of various robots. (K3)
3. Summarize the use of various sensors deployed in autonomous robots. (K2)
4. Solve the motion path planning and its control for an autonomous robot. (K3)
5. Explain the robust feedback control methods. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	2	-	-	-	-	1	-	1	2	3
CO2	3	3	1	3	2	-	-	-	-	1	-	1	2	3
CO3	3	2	1	2	2	-	-	-	-	1	-	1	2	3
CO4	3	2	1	3	2	-	-	-	-	-	-	1	2	2
CO5	2	3	1	3	2	-	-	-	-	-	-	1	1	2

PROFESSIONAL ELECTIVE - IV

20MUPE805 SDG NO. 4,7,8,9, 11,12	WIRELESS SENSORS NETWORKS FOR ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To know the basic knowledge about wireless sensor networks
- To impart knowledge in networking using sensors
- To know about the tools used in networking
- To understand the basic in wireless architecture
- To know about the different techniques used in networking

UNIT I   OVERVIEW OF WIRELESS SENSOR NETWORKS   7

Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks.

UNIT II   ARCHITECTURES   10

Single-Node Architecture- Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture-Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT III   NETWORKING SENSORS   10

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts-S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols-Energy-Efficient Routing, Geographic Routing.

UNIT IV   INFRASTRUCTURE ESTABLISHMENT   9

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V   SENSOR NETWORK PLATFORMS AND TOOLS   9

Sensor Node Hardware– Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming

TOTAL:45 PERIODS

TEXT BOOKS:

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2007.
2. Waltenegus Dargie , Christian Poellabauer, "Fundamentals of Wireless Sensor Networks - Theory and Practice", John Wiley & Sons Publications, 2011

REFERENCES:

1. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
2. MounirFrikha, " Ad hoc Networks Routing, Qos and Optimization", Wiley, 2011.
3. Fei Hu, Xiaojun Cao, "Wireless Sensor Networks Principles and Practice", CRC Press, 2010.

WEB RESOURCES:
1. http://pages.di.unipi.it/bonuccelli/sensori.pdf
2. https://www.worldscientific.com/worldscibooks/10.1142/8943#t= aboutBook
3. https://ieeexplore.ieee.org/document/6567456

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/106/105/106105160/
2. https://onlinecourses.swayam2.ac.in/arp19_ap52/preview
3. https://cse.iitkgp.ac.in/~smisra/course/wasn.html
4. https://archive.nptel.ac.in/courses/106/105/106105160/#
5. https://archive.nptel.ac.in/courses/117/104/117104118/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Illustrate the overview of wireless sensor networks and enabling technologies for wireless sensor networks. (K2)
2. Apply the design principles of WSN architectures and operating systems for simulating environment situations. (K3)
3. Apply various concepts for assignment of MAC addresses. (K3)
4. Select the appropriate infrastructure, topology, joint routing and information for wireless sensor networks (K3)
5. Build the sensor network platform and tools state-centric programming. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	2	-	-	-	2	-	2	-	-
CO2	3	-	3	-	-	3	3	-	-	3	-	-	-	3
CO3	2	-	-	-	2	-	-	-	-	2	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	2	-	-	2	-
CO5	-	2	-	-	2	-	-	2	-	2	-	-	2	-

PROFESSIONAL ELECTIVE - IV

20MUPE806 SDG NO. 4, 9	**CLOUD COMPUTING FOR INDUSTRIAL AUTOMATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To learn about cloud computing technology.
- To learn the functioning of cloud computing, storage and cloud services.
- To Implement a prototype of the IoT/cloud system design
- To Understand the existing cloud architectures

UNIT I INTRODUCTION TO CLOUD COMPUTING 9

Introduction to cloud computing, From collaborative to the Cloud – A short history Client – Server Computing, Peer-to-Peer Computing, Distributed Computing, Collaborative Computing, Functioning of Cloud Computing, Cloud Architecture and Storage, Cloud Services, Industrial Applications.

UNIT II CLOUD COMPUTING TECHNOLOGY 10

Introduction-Objectives, Clients – Mobile – Thin – Thick, Security - Data Linkage - Offloading Work - Logging - Forensics - Development – Auditing, Network- Basic Public Internet- The Accelerated Internet- Optimized Internet Overlay- Site-to-Site VPN- Cloud Providers- Cloud Consumers - Pipe Size-Redundancy, Services- Identity- Integration- Mapping- Payments- Search.

UNIT III DATA ANALYTICS 10

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting. Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Real time Analytics Platform (RTAP) Applications.

UNIT IV VIRTUALIZATION 7

Virtualization, load balancing, scalability, deployment, replication, monitoring, SDN, network function virtualization, MapReduce, identity and access management, SLAs.

UNIT V CLOUD SERVICE AND PLATFORMS 9

Commercial clouds (such as Amazon elastic compute cloud, Google Compute engine, Windows Azure), Storage services, database services, application services, content delivery services, analytics services, Open-source private clouds.

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Dan C. Marinescu, "Cloud Computing Theory and Practice" Morgan Kaufmann, 2015.
2. Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, "Distributed and Cloud Computing", Elsevier, 2012.

REFERENCES:
1. Barrie Sosinsky, "Cloud Computing Bible", John Wiley India, 2012.
2. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
3. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.
4. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012.
5. Thomas Erl, Cloud computing: Concepts, technology & Architecture' Pearson, 2014.

WEB RESOURCES:
1. https://nptel.ac.in/courses/106/105/106105167/
2. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

ONLINE RESOURCES:
1. https://nptel.ac.in/courses/106105195
2. https://nptel.ac.in/courses/108105063
1. https://nptel.ac.in/courses/108104096

OUTCOMES:
Upon completion of the course, the students should be able to
1. Define Cloud Computing and memorize the different Cloud service and deployment models. (K2)
2. Describe importance of virtualization along with their technologies. (K2)
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics. (K3)
4. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing. (K2)
5. Apply the concepts of cloud computing in industrial automation. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	2	2	-	-	-	-	-	1	1	1	2
CO2	1	2	1	2	2	-	-	-	-	-	1	1	2	2
CO3	1	2	1	2	2	-	-	-	-	-	-	1	2	2
CO4	1	2	1	2	2	-	-	-	-	-	1	1	1	1
CO5	1	2	1	2	2	-	-	-	-	-	-	1	1	1

PROFESSIONAL ELECTIVE - IV

20MUPE807 SDG NO. 8,9,11,12	**MEDICAL ROBOTICS**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
- To know about the concept of planning in robotics.
- To be made aware of applications or robotics in medical practice.

UNIT I INTRODUCTION 9

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM

UNIT II LOCALIZATION AND TRACKING 9

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based -Electromagnetic - Impedance-based - In-bore MRI Tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III DESIGN OF MEDICAL ROBOTS & SURGICAL ROBOTICS 9

Characterization of gestures to the design of robots - Design methodologies - Technological choices- Security. Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopaedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery - case studies

UNIT IV   AI AND ROBOTICS   **9**

Artificial intelligence - Knowledge representation - Search techniques - Adaptive approaches to robot control- Reinforcement learning for control- Model Based learning approaches to control Learning Maps Evolutionary approaches of AI and robotics.

UNIT V   APPLICATIONS   **9**

Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery –Cardiac and abdominal procedures with tele operated robots, Orthopaedic surgery with cooperative robots.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India,2003.
2. Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.

REFERENCES:

1. Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016 Niku, Introduction to Robotics, Pearson Education, 2011.
2. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.
3. Daniel R. Faust, Medical Robots, The Rosen Publishing Group, Inc, 15 Jul 2016.
4. Eduard Fosch-Villaronga, Hadassah Drukarch, AI for Healthcare Robotics, Published by CRC Press, 1st Edition, 2022.
5. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.

WEB RESOURCES:

1. https://www.intechopen.com/books/3583
2. https://web.stanford.edu/class/me328/
3. https://www.classcentral.com/course/medtech-ai-and-medical-robots-14408
4. https://www.gcu.edu/blog/engineering-technology/robotics-healthcare-look-exciting-medical-science-advancements

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc24_me18/preview
2. https://web.stanford.edu/class/me328/

3. https://www.classcentral.com/course/youtube-robotics-by-prof-d-k-pratihar-47367

OUTCOMES:
Upon completion of the course, the students should be able to
1. Identify various medical robots and their potential applications. (K2)
2. Recognize the position tracking and hybrid systems. (K2)
3. Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics. (K2)
4. Plan the robotic control using AI (K3)
5. Elaborate the application of robotics in medical practice. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	1	1	2
CO2	2	2	1	1	-	-	-	-	-	-	-	1	1	2
CO3	2	2	1	1	-	-	-	-	-	-	-	1	1	2
CO4	2	2	1	1	-	-	-	-	-	-	-	1	1	2
CO5	2	2	1	1	-	-	-	-	-	-	-	1	1	2

PROFESSIONAL ELECTIVE - IV

20MUPE808 SDG NO. 4,7,8,9, 11,12	**SUSTAINABLE MANUFACTURING**	L	T	P	C
		3	0	0	3

OBJECTIVES:
- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I   ECONOMIC SUSTAINABILITY   9
Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative

products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability -Assessments of economic sustainability

UNIT II   SOCIAL AND ENVIRONMENTAL SUSTAINABILITY   9

Social sustainability – Introduction-Work management -Human rights - Societal commitment -Customers - Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT III   SUSTAINABILITY PRACTICES   9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing - Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model.

UNIT IV   MANUFACTURING STRATEGY FOR SUSTAINABILITY   9

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT V   TRENDS IN SUSTAINABLE OPERATIONS   9

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

TOTAL:45PERIODS

TEXT BOOKS:

1. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises Concepts, Analyses and   Assessments for Industry 4.0", Springer International Publishing., United States, 2016.

2. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010.

REFERENCES:
1. Jovane F, Ęmper, W.E. and Williams, D.J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer, 2009.
2. Kutz M., "Environmentally Conscious Mechanical Design", John Wiley & Sons., United States, 2007.
3. Seliger G., "Sustainable Manufacturing: Shaping Global Value Creation", Springer, United States, 2012.
4. Rainer Stark, Gunther Seliger, "Sustainable Manufacturing" Springer open, 2017.
5. Kapil Gupta & Konstantions Salonitis, "Sustainable Manufacturing" Elseiver, 2021.

WEB RESOURCES:
1. https://www.sap.com/india/products/scm/what-is-sustainable-manufacturing.html
2. https://sustainabilityguide.eu/ecodesign/manufacturing/
3. https://precog.co/glossary/sustainable-manufacturing/

ONLINE RESOURCES:
1. https://archive.nptel.ac.in/courses/112/104/112104225/
2. https://archive.nptel.ac.in/courses/110/104/110104119/

OUTCOMES:
Upon completion of the course, the students should be able to
1. Discuss the importance of economic sustainability. (K1)
2. Describe the importance of sustainable practices. (K2)
3. Identify drivers and barriers for the given conditions. (K2)
4. Formulate strategy in sustainable manufacturing. (K2)
5. Plan for sustainable operation of industry with environmental, cost consciousness. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2
CO2	3	-	-	-	-	-	2	-	-	1	1	2	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	2	2
CO4	3	-	3	-	-	-	2	-	-	1	1	2	2	2
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2

PROFESSIONAL ELECTIVE - IV

20MUPE809 SDG NO. 4,7,8,9, 11,12	**COMPUTER AIDED INSPECTION**	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the various optical measuring instruments used in industries.
- To understand the various errors involved in precision manufacturing.
- To evaluate the advanced concepts relevant to operational characteristics of CMMS.
- To analyze the importance of surface metrology and the different methods of measuring surface finish.
- To summarize the concepts of nanometrology.

UNIT I   OPTICAL DIMENSIONAL METROLOGY   9

Basic to advanced metrology evolution, Optical dimensional metrology of precision features – Machine vision, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus variation based Optical Metrology- Fringe projection method.

UNIT II   METROLOGY OF MACHINE TOOLS   9

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

UNIT III   COORDINATE METROLOGY   9

Coordinate measuring system – algorithms and filters, Performance evaluation, Temperature fundamentals, Environmental control, Error compensation of CMMs, Calibration and Measurement uncertainty for coordinate measuring systems,

UNIT IV   ADVANCES IN SURFACE METROLOGY   9

Surface Geometry and Its Importance in Function, Surfaces and Manufacture, Filtering – Gaussian, 2RC, Advanced Filters, Surface finish parameters – Amplitude, Spacing, Hybrid, Shape, Autocorrelation, Power Spectral Density, Bearing Area.3D areal and parametric measurement, Need for 3D surface topography measurement, Stylus instruments, Optical Instruments – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

UNIT V   NANOMETROLOGY   9

Precision to Nanometrology, Optical Micro-Metrology of Small Objects - White-Light Interference 3D Microscopes, Focus-Based Optical Metrology-Fringe projection method, Measurement of Typical Nano features, Measuring Length to Nanoscale with Interferometers and Other Devices, Nano Geometry in Macro Situations.

TOTAL:45PERIODS

TEXT BOOKS:

1. Jain R.K., "Engineering Metrology", Khanna Publishers, 2014.
2. David J. Whitehouse, "Handbook of Surface and Nano metrology", Second Edition, CRC Press, 2010.

REFERENCES:

1. Beckwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education, 2014.
2. Dotson Connie, "DimensionalMetrology", CengageLearning, Firstedition, 2012.
3. Ammar Grous,J"Applied Metrology for Manufacturing Engineering",Wiley-ISTE,2011.
4. Toru Yoshizawa, "Handbook of Optical Metrology: Principles and Applications", CRC Press, 2009.
5. Robert J. Hocken, Paulo H. "Coordinate Measuring Machines and Systems", CRC Press, 2nd edition, 2016.

WEB RESOURCES:

1. https://archive.nptel.ac.in/courses/112/107/112107259/
2. https://archive.nptel.ac.in/courses/112/104/112104250/
3. https://archive.nptel.ac.in/courses/112/106/112106179/
4. https://archive.nptel.ac.in/courses/112/106/112106138/
5. https://archive.nptel.ac.in/courses/112/106/112106139/

ONLINE RESOURCES:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2,_for_Unit_2B.pdf
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7471758/
3. https://www.slideshare.net/MAYMODI/introduction-to-mechanical-measurement-and-metrology

OUTCOMES:

Upon completion of the course, the students should be able to

1. Describe the working principle and applications of optical measuring instruments. (K2)
2. Explain the errors involved in precision machine tools and calculate the error budgets for a given situation. (K3)
3. Illustrate the performance of CMMs for measurement applications. (K3)
4. Apply advanced surface finish measurement techniques in manufacturing process analysis. (K2)
5. Outline the principles and methods of Nano metrology. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	-	-	-	-	-	1	1
CO2	2	2	1	3	-	-	-	-	-	-	-	-	3	2
CO3	-	-	1	3	-	-	-	-	-	-	-	-	3	3
CO4	2	2	1	2	-	-	-	-	-	-	-	-	2	-
CO5	3	-	1	1	-	-	-	-	-	-	-	-	2	2

PROFESSIONAL ELECTIVE - IV

20MUPE810 SDG NO. 4,7,8,9, 11,12	GREEN MANUFACTURING DESIGN AND PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concept of environmental design and industrial ecology.
- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.

- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To introduce the concept of green co-rating and its need

UNIT I   DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT   9

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT II   AIR POLLUTION SAMPLING AND MEASUREMENT   9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equationthe Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dixide, carbon monoxide, oxidants and ozone.

UNIT III   NOISE POLLUTION AND CONTROL   9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noiseOccupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT IV   WATER DEMAND AND WATER QUALITY   9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT V   GREEN CO-RATING   9

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green CoRating

TOTAL:45PERIODS

TEXT BOOKS:
1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2014
2. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Fourth Edition, 2012

REFERENCES:
1. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
2. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
3. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
4. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

WEB RESOURCES:
1. https;//www.cii.in/webcms.
2. https://study.com/academy/lesson/green-design-sourcing-manufacturing.
3. https://Engineering.purdue.edu/LSM/research/area3.
4. https://Books.google.co.on
5. https://www.teslamechanicaldesigns.com/blog/concept-of-green-design-and-manufacturing/.
6. https://www.mindluster.com/certificate/9722/green-manufacturing.

ONLINE RESOURCES:
1. onlinecourses.nptel.ac.in/noc21_mg85/preview.

OUTCOMES:
Upon completion of the course, the students should be able to
1. Explain the environmental design and selection of eco-friendly materials. (K2)
2. Explain approaches used in manufacturing to reduce or eliminate air pollution. (K2)
3. Identify various Manufacturing procedures to reduce or eliminate noise pollution. (K2)
4. Approaches used in manufacturing to reduce or eliminate water pollution. (K2)
5. Evaluate green co-rating and its advantages. (K2)

CO - PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	1	3	-	-	-	3	-	-	-	-	1	1	2
CO2	-	1	3	-	-	-	3	-	-	-	-	1	1	2
CO3	-	1	3	-	-	-	3	-	-	-	-	1	1	2
CO4	-	1	3	-	-	-	3	-	-	-	-	1	1	2
CO5	-	-	3	-	-	-	3	-	-	-	-	1	1	2

Imagine the Future and
Make it happen!

M.F. LN. LEO MUTHU
Founder Chairman - Sairam Institutions

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

Sairam SDG ACTION PROGRAM

Together let's build a better world where there is NO POVERTY and ZERO HUNGER.
We have GOOD HEALTH AND WELL BEING QUALITY EDUCATION and full GENDER EQUALITY everywhere.
There is CLEAN WATER AND SANITATION for everyone. AFFORDABLE AND CLEAN ENERGY
which will help to create DECENT WORK AND ECONOMIC GROWTH. Our prosperity shall be fuelled
by investments in INDUSTRY, INNOVATION AND INFRASTRUCTURE that will help us to
REDUCE INEQUALITIES by all means. We will live in SUSTAINABLE CITIES AND COMMUNITIES.
RESPONSIBLE CONSUMPTION AND PRODUCTION will help in healing our planet.
CLIMATE ACTION will reduce global warming and we will have abundant,
flourishing LIFE BELOW WATER, rich and diverse LIFE ON LAND.
We will enjoy PEACE AND JUSTICE through STRONG INSTITUTIONS
and will build long term PARTNERSHIPS FOR THE GOALS.

For the goals to be reached,
everyone needs to do their part:
governments, the private sector,
civil society and **People like you.**

Together we can...

Sai Prakash Leo Muthu
Chairman & CEO – Sairam Institutions