CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2022-2023 onwards)

B.E. ROBOTICS AND AUTOMATION - FIRST SEMESTER

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19HST101	Communicative Techno English - I	HS	3	0	0	3	40	60	100
19MAT101	Engineering Mathematics - I	BS	3	1	0	4	40	60	100
19CYE101	Engineering Chemistry	BS	3	0	2	4	50	50	100
19PHE101	Engineering Physics	BS	3	0	2	4	50	50	100
19GET101	Engineering Graphics	ES	3	0	0	3	40	60	100
19GEE101	Computer Fundamentals andPython Programming	ES	3	0	2	4	50	50	100
19EEC101	Life Skills for Engineers	EEC	0	0	2	0	100	-	100
19MDC101	Induction Program (2 Weeks)	MC	-	-	-	-	-	-	-
TOTAL CREDITS IN SEMESTER - I			22						

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B.E. ROBOTICS AND AUTOMATION - SECOND SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19HST201	Communicative Techno English - II	HS	3	0	0	3	40	60	100
19CYT201	Environmental Science and Engineering	HS	3	0	0	3	40	60	100
19MAT201	Engineering Mathematics - II	BS	3	1	0	4	40	60	100
19PHT201	Physics of Materials	BS	3	0	0	3	40	60	100
19EEE201	Circuit Theory	PC	3	0	2	4	50	50	100
19MET201	Engineering Mechanics	PC	3	1	0	4	40	60	100
19EEC201	Technical Skill (AutoCAD)	EEC	0	0	2	0	100	-	100
19MDC201	NSS / YRC /RRC	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - II			21						

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B.E. ROBOTICS AND AUTOMATION - THIRD SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19MAT301	Transforms and Partial Differential Equations	BS	3	1	0	4	40	60	100
19EEE302	Analog and Digital Electronics	PC	3	0	2	4	50	50	100
19EEE303	Electric Machines and Power System	PC	3	0	2	4	50	50	100
19RME301	Strength of Materials	PC	3	0	2	4	50	50	100
19RME302	Manufacturing Technology	PC	3	0	2	4	50	50	100
19EEC302	Entrepreneurship Development Activity	EEC	0	0	2	0	100	-	100
19MDC301	Leadership Enhancement Programme	MC	1	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - III			20						

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B.E. ROBOTICS AND AUTOMATION - FOURTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19MAT405	Numerical Methods and VirtualSimulation	BS	3	1	0	4	40	60	100
19RMT401	Kinematics and Dynamics ofMachines	PC	3	1	0	4	40	60	100
19RMT402	Sensors and Instrumentation	PC	3	0	0	3	40	60	100
19ECE402	Linear Integrated Circuits	PC	3	0	2	4	50	50	100
19EEE402	Control Systems Engineering	PC	3	0	2	4	50	50	100
19ADE403	Data Structures using Python	PC	3	0	2	4	50	50	100
19EEC301	Communication Skills	EEC	0	0	2	0	100	-	100
19MDC401	Value Added Course - I	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - IV			23						

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B.E. ROBOTICS AND AUTOMATION - FIFTH SEMESTER

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19RMT501	Design of Machine Elements andTransmission Systems	PC	3	1	0	4	40	60	100
19RMT502	Machine Vision Systems	PC	3	1	0	4	40	60	100
19RME501	CNC Machine	PC	3	0	2	4	50	50	100
19RME502	Principles of Robotics	PC	3	0	2	4	50	50	100
19RME503	Hydraulics and Pneumatics	PC	3	0	2	4	50	50	100
19ECE503	Microprocessor and Microcontroller	PC	3	0	2	4	50	50	100
19EEC501	Quantitative Aptitude Learning	EEC	0	2	0	0	100	-	100
19MDC501	Value Added Course - II	MC	-	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - V			24						

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B.E. ROBOTICS AND AUTOMATION - SIXTH SEMESTER

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19RMT601	Industrial Robotics	PC	3	0	0	3	40	60	100
19RME601	Automation System Design	PC	3	0	2	4	50	50	100
19RME602	Industrial Automation using PLC	PC	3	0	2	4	50	50	100
19RME603	Power Electronics and Drives	PC	3	0	2	4	50	50	100
	Professional Elective I	PE	3	0	0	3	40	60	100
	Open Elective I	OE	3	0	0	3	40	60	100
19RMJ601	Mini Project	EEC	0	0	2	1	100	-	100
19MDC601	Constitution of India	MC	3	-	-	-	100	-	100
TOTAL CREDITS IN SEMESTER - VI			22						

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BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
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ESE : End Semester Examination
TOT : Total

B.E. ROBOTICS AND AUTOMATION - SEVENTH SEMESTER

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19RMT701	AI Expert System	PC	3	1	0	4	40	60	100
	Professional Elective II	PE	3	0	0	3	40	60	100
	Professional Elective III	PE	3	0	0	3	40	60	100
	Open Elective -II	OE	3	0	0	3	40	60	100
19RMJ701	Industrial Training	EEC	0	0	2	2	100	-	100
TOTAL CREDITS IN SEMESTER - VII			15						

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PE : Professional Elective
OE : Open Elective
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B.E. ROBOTICS AND AUTOMATION - EIGHTH SEMESTER

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
	Professional Elective – IV	PE	3	0	0	3	40	60	100
	Professional Elective - V	PE	3	0	0	3	40	60	100
19RMJ801	Project Work	EEC	0	0	20	12	40	60	100
TOTAL CREDITS IN SEMESTER - VIII			18						

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BS : Basic Sciences
ES : Engineering Sciences
PC : Professional Core
PE : Professional Elective
OE : Open Elective
EEC : Employability Enhancement Courses
MC : Mandatory Courses
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LIST OF PROFESSIONAL CORE (PC) COURSES

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19EEE201	Circuit Theory	PC	3	0	2	4	50	50	100
19MET201	Engineering Mechanics	PC	3	1	0	4	40	60	100
19EEE302	Analog and Digital Electronics	PC	3	0	2	4	50	50	100
19EEE303	Electric Machines and Power System	PC	3	0	2	4	50	50	100
19RME301	Strength of Materials	PC	3	0	2	4	50	50	100
19RME302	Manufacturing Technology	PC	3	0	2	4	50	50	100
19RMT401	Kinematics and Dynamics of Machines	PC	3	1	0	4	40	60	100
19RMT402	Sensors and Instrumentation	PC	3	0	0	3	40	60	100
19ECE402	Linear Integrated Circuits	PC	3	0	2	4	50	50	100
19EEE402	Control Systems Engineering	PC	3	0	2	4	50	50	100
19ADE403	Data Structures using Python	PC	3	0	2	4	50	50	100
19RMT501	Design of Machine Elements and Transmission Systems	PC	3	1	0	4	40	60	100
19RMT502	Machine Vision Systems	PC	3	1	0	4	40	60	100
19RME501	CNC Machine	PC	3	0	2	4	50	50	100
19RME502	Principles of Robotics	PC	3	0	2	4	50	50	100
19RME503	Hydraulics and Pneumatics	PC	3	0	2	4	50	50	100
19ECE503	Microprocessor and Microcontroller	PC	3	0	2	4	50	50	100
19RMT601	Industrial Robotics	PC	3	0	0	3	40	60	100
19RME601	Automation System Design	PC	3	0	2	4	50	50	100
19RME602	Industrial Automation using PLC	PC	3	0	2	4	50	50	100
19RME603	Power Electronics and Drives	PC	3	0	2	4	50	50	100
19RMT701	AI Expert System	PC	3	1	0	4	40	60	100

LIST OF PROFESSIONAL ELECTIVE (PE) COURSES

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – I									
19RMPX01	Automotive Electronics	PE	3	0	0	3	40	60	100
19RMPX02	Robotic Operating System	PE	3	0	0	3	40	60	100
19RMPX03	Composite and Smart Materials	PE	3	0	0	3	40	60	100
19RMPX04	Additive Manufacturing	PE	3	0	0	3	40	60	100
19RMPX05	Metrology and Measurements	PE	3	0	0	3	40	60	100

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – II									
19RMPX06	Lean Manufacturing and Six Sigma	PE	3	0	0	3	40	60	100
19RMPX07	Industrial Design and Applied Ergonomics	PE	3	0	0	3	40	60	100
19RMPX08	Operations Research	PE	3	0	0	3	40	60	100
19RMPX09	Farm Automation	PE	3	0	0	3	40	60	100
19RMPX10	Process Planning and Cost Estimation	PE	3	0	0	3	40	60	100

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – III									
19RMPX11	Field and Service Robotics	PE	3	0	0	3	40	60	100
19RMPX12	Autonomous Vehicle	PE	3	0	0	3	40	60	100
19RMPX13	Virtual Instrumentation	PE	3	0	0	3	40	60	100
19RMPX14	Production Planning and Control	PE	3	0	0	3	40	60	100
19RMPX15	Advanced Control System	PE	3	0	0	3	40	60	100

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – IV									
19RMPX16	Non Destructive Test	PE	3	0	0	3	40	60	100
19RMPX17	Maintenance and Safety Engineering	PE	3	0	0	3	40	60	100
19RMPX18	Optimization Techniques	PE	3	0	0	3	40	60	100
19RMPX19	Internet of Things	PE	3	0	0	3	40	60	100
19RMPX20	Unconventional Machining Process	PE	3	0	0	3	40	60	100

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Professional Elective – V									
19RMPX21	Embedded System Design	PE	3	0	0	3	40	60	100
19RMPX22	Wireless Sensors Networks for Robotics	PE	3	0	0	3	40	60	100
19RMPX23	Computer Integrated Manufacturing Systems	PE	3	0	0	3	40	60	10
19RMPX24	Supply Chain Management	PE	3	0	0	3	40	60	100
19RMPX25	Micro Electro Mechanical Systems	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVE (OE) COURSES FOR OTHER BRANCHES

Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
OPEN ELECTIVE - I									
19RMOX01	Air Pollution and Control Engineering	OE	3	0	0	3	40	60	100
19RMOX02	Fiber Reinforced Plastics	OE	3	0	0	3	40	60	100
19RMOX03	Industrial Safety Engineering	OE	3	0	0	3	40	60	100
19RMOX04	Robotics Application for Disaster Management	OE	3	0	0	3	40	60	100
19RMOX05	Professional Ethics In Engineering	OE	3	0	0	3	40	60	100
Course Code	**Name of the Subject**	**Category**	**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CIA**	**ESE**	**TOT**
OPEN ELECTIVE - II									
19RMOX06	Entrepreneurship Development	OE	3	0	0	3	40	60	100
19RMOX07	Fundamentals of Robotics	OE	3	0	0	3	40	60	100
19RMOX08	Sensor and Transducers	OE	3	0	0	3	40	60	100
19RMOX09	Intellectual Property Rights	OE	3	0	0	3	40	60	100
19RMOX10	Total Quality Management	OE	3	0	0	3	40	60	100

CURRICULUM AND SYLLABI FOR NCC AIRFORCE

(For the NCC Cadets of B.E. Degree Programmes)

LIST OF GENERAL ELECTIVE (GE) COURSES

Course Code	Name of the Subject	Category	Hours/ Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19NCCL01	NCC AIRFORCE LEVEL-1	GE	2	0	2	3	40	60	100
19NCCL02	NCC AIRFORCE LEVEL - 2	GE	2	0	2	3	40	60	100
TOTAL CREDITS			6						

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2022-2023 onwards)

SEMESTER I

19HST101 **COMMUNICATIVE TECHNO ENGLISH – I** **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 0 0 3**

OBJECTIVES

To enable students to:

- Understand the basics of the English Language in a graded manner.
- Enrich grammar usage for the development of all the four language skills (LSRW).
- Improve writing skills to express thoughts freely through Informal Letter, e-mail writing
- Develop speaking skills through self introduction and delivering speeches.
- Enhance the Reading Skills

UNIT I VOCABULARY **8**

Synonyms and Antonyms- Single Word Substitutes - Use of Abbreviations and Acronyms- Homonyms and Homophones- Business Vocabulary - Commonly Confused Words- Collocation - British and American Vocabulary- Word formation.

Activity: Grammar worksheets on the given topics.

UNIT II GRAMMAR **10**

Parts of speech - Be, Have and Do verbs - Punctuation - Tenses - Numerical Adjectives - modal verbs - Single line Definition- Direct and Indirect Speech- Gerunds and Infinitives - Same Word Used as Different Parts of Speech.

Activity: Grammar worksheets on the given topics.

UNIT III INFORMAL WRITING **9**

Letter Writing - Informal Letters – e-mail Writing - Informal Dialogues – Essay Writing- Informal Essays- Movie Reviews -Writing Instructions.

Activity: Giving topic and ask the students to write informal letters, e-mail.

UNIT IV LANGUAGE ENHANCEMENT THROUGH SPEAKING **9**

Self Introduction- (exchanging personal information) personal information, hobbies, strengths and weaknesses, likes and dislikes, special features of home town. Narrating Personal Experiences and Incidents-Two minute talk- expressing attitudes and opinions in Debate discussion.

Activity: Ask the students to speak about the above given topics.

UNIT V READING SKILLS **9**

Reading Comprehension – reading techniques, pre-reading, post-reading, comprehension questions (multiple choice questions or short questions)- Short comprehension passages, practice skimming-scanning and predicting - Reading the passage and taking (Note making) Notes - Scan and understand main contents of the passage.

Activity: Giving topic and ask the students to find out answers for given passage

TOTAL: 45 PERIODS

OUTCOMES

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

- Use a wide range of vocabulary in oral and written communication
- Frame grammatically correct sentences.
- Write informal letters and other communications.
- Give short informal presentations and participate in classroom discussions
- Learn to acquire usage of English.

TEXT BOOKS

1. Board of Editors. Using English A Course book for Under graduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad: 2015.
2. Richards, C. Jack. Interchange Students" Book-2 New Delhi: CUP, 2015.

REFERENCES

1. Department of English, Anna University, "Mindscapes: English for Technologistsand Engineers", 1st Edition, Orient Black Swan, Chennai. 2012.
2. Krishna Mohan, Meera Banerji, "Developing Communication Skills", MacMillan Publishers, Paperback 2019.

E-RESOURCES

1. http://www.usingenglish.com
2. https://www.khanacademy.org/humanities/grammar

19MAT101 **ENGINEERING MATHEMATICS - I** **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DSMEE, IT & RM) **3 1 0 4**

OBJECTIVES

The main objective of this course is to:

- Develop the use of matrix algebra techniques that are needed by engineers for practical applications.
- Familiarize the students with differential calculus.
- Describe the student with functions of several variables.
- Explore the students understand various techniques of integration.
- Acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT I MATRIC **9+3**

Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of aquadratic form to canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS **9+3**

Representation of function – Limit of a function – Continuity – Derivatives – Differentiation rule - Maximum and Minimum values - absolute Maximum and Minimum - local Maximum and Minimum.

UNIT III FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial differentiation - Homogeneous functions and Euler's theorem - Total derivative - Jacobians - Taylor's series for functions of two variables - Maxima and minima of functions of two variables - Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS **9+3**

Definite and Indefinite integral –Substitution rule – Integration by parts - Trigoniometric substitutions - Integration of rational function by partial fraction - Improper integrals - Bernoulli's formula.

UNIT V MULTIPLE INTEGRALS **9+3**

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.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Classify the matrix algebra methods for solving practical problems.
- Discover differential calculus tools in solving various application problems.
- Develop differential calculus ideas on several variable functions.
- Compare different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS

1. Grewal B.S., - "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition,2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7 th Edition, New Delhi,2015.

REFERENCES

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media(An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ‖", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/111105121
2. https://nptel.ac.in/courses/111107112

19CYE101 **ENGINEERING CHEMISTRY** **L T P C**

(Lab Embedded Theory Course) **3 0 2 4**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM)

OBJECTIVES

The main objective of this course is to:

- Classify the impurities of water and know the treatment and the conditioning methods for domestic and industrial uses.
- Outline about fundamentals, properties and moulding process of polymers.
- Discuss the types of corrosion and control measures and working of batteries.
- Explain about the phase rule and its applications to engineering field and also gain knowledge about the properties of alloys.
- Summarize the basics of Nanochemistry, synthesis, properties and applications of Nano materials .
- Acquire practical skills in the determination of water quality parameters, molecular weight of polymer rate corrosion through volumetric and instrumental analysis.

UNIT I WATER TECHNOLOGY **9**

Introduction - Characteristics – hardness – estimation of hardness by EDTA method – alkalinity andits estimation - Boiler feed water – requirements –Boilers troubles (Scale and Sludge) – Internal conditioning (colloidal – phosphate – calgon and carbonate conditioning methods) – External conditioning – zeolite process, demineralization process – Desalination of brackish water by reverse osmosis - Municipality water treatment - Break point chlorination.

UNIT II POLYMER CHEMISTRY **9**

Introduction - Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types of polymerization: Addition condensation and copolymerization, Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Preparation, properties and uses of PVC, Nylon 6,6, Polyethylene - Rubbers – types- vulcanization of rubber – Plastics – Moulding constituents of plastics – Moulding of plastics - compression, injection and blow moulding- Biodegradable polymers-Conducting polymers.

UNIT III CORROSION AND BATTERY TECHNOLOGY **9**

Corrosion – Types – Chemical Corrosion – Electrochemical Corrosion (Galvanic and Differential aeration) Factors influencing corrosion – Material selection and design aspects-control methods of corrosion – Sacrificial anodic and impressed current cathodic protection - Protective coatings – paints – constituents and their functions - electroplating of Copper - electroless plating of

Nickel. Batteries: Definition, Types - example, Lead acid battery, Lithium ion battery - H_2 - O_2 fuel cell-solar cell.

UNIT IV PHASE RULE AND ALLOYS **9**

Phase rule - explanation of terms involved – one component system – water system – condensed phase rule construction of phase diagram by thermal analysis – simple eutectic systems (lead – silver system only). Alloys: Introduction- definition- properties of alloys- significance of alloying, functions and effect of alloying elements - ferrous alloys – nichrome and stainless steel – heat treatment of steel, non-ferrous alloys – brass and bronze.

UNIT V CHEMISTRY OF NANO MATERIALS **9**

Nano chemistry – Basics (Surface area to volume ratio - Quantum confinement – 0D, 1D, 2D & 3D) - Distinction between Molecules, Nanoparticles and Bulk Materials - Characterisation of nano materials using XRD and SEM. Synthesis of nano materials: Top down approach - Ball milling - Bottom up approach - Sol-gel method, Chemical vapour deposition - Properties of nanomaterials and Applications of Nanomaterials (Nano products of today).

LIST OF EXPERIMENTS

(Any Eight Experiments to be conducted)

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
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. Estimation of sodium and potassium present in water using flame photometer.
7. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
8. Conductometric titration of strong acid vs strong base.
9. Corrosion experiment-weight loss method.
10. Estimation of copper content in the brass by Iodometry.
11. Determination of pH of soil.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Develop innovative methods to produce soft water for industrial and domestic use at cheaper cost.
- Understand the chemical structure of polymers and its effect on their variousproperties when used as engineering materials and also discuss the applications of polymers.
- Illustrate the principles involved in corrosion reactions and techniques used for preventing it and acquire the ability to design and develop materials for energy storage systems.
- Acquire knowledge of phase, equilibrium, component, degree of freedom and phase rule concepts, basics of alloys and its applications.
- Explain the basics of nanochemistry, synthesis, characterization, properties of nanomaterials and its applications.
- Apply the practical knowledge for determining the water quality parameters and demonstrate the instrumental analysis.

TEXT BOOKS

1. Jain P.C and Monika Jain, "Engineering Chemistry", Dhanpet Rai Publishing Company(P)Ltd., New Delhi, 2013.
2. Viswanathan B, "Nanomaterials" Alpha Science International Ltd, 2009.

REFERENCES

1. S. S. Dara and S. S. Umare, " A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/118104008
2. https://nptel.ac.in/courses/118102003

19PHE101 **ENGINEERING PHYSICS** **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Recognize the structure of crystalline materials using crystallographic knowledge.
- Apply the knowledge of materials elasticity, stress, and strain for industrial applications.
- Generalize the fundamentals of lasers and optical fibres, as well as their applications.
- Investigate the complex physical phenomenon using the fundamental principles of quantum mechanics and Schrödinger's wave equation.
- Design the structures with acoustics, ultrasonic production for structural applications.
- Judge the Engineering Physics that can be applied to optics, thermal physics, matter characteristics and to determine fluid properties.

UNIT I STRUCTURE OF SOLIDS **9**

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d -Spacing in Cubic lattice -Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Crystal Growth Techniques -Solution, melt (Bridgman and Czochralski) and Vapour growth techniques(qualitative).

UNIT II ELASTICITY **9**

Elasticity – Stress-Strain diagram and its uses - Factors affecting elastic modulus and tensile strength – Torsional stress and deformations – Twisting couple - Torsion pendulum: theory and experiment - Bending of beams :Bending moment – Cantilever: Theory and Experiment – Uniform andNon-uniform bending: Theory and experiment - I- Shaped girders.

UNIT III PHOTONICS **9**

Introduction to interaction of radiation with matter- Spontaneous and Stimulated emission-PopulationInversion - Derivation of Einstein's A and B coefficients – Principle and working of Laser - Nd:YAG laser - Direct bandgap and indirect band gap semiconductors - Semiconductor diode Laser-Principle and propagation light in optical fibres- Derivation of Numerical aperture and Acceptance angle - Fibre optic communication system.

UNIT IV QUANTUM PHYSICS **9**

Black body radiation – Planck"s theory (derivation) – Compton Effect: theory and experimental verification — Wave particle duality– Electron diffraction — Concept of wave function and

its Physical significance – Schrödinger"s wave equation: Time independent and time dependent equations – Particle in a one- dimensional rigid box- Quantum Tunnelling – Tunnelling Electron Microscope.

UNIT V ACOUSTICS AND ULTRASONICS 9

Classification of sound- decibel- Weber-Fechner law – Sabine"s formula - Derivation using growth and decay method – Absorption Coefficient and its determination – Factors affecting acoustics of buildings and their remedies Introduction- Classification of Sound waves - Production of Ultrasonic's by magnetostriction and piezoelectric methods - Acoustic grating – Cavitations - Applications of Ultrasonic's

LABORATORY PART

LIST OF EXPERIMENTS

(Eight experiments are to be conducted in Lab and Two experiments are to be conducted virtually)

1. Laser: Determination of wavelength of laser and particle Size.
2. Fibre Optics: Determination of Numerical Aperture and Acceptance angle.
3. Determination of wavelength of mercury spectrum- Spectrometer.
4. Determination of Young's modulus – Non- Uniform bending.
5. Determination of Young's modulus - Uniform bending.
6. Torsional Pendulum: Determination of moment of inertia and rigidity modulus.
7. Determination of velocity of ultrasonic in liquid.
8. Determination of Viscosity of a liquid –Poiseulle's Method
9. Photoelectric Effect.(Virtual)
10. Determination of band gap of semiconductor.(Virtual)

TOTAL: 45 + 15 =60 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Familiarize the structure of crystalline solids by applying knowledge of crystallography.
- Analyze theories of failure and yield criteria as an element of properties of matter.
- Learn the basics of lasers and optical fibers and their use in some applications
- Apply the basic principles of quantum mechanics and Schrödinger's wave equation to study the complex physical phenomenon Comprise the fundamentals of Acoustics, production and applications of ultrasonic.
- Compose principles of elasticity, optics and acoustic properties in engineering applications through The Experiments.

TEXT BOOKS

1. Avadhanulu M.N & Kshirsagar P.G "Text Book of Engineering Physics". S.Chand, 2006
2. P.Mani, "Engineering Physics Practicals", Dhanam Publications, 2019

REFERENCES

1. Raghavan V, Materials Science and Engineering: A First Course, PHI Publications, 2015
2. Rajendran V."Engineering Physics". Tata McGraw Hill Publications, 2012

E-RESOURCES

1. https://www.classcentral.com/course/youtube-basic-courses-engineering-physics
2. https://www.courses.com/physics
3. https://vlab.amrita.edu/index.php?sub=1&brch=195&sim=840&cnt=1
4. https://bop-iitk.vlabs.ac.in/exp/energy-band-gap

19GET101 **ENGINEERING GRAPHICS** **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 0 0 3**

OBJECTIVES

The main objective of this course is to:

- Understand the principles in graphic skill to communicate the concepts, ideas and design of engineering components.
- Learn projections of points, lines, planes viewed in different positions.
- Learn the projection of solids viewed in different positions.
- Gain the knowledge about the section of solids and development of surfaces of the given solids.
- Expose the international standards of technical drawing.

UNIT I GENERAL PRINCIPLES OF ORTHOGRAPHIC PROJECTION **9**

Graphics significance in engineering applications - study of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets – principle of Letter writing and dimensioning. Projections of points, lines and planes. Principles of orthographic projection - First angle projection only - Layout of views - Projection of points located in all quadrant - Projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT II PROJECTION OF SOLIDS **9**

Projections of solids like prisms, pyramids, cylinder and cone when the axis is inclined to onereference plane by change of position method.

UNIT III SECTION OF SIMPLE SOLIDS **9**

Section of solids - prisms, pyramids, cylinder and cone. Obtaining sectional views and true shape when the axis of the solid is vertical and cutting plane inclined to one reference plane.

UNIT IV DEVELOPMENT OF SURFACES **9**

Development of lateral surfaces of simple and truncated solids - prisms, pyramids, cylinders and cones with cutout, perpendicular and inclined to the horizontal axis

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS **9**

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones. Conversion of isometric projection into orthographic projection. Perspective projection of prisms, pyramids and cylinders by visual ray method.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Construct multiple views of engineering components.
- Prepare the pictorial drawings as per the standards.
- Develop the projection of solids.
- Draw the section of solids drawings and development of surfaces of given objects.
- Apply free hand sketching and concept of isometric in engineering practice.

TEXT BOOKS

1. Venugopal K. and Prabhu Raja V., - "Engineering Graphics", 15th Edition, New Age International (P) Limited, New Delhi, 2018.
2. Natarajan K.V., "Engineering Graphics", 32nd Edition, Dhanalakshmi Publishers, Chennai, 2019.

REFERENCES

1. K.R. Gopalakrishna, "Engineering Drawing Volume 1 & 2", 55th Edition, Subhas Publications, Bangalore, 2017.
2. T.Jeyapoovan., "Engineering Graphics using Auto CAD" 3rd Edition, vikas publishing house Pvt Ltd, New Delhi, 2017.

E- RESOURCES

1. https://nptel.ac.in/courses/112/103/112103019/ - (Geometric Constructions)
2. https://nptel.ac.in/courses/105/104/105104148/ - (Projections)

19GEE101 COMPUTER FUNDAMENTALS AND PYTHON PROGRAMMING L T P C
(Lab Embedded Theory Course) **3 0 2 4**
(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM)

OBJECTIVES

The course objectives are to:

- Enable the student to learn the major components of a computer system and software.
- Know the basics of algorithmic problem solvinand fundamentals of pythonprogramming.
- Develop simple python programs.
- Define controls and functions in python.
- Use python data structures - lists, tuples and dictionaries.

UNIT I INTRODUCTION **9**

Introduction, Characteristics of Computers, Generation and Classifications of Computers, Basic Computer Organization, Computer Software, Types of Software, Software Development Steps, Internet, Getting connected to Internet Applications

UNIT II PROBLEM SOLVING AND PYTHON FUNDAMENTALS **9**

Algorithms, building blocks of algorithms (instructions/statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Introduction to Python: Basics of Python and history of Python - Unique features of Python, interpreter and interactive mode - values and types: int, float, boolean, string, and list; variables.

UNIT III EXPRESSIONS AND STATEMENTS **9**

Expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT IV CONTROL FLOW AND FUNCTIONS **9**

Conditionals: Boolean values and operators, conditional (if), alternative (if -else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions, Strings, Lists as arrays. Illustrative programs: square root, gcd, Tower of Hanoi, exponentiation, sum an array of numbers, linear search, binary search.

UNIT V LISTS, TUPLES AND DICTIONARIES **9**

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.

LIST OF EXPERIMENTS

(Any Eight to be conducted)

1. Document Creation, Table Creation and Flow chart
2. Spread sheet- Chart, Formula, Sorting
3. Compute the GCD of two numbers.
4. Find the square root of a number (Newton„s method)
5. Exponentiation (power of a number)
6. Find the maximum of a list of numbers
7. Linear search and Binary search
8. First n prime numbers
9. Multiplication of two matrices
10. Simulate elliptical orbits in Pygame

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Know the Computer basics, Components and Software's.
- Develop algorithmic solutions to simple computational problems and Read, write, execute by hand simple Python programs. Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, and dictionaries.

TEXT BOOKS

1. Ashok.N.Kamthane," Computer Programming", Pearson Education (India), (2015).
2. Allen B. Downey, „'Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff /O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

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. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/106/106/106106145/ - (Introduction to Algorithms)
2. https://nptel.ac.in/courses/106/106/106106182/ - (Joy of Computing)

19EEC101	LIFE SKILLS FOR ENGINEERS (Employability Enhancement Course	L T P C 2 0 0 0

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM)

OBJECTIVES

To enable students to,

- Develop communication competence for engineers and enable them to convey thoughts and ideas withclarity and focus
- Inculcate critical thinking process on problem solving
- Have an overview on career skills required in their profession
- Learn professional Ethics and Moral values
- Lead a team with more responsibilities to be succeeded in their Endeavour.

UNIT COMMUNICATION SKILL **6**

Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication- Technical Presentation

UNIT II CRITICAL THINKING & PROBLEM SOLVING **6**

Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Mind Mapping & Analytical Thinking.

UNIT III CAREER SKILL **6**

Introduction to Employability and Career Skills - developing a long - term career plan - making career changes - Time Management - General awareness of Current Affairs - Stress management - Team work - Career planning.

UNIT IV ETHICS MORAL & PROFESSIONAL VALUES **6**

Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics,Global Issues.

UNIT V LEADERSHIP SKILLS AND UNIVERSAL HUMAN VALUES **6**

Leadership, Levels of Leadership, Making of a leader, Types of leadership, Universal Human Values: Non-Violence - Righteousness - Peace - Service – Renunciation.

TOTAL: 30 PERIODS

OUTCOMES

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

- Communicate effectively and make effective presentations
- Think critically on a particular problem solving.
- Explore the career skills with stress management.
- Implement the professional Values and ethics.
- Lead life in happiest manner with leadership skills

TEXT BOOKS

1. Life Skills for Engineers, McGraw Hill Education (India) Private Ltd., 2016
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015

REFERENCES

1. Barun K. Mitra; (2011), "Personality Development & Soft Skills", First Edition; Oxford Publishers.

   Kalyana;(2015) "Soft Skill for Managers"; st Edition; Wiley Publishing L

SEMESTER II

19HST201 COMMUNICATIVE TECHNO ENGLISH - II **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 0 0 3**

OBJECTIVES

To enable students to:

- Acquire usage of grammar in English language.
- Enhance the reading skill to comprehend technical writing.
- Improve business writing skills.
- Develop presentation skills in analytical view.
- Help learners to develop their speaking skills and speak fluently in real contexts.

UNIT I GRAMMAR **9**

Compound words- prepositions- articles- conditionals - Direct and indirect speeches-subject verb agreement- Active and passive voice- Impersonal Passive Voice.

Activity: Grammar worksheets on the given topics.

UNIT II LANGUAGE ENHANCEMENT THROUGH LISTENING & READING **9**

Syllabification- sentence stress -Reading Vocabulary-Reading News Papers-. Listening to You Tube Documentaries- Listening to Podcast-Listening to motivational Movies

Activity: Playing movies & podcast and enhancing listening vocabulary.

UNIT III BUSINESS WRITING **9**

Writing Recommendations - Checklist- Business Letters - Calling for Quotations, Placing Orders, Letter of Complaint, Letter of Clarification - Cover Letter with Résumé- Report Writing - Accident Report, Industrial Visit Report, Survey Report and Feasibility Report.

Activity: Giving topic and ask the students to prepare checklist and complaint.

UNIT IV WRITING **9**

Transcoding Graphics - Bar Chart, Flow Chart, Pie Chart and Tables-Tour Itinerary - Process Description- Agenda and Minutes of meeting.

Activity: Giving charts to the students and ask them to transcode.

UNIT V SPEAKING **9**

Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging -suggesting - comparing and contrasting – expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words- Roleplay.

TOTAL: 45 PERIODS

OUTCOMES

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

- Acquire advanced level grammatical knowledge.
- Improve their language usage in LSRW skills.
- Enhance the writing skills to express the ideas in the business context
- Acquire the ability to understand different written texts.
- Categorize a wide range of vocabulary and English usage.

TEXT BOOKS

1. S. Sumant Maven Learning, "Technical English II" January 2011
2. KN Shoba, Lourdes Joavani Rayen "Communicative English" Cambridge university 2017

REFERENCES

1. Dr K Elango, Dr. Veena Selvam, Dr. Sujatha Priyadarshini, "Resonance English for Engineers and Technologists", Cambridge University Press, 1st Edition, Foundation Books, New Delhi, 2013.
2. Seely, John. Oxford Guide to Effective Writing and Speaking. Indian ed., New Delhi: Oxford University Press. 2005.

E-RESOURCES

1. https://www.fluentu.com/Blog/english/english-small-talk/
2. https://wwwit.br ishcouncil.com

19CYT201 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 0 0 3**

OBJECTIVES

The main objective of this course is to:

- Explain the importance of the environment, concepts of ecosystem and overview of bio diversity and its conservation.
- Summarize the causes, effects and control of the various environmental pollution.
- Describe about natural resources and resource management.
- Assess the social issues to improve the quality of environment.
- Analyze the causes of population explosion, importance of value education and relation between human health and environment.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 11

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, rivers, oceans) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – bio geographical classification of India – value of biodiversity – India as a mega-diversity nation – hot- spots of biodiversity – threats to biodiversity – endangered and endemic species of India - conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Activity: Biodiversity in and around the campus and report submission.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes - e-waste – role of an individual in prevention of pollution - pollution case studies - disaster management: floods, earthquake and cyclone.

Activity: Local Pollution Case Study and report submission.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and

exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, effects of modern agriculture , fertilizer- pesticide problems, water logging, salinity, case studies - Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies - Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification - role of an individual in conservation of natural resources.

Activity: Waste to wealth.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT **9**

From unsustainable to sustainable development – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies - environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – waste land reclamation – Green Chemistry and principles - environment production act – Air (Prevention and Control of Pollution) act - Water (Prevention and control of Pollution) act - Wildlife protection act – Forest conservation act –Public awareness.

Activity: Creating Environmental Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT **6**

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health - Case studies.

Activity: Visit to local primary health center.

TOTAL: 45 PERIODS

OUTCOMES

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

- Discuss about the features of various ecosystems and need of conservation of biodiversity.
- Apply the appropriate methodologies to control the various environmental pollution.
- Get the knowledge about the different types of resources like land, water, mineraland energy and also about the effects of environment by the usage of these resources.
- Assess the social issues to improve the quality of environment and participating actively insolving current environmental problem.

- Find solution for the effects of the population explosion as well as environmentaland human health issues.

TEXT BOOKS

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.

REFERENCES

1. Erach Bharucha, "Textbook of Environmental Studie'", Universities Pres (I) Pvt Ltd., Hydrabad, 2015.
2. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd., New Delhi, 2007

E-RESOURCES

1. https://nptel.ac.in/courses/103107084
2. https://nptel.ac.in/courses/120108005

19MAT201 **ENGINEERING MATHEMATICS – II** **L T P C**
(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 1 0 4**

OBJECTIVES

The main objective of this course is to:

- Acquire sound knowledge of techniques in solving ordinary differential equations obtained fromengineering problems.
- Acquaint the student with the concepts of vector calculus that is needed for problems in engineering disciplines.
- Develop the fundamental concepts in analytic functions, conformal mapping and Bilinear transformations.
- Extend the standard techniques of complex integration.
- Compose the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I: DIFFERENTIAL EQUATIONS **9+3**

Higher order linear differential equations with constant coefficients - Method of variation of parameters - Homogenous equation of Euler's and Legendre's type - System of simultaneous linear differential equations with constant coefficients.

UNIT II: VECTOR CALCULUS **9+3**

Gradient and directional derivative - Divergence and curl - Line integral over a plane curve - Surface integral - Area of a curved surface - volume integral - Green's, Gauss divergence and Stoke's theorems - Verification and application in evaluating line, surface and volume integrals.

UNIT III: ANALYTIC FUNCTIONS **9+3**

Analytic functions - Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping - Mapping Function $w = \frac{1}{z}$ Bilinear transformation

UNIT IV: COMPLEX INTEGRATION **9+3**

Cauchy's integral theorem– Cauchy's integral formula –Laurent's series – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNITV: LAPLACE TRANSFORMS **9+3**

Existence conditions - Transforms of elementary functions - Transform of unit step function and unit impulse function - Basic properties - Shifting theorems - Transforms of derivatives and integrals -

Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 45+15=60 PERIODS

OUTCOMES

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

- Apply various techniques in solving differential equations which arises in Engineering problems.
- Solve engineering problems using the concept of vector calculus.
- Develop the concept of analytic functions, conformal mapping and Bilinear transformations.
- Evaluate integrals using Cauchy"s integral formula and residue theorem.
- Build the Laplace transforms techniques in solving differential equations.

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition,2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi,2015.

REFERENCES

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, Delhi,10th Edition, New 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", NarosaPublications, New Delhi, 3rd Edition, 2007
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics", Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/111105134
2. https://nptel.ac.in/courses/111106139

19PHT201	PHYSICS OF MATERIALS (Common to Civil, Mech, & RM)	L T P C 3 0 0 3

OBJECTIVES

The main objectives of this course are to:

- Investigate different materials' heat transmission modes and fundamentals of thermal conduction in solid and its applications.
- Defend the knowledge on ferrous alloy, various microstructures of steels and its classifications.
- Recognize the application of physics concepts to microscopic procedures, nondestructive testing and engineering.
- Learn the principles of cryogenics and superconductivity, as well as their technological applications.
- Demonstrate the knowledge of advanced engineering and ceramic materials for various engineering applications.

UNIT I THERMAL PHYSICS **9**

Transfer of heat energy – Thermal expansion of solids and liquids – Expansion joints - Bimetallic strips- Thermal conduction, convection and radiation – Heat conductions in solids – Thermal conductivity – Forbe's and Lee's disc method: theory and experiment - Conduction through compound media (series and parallel) – Thermal insulation.

UNIT II FERROUS ALLOYS **9**

The iron-carbon equilibrium diagram - Phases, Invariant reactions - Microstructure of slowly cooled steels Eutectoid steel, hypo and hypereutectoid steels - Phase transformations – TTT diagram for eutectoid steel – Pearlitic, baintic and martensitic transformations (qualitative) - Tempering of martensite – Steels – Stainless steels – Cast irons.

UNIT III MATERIALS CHARACTERIZATION **9**

Introduction to materials and Techniques-X-ray diffraction (XRD) - Electron Microscope-Scanning Electron Microscope (SEM)-Transmission Electron Microscope (TEM)- Non-destructive testing (NDT) : Liquid penetrant test, magnetic detection, Electromagnetic testing, Ultrasonic test, Thermal infrared testing and Spark test.

UNIT IV CRYOGENICS **9**

Introduction to Cryogenics - Properties of Cryogenic Fluids- Gas-Liquefaction of gases and Refrigeration Systems – Cryocoolers -Cryogenic Insulations - Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity - High Tc superconductors – General applications of superconductors –Cryotron and Magnetic levitation, High Tc Superconductors - Superfluity.

UNIT V NEW ENGINEERING MATERIALS **9**

Ceramics – types and applications -Composites: classification, Role of matrix and reinforcement, Characterisation of fiber reinforced plastics - Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application- Carbon Nano Tubes (CNT) structure, properties and applications

TOTAL: 45 PERIODS

OUTCOMES

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

- Expand the basics, kinds and applications of thermal conduction in solids.
- Learn about ferrous alloys, different steel microstructures and classifications.
- Comprehend use of concepts of physics for microscopic techniques, Non Destructive Testing and its application to engineering.
- Summarize the basics of cryogenics and superconductivity to explore new technological applications.
- Demonstrate the advanced engineering and ceramic materials for a variety of engineering applications.

TEXT BOOKS

1. P.Mani, " A text book of Engineering Physics " Dhanam Publications, 2018
2. Rajendran V. "Engineering Physics". Tata McGraw Hill Publications, 2012.

REFERENCES

1. Askeland, D. "Materials Science and Engineering". Brooks/Cole, 2010.
2. Wahab, M.A. "Solid State Physics: Structure and Properties of Materials" Narosa Publishing House, 2009

E-RESOURCES

1. https://nptel.ac.in/courses/113106039
2. https://nptel.ac.in/courses/115103030

19EEE201 **CIRCUIT THEORY** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Introduce electric circuits and its analysis.
- Impart knowledge on solving circuit equations using network theorems.
- Introduce the phenomenon of resonance and coupled circuits.
- Educate on obtaining the transient response of circuits.
- Introduce Phasor diagrams and analysis of three phase circuits.
- Simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab and Gain Practical experienceon electric circuits and Verification of Theorem.

UNIT I BASIC CIRCUITS ANALYSIS **9**

Ohm's Law - Kirchhoff's laws - DC and AC Circuits - Resistors in series and parallel circuits - Mesh current and node voltage method of analysis for D.C and A.C. circuits.

UNIT II NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS **9**

Network reduction: Voltage and current division, source transformation - Star delta conversion - Thevenin's and Norton's Theorem - Superposition Theorem - Maximum power transfer theorem – Reciprocity Theorem - Millman's Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS **9**

Series and parallel resonance - Frequency response - Quality factor and Bandwidth - Self and mutual inductance - Dot rule - Coefficient of coupling - Tuned circuits - Single tuned and double tuned circuits.

UNIT IV TRANSIENT ANALYSIS **9**

Natural response - Forced response - Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input - Characterization of two port networks in terms of Z, Y, h and ABCD parameters.

UNIT V THREE PHASE CIRCUITS **9**

Average and RMS value - Phasor diagram - Power, power factor and Energy - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - Phasor diagram of voltages and currents - Power and power factor measurements in three phase circuits

LIST OF EXPERIMENTS

1. Simulation and Experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Simulation and Experimental verification of electrical circuit problems using The venin"s theorem and Norton's theorem.
3. Simulation and Experimental verification of electric circuit problem using superposition theorem.
4. Simulation and Experimental verification of Maximum Power transfer Theorem.
5. Measurement of self-inductance of a coil.
6. Simulation and Experimental validation of R-C electric circuit transients
7. Simulation and Experimental validation of frequency response of RLC electric circuit.
8. Design and Simulation of series and parallel resonance circuit.
9. Simulation of three phase balanced and unbalanced star, delta networks circuits.
10. Calibration of single phase energy meter.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Learn the basic concepts of DC and AC electrical circuits.
- Understand and apply the knowledge of circuit theorems.
- Acquire knowledge about resonance and coupled circuits.
- Apply the concepts in transients.
- Analyze the three phase circuits.
- Understand and apply circuit theorems and concepts in engineering applications.

TEXT BOOKS

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, "Engineering CircuitsAnalysis", Tata McGraw Hill publishers, 9th Edition, New Delhi, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill, 6th Edition, 2019.

REFERENCES

1. Chakrabati A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai & Sons, 3rd Edition, 2018.
2. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Tata McGrawHill, 5th Edition, 2017.

E-RESOURCES

1. https://nptel.ac.in/courses/108102042/ - (Resonance and coupled circuits)
2. https://www.my-mooc.com/en/mooc/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0/ - (Three phase Circuits

19MET201 **ENGINEERING MECHANICS** **L T P C**
(Common to Civil and Mechanical Engineering & RM) **3 1 0 4**

OBJECTIVES

The objective of this course will enable students to:

- Understand the definition of particle, body, force and their equilibrium conditions.
- Understand the concept of equilibrium of rigid bodies.
- Learn the basic concepts of friction.
- Learn about the center of gravity and moment of inertia of surfaces and solids.
- Understand the force motion relationship in components subjected to external forces and analysis of standard mechanism.

UNIT I STATICS OF PARTICLES **9+3**

Introduction Laws of Mechanics – Parallelogram and triangular Law of forces – Principle of transmissibility – Coplanar Forces – Resolution and composition of force – Free body diagram – Equilibrium of a particle in plane – Forces in space – Equilibrium of a particle in space.

UNIT II STATICS OF RIGID BODIES **9+3**

Moments: Moment of a force about a point and about an axis – Scalar components of a moment – Varignon's theorem – Single equivalent force – Types of supports and reactions — stable equilibrium — Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT III FRICTION **9+3**

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – Angle of Repose – Belt friction – Ladder friction – wedge friction – Rolling resistance.

UNIT IV PROPERTIES OF SURFACES AND SOLIDS **9+3**

Determination of areas and Volumes – First moment of area and Centroids of sections –T - section, I- section, - Angle section, Hollow section by using standard formula – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I-section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas - Relation to area moments of inertia.

UNIT V DYNAMICS OF PARTICLES **9+3**

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion

- Newton's laws of motion – Work Energy Equation – Impulse and Momentum – Impact of elastic bodies.

TOTAL: 45+15=60 PERIODS

OUTCOMES

On successful completion of this course, The Students can able to:

- Understand the forces and its related laws of mechanics in static and dynamic conditions.
- Solve problems in engineering systems using the concept of static equilibrium.
- Solve problems involving frictional phenomena in machines.
- Solve the moment of inertia of any sections and masses for the structural members.
- Apply the different principles to study the motion of a body and analyze their constitutive equations.

TEXT BOOKS

1. Dr.N.Kottiswaran, "Engineering Mechanics",11th Edition, Sri Balaji Publications, Coimbatore, (2017).
2. Vela Murali, "Engineering Mechanics", Oxford University Press, (2017).

REFERENCES

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education, 2010.
2. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units):Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).

E-RESOURCES

1. https://nptel.ac.in/courses/122/104/122104015/ - (Engineering Mechanics)
2. https://www.courses.com/indian-institute-of-technology-guwahati/engineering-mechanics - (Engineering Mechanics)

19EEC201	TECHNICAL SKILL (AutoCAD) (Employability Enhancement Course) (Common to Civil, Mech & RM)	L T P C 0 0 2 0

OBJECTIVES

The objective of this course will enable students to:

- Develop skill to use software to create 2D and 3D models.

LIST OF EXERCISES USING SOFTWARE CAPABLE OF DRAFTING AND MODELING

1. Study of capabilities of software for Drafting and Modeling - Coordinate systems (absolute, relative, polar, etc.) - 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, involutes using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etcand dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial.
6. Views (eg.V-Block, Base of a mixie, Simple stool, Objects with hole and curves).
7. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.).
8. Drawing of a simple steel truss.
9. Drawing sectional views of prism, pyramid, cylinder, cone, etc.
10. Drawing isometric projection of simple objects.
11. Creation of 3D models of simple objects and obtaining 2D multi - view drawings from 3Dmodel.

TOTAL: 20 PERIODS

OUTCOMES

On successful completion of this course, The Students can able to:

- Understand develop skill to use software to create 2D and 3D models.

SEMESTER III

19MAT301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **3 1 0 4**

OBJECTIVES

The main objective of this course is to:

- Discover the basic concepts of Partial differential equation for solving standard partial differential equations.
- Apply the Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- Acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- Explain Fourier transform techniques used in wide variety of situations.
- Utilize the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

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 homogeneous types.

UNIT II FOURIER SERIES 9+3

Dirichlet's conditions - General Fourier series - Odd and even functions - Half range Sine and Cosine series - Parseval's identity - Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

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 IV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem - Fourier transform pair - Fourier sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem -Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties - Inverse Z-transform (using partial fraction and residues) -Initial and final value theorems - Convolution theorem - Solution of difference equations using Z - transform.

TOTAL= 45+15=60 PERIODS

OUTCOMES

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

- Use the standard types of partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Relate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.
- Analyze some of the physical problems of engineering by Fourier transforms.
- Apply Z transforms techniques in solving difference equation.

TEXT BOOKS

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G., "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES

1. N.P. Bali. and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley, India, 2016.

E-RESOURCES

1. https://nptel.ac.in
2. https://swayam.gov.in/nd1_noc19_ma22/preview

19EEE302 **Analog and Digital Electronics** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Understand the structure of basic electronic devices.
- Be exposed to active and passive circuit elements.
- Introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions.
- Establish the methods for simplifying Boolean expressions.
- Outline the formal procedures for the analysis and design of combinational circuits and sequential circuits.

UNIT I PN JUNCTION DIODE AND ITS APPLICATIONS **9**

Semiconductor Device Modeling and Simulation for Electronic Circuit Design - PN junction diode - Structure, operation and V-I characteristics - Rectifiers : Half Wave and Full Wave Rectifier - Display devices : ED, Laser diodes - Zener diode: Characteristics , Zener Reverse characteristics , Zener as regulator – Switched mode power supply.

UNIT II TRANSISTORS AND THYRISTORS **9**

BJT, JFET, MOSFET- Structure, operation, characteristics and Biasing UJT - Thyristors and IGBT : Structure and characteristics

UNIT III DIGITAL FUNDAMENTALS **9**

Number Systems - Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes - Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Min terms and Max terms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT IV COMBINATIONAL CIRCUIT DESIGN **9**

Design of Half and Full Adders, Half and Full Sub tractors, Binary Parallel Adder - Carry look ahead Adder,BCD Adder, Multiplexer, De multiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Verilog HDL for combinational circuits.

UNIT V SYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Flip flops - SR, JK, T, D, Master/Slave FF - operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits - state minimization, state assignment, circuit implementation - Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode and Zener diode.
2. Characteristics of a NPN Transistor under common emitter, common collector and common base configurations.
3. Characteristics of JFET (Draw the equivalent circuit).
4. Characteristics of photo diode & photo transistor, Study of light activated relay circuit.
5. Design and testing of RC phase shift and LC oscillator
6. Verification of Boolean theorems using digital logicgates.
7. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters, etc.
8. Design and implementation of 4-bit binary adder / subtractor using basic gates and MSI devices.
9. Design and implementation of parity generator / checker using basic gates and MSI devices.
10. Design and implementation of magnitude comparator.

TOTAL: 45+15=60PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Explain the structure and working operation of basic electronic devices.
- Identify and differentiate both active and passive elements.
- Analyze the characteristics of different electronic devices such as diodes and transistors.
- Analyze different methods used for simplification of Boolean expressions.
- Design and implement Combinational circuits.
- Design and implement synchronous and asynchronous sequential circuits

TEXT BOOKS

1. David A.Bell."Electronic devices and circuits", Oxford University higher education, 5th Edition, 2018.
2. S.Salivahanan, N.Sureshkumar, "Electronic devices and circuits", McGrawhill Education, 4th Edition, 2017.

REFERENCES

1. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2018.
2. V.K.Mehta, Rohit Mehta, "Principles of Electronics", S.Chand Publishing, 12th Edition, 2020.
3. G. K. Kharate, Digital Electronics, Oxford University Press, 2010

E-RESOURCES

1. https://nptel.ac.in/courses/108/102/108102095/ - (Analog Electronic Circuits)
2. https://nptel.ac.in/courses/117/106/117106086/ - (Introduction to digital circuits)

19EEE303	Electric machines and Power System (Lab Embedded Theory Course)	L T P C 3 0 2 4

OBJECTIVES:

The main objective of this course is to:

- Study about basic electrical prime movers, electrical transmission and distribution systems.
- Study about the transformers
- Study about the different types of induction motors
- Study about the special machines
- Study about the power system
- Expose the students to the basic operation of electrical machines and helps them to develop experimental skills.

UNIT I D.C. MACHINES **10**

Constructional details – EMF equation – methods of excitation – self and separately excited generators – characteristics of series, and shunt generators – principle of operation of D.C. Motor – back emf and torque equation – characteristics of series and shunt motors - starting of D.C. Motors – types of starters - speed control and braking of DC motors.

UNIT II TRANSFORMERS **10**

Constructional Details – Principle Of Operation – EMF Equation – Transformation Ratio – Transformer on No Load – Parameters Referred To HV/LV Windings – Equivalent Circuit – Transformer on Load – Regulation - Testing – Load Test - 3- PHASE Transformers connections.

UNIT III INDUCTION MOTORS **10**

Construction – types – principle of operation of three-phase induction motors – equivalent circuit – starting and speed control – single-phase induction motors (only qualitative analysis).

UNIT IV SYNCHRONOUS AND SPECIAL MACHINES **8**

Construction of Synchronous machines-types – induced emf – brushless alternators – reluctance motor – stepper motor servo motor.

UNIT V INTRODUCTION TO POWER SYSTEM **7**

Structure of electric power systems – generation, transmission, sub-transmission and distribution systems -EHVAC and EHVDC transmission systems – substation layout. (Concepts only).

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Open circuit characteristics of D.C. shunt generator.
2. Load characteristics of D.C. shunt generator.
3. Load test on D.C. shunt motor.
4. Load test on D.C. series motor.
5. Speed control of D.C. shunt motor.
6. Load test on single phase transformer
7. Open circuit and short circuit tests on single phase transformer(Determination of equivalent circuit parameters).
8. Load test on single phase induction motor.
9. No load and blocked rotor tests on three phase induction motor (Determination of equivalent circuit parameters)
10. Load test on Three phase induction motor.
11. Study of Starters

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Understanding the principles of operations and characteristics of DC machines
- Knowledge of electrical transformers and induction motors
- Know about the different types of induction motors
- Able to visualize the operation of synchronous motors stepper and sevomotors.
- Comprehending the power transmission and distributing systems.
- Knowledge about the basic operation of electrical machines and help them to develop experimental skills.

TEXT BOOKS

1. Murugesh Kumar K. , „Electric Machines Vol II', Vikas Publishing House Pvt Ltd, 2010
2. Mehta V.K. and Rohit Mehta, „Principles of Power System', S.Chand and Company Ltd, 2003

REFERENCES

1. Fitzgerald A.E., Charles Kingsley, Stephen.D.Umans, "Electric Machinery", Tata McGraw Hill publishing Company Ltd, 2003.
2. Gupta J.B., „Theory and Performance of Electrical Machines', S.K.Kataria and Sons, 2002

19RME301 **STRENGTH OF MATERIALS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Make the students to understand the concepts of stress and strains.
- Study the concept of two dimensional stress systems and stresses in thin and thick cylinders.
- Familiarize about shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- Impart knowledge on finding slope and deflection of beams by various methods
- Provide awareness on stresses on shafts and helical springs based on theory of torsion.
- Learning the mechanical properties of materials when subjected to different types of loading.

UNIT I STRESS, STRAIN, DEFORMATION OF SOLIDS **9**

Stresses types -Tension, compression and shear stresses - Hooke's law - Stresses and strains due to axial force in stepped and composite bars - Stresses due to thermal effect in composite bars - Factor of safety - Poisson ratio - Elastic constants and their relationship.

UNIT II STRESSES IN TWO DIMENSIONS **9**

Stresses on inclined planes - Principal planes and Principal stresses - Mohr's circle for bi-axial stress with shear stress - Analytical and Graphical methods.Hoop and longitudinal stresses in thin and thick cylindrical vessels, Maximum Shear stress, Changes in dimensions and volume.

UNIT III TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS **9**

Types of supports, Loads and beams - Shear force and bending Moment in cantilever, simply supported and overhanging beams.Theory of simple bending - Bending stress distribution – Load carrying capacity - Proportioning of sections - Shear stress distribution.

UNIT IV DEFLECTION OF BEAMS **9**

Evaluation of slope and deflection of cantilever and simply supported beams - Double integration method - Macaulay's method.

UNIT V TORSION IN SHAFT AND HELICAL SPRING **9**

Torsion of circular solid and hollow shafts - Shear strength - Angle of twist and torsional stiffness - Stresses in helical springs - Deflection of helical springs, carriage springs.

LIST OF EXPERIMENTS

1. Tension test on steel rod in U.T.M.
2. Torsion test on steel rod.
3. Impact test on metal specimen.
4. Hardness test on metals - Brinell and Rockwell Hardness.
5. Deflection test on beams.
6. Spring Test - Open coil and Closed coil.
7. Effect of Hardening – improvement of hardness and impact resistance of steels.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Calculate the stress and strains in regular and composite structures subjected to axial loads.
- Analyze the importance of two dimensional stress systems and stresses in thin and thick cylinders.
- Draw the shear force diagram, bending moment diagram for beams subjected to differentloading conditions. Evaluate the bending stress and shear stress distribution.
- Estimate the slope and deflection of beams
- Apply torsion equation in design of circular shafts and helical springs.
- Perform tension test, torsion test, impact test, hardness test, deflection test and spring test on given specimen.

TEXT BOOKS

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., New Delhi, 6th Edition, 2017.
2. F.P. Beer and R.Johnston, "Mechanics of Materials", McGraw Hill Education India (P) Ltd., 7th Edition, 2017.

REFERENCES

1. Rajput R K., "A Textbook of Strength of Materials (Mechanics of Solids)", S Chand and Company Ltd., New Delhi, 7th Edition, 2018.
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series,3rd Edition, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/112/107/112107146 - (Strength of Materials)
2. https://nptel.ac.in/courses/105/105/105105108/ - (Introduction to Strength of Materials)

19RME302 **MANUFACTURING TECHNOLOGY** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES:

The main objective of this course is to:

- Study the sand casting for a two part mould is to remove the pattern without breaking the mould cavity and ready to be filled with the molten metal.
- Join two separate pieces of metal or plastic together to form one singular piece and not be able to break apart under (potential) applied load.
- Understand modern forging machine driven impact hammers or presses which deform the work pieceby controlled pressure**.**
- Acquire knowledge on the mechanism of chip formation in machining, cutting tool materials, tool life and cutting fluids.
- Understand the working of lathe and milling machine.
- Provide working skill and knowledge on shaping, planing, slotting and different drilling operatio**ns.**

UNIT I CASTING PROCESSES **9**

Sand casting - Sand moulds - Type of patterns - Pattern materials - Pattern allowances - Types of moulding sand - Properties - Core making - Methods of Sand testing - CO2 process - Moulding machines - Melting furnaces. Working principle of special casting processes - Shell, investment casting - Pressure die casting -Centrifugal casting - Sand Casting defects

UNIT II METAL JOINING PROCESSES **9**

Fusion welding processes - Types of Gas welding - Equipments used - Flame characteristics - Filler and Flux materials - Arc welding equipments - Electrodes - Coating and specifications - Principles of Resistancewelding - Spot/butt, Seam welding - Percussion welding - Gas metal arc welding - Flux cored - Submergedarc welding - Electro slag welding - TIG welding. Principle and application of special welding processes - Plasma arc welding - Thermit welding - Electron beam welding, Laser Beam Welding, Friction stir welding, Ultrasonic Welding - Weld defect

UNIT III LATHE AND MILLING MACHINE **9**

Lathe machine - Centre lathe, tool nomenclature, operations, machining time and power estimation - Milling -Specifications - Types - Cutter nomenclature - Operations - Milling processes - Indexing - Gear forming.

UNIT IV MACHINE TOOLS AND HOLE MAKING **9**

Types, Specification and Quick return Mechanisms: Shaper, Planer and Slotter - Hole making operations - drilling, reaming, boring, counter boring, counter sinking and tapping.

UNIT V GRINDING AND GEAR GENERATION **9**

Grinding - Types of grinding - Grinding wheel designation and selection - Honing, lapping, super finishing, polishing and buffing - Gear generation - Gear shaping and gear hobbing - Specifications - Cutting spur and helical gears

LIST OF EXPERIMENTS

1. Mould with solid and split patterns.
2. Mould with loose-piece pattern.
3. Perform facing, plain turning and step turning operations in centre lathe.
4. Perform taper turning, thread cutting and knurling operations in centre lathe.
5. Fabrication of simple structural shapes using welding.
6. Spur gear/contour cutting in milling machine.
7. Keyway cutting in shaper
8. Round to square in shaper
9. Prepare good surface finish on flat metal.
10. Gear generation in hobbing machine.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course the students will be able to:

- Understand the usage of pattern and casting production by using different methods.
- Understand the basic concepts of metal joining and their application.
- Describe the fundamentals of metal cutting in machining operations.
- Identify the components of lathe and milling machine.
- Execute various machining processes such as shaping, milling and gear cutting..
- Identify the components of lathe and milling machine.

TEXT BOOKS

1. Hajra Chouldhary S.K and Hajra Choudhury. A.K., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2008.
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013.
3. Rajput R. K, "Manufacturing Technology", Laxmi Publications (P) Ltd., New Delhi, 2013.

REFERENCES

1. Rao,P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2013.
2. Roy.A.Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2006.
3. Hajra Choudhury S.K, "Elements of Workshop Technology", Vol. II, Media Promoters & Publishers Pvt Ltd., Mumbai, 2010.

E-RESOURCES

1. http://nptel.ac.in/courses/1121 05126/ - Rao P.N, "Manufacturing Technology - Metal Cutting and Machine Tools"
2. https://nptel.ac.in /courses/112/105/112105126/ - (Manufacturing Process - II)

19EEC302 **ENTREPRENEURSHIP DEVELOPMENT ACTIVITY** **L T P C**
(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **0 0 2 0**

OBJECTIVES

The objectives will make the students to :

- Evaluate social and civil responsibilities of business ownership.
- Describe typical behavioral characteristics of an effective entrepreneur.
- Develop a business plan, including identifying an executive summary; conducting a marketing and competitive analysis report; and developing a marketing, management, and financial plan.
- Determine career opportunities, responsibilities and educational and credentialing requirements related to various entrepreneurship ventures.
- Interpret research data to determine market-driven problems faced by entrepreneurs.

TOIPICS TO BE COVERED

1. Should You Become an Entrepreneur?
    - Entrepreneurship: Present & Past
    - Is Entrepreneurship Right for You
    - Identify Business Opportunities & Set Goals
2. What Skills Do Entrepreneurs Need
    - Communication Skills
    - Math Skills
    - Problem Solving Skills
3. Entrepreneurs in a Market Economy
    - What is an Economy?
    - The Concept of Cost
    - Government in a Market Economy
4. Select a Type of Ownership
    - Run an Existing Business
    - Own a Franchise or Start a Business
    - Choose the Legal Form of Your Business
5. Develop a Business Plan
    - Why Do You Need a Business Plan
    - What Goes into a Business Plan

- Create an Effective Business Plan

6. Identify and Meet a Market Need
   - The Value of Market Research
   - How to Perform Market Research Entrepreneurship Syllabus
   - Identify Your Competition
7. Finance, Protect, and Insure Your Business
   - Put Together a Financial Plan
   - Obtain Financing for Your Business
   - Protect Your Business
8. Choose Your Location & Set Up for Business
   - Choose a Retail Business Location
   - Choose a Location for a Nonretail Business
   - Obtain Space and Design the Physical Layout
   - Purchase Equipment, Supplies, and Inventory
9. Market Your Business
   - The Marketing Mix
   - Product, Price, Distribution, Price, and Promotion
   - Set Marketing Goals
10. Hire and Manage a Staff
    - Hire Employees
    - Create a Compensation Package
    - Manage your Staff
11. Record-Keeping and Accounting
    - Set up a Record Keeping System
    - Understand Basic Accounting
    - Track Your Inventory
12. Financial Management
    - Manage your Cash Flow
    - Analyze Your Financial Performance
    - Hire Experts
13. Use Technology
    - Technology and Your Business

- Learn about the Interest
- Purchase Technology

14. Intellectual property Rights
    - Patents
    - Copyright
    - Industrial design rights
    - Trademarks
    - Trade secrets
15. Innovation Contest
    - Innovative Idea
    - Proof of Concept (PoC)
    - Prototype Creation
    - The students may be grouped into 2 to 3 and work under a project supervisor. The Prototypes to be fabricated may be decided in consultation with the supervisor. A innovative report to be submitted by the group and the model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department.

OUTCOMES

At the end of this course, students can:

- Identify personal strengths and value systems.
- Recall important tenets of digital literacy.
- Discuss the essentials of matters pertaining to money.
- Prepare for employment and self-employment.
- Illustrate the basics of entrepreneurship and identify new business opportunities.

TOTAL: 15 PERIODS

19MDC301 **LEADERSHIP ENHANCEMENT PROGRAMME** **L T P C**

(Common to Civil, CSE, CSE (CS), ECE, EEE, Mech, AI&DS MEE, IT & RM) **1 0 0 0**

OBJECTIVES

The objective of the course is enabling the students to:

- Find new, innovative ways of developing and managing people.
- Develop new business opportunities.
- Tackle the broader societal issues the face.
- Key benefits of leadership skills in different situations.
- Formulate and implement effective leadership strategies.

TOIPICS TO BE COVERED

1. Leadership for an Engineering students: Skills & Strategies
2. Qualities of good leaders and 21 irrefutable laws of Leadership
3. Empowering Others and Managing People
4. Leading Meetings
5. Leadership competencies and Leadership Styles
6. Difference between a boss and a leader.
7. Leadership and Assertiveness Skills : A Good Leader, Leadership Theories, Leadership Behavior, Assertiveness skills.
8. Leadership development opportunities and suggestions
9. Teamwork and Leadership: Concept of teams, Building Effective teams,Concept of leadership and sharpening leadership skills.
10. Teamwork and Leadership Activities: Group discussion, Solving Puzzle as a team, describing a leadership style.

OUTCOMES

At the end of the course, the students will be able to:

- Develop the capabilities needed to increase team's work productivity.
- Help to decrease employee turnover and increase engagement, creating a strongand united team.
- Develop communication skills, mastering the art of negotiation, influence and conflict management.
- More confident as a leader and find new ways of influencing the teams they lead.
- Effectively connect to people, developing the ability to give constructive feedback, and critically seek the feedback of the team.

TOTAL: 12 PERIODS

TEXT BOOKS

1. John maxwell, "21 irrefutable laws of leadership" 2008
2. Sara N. King, David G. Altman, Robert J. Lee, "Discovering the leader in you"
3. Louis carter, David ulrich , Marshall Goldsmith "Best practices in leadership development and Organization change".

REFERENCES

1. Barry Benator, Albert Thumann, "Project Management and Leadership Skills for Engineering and Construction Projects" 2003.
2. Sydänmaanlakka Pentti. "Intelligent leadership and leadership competencies". Dissertation Series.

E-RESOURCES

1. https://nptel.ac.in/courses/122/105/122105021/ - (Introduction to Leadership)
2. www.ccl.org/leadership/research/index.aspx - (Centre for Creative Leadership)

SEMESTER IV

19MAT405	Numerical Methods and Virtual Simulation	L T P C 3 1 0 4

OBJECTIVES

The main objective of this course is to:

- Develop the basic concepts of solving algebraic, transcendental, exponential and logarithmic equations.
- Introduce the numerical techniques of interpolation in various intervals in real life situations.
- Apply numerical techniques of differentiation and integration.
- Explain various methods of solving ordinary differential equations.
- Produce the knowledge of Programs of the standard methods in MATLAB.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations by Newton Raphson method – Solution of linear system of equations by Gauss elimination, Gauss Jordan and Gauss Seidel methods – Matrix Inversion by Gauss Jordanmethod – Eigen values of a matrix by Power method.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with equal intervals by Newton's forward and backward difference formulae - Interpolation with unequal intervals by Lagrange's interpolation and Newton's divided difference formulae – Cubic Spline interpolation.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal and Simpson's 1/3 rule - Romberg's Method - Two point and three point Gaussian quadrature formulae - Evaluationof double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods - Taylor's series method - Euler's and Modified Euler's method - Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictorcorrector methods for solving first order equations.

UNIT V NUMERICAL METHODS USING MATLAB 9+3

MATLAB introduction - An overview of MATLAB features - Relational and logical operators - Conditional statements - Loops - Programs of standard methods in MATLAB.

TOTAL:45+15 PERIODS

OUTCOMES

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

- Extend the basic concepts of solving algebraic, transcendental, exponential and logarithmic equations.
- Summarize the numerical techniques of interpolation and error approximations in various intervals in reallife situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Evaluate ordinary differential equations of first and second order by various techniques and methods.
- Construct the Programs of standard methods in MATLAB with engineering applications.

TEXT BOOKS

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering & Science with programs in C,C++& MATLAB", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Dr.Kandasamy. P, Dr.Thilagavathy . K and Dr. Gunavathy .K., "Numerical Methods",S. Chand and Company Pvt. Ltd., New Delhi, 2016.

REFERENCES

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Dr. Jaan Kiusalaas, "Numerical Methods in Engineering with MATLAB", United States of America byCambridge University Press, New York, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/111/107/111107105/ (Numerical Methods).

2. https://archive.nptel.ac.in/courses/103/106/103106118/(MATLAB Programming For Numerical Computation)

19RMT401 **KINEMATICS AND DYNAMICS OF MACHINCES** **L T P C**
3 1 0 4

OBJECTIVES:

The main objective of this course is to:

- Understand the basic knowledge about kinematics of machines.
- Understand the basic components and layout of linkages in the assembly of a system/machine.
- Understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- Understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- Supplement the principles learnt in kinematics and dynamics of machinery.
- Understand how certain measuring devices are used for dynamic testing

UNIT I KINEMATIC OF MACHINES **9+3**

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods –computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

UNIT II GEARS and GEAR TRAINS **9+3**

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth actioninterference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

UNIT III FRICTION **9+3**

Sliding and Rolling Friction angle – friction in threads – Friction Drives –Belt and rope drives.

UNIT IV FORCE ANALYSIS **9+3**

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three andfour members – Static Force analysis in simple machine members – Dynamic Force Analysis –Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic Force Analysis in simple machine members.

UNIT V BALANCING AND VIBRATION **9+3**

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines –free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft .

TOTAL:45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- The students be able to understand the basic knowledge of kinematics of machines
- Students can able to apply fundamentals of mechanism for the design of new mechanisms
- Able to know about the linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- Impart knowledge about the gears and gear trains.
- Ability to analyse them for optimum design.
- Ability to demonstrate the principles of kinematics and dynamics of machinery.

TEXT BOOKS

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003

REFERENCES

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh. A, and A.K. Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi,1988.
3. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi,1992.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999.
5. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.

19RMT402 **SENSORS AND INSTRUMENTATION** **L T P C**
3 0 0 3

OBJECTIVES

The objective of this course will enable students to:

- Understand the concepts of measurement technology.
- Learn the various sensors used to measure various physical parameters.
- Learn the fundamentals of signal conditioning
- Study data acquisition and communication systems used in mechatronics system development.
- Make students familiar with the constructions and working principle of different types of sensors and transducers.

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 Gage, 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 & NanoSensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Familiar with various calibration techniques and signal types for sensors.
- Apply the various sensors in the Automotive and Mechatronics applications
- Describe the working principle and characteristics of force, magnetic and heading sensors.
- Understand the basic principles of various pressure and temperature, smart sensors.
- Ability to implement the DAQ systems with different sensors for real time applications.

TEXT BOOKS

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

REFERENCES

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001
2. .Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.

19ECE402 **LINEAR INTEGRATED CIRCUITS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Introduce the basic building blocks of linear integrated circuits
- Introduce the theory and applications of analog multipliers and pll
- Learn the theory of adc and dac
- Introduce the concepts of waveform generation and introduce some special functions
- Impart launch on experience in 56 characterizing different lic
- Train the students in matlab simulation of study the characteristics of lic

UNIT I BASICS OF OPERATIONAL AMPLIFIERS **9**

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier - General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations – JFET Operational Amplifiers – LF155 and TL082.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS **9**

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III ANALOG MULTIPLIER AND PLL **9**

Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell — Variable trans conductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronisation.

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS **9**

Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R - 2R Ladder types - switches for D/A converters, highspeed sample-and-hold circuits, A/D Converters – specifications - Flash type – Successive Approximation type - Single Slope type – Dual Slope type - A/D Converter using

Voltage-to-Time Conversion - Over-sampling A/D Converters, Sigma – Delta converters.

UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS **9**

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators - Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Monolithic switching regulator, Low Drop - Out(LDO) Regulators - Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto- couplers and fibre optic IC.

LIST OF EXPERIMENTS:

1 Characteristics and Applications of Op-Amp.
2. Waveform Generation using Op-Amp.
3. Performance characteristics of Voltage Regulator Ics.
4. Study of 555 Timer and 566 VCO.
5. Design and Implementation of Active Filters.
6. Determination of transfer function of DC servomotor.
7. Determination of transfer function of AC servomotor and study of synchros.
8. Time domain Response of first order and second order systems using MATLAB.
9. Frequency response of first and second order system using MATLAB.
10. Characteristics of PID controllers using MATLAB.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Design linear and non linear applications of OP – AMPS
- Design applications using analog multiplier and PLL
- Design ADC and DAC using OP – AMPS
- Generate waveforms using OP – AMP Circuits
- Analyze special function ICs
- Ability to design LIC and describe the characteristics.

TEXT BOOKS

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd.,2018, Fifth Edition. (Unit I – V)

2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits",4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

REFERENCES

1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", 6th Edition, PHI, 2001.
3. B.S.Sonde, "System design using Integrated Circuits", 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 5th Edition, 2009.

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19EEE402 **CONTROL SYSTEMS ENGINEERING** **L T P C**
(Lab Embedded Theory Course**)** **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- Derive the transfer function of a given system using mathematical models.
- Assess the system performance using time domain analysis and methods for improving it.
- Import knowledge in obtaining the open lop and closed-loop frequency responses of systems
- Determine and analyze the stability of given system.
- Learn the various approaches for the state variable analysis.
- Provide practical knowledge on analysis and design of control system along with basics of instrumentation.

UNIT I BASIC CONCEPTS AND SYSTEM REPRESENTATION **9**

Introduction - Open Loop and Closed Loop Systems - Mathematical Model of Control Systems - Transfer Functions - Mechanical Translational Systems - Mechanical Rotational Systems - Block Diagram Algebra Signal Flow Graph - Mason's Gain Formula - Synchro's-AC and DC servo motors - Application of control systems.

UNIT II TIME RESPONSE ANALYSIS **9**

Time Response - Standard Test Signals - Type and Order of Control System - Time Response of First order System for Unit Step - Unit Ramp and Impulse Input - Time Response of Second Order System for Unit Step Input - Time Domain Specifications - Steady State Error and Static Error Constants — P, PI and PID Controllers - Simulation of first and second order systems, Analysis of simple linear system models in MATLAB.

UNIT III FREQUENCY RESPONSE ANALYSIS **9**

Frequency Response - Frequency Domain Specifications - Resonant Peak - Resonant Frequency - Bandwidth- Cut-Off Rate - Gain Margin and Phase Margin - Frequency Response Plots - Bode Plot- PolarPlot - Correlation between time and Frequency response-M and N Circles.

UNIT IV STABILITY ANALYSIS **9**

Concepts of Stability - Necessary Conditions for Stability - Relative Stability - Routh Hurwitz Stability Criterion - Root Locus - Effect of Addition of Poles - Effect of Addition of Zeros - Nyquist Stability Criterion- Simulation of control system by mathematical development tools in MATLAB.

UNIT V COMPENSATORS AND STATE SPACE ANALYSIS **9**

Compensators: Introduction – Types, Lag, Lead and Lag-Lead Design using Bode Plots. State Space Analysis: Concepts of State - State Variables and State phase Model for Linear Continuous Time Systems - Controllability and Observability- State space representation for Discrete time

systems. Sampled Data control systems - Sampling Theorem - Sample & Hold - Open loop & Closed loop sampled data systems.

LIST OF EXPERIMENTS

1. Simulation of Control Systems by Mathematical development tools and Stability Analysis
2. Design of Lag, Lead and Lag-Lead Compensators
3. Position Control Systems
4. Synchro-Transmitter- Receiver and Characteristics
5. Bridge Networks AC and DC Bridges
6. Dynamics of Sensors/Transducers a. Temperature b. Pressure c. Displacement
7. Power and Energy Measurement

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Develop various representations of system based on the knowledge of Mathematics, Science and Engineering fundamentals.
- Determine the transient and steady state behavior of systems subjected to standard test signals.
- Analysis the various frequency response plots and its systems.
- Relate the concepts of various system stability criterions.
- Design the various compensators and digital control system using state variable models.
- Apply advanced control theory to practical engineering problems and their applications to various industries.

TEXT BOOKS

1. I.J.Nagrath and M.Gopal, "Control Systems Engineering", 6th Edition, New Age International (P) Ltd, Publishers, 2017.
2. K. Ogata "Modern Control Engineering", 4th Edition, Prentice Hall, 2015.

REFERENCES

1. M.Gopal, Control Systems, "Principles and Design", 4th Edition, Tata McGraw Hill, New Delhi, 2014.
2. A.Nagoorkani, "Control Systems Engineering", 3rd Edition, RBA Publications, 2021.

E-RESOURCES

1. http://www.nptel.ac.in/courses/107/106/107106081 - (Introduction of Control Systems)
2. http://www.nptel.ac.in/courses/108/106/108106098 - (Introduction of system and control)

19ADE403 **DATA STRUCTURES USING PYTHON** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of the course is, to

- Understand implement the concepts of adts
- Design and implement linear data structures - lists, stacks, and queues To understand sorting,
- Searching, and hashing algorithms
- Implement sorting, searching and hashing algorithms
- Implement apply Tree and Graph structures

UNIT I ABSTRACT DATA TYPES **9**

Abstract Data Types (ADTs) – ADTs and classes – introduction to OOP – classes in Python – inheritance - namespaces - shallow and deep copying Introduction to analysis of algorithms - asymptotic notations – divide & conquer – recursion – analyzing recursive algorithms

UNIT II LINEAR STRUCTURES **9**

List ADT - array-based implementations - linked list implementations - singly linked lists - circularly linked lists - doubly linked lists - Stack ADT - Queue ADT - double ended queues - applications

UNIT III SORTING AND SEARCHING **9**

Bubble sort - selection sort - insertion sort - merge sort - quick sort - analysis of sorting algorithms – linear search – binary search – hashing – hash functions – collision handling – load factors, rehashing, and efficiency

UNIT IV TREE STRUCTURES **9**

Tree ADT – Binary Tree ADT – tree traversals – binary search trees – AVL trees – heaps – multi- way search trees

UNIT V GRAPH STRUCTURES **9**

Graph ADT – representations of graph – graph traversals – DAG – topological ordering – greedy algorithms - dynamic programming - shortest paths - minimum spanning trees - introduction to complexity classes and intractability

LIST OF EXPERIMENTS

(Any Eight Experiments to be conducted)

1. Implement simple ADTs as Python classes
2. Implement recursive algorithms in Python
3. Implement List ADT using Python arrays
4. Linked list implementations of List
5. Implementation of Stack and Queue ADTs

6. Applications of List, Stack and Queue ADTs
7. Implementation of sorting and searching algorithms
8. Implementation of Hash tables
9. Tree representation and traversal algorithms
10. Implementation of Binary Search Trees
11. Implementation of Heaps
12. Graph representation and Traversal algorithms
13. Implementation of single source shortest path algorithm
14. Implementation of minimum spanning tree algorithms

TOTAL: 45+15=60PERIODS

OUTCOMES

At the end of the course, the student should be able to,

- Implement ADTs as Python classes
- Design, implement, and analyze linear data structures, such as lists, queues and stacks, according to the needs of different applications
- Design, implement, and analyze efficient tree structures to meet requirements such as searching,
- indexing, and sorting.
- Model problems as graph problems and implement efficient graph algorithms to solve them.

TEXT BOOKS

1. Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser, "Data Structures & Algorithms in Python", An Indian Adaptation, John Wiley & Sons Inc., 2021

REFERENCES

1. Lee, Kent D., Hubbard, Steve, "Data Structures and Algorithms with Python" Springer Edition 2015
2. Rance D. Necaise, "Data Structures and Algorithms Using Python", John Wiley & Sons, 2011
3. Aho, Hopcroft, and Ullman, "Data Structures and Algorithms", Pearson Education, 1983.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", Second Edition, McGraw Hill, 2002.
5. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Fourth Edition, Pearson Education, 2014.

E – RESOURCES

1. https://onlinecourses.nptel.ac.in/noc22_cs26/preview
2. https://nptel.ac.in › courses

19EEC301 **COMMUNICATION SKILLS** **L T P C**
0 0 2 0

OBJECTIVES

The purpose of learning this course is to:

- Improve fluency in English through well developed vocabulary.
- Develop the oral communication skills
- Focus the effective reading of general and technical text
- Enrich writing skill
- Communicate ideas in group discussion and interviews

UNIT I VOCABULARY **6**

Vocabulary building – articulate ideas and thoughts; usage of palindromes, greetings, wishes, festival related words - homophones and homonyms - connotation - vocabulary words with sentences. - Idiomatic Expressions One- word Substitutes.

Activities: Learn a word a week, Use newspaper to write unfamiliar words, Word association games.

UNIT II LISTENING **6**

Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening strategies- Listening to telephonic conversations - Ted talks - Watching Inspiring Speech videos on You tube- Listening native speaker's videos for pronunciation - Listening to broadcast, messages, announcements - Listening to Instagram Videos.

Activities: Listen and draw the different scenes in a story, Secret Message games, watching videos and listing difficult words.

UNIT III SPEAKING **6**

JAM Talk - Role play – Debate - Conversational skills (formal and informal) - Conversation prac – group discussion and interview skills – Introducing oneself and others - Presentation skills -Making presentations (individual and group) through seminars / PPTs.

Activities: Picture Description, Giving Directions and Guidelines, Making a short speech-Extempore.

UNIT IV READING **6**

Strategies for effective reading (Guessing meanings from contexts -Scanning, skimming, inferring meaning and critical reading)- Read and recognize different text types ranging from newspaper articles, magazines, books, Technical articles and Reading autobiographies -.

Activities: Reading online sources like e-books, e-journals and e-newspapers, cloze exercises, Reading and answering questions.

UNIT V WRITING **6**

Develop a paragraph: topic sentence, supporting sentences, concluding sentence - Writing simple Essays –argument, descriptive and comparative essays- Creative writing.

Activities: Write Essays with sub titles, Write a story that uses as many clichés and idioms, Write Paragraph.

TOTAL: 30 PERIODS

The following Practice Session will be conducted for the Communication Skills (CS) Lab sessions:

- Activities on Presentations Skills- Students make presentations on given topics
- Activities on Group Discussion- Students participate in group discussions
- Interview Skills- Students participate in Mock Interviews
- Essay Writing - Students prepare their own paragraph and essay

Guidelines for conducting assessments as per 2019 regulations

- 30 hours – Two consecutive hours allotted for each class.
- Three Continuous assessments only conducted and no end semester exam.
- For the award of Continuous assessment the best three activities from Essay Writing, Oral Presentation, Extempore, Group Discussion and Mock Interview (one-on-one basis) can be taken.

OUTCOMES

At the end of this course, learners will be able to:

- Improve vocabulary and express the same contextually
- Comprehend the general and technical text
- Communicate to his peer group properly and make presentations
- Write simple paragraph and essay in any topic
- Participate in group discussions expressing ideas relevantly, coherently and cogently

TEXT BOOKS

1. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011.
2. Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.

REFERENCES

1. Davis, Jason and Rhonda LIss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006.
2. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Blackswan:
3. Anderson, Kenneth et al. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press 1992.
4. Asraf rezvi "Technical communication".

E- RESOURCES

1. www.youglish.com
2. www.Newwellington University.com
3. www.newsinlevels.com
4. www.Britishcouncil.org
5. www.writeandimprove.com
6. www.purdueonline.com

19MDC401	VALUE ADDED COURSES- I (SOLIDWORKS)	L T P C - - - -

OBJECTIVES

The main objective of this course is to:

- Learn the individual features and functions of SOLIDWORKS, thereby emphasizing processes and procedures for completion of any task.
- Understand the principles of technical drawings to create different 3D models.
- Extend a knowledge of parametric 3D models to design and build mechanical partsand assemblies.
- Know the setup sheets for plotting with text, dimensions, and details.
- Familiar with Parametric Modeling to manufacturing and engineering concepts.

COURSE CONTENTS

a. **2D DRAFTING**
b. **3D-MODELLING**
c. **SURFACE CREATIONS AND ASSEMBLY**
d. **DRAFTING & DRAWING**
e. **SHEET METAL FEATURES**
f. **PHOTO WORKS**

PROJECT OUTCOMES

At the end of this course, learners will be able to:

- Demonstrate competency with multiple drawing and modification commands.
- Create three-dimensional solid models.
- Build three-dimensional assemblies incorporating multiple solid models.
- Apply industry standards in the preparation of technical mechanical drawings.
- Make simulation of the assemblies incorporating multiple solid models.

TEXT BOOKS

1. John E Matsson, "An Introduction to Solidworks Flow Simulation 2020", SDC Publication, USA, 2020.
2. Prof. Sham Tickoo , "Solidworks 2020 for designers", Purdue University Northwest, USA, 2020.

REFERENCES

1. Alejandro Reyes, "Beginner's Guide to Solidworks 2020", SDC Publication, USA, 2019.
2. Matt Lombard, "Mastering SolidWorks", Wiley Publisher, 2018.

E-RESOURCES

1. https://mlc-cad.com/solidworks-online-resources/
2. https://www.cadimensions.com/video/solidworks-online-resources-webinar/

SEMESTER V

19RMT501 DESIGN OF MACHINE ELEMENTS AND TRANSMISSION SYSTEMS L T P C
(Use of Approved Design Data Book is Permitted) **3 1 0 4**

OBJECTIVE

The main objective of this course is to

- To introduce students to the design and theory of common machine elements and to give students experience in solving design problems involving machine elements.
- Analyze the stresses acting on the temporary and permanent joints
- Acquire knowledge on analysis of forces acting on the machine elements and appropriate design methodology and design of couplings.
- Find out the design procedure of spur and helical gear drives and Study the design procedure of belt drive.
- Design various types of bearing like Journal and Roller Bearings .

UNIT I INTRODUCTION 9+6

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Selection of Materials –Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

UNIT II DETACHABLE AND PERMANENT JOINTS 9+6

Design of Bolts under Static Load, Design of Bolt with Tightening/Initial Stress, Design of Bolts subjected to Fatigue – Keys -Types, Selection of Square and Flat Keys-Design of Riveted Joints and Welded Joints

UNIT III SHAFTS AND COUPLING 9+6

Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types,Flange, Muff and Flexible Rubber Bushed Coupling

UNIT IV GEARS AND BELT DRIVES 9+6

Design of Spur and Helical Gear drives-Design of Belt drives-Flat and V Belts

UNIT V SPRINGS AND BEARINGS 9+6

Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Leaf Spring-Design of Journal Bearing -Antifriction Bearing-Types, Life of Bearing, Reliability Consideration, Selection of Ball and Roller Bearings

TOTAL: 75 PERIODS

OUTCOMES

At the end of the course, the students should be able to

- To formulate and analyze stresses and strains in machine elements subjected to various loads
- To analyze and design structural joints such as Riveted joints, welded joints, Bolts
- To analyze and design the components for power transmission like shaft and couplings.
- To analyze and design different types of gears and belts for engineering applications.
- To analyze and design mechanical springs and bearings.

TEXT BOOKS

1. Joseph Edward Shigley, Charles R. Mischke " Mechanical Engineering Design", McGraw Hill, International Edition, 1992
2. Sharma. C.S. and Kamlesh Purohit, " Design of Machine Elements", Prentice Hall of India Private Limited, 2003

REFERENCES

1. Bhandari. V.B., "Design of Machine Elements", Tata McGraw-Hill Publishing Company Limited, 2003.
2. Robert L.Norton, "Machin Design – An Integrated Approach", Prentice Hall International Edition, 2000.

19RMT502 MACHINE VISION SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

The main objective of this course is to:

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision
- To know about the recognition of object
- To be familiar about the applications regarding vision
- To know about the components used for vision

UNIT I VISION SYSTEM 9

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces

UNIT II VISION ALGORITHMS 9

Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation – Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.

UNIT III OBJECT RECOGNITION 9

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

UNIT IV APPLICATIONS 9

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatiograms, K-means Clustering, EM Clustering.

UNIT V ROBOT VISION 9

Basic introduction to Robotic operating System (ROS) - Real and Simulated Robots - Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to Open CV – The cv bridge Package.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course, the students should be able to

- Knowledge or gadgets of vision systems
- Ability to understand the image capturing and processing techniques
- Ability to apply the vision system in other machines
- Knowledge for recognizing the objects.
- Knowledge in application of vision and image processing in robot operations.

TEXT BOOKS

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, "Machine Vision Algorithms and Applications", WILEY-VCH, Weinheim,2008.
2. Damian m Lyons,"Cluster Computing for Robotics and Computer Vision", World Scientific, Singapore, 2011.

REFERENCES

1. Rafael C. Gonzalez and Richard E.woods, "Digital Image Processing", Addition – Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, "High-Level Vision: Object recognition and Visual Cognition", A Bradford Book, USA, 2000.
3. R.Patrick Goebel, " ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I", A Pi Robot Production, 2012.

19RME501 **CNC MACHINES** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES:

The main objective of this course is to

- Understand evolution and principle of CNC machine tools
- To learn about system and drives
- Write simple programs for CNC turning and machining centres
- To learn about Feedback Devices
- Generate CNC programs for popular CNC controller

UNIT I INTRODUCTION **7**

History - Advantages and disadvantages of CNC, block diagram of CNC - Features available in CNC systems - Types- Turning centres, machining centres, grinding machines, EDMs, turret punch press, laser and water jet cutting machines - Constructional details of Turning centres, and machining centres - Machine accessories, Axis representations, Operator panel - Various modes of operation - Feed selection and MPG

UNIT II CNC SYSTEMS AND DRIVES **10**

Functions of CNC, system hardware, CPU, PLC, Servo control, Interfacing with keyboard, monitor, field inputs, outputs - Contouring control - interpolation, Parameters and diagnosis, compensation for machine accuracies - Open architecture systems and PC based controllers - Networking of CNC machines – Ethernet, IoT- Interfacing of robot with CNC Axis drive arrangements, guide ways, ball screw and nut, bearing arrangements, timing belts and couplings - sizing of servomotors for axis drives - DC and AC servo drives and servomotors, servo tuning - Selection criteria - drive optimization and protection - Spindle motors and drives- DC and AC

UNIT III CNC PART PROGRAMMING PROCESS **8**

Basic G and M codes, Structure of part program - Absolute and Incremental systems - Tooling concepts, Tool offsets, part geometry and writing of tool motion statements - Development of simple manual part programs for turning operations - Simple part programming for milling - CNC turning and milling part programming using canned cycles - Post processors - CNC part programming with CAD/CAM systems

UNIT IV CONTROL AND FEEDBACK DEVICES 10

Electrical cabinet and control panel wiring, Electrical standards - Control panel layout and arrangement of control elements, cables and terminations - Applications of feedback devices in CNC machines Absolute and incremental encoders, resolvers, linear scales, Proximity switches, limit switches – Thermal sensors, pressure and float switches - Hydraulic systems of a CNC lathe

UNIT V ECONOMICS AND MAINTENANCE 10

Factors influencing the selection of CNC Machines - Machine accessories Conveyors, Turret, ATC, APC - Cost of operation of CNC Machines, Testing of CNC Machines - Safety considerations software and hardware interlocks - Maintenance of CNC Machines, Preventive Maintenance, TPM - Selection and sizing of Isolation Transformer for CNC Machine - Earthing standards for CNC machines

LIST OF EXPERIMENTS

1. Study of the CNC machine
2. Programming and simulation of a lathe using any CAM package
3. Programming and simulation of a machining centre using any CAM package
4. Programming and operation of a CNC Lathe
5. Programming and operation of a CNC machining centre

Total L: 45+15=60

OUTCOMES

At the end of the course, the students should be able to

- Ability to know about the basic in CNC machineries
- Evolution and principle of CNC machine tools and different measurement technologies
- Able to write simple programs for CNC machinery
- Ability to prepare CNC program from the component drawing
- Ability to understand the features and operation of CNC machines.

TEXT BOOKS

1. HMT Limited, "Mechatronics", Tata McGraw Hill, New Delhi, 1998.
2. Radhakrishnan P, "Computer Numerical Control Machines", New Central Book Agency, 1992.

REFERENCES

1. Yorem Koren, "Computer Control of Manufacturing Systems", Pitman, London, 1987.
2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3. Peter Smid, "CNC Programming Techniques", 1st Edition, Industrial Press, Inc., 2005.
4. B. S. Pabla, M Adithan, "CNC Machines", 3rd Edition, New Age International, New Delhi, 2014.

19RME502	PRINCIPLES OF ROBOTICS (Lab Embedded Theory Course)	L T P C 3 0 2 4

OBJECTIVES

The main objective of this course is to

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulator
- To introduce different types of robotics and demonstrate them to identify different parts and components.

UNIT I BASIC CONCEPTS **9**

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and controlissues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II DIRECT AND INVERSE KINEMATICS **9**

Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III MANIPULATOR DIFFERENTIAL MOTION AND STATICS **9**

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV PATH PLANNING **9**

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V DYNAMICS AND CONTROL **9**

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

LIST OF EXPERIMENTS
(Any 7 Experiments)

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place
5. Robot programming and simulation for Colour identification
6. Robot programming and simulation for Shape identification
7. Robot programming and simulation for machining (cutting, welding)
8. Robot programming and simulation for writing practice
9. Robot programming and simulation for any industrial process (Packaging, Assembly)
10. Robot programming and simulation for multi process.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries.
- Use of any robotic simulation software to model the different types of robots and calculate work volume for different robots

TEXT BOOKS

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.

REFERENCES

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.

19RME503 **HYDRAULICS AND PNEUMATICS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to

- Understand the working principles of fluid power systems and hydraulic pumps.
- Impart knowledge on working principles of hydraulic actuators and control components.
- Familiarizing hydraulic circuits and systems.
- Know the working principles of pneumatic power system and its components.
- Solving problems and troubles in fluid power systems.
- To know the method of programming the microprocessor and also the design, modeling & analysis of basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept of mechatronics

UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal‟s Law – Principles of flow - Friction loss – Work, Power and Torque- Problems, Sources of Hydraulic power : Pumping Theory-– Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps — Problems.

UNITII HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary actuators-Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories : Reservoirs, Pressure Switches – Filters –typesand selection- Applications – Fluid Power ANSI Symbols – Problems.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits ,Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits,–Servo and Proportional valves — Applications- Mechanical ,hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – classification- single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits ,Electro Pneumatic System – Elements – Ladder diagram – timer circuits-Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL = 45 PERIODS

LIST OF EXPERIMENTS

1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of DC motor. 5. Study of various types of transducers.
6. Study of hydraulic, pneumatic and electro-pneumatic circuits. 7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Study of PLC and its applications.
9. Study of image processing technique

OUTCOMES

Upon completion of this course, the students will be able to

- Define various concepts of hydraulics and describe the constructional details of pumps.
- Explain the working principles of hydraulic actuators and control components.
- Classify and develop hydraulic circuits and systems.

- Categorize the various components of pneumatic power system and electro pneumatic systems.
- Identify, analyze and solve problems related to fluid power systems.
- Demonstrate the functioning of mechatronics system with various pneumatic, hydraulic and electrical systems.

TEXT BOOKS

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

REFERENCES

1. Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
2. Joshi.P., Pneumatic Control", Wiley India, 2008.

E-RESOURCES

1. https://www.excavatorfinaldrivesolutions.com/ - (Pneumatic actuators)
2. https://realpars.com - (Hydraulic and Pneumatic power packs).

19ECE503 **MICROPROCESSORS AND MICROCONTROLLERS** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to

- Understand the Architecture of 8086 microprocessor.
- Learn the design aspects of Memory Interfacing circuits.
- Interface microprocessors with supporting chips.
- Study the Architecture of 8051 microcontroller.
- Design a microcontroller – based system.
- Write Program to interface different I/O's with 8086 Processor and 8051 Microcontroller.

UNIT I 8086 MICROPROCESSOR 9

Introduction to 8086 - Microprocessor architecture - Addressing modes - Instruction set and assembler directives - Assembly language programming - Modular Programming - Linking and Relocation - Stacks - Procedures - Macros - Interrupts and interrupt service routines - Byte and String Manipulation.

UNIT II 8086 SYSTEM BUS STRUCTURE 9

8086 signals - Basic configurations - System bus timing -System design using 8086 - I/O programming - Introduction to Multiprogramming - System Bus Structure – Multiprocessor configurations - Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III I/O INTERFACING 9

Memory Interfacing and I/O interfacing - Parallel communication interface - Serial communication interface - D/A and A/D Interface - Timer - Keyboard /display controller - Interrupt controller - DMA controller - Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT IV MICROCONTROLLER 9

Architecture of 8051 - Special Function Registers(SFRs) - I/O Pins Ports and Circuits – Instruction set - Addressing modes - Assembly language programming.n

UNIT V INTERFACING OF MICROCONTROLLER 9

Programming 8051 Timers - Serial Port Programming - Interrupts Programming - LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors.

LIST OF EXPERIMENTS

8086 Programs using kits and MASM

1. Basic arithmetic and Logical operations.
2. Move a data block without overlap.
3. Ascending Descending Order.

Peripherals and Interfacing Experiments

1. Stepper motor control.
2. Key board and Display.
3. A/D and D/A interface and Waveform Generation.
4. Traffic light Controller

8051 Experiments using kits and MASM

1. Basic arithmetic and Logical operations.
2. Square and Cube program, Find 2's complement of a number.

TOTAL: 45+15=60 PERIODS

OUTCOMES

At the end of the course, the students should be able to:

- Understand and execute programs based on 8086 microprocessor.
- Design Memory Interfacing circuits.
- Design and interface I/O circuits.
- Design and implement 8051 microcontroller based systems.
- Develop counters and Time delay circuits.
- Interface different I/O's with Processor and Controller.

TEXT BOOKS

1. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family Architecture, Programming and Design", 2nd Edition, Prentice Hall of India, 2007.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontrollerand Embedded Systems: Using Assembly and C", 2nd Edition, Pearson education, 2011.

REFERENCES

1. Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware",TMH,2012.
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata Mc Graw Hill, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/108/105/108105102/ (Microprocessors and Microcontrollers)
2. https://nptel.ac.in/courses/106/108/106108100/ (Microprocessors and Microcontrollers)

19EEC501	QUANTITATIVE APTITUDE LEARNING (Common to Civil, CSE, ECE, EEE ,Mechanical & Robotics and Automation)	L T P C 0 2 0 0

OBJECTIVES

The main objective of this course is to

Understand the basics of the numbers, Highest common factor and Least common multiple.

- Develop the use of decimal fraction and problems on ages.
- Introduced basic concepts of time, work, distance, calendar and clock.
- Acquaint the student with the concept of simple and compound interest.
- Understand the knowledge of polynomial and quadratic equations.
-

UNIT I NUMBERS, HIGHEST COMMON FACTOR AND LEAST COMMON MULTIPLE 9

Numbers and their basic classification – Types of number – Basic operations of numbers – Progression – Tests of divisibility – Highest common factor – Least common multiple.

UNIT II DECIMAL FRACTION AND PROBLEMS BASED ON AGES 9

Decimal fraction – Types of fraction – Comparison of fractions – Inserting fractions in between two given fractions – Relation between decimal fraction and normal fraction – Conversion of a decimal fraction into a vulgar fraction – Types of decimals – Conversion of mixed recurring decimal into a vulgar fraction – Standardform of decimal — Problems based on ages.

UNIT III TIME, WORK, DISTANCE, CALENDER AND CLOCK 9

General rule for time and work – General rule for work and wages – Speed – Unit of speed – Average speed –Some useful relations – Problems on Trains – Calendars and clocks – Odd days – Ordinary year – Leap year.

UNIT IV SIMPLE INTEREST, COMPOUND INTEREST AND ELEMENTARY ALGEBRA 9

Simple interest – Compound interest – Some useful relations – Difference between compound interest and simple interest – Short cut methods to solve special types of problems – Elementary Algebra and averages.

UNIT V POLYNOMIAL AND QUADRATIC EQUATIONS **9**

Polynomial introduction – Degree of a polynomial – Types of polynomial – Operations on

polynomial – Remainder and factor theorem – Quadratic equation – Pure Quadratic equation – Discriminant – Roots of theQuadratic equations – Solution of Quadratic equation – Framing of a Quadratic equation – Special types of roots.

TOTAL: 45 PERIODS

OUTCOMES

After successfully completing the course, the student will have a good understanding of the following topicsand their applications.

- Understand the basic concepts and techniques of the numbers, Highest common factor andLeast common multiple.
- Apply the concept of decimal fraction and problems on ages.
- Understand and apply the concept of time, work, distance, calendar and clock.
- Acquire skills in simple interest, compound interest and elementary algebra.
- Be exposed to concepts and properties of polynomial and quadratic equations.

TEXT BOOKS

1. Aggarwal R.S., "Quantitative Aptitude", S.Chand & Company Ltd, New Delhi, 2012.
2. Dinesh Khattar, "Quantitative Aptitude for competitive examinations ", Pearson India EducationServices Pvt. Ltd, New Delhi, 2019.

REFERENCES

1. Praveen R.V., "Quantitative Aptitude and Reasoning", PHI Learning Private Limited, Delhi,2013.
2. Gupta P, "A unique Approach to Quantitative Aptitude ", Unique Publishers (I) Pvt. Ltd, NewDelhi, 2017.

E-RESOURCES

1. https://youtube.com/playlist?list=RDQM5Xl256aOq24
2. https://youtu.be/KE7tQf9spPg

19MDC501 **VALUE ADDED COURSE – II** **L T P C**
ANSYS **- - - -**

OBJECTIVES

The main objective of this course is to

- Acquire skill in finite element simulations using commercially available software.
- Know the steps involved in discretization of the cad model using various elements.
- Learn the steps involved in solving structural problems with given specifications.
- Gain knowledge on modal and harmonic analysis.
- Understand the thermal analysis with given specifications.

COURSE CONTENTS

a) Analysis of a plate with a circular hole.
b) Analysis of beams (Cantilever, Simply supported and Fixed ends).
c) Analysis of truss component.
d) Analysis of an Axi-symmetric component.
e) Modal analysis of a component.
f) Harmonic analysis of a component.
g) Thermal mixed boundary conditions (Conduction and Convection).

OUTCOMES

At the end of the course, the students will be able to

- Solve structural analysis problems using one dimensional and two dimensional elements.
- Determine numerical solution of problem using axi-symmetric condition.
- Evaluate various model of failure of a machine component using Modal analysis.
- Apply harmonic analysis to find the response of a structural system using simulation.
- Analyze engineering heat transfer problem under given boundary conditions.

TEXT BOOKS

1. John E Matsson, "An Introduction to ANSYS Fluent 2020", SDC Publications, 1st Edition, 2020.
2. Huei-Huang Lee, "Finite Element Simulations with ANSYS Workbench 2020", SDC Publications.

REFERENCES

1. Choudary R.B., "Introduction to ANSYS 16.0", 2nd Edition, IK International Publishing 2016.
2. Muralidhar K, Sundarajan T., "Computational Fluid Flow and Heat Transfer", 2nd Edition, NarosaPublishing House, 2014.

E-RESOURCES

1. https://nptel.ac.in/courses/105/103/105103140/ - (Structural Reliability)
2. https://nptel.ac.in/courses/112/105/112105045/ - (Computational Fluid Dynamics)

SEMESTER VI

19RMT601 INDUSTRIAL ROBOTICS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To introduce the basic concepts, parts of robots and types of robots.
- To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
- To select the robots according to its usage.
- To discuss about the various applications of robots, justification and implementation of robot.
- To know about material handling in a system.

UNIT I INTRODUCTION 9

Introduction- Basic components of robot-Laws of robotics- classification of robot-work space - accuracy-resolution–repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives

UNIT II ROBOT END EFFECTORS 9

Introduction- Classification of end effectors – Tools as end effectors. Drive system for grippers-Mechanical - adhesive-vacuum-magnetic grippers. Hooks &scoops. Grip per force analysis and gripper design. Active and passive grippers.

UNIT III SENSORS 9

Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors, binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT IV ROBOT PROGRAMMING 9

Robot Languages- Classification of robot language-Computer control and robot software-Val system and Languages.

UNIT V FIELD APPLICATIONS OF ROBOTICS **9**

Material transfer, Machine loading, Assembly, inspection, processing operations and service robots, Delivery Robots – Intelligent vehicles – Survey and inspection robots – Space Robots – Autonomous aircrafts – Underwater Inspection – Agriculture and Forestry – Military robots.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the students will be able to

- Learn about the basic concepts, parts of robots and types of robots.
- To design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.
- Ability in selecting the required robot
- Know various applications of robots
- Apply their knowledge in handling the materials.

TEXT BOOKS

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, "Robotic Engineering – An integrated Approach" Prentice HallIndia, New Delhi, 2001.
2. Mikell P. Groover,"Automation, Production Systems, and Computer Integrated Manufacturing", 2nd Edition, John Wiley & sons, Inc, 2007

REFERENCES

1. James A Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall of India, 2002.
2. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994

19RME601 **AUTOMATION SYSTEM DESIGN** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to:

- To know about the basic concepts in industrial automation and design automated systems.
- To know about transfer lines and automated assembly
- To illustrate the design and simulation of multiple actuator systems using pneumatic, electro-pneumatic and PLCs and enable the students to integrate various fringe conditions in multiple actuator systems.
- To programmable for CNC system
- To design the Automatic Assembly
- To design a Microcontroller kit with stepper motor and drive circuit using LABVIEW software

UNIT I FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION 9

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation.

UNIT II TRANSFER LINES AND AUTOMATED ASSEMBLY 10

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

UNIT III DESIGN OF MECHATRONIC SYSTEMS 8

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system.

UNIT IV PROGRAMMABLE AUTOMATION 9

Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems.:

UNIT V DESIGN FOR HIGH SPEED AUTOMATIC ASSEMBLY 9

Introduction, Design of parts for high speed feeding and orienting, high speed automatic insertion.

Analysis of an assembly. General rules for product design for automation.

LIST OF EXPERIMENTS

1. Co-ordinated motion of multiple pneumatic actuators in a desired sequence using Cascade method
2. Integration of fringe condition modules in multiple actuator pneumatic systems
3. Co-ordinated motion of multiple actuator, electro – pneumatic systems in a desired sequence using hard – wire programmed control systems
4. Co-ordinated motion of multiple actuator, electro – pneumatic systems in a desired sequence using PLC.
5. Interfacing of an LVDT with a PC for monitoring the displacement of machine slide and raising an alarm if the displacement exceeds specified limit.
6. Inspection using Machine vision System
7. Control of speed, direction and number of revolutions of a stepper motor using PC.
8. Development of an obstacle avoidance robot using servo motors, ultrasonic and touch sensors.

TOTAL:45+15=60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Understanding of Industrial Automation
- Knowledge of industrial automation by transfer lines and automated assembly lines.
- Ability to design an automated system
- Understanding of automated controls using pneumatic and hydraulic systems
- Ability to understand the electronic control systems in metal machining and other manufacturing processes.
- Ability to design Microcontroller kit with stepper motor and drive circuit using LABVIEW software

TEXT BOOKS

1. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2001.
2. Bolton W, "Mechatronics", Pearson Education, 1999.

REFERENCES

1. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2000.
2. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
3. Joffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011

19RME602 **INDUSTRIAL AUTOMATION USING PLC** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

- To understand the construction, operation and installation of PLCs.
- To provide the knowledge on interfacing the PLCs and field devices with communication protocols.
- To understand the concepts of DCS and SCADA systems.
- To understand the control system
- To understand the Process control system

UNIT I PROGRAMMABLE LOGIC CONTROLLER **9**

Introduction — Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram into ladder diagram. PLC programming- Simple instructions – Manually operated switches – Mechanically operated switches – Latching relays.

UNIT II APPLICATIONS OF PLC **9**

Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Motor start and stop, Simple materials handling applications, Automatic water level controller, Automatic lubrication of supplier Conveyor belt, Automatic car washing machine, Bottle label detection and process control application.

UNIT III SCADA SYSTEM & ARCHITECTURE **9**

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries - SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA/HMI Systems Various SCADA architectures, advantages and disadvantages of each system

UNIT IV DISTRIBUTED CONTROL SYSTEM **9**

Introduction to DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities Operator interfaces - Low level and high level operator interfaces –

Displays - Engineering interfaces – Low level and high level engineering interfaces – Factors to be considered in selecting DCS – Case studies – Sugar industry and Power plant

UNIT V INDUSTRIAL PROCESS CONTROL 9

Study of Advanced Process control blocks: Statistical Process Control, Model Predictive Control, Fuzzy Logic Based Control, Neural-Network Based Control, PID Control

LIST OF EXPERIMENTS (Any 7)

1. PLC wiring for three phase induction motor starting and direction control
2. Developing Ladder logic diagram for Boolean functions and verification using I/O devices
3. Implementation of Timer, Counter, Compare and Math instructions using PLC
4. Implementation of analog and PWM control using PLC and HMI
5. Tuning of PID based temperature control
6. Speed control of AC servo motor using PLC
7. Design of conveyor automation system using SCADA
8. Design of SCADA based water management system
9. Picture window control in SCADA
10. Control and monitoring of VF

TOTAL:45+15=60 PERIODS

OUTCOMES

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

- Choose appropriate PLC and explain the architecture, installation procedures and trouble shooting.
- Develop PLC programs using various functions of PLCs for a given application.
- Explain the application development procedures in SCADA and manage data, alarm and storage.
- Distinguish DCS, SCADA and PLC and explain the architecture of DCS
- Describe the controller elements and program methods.

TEXT BOOKS

1. Gary Dunning, "Introduction to Programmable Logic Controllers",3rd India edition, Cengage Learning, 2007

2. John Webb, "Programmable Logic Controllers: Principles and Applications",5th edition Prentice Hall of India, 2012.

3. Krishna Kant "Computer Based Process Control", Prentice Hall of India, 2004.

REFERENCES

1. B. G. Liptak "Instrument Engineer's Handbook – Process Software and Digital Network", 3rdedition, CRC Press,2002.

2. Jose A. Romagnoli, Ahmet Palazoglu, "Introduction to Process control", CRC Taylor and Francisgroup, 2005.

3. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

19RME603 **POWER ELECTRONICS AND DRIVES** **L T P C**
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

The main objective of this course is to

- Comprehensive introduction to various power electronic devices, their structure, operating principle and characteristics
- Give exposure to Various topologies, working principle and analysis of controlled rectifiers and ac controllers
- Detailed knowledge on Classifications, structure, operating principle of dc choppers
- Introduction to different types of Inverters , their principle of operation and waveform control Overview on dc and ac drives and their control using power electronic circuits.
- To provide hands on experience with power electronic converters and testing.

UNIT I POWER SEMICONDUCTOR DEVICES AND CHARACTERISTICS 9

Operating principle and switching Characteristics: Power diodes, Power BJT, Power MOSFET, GBT,SCR, TRIAC, GTO, MCT, Power integrated circuits (PIC) – Drive and Protection circuits – Series and parallel operation – Commutation – Simulation tools.

UNIT II CONTROLLED RECTIFIERS AND AC CONTROLLERS 9

Single phase – Three phase – Half controlled – Fully controlled rectifiers – Dual converters -Effect of source and load inductance - AC voltage controllers –Introduction to Cycloconverters, Matrix converters.

UNIT III DC TO DC CONVERTERS 9

Step up and Step down Chopper – Chopper classification - quadrant of operation – Switching mode Regulators – Buck, Boost, Buck-Boost, and Cuk Regulators.

UNIT IV INVERTERS 9

Voltage source Inverters – Half bridge – Full bridge – Three Phase Bridge Inverters – Voltage control– PWM Techniques – Current Source Inverters: Capacitor Commutated Inverter- Resonant inverters: Series, Parallel, ZVS, ZCS – Introduction to multilevel Inverters.

UNIT V DRIVES AND CONTROL **9**

Static and Dynamic equations of dc and ac machines – Electrical breaking – Rectifier and chopper control of DC drives – Principles of v/f control of AC drives – Open loop and Closed loop schemes for DC and AC drives(Block diagram approach only) – Introduction to vector control of AC drives.

LIST OF EXPERIMENTS

1 Gate Pulse Generation using R, RC and UJT.
2 Characteristics of SCR and TRIAC
3 Characteristics of MOSFET and IGBT
4 AC to DC half controlled converter
5 AC to DC fully controlled Converter
6 Step down and step up MOSFET based choppers
7 IGBT based single phase PWM inverter
8 IGBT based three phase PWM inverter
9 AC Voltage controller
10 Switched mode power converter.
11 Simulation of PE circuits (1Φ & 3Φ semi converters, 1Φ & 3Φ full converters, DC-DC converters, AC voltage controllers).
12 Characteristics of GTO & IGCT.
13 Characteristics of PMBLDC motor

TOTAL: 45+15=60 PERIODS

OUTCOMES:

At the end of the course, the students will be able to:

- Ability to explain various devices and their structure, operating characteristics in the field of electronics.
- Ability to classify, analyze and design, Control rectifier, chopper and inverter.
- Will have ability to apply power electronic circuits for the control of popular applications.
- Exposure to design and analyze PE circuit using simulation software.
- Ability to practice and understand converter and inverter circuits and apply software for engineering problems.
- Ability to experiment about switching characteristics various switches.

TEXT BOOKS

1. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", PHI, 3rd Edition, 2004.
2. Mohan, Udeland and Robbins., "Power Electronics", John Wiley and Sons, New York, 1995.

REFERENCES

1. Singh, M.D., and Khanchandani, K.B., "Power Electronics", 2nd Edition., Tata McGraw-Hill, 2011.
2. Bose, B.K., "Modern Power Electronics and AC Drives", Pearson Education, 2002.
3. Bimbra, P.S., "Power Electronics", Khanna Publishers, 2006. 4. Moorthi, V.R., "Power Electronics - Devices, Circuits and Industrial Applications", Oxford University Press, 2005.
5. NPTEL Lecture Series on "Power Electronics" by Dr.B.G.Fernandes, IIT Bombay.

19RMJ601 **MINI PROJECT** **L T P C**
0 0 2 1

OBJECTIVES

The main objective of this course is to:

- Design and fabrication of one or more components of a complete working model, which isdesigned by them.
- Ability to fabricate any components using different manufacturing tools.

GUIDELINES FOR REVIEW AND EVALUATION

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.

TOTAL: 60 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Design and fabricate the machine element or the mechanical product.
- Demonstrate the working model of the machine element or the mechanical product.

19MDC601 **CONSTITUTION OF INDIA** **L T P C**

(Common to Civil, CSE, ECE, EEE & Mechanical,RM) **3 0 0 0**

OBJECTIVES

The main objective of this course is to:

- Understand the meaning of the Constitution law and Constitutionalism.
- Realize the fundamental rights.
- Understand the execution powers of union and states bout.
- Be aware of the Constitutional powers.
- Acquaint with other Constitutional functionaries.

UNIT I INTRODUCTION **3**

Meaning of the Constitution law and constitutionalism – Historical perspective of the Constitution of India – Preamble – Salient features and characteristics of the Constitution of India – Citizenship.

UNIT II FUNDAMENTAL RIGHTS **3**

Scheme of the fundamental rights - The scheme of the fundamental duties and its legal status - The directive principles of state policy - Its importance and implementation.

UNIT III UNION AND STATE EXECUTIVE **3**

Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary form of Government in India - The Constitution powers and status of the President of India - Governor - Appointment, powers and functions.

UNIT IV CONSTITUTIONAL POWERS **3**

Amendment of the Constitutional powers and procedure - The historical perspectives of the Constitutional amendments in India - Emergency provisions : National emergency, President rule, financial emergency.

UNIT V OTHER CONSTITUIONAL FUNCTIONARIES **3**

Election Commission of India: Organization, powers and functions, Union Public Service Commission, State Public Service Commission - Local Self Government.

TOTAL: 15 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Understand the salient features and characteristics of the Constitution of India.
- Analyze the scheme of the fundamental rights and duties.
- Evaluate in detail the powers between the Union and the States.
- Know the concept of Constitutional powers.
- Recognize other Constitutional functionaries.

TEXT BOOKS

1. Introduction to the Constitution of India - Durga Das Basu.
2. Our Constitution by Subhash by C. Kashyap.

REFERENCES

1. Indian Polity by Spectrum.
2. The Indian Constitution: Cornerstone of a Nation, by Granville Austin.

E-RESOURCES

1. https://www.youtube.com/watch?v=vq2Q1_v6TNU
2. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text

SEMESTER VII

19RMT701	AI AND EXPERT SYSTEM	L T P C 3 0 0 3

OBJECTIVES:

The main objective of this course is to:

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.
- Learn about planning and reasoning artificial intelligence.
- Solve the risk in artificial intelligence.

UNIT I: INTRODUCTION **9**

History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: 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 withforward and backward State space search – Partial order planning – Planning graphs–Planning with propositional logic – Planning and acting in real world.

UNIT III: REASONING **9**

Uncertainity – 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, 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

OUTCOMES

At the end of the course, the students will be able to

- Identify problems that are amenable to solution by AI methods.
- Identify appropriate AI methods to solve a given problem.
- Formalise a given problem in the language/framework of different AI methods.
- Implement basic AI algorithms.
- Design and carry out an empirical evaluation of different algorithms on a problem formalisation,and state the conclusions that the evaluation supports.

TEXT BOOKS

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A modern approch", Pearson Education, India2003.
2. Negnevitsky, M, "Artificial Intelligence: A guide to Intelligent Systems",. Harlow: Addison-Wesley, 2002.

REFERENCE

1. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992.

19RMJ701 **INDUSTRIAL TRAINNING** **L T P C**
0 0 2 1

OBJECTIVES

The main objective of this course is to

- Design and fabrication of one or more components of a complete working model, which isdesigned bythem.
- Ability to fabricate any components using different manufacturing tools.

GUIDELINES FOR REVIEW AND EVALUATION

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.

TOTAL: 60 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Design and fabricate the machine element or the mechanical product.
- Demonstrate the working model of the machine element or the mechanical product.

SEMESTER VIII

19RMJ801	**PROJECT WORK**	**L T P C** **0 0 20 12**

OBJECTIVES

The main objective of this course is to

- Develop skills to formulate a technical project.
- Develop the ability to solve specific problem.
- Teach use of new tools, algorithms and techniques required to carry out the projects.
- Give guidance on the various procedures for validation of the product and analyze the costeffectiveness.
- Provide guidelines to prepare technical report of the project.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares 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 jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 300 PERIODS

OUTCOMES

At the end of the project, the students will be able to:

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies.
- Test and validate through conformance of the developed prototype and analysis the costeffectiveness.
- Prepare technical report and oral presentations.
- On completion of the project work students will be in a position to take up any challengingpractical problem in the field of engineering and find better solutions to it.

PROFESSIONAL ELECTIVE – I

19RMPX01 AUTOMOTIVE ELECTRONICS L T P C
3 0 0 3

OBJECTIVES

- The intention and purpose of this course is to study the basics of electronics, emission controls and its Importance in automobiles.
- To Study Ignition system
- To study the various sensors and actuators used in automobiles for improving fuel economy and emission control.
- To study the various blocks of control units used for control of fuel, ignition and exhaust systems.
- To Study Safety system

UNIT I INTRODUCTION 8

Evolution of electronics in automobiles – emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards. Charging systems: Working and design of chargingcircuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

UNIT II IGNITION AND INJECTION SYSTEMS 10

Ignition systems: Ignition fundamentals - Electronic ignition systems - Programmed Ignition – Distributionless Ignition - Direct ignition – Spark Plugs. Electronic fuel Control: Basics of combustion – Engine fuelling and exhaust emissions – Electronic control of carburetion – Petrol fuel injection – Diesel fuel injection.

UNIT III SENSORS AND ACTUATORS IN AUTOMOTIVES 7

Working principle and characteristics of Airflow rate, Engine crankshaft angular position, Hall effect, Throttle position, Velocity, temperature, exhaust gas oxygen sensors – study of fuel injector, exhaust gas recirculation actuators, stepper motor actuator, vacuum operated actuator.

UNIT IV ENGINE CONTROL SYSTEMS 10

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system. In

vehicle networks: CAN standard, format of CAN standard – Introduction to LIN and Flexray diagnostics systems in modern automobiles.

UNIT V CHASSIS AND SAFETY SYSTEMS 10

Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems –centralized door locking system – climate control of cars.

TOTAL : 45 PERIODS

OUTCOMES

After successful completion of this course, the students should be able to

- Know the importance of emission standards in automobiles.
- Understand the electronic fuel injection/ignition components and their function.
- Choose and use sensors and equipment for measuring mechanical quantities, temperature and appropriate actuators.
- Diagnose electronic engine control systems problems with appropriate diagnostic tools.
- Analyses the chassis and vehicle safety system.

TEXT BOOK

1. Ribbens, "Understanding Automotive Electronics", 8th Edition, Elsevier, Indian Reprint, 2013
2. Tom Denton, "Automobile Electrical and Electronics Systems", Edward Arnold Publishers, 2000

REFERENCES

1. Barry Hollembeak, "Automotive Electricity, Electronics & Computer Controls", Delmar Publishers, 2001.
2. Richard K. Dupuy "Fuel System and Emission controls", Check Chart Publication, 2000.
3. Ronald. K. Jurgon, "Automotive Electronics Handbook", McGraw-Hill, 1999.

19RMPX02 **ROBOTIC OPERATING SYSTEM** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce ROS and programming
- To develop the Robot environment
- To obtain the simulation robots in ROS with GAZEBO
- To simulate robots with V-Rep
- To understand mapping, navigation and motion planning ROS with Move-it

UNIT I ROS ESSENTIALS **9**

Introduction to ROS- Advantages and Disadvantages of ROS - ROS Framework- ROS packageC++, Python – ROS computation Graph – nodes, Messages, topics, services, bags, ROS Master- ROS Community- Basic programming and Syntax overview in C++ and Python – start with ROS programming - Creating Environment - Services-Actions and Nodes- Simple Interaction with the Simulation environment

UNIT II BUILD YOUR OWN ROBOT ENVIRONMENT **9**

CAD Tools for Robot Modelling – ROS Packages for robot modelling – Unified Robot Description Format and Tags- Kinematics and Dynamics Library – Create URDF Model - Robot Modelling using Unified Robot Description Format (URDF),-ROS parameter server and adding real-world object representations to the simulation environment _ Create Robot description using 7 DOF: joint number, name, type and angle limits – Xacro – Rviz – viewing of 7 DOF arm – creation of wheeled robot

UNIT III SIMULATION ROBOTS IN ROS WITH GAZEBO **9**

Robot simulation - Gazebo –create simulation model at Gazebo- Adding colors, textures, transmission tags, 3D vision sensor to Gazebo- Moving robot joints using ROS controllers- ROS controller interacts with Gazebo, interfacing state controller, simulation of moving the robot joints – simulation of differential wheeled robot in Gazebo.

UNIT IV ROS WITH VREP **9**

V-REP is a multi-platform robotic simulator - Simulating the robotic arm using V-REP - Adding the ROS interface to V-REP joint - Simulating a differential wheeled robot, Adding a laser sensor , 3D vision sensor

UNIT V MAPPING, NAVIGATION AND MOTION PLANNINGROS WITH MOVEIT 9

Move it Instattion - Generating the Self-Collision matrix .virtual joints, planning groups, robot poses, robot end effector - MoveIt Architecture Diagram - Trajectory from RViz GUI executing in Gazebo - Planning scene overview diagram- Collision Checking - Motion Planning, Pick and Place Behaviors using Industrial Robots with ROS Moveit – ROS with MATLAB - ROS with Industrial

TOTAL: 45 PERIODS

COURSE OUTCOMES

- Upon successful completion of the course, students should be able to:
- Recognize the concept of ROS and programming.
- Evaluate various robot algorithms in ROS programming
- Deploy mapping, navigation and motion planning ROS with Move-it.
- Simulate robots in ROS with GAZEBO and V-REP

TEXT BOOK

1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018
2. Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013.

REFERENCES

1. Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.
2.Lentin Joseph, Aleena Johny, "Robot Operating System (ROS) for Absolute Beginners Robotics Programming Made Easy", Second Edition, Apress, 2022.
3. Lentin Joseph, "ROS Robotics Projects", Packt publishing, 2017

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19RMPX03 COMPOSITE AND SMART MATERIALS **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Know the different manufacturing methods available for composite material.
- Enlighten the students in different types of reinforcement.
- Aware of different processing methods of composite materials.
- Understand properties of composite materials.
- Extend a knowledge of applications and selection of different composites in consideration of the properties and characteristics.

UNIT I INTRODUCTION TO COMPOSITES 9

Fundamentals of composites - Need for composites - Enhancement of properties - Classification of composites - Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) - Reinforcement - Particle reinforced composites, Fibre reinforced composites. - Applications of various types of composites.

UNIT II METAL MATRIX COMPOSITES 9

Characteristics of MMC - Various types of Metal matrix composites - Alloy vs. MMC - Advantages of MMC -Limitations of MMC - Metal Matrix, Reinforcements - Particles - Fibres - Effect of reinforcement - Volume fraction - Rule of mixtures - Processing of MMC - Powder metallurgy process - Diffusion bonding - Stir casting - Squeeze casting.

UNIT III POLYMER MATRIX COMPOSITES 9

Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres - Rovings - Woven fabrics - Non woven random mats - various types of fibres - PMC processes -Hand layup processes - Spray up processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding -Pultrusion - Filament winding - Injection moulding. Fibre reinforced plastics (FRP), Glass fibre reinforced plastics (GRP).

UNIT IV CERAMIC MATRIX COMPOSITES 9

Engineering ceramic materials - Properties - Advantages - Limitations - Monolithic ceramics - Need for CMC -Ceramic matrix - Various types of Ceramic Matrix composites- Oxide ceramics - Non oxide ceramics -Aluminium oxide - Silicon nitride - Reinforcements - Particles- Fibres- Whiskers - Sintering

- Hot pressing -Cold isostatic pressing (CIPing) - Hot Isostatic Pressing (HIPing).

UNIT V ADVANCES IN COMPOSITE MATERIALS 9

Carbon /carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre -chemical vapour deposition of carbon on carbon fibre perform. Solgel technique. Composites in aerospace applications.

TOTAL= 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project.
- Describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
- Acquire the knowledge in metal matrix composites and its processing methods.
- Acquire the knowledge in ceramics matrix composites and its processing methods.
- Adequate Knowldege about the composite materials in industry.

TEXT BOOKS

1. Chawla, K.K, "Composite Material s", Fourth Edition, Springer Science in progress, 2019.
2. Balasubramaniam, Composite Materials, John Wiley & Sons, Indian Ed., 2014.

REFERENCES

1. Sharma S.C., "Composite materials", Narosa Publications, 2000.
2. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, 1st Indian Edition – 2007.

E-RESOURCES

1. http://nptel.ac.in/courses/101104010/ - (Composite Materials and Structures)
2. https://www.digimat.in/nptel/courses/video/112104229/L01.html - (Introduction to composites)

19RMPX04 **ADDITIVE MANUFACTURING** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- 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 direct energy deposition processes
- To be familiar with powder bed fusion and material extrusion processes.
- To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

UNIT I INTRODUCTION **9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING **9**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials – Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION **9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications.

UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 9

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

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- Acquire knowledge on process of transforming a concept into the final product in AM technology.
- Elaborate the vat polymerization and direct energy deposition processes and its applications.
- Acquire knowledge on process and applications of powder bed fusion and material extrusion.
- Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

TEXT BOOKS

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0

2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCES

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.

2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, andApplications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.

3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press.,United States, 2015, ISBN-13: 978-1482223590.

19RMPX05 METROLOGY AND MEASUREMENTS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Study the concepts of measurement and characteristics of instruments.
- Learn the method of linear and angular measurements techniques.
- Identify the use of laser and advances in metrology for linear geometric dimensions.
- Provide knowledge on measurement of thread and gear terminologies using suitable instruments.
- Categorize the methods of measurement of force, torque, power, flow and temperature.
-

UNIT I BASICS OF METROLOGY 9

Introduction - Need for measurements - Methods of measurement - Generalized measuring systems - Units and Standards - Types of measuring instruments - Errors in Measurement - Types of errors - Calibration and Interchangeability - Precision and Accuracy - Characteristics of measuring instruments.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments: Vernier Caliper, Vernier Height and Vernier Depth Gauge - Inside, Outside and

Depth Micrometer - Slip Gauge - Limit Gauge - Comparator: Mechanical, Pneumatic and Electrical - Angular Measurements: Bevel protractor, Sine bar, Angle Decker, Autocollimator.

UNIT III ADVANCES IN METROLOGY 9

Interferometer: NPL Flatness, Laser and Michelson - Coordinate Measuring Machine - Basic concept, Types, Constructional features, Probes, Accessories - Basic concepts of Machine Vision System - Element -Applications.

UNIT IV FORM MEASUREMENT 9

Principles and Methods of straightness - Flatness measurement - Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications

UNIT V MEASUREMENT OF MECHANICAL PARAMETERS 9

Measurement of forces: Direct methods - Equal arm balance and unequal arm balance - Indirect methods -Accelerometers, Load cells, Bourdon tubes. Torque measurement: Strain gauges - Torsion bars. Measurement of Power: Mechanical and DC dynamometers, Eddy current dynamometers. Measurement of flow: Hot wire anemometer, Ultrasonic flow meter. Temperature Measurement: Bimetallic strip, pyrometers, Pressure thermometers, Thermocouples, Thermopoile, Thermistors.

TOTAL=45 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Describe the concepts of measurements to apply in various metrological instruments.
- Illustrate the methods for linear, angle and flatness measurements and select a suitable method and its relevant instrument for a given application.
- Understand the procedure for conducting computer aided inspection.
- Measure the threads, gear tooth profiles, surface roughness and flatness using appropriate instruments and analyze the data.
- Identify the construction, working principles and select appropriate measuring instruments for force, torque, power, flow and temperature for a given application.

TEXT BOOKS

1. Jain R.K. "Engineering Metrology", Khanna Publishers, 21st Edition, 2010.
2. R.K .Rajput, " A textbook of Measurements and Metrology", Katson Publishers, 2013.

REFERENCES

1. Raghavendra , Krishnamurthy "Engineering Metrology & Measurements", Oxford Univ. Press, 1st Edition, 2013.
2. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.

E-RESOURCES

1. https://nptel.ac.in/courses/112/104/112104250/ - (Introduction to Measurements and Metrology)
2. http://www.downloadmela.com/video-lectures/engineering5/mechanicalengineering6/mechanical measurements-and-metrology/ - (Metrology and Measur

PROFESSIONAL ELECTIVE – II

19RMPX06 LEAN MANUFACTURING AND SIX SIGMA L T P C
3 0 0 3

OBJECTIVES

- To introduce the basics of 6 SIGMA
- To learning about the lean manufacturing tools.
- To study about the deeper understanding methodologies of Lean manufacturing.
- To study the lean concepts and its elements.
- To learn implementation and challenges of lean manufacturing.

UNIT I BASICS OF 6 SIGMA 9

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

UNIT III DEEPER UNDERSTADING METHODOLOGIES 9

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT IV LEAN ELEMENTS 9

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

UNIT V IMPLEMENTATION AND CHALLENGES 9

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL :45 PERIODS

OUTCOMES

At the end of the course the students would be able to

- Discuss the basics of 6 SIGMA
- Elaborate the lean manufacturing tools.
- Illustrate about the deeper understanding methodologies of Lean manufacturing.
- Discuss lean concepts and its elements.
- Describe the implementation and challenges of lean manufacturing.

TEXT BOOKS

1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3. The Toyota Way: 14 Management Principles

REFERENCES

1. Quality Council of India https://qcin.org/ & its library.
   https://qcin.org/nbqp/knowledge_bank/
2. International Society of Six Sigma Professionals: https://isssp.org/about-us/
3. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP.

19RMPX07 INDUSTRIAL DESIGN AND APPLIED ERGONOMICS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To explain the general principles that governs the interaction of humans in their working environment
- To improve improving worker performance and safety.
- To know about the environmental conditions in the industry.
- To know about bio thermodynamics and bioenergetics
- To know about the human factors in industrial aspects

UNITI INTRODUCTION 12

Definition, human technological system, multidisciplinary engineering approach, human–machine system, manual, mechanical, automated system, human system reliability, conceptual design, advanced development, detailed design and development. INFORMATION INPUT: Input and processing, text, graphics, symbols, codes, visual display of dynamic information, auditory, tactual, olfactory displays, speech communications.

UNIT II HUMAN OUTPUT AND CONTROL 12

Physical work, manual material handling, motor skill, human control of systems, controls and data entry devices, hand tools and devices. WORKPLACE DESIGN: Applied anthropometry, workspace design and seating, arrangement of components within a physical space, interpersonal aspects of work place design, design of repetitive task, design of manual handling task, work capacity, stress, and fatigue.

UNIT III ENVIRONMENTAL CONDITIONS 11

Illumination, climate, noise, motion, sound, vibration, colour and aesthetic concepts. BIOMECHANICS: Biostatic mechanics, statics of rigid bodies, biodynamic mechanics, human body kinematics, kinetics, impact and collision.

UNIT IV BIOTHERMODYNAMICS AND BIOENERGETICS 5

Biothermal fundamentals, human operator heat transfer, human system bioenergetics, thermoregulatory physiology, human operator thermo regularity, passive operator, active operator, heat stress.

UNIT V HUMAN FACTORS APPLICATIONS 5

Human error, accidents, human factors and the automobile, organizational and social aspects, steps according to ISO/DIS6385, OSHA"s approach, virtual environments.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Know about ergonomic principles to design workplaces
- improve human performance
- judge the environmental conditions in the work place.
- know about bio thermodynamics and bioenergetics
- implement latest occupational health and safety to the work place.

TEXT BOOK

1. Chandler Allen Phillips, "Human Factors Engineering", John Wiley and Sons, New York, 2000.

REFERENCES

1. Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London, 2003.
2. Mayall W H, "Indus trial Design for Engineers", London ILIFFEE Books Ltd., UK, 1998.
3. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, New York, 1993

19RMPX08 **OPERATIONAL RESEARCH** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To learn selecting the constraints on the availability of resources and developing a model and rendering an optimal solution for the given circumstances.
- To study Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
- To learn Planning the purchase/ manufacturing policies, managing the spares/ stocks and meeting the customer demands.
- To Analysing the queue discipline and exploring the avenues for better customer service.
- To Investigating the nature of the project and offering methodical assistance towards decision making in maintenance.

UNIT I INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING 9

Operation Research: Definition – Models – Steps – Important topics – Scope - Tools. Linear Programing (LP): Introduction – Concept (Problem mix, Assumption, Properties) –Development (Problem formulation) – Problems in: Graphical method, Simplex methods, Big M method.

UNIT II TRANSPORTATION, ASSIGNMENT AND PRODUCTION SCHEDULING PROBLEMS 9

Transportation problems: Introduction, Model, Types – Problems in: Initial Basic (feasible) solution: Northwest Corner Cell method; Least Cost Cell method; Vogel's Approximation method and Optimal solution MODI (U-V) method. Assignment problems: Introduction,Types, Problems in Hungarian method. Production Scheduling problems: Introduction –Problems in Single Machine Scheduling: SPT; WSPT, EDD methods – Problems inJohnson's Algorithm: n job 2 machines, n job 3 machines.

UNIT III INVENTORY CONTROL MODELS & SYSTEMS 9

Inventory Control: Introduction, Models – Problems in Purchase and Production(Manufacturing) models with and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ, SDE and HML.

IV QUEUING THEORY **9**

Queuing Theory: Introduction; Applications; Terminology, Poisson process and exponential distribution – Problems in Single Server and Multi Server Queuing Models –Case study on simulation using Monte Carlo technique.

UNIT V PROJECT MANAGEMENT AND REPLACEMENT MODELS **9**

Project Management: Introduction; Guidelines for Networking AOA Diagrams – Problems in Critical Path Method (CPM) & Program Evaluation Review Technique (PERT) – Differences of CPM & PERT. Replacement Problems: Types – Problems in: Determination of Economic Life of an Asset – Problems in: Individual and Group Replacement Policies , Apply OR software

TOTAL :45 PERIODS

OUTCOMES

At the end of the course the students would be able to

- Discuss the selection of the constraints on the availability of resources, develop a model and render an optimal solution for the given circumstances.
- Explain the appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
- Explain plan the purchase/ manufacturing policies, manage the spares/ stocks, and meet the customer demands.
- Analyze the queue discipline and explore the avenues for better customer service.
- Investigate the nature of the project and offer methodical assistance towards decision making in maintenance.

TEXT BOOKS

1. Pannerselvam R, "Operations Research", 2nd Edition, PHI, 2009.
2. Hamdy A. Taha, "Operations Research an Introduction", 10th Edition, PHI/Pearson Education, 2017.

REFERENCES

1. Ravindran, Phillips and Solberg, "Operations Research Principles and Practice", 2nd Edition, Wiley India, 2007.
2. Srinivasan G, "Operations Research Principles and Applications", 3 rd Edition EEEPHI, 2017.
3. Sharma J K, "Operations Research Theory and Applications",5th Edition, Macmillan India, 2013.
4. Premkumar Gupta and D.S.Hira, "Problems in Operations Research", S.Chand,2009.

19RMPX09 **FARM AUTOMATION** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- 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 TractionTraction models, Traction predictor spreadsheet, 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 : 45 Hours

OUTCOMES

At the end of the course the students would be able to

- Design robot for agriculture purposes.
- Integrate sensor and system for a required agricultural applications.
- Develop suitable testing and tracking devices.
- Implement suitable Weed Management system.
- Develop and select suitable machinery for specific tasks.

TEXT BOOKS

1 Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster , "Engineering Principles of Agricultural Machines", ASAE Publication, 2006.

2 Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2013

REFERENCES

1 Qin Zhang, Francis J. Pierce , "Agricultural Automation Fundamentals and Practices", CRC Press, 2013.

2 StephenL.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,2017.

4 Guangnan Chen , "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2018.

19RMPX10 PROCESS PLANNING AND COST ESTIMATION L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Introduce the steps involved in process planning and computer aided process planning.
- Study the process parameter calculation
- n for various production process.
- Acquire knowledge on elements and estimation of cost, material cost and weight estimation.
- Estimate the production cost.
- Introduce the techniques in estimation of time and cost of machining, forging and welding.

UNIT I INTRODUCTION TO PROCESS PLANNING 9

Introduction - Methods of process planning - Drawing interpretation - Material evaluation - Steps in process selection - Production equipment and tooling selection.

UNIT II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes - Selection jigs and fixtures - Selection of quality assurance methods - Set of documents for process planning - Economics of process planning - Case studies.

UNIT III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation - Methods of costing - Elements of cost estimation -Types of estimates - Estimating procedure - Estimation labor cost, material cost - Allocation of overhead charges - Calculation of depreciation cost.

UNIT IV PRODUCTION COST ESTIMATION 9

Estimation of different types of jobs - Estimation of forging shop - Estimation of welding shop - Estimation of foundry shop.

UNIT V MACHINING TIME CALCULATION 9

Estimation of machining Time - Importance of machine time calculation - Calculation of machining Time for different lathe operations - Drilling and boring - Machining time calculation for milling, shaping and planning -Machining time calculation for grinding.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Summarize the steps involved in process planning and/or computer aided process planning.
- Identify the elements of cost during manufacture of a product and/or apply the methods to estimate the cost.
- Estimate the material cost weight for a particular part.
- Determine the machining time of material removal processes in lathe, milling, shaping, planning and grinding.
- Adopt the methods of estimation in forging and welding processes to find cost of the process.

TEXT BOOKS

1. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems, John Wiley", 9th Edition, 1998.
2. Dr.V.Jayakumar, "Process Planning and Cost Estimation", Lakshmi publications, Chennai, 2013.

REFERENCES

1. Davim, J. Paulo, Jain, Ajai, Phanden, Rakesh Kumar "Integration of process planning and scheduling: approaches and algorithms" CRC Press/Taylor & Francis Group, 2020.
2. R. Kesavan, C. Elanchezhian, B. Yijaya ramnath "Process Planning and Cost Estimation", New Age International (P) Limited, New Delhi, 2016.

E-RESOURCES

1. https://nptel.ac.in/courses/110/101/110101132/ - (Cost Accounting)
2. https://youtu.be/y24meNZbUoU - (Process Planning)

PROFESSIONAL ELECTIVE – III

19RMPX11	FIELD AND SERVICE ROBOTICS	L T P C 3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study about the localization, planning and navigation.
- To study the control of robots for some specific applications.
- To study about the humanoid robots.

UNIT I INTRODUCTION **9**

History of service robotics – Present status and future trends – Need for service robots - applications- examples and Specifications of service and field Robots. Non conventional Industrial robots.

UNIT II LOCALIZATION **9**

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

UNIT III PLANNING AND NAVIGATION **9**

Introduction-Path planning overview- Road map path planning- Cell decomposition path planning- Potential field path planning-Obstacle avoidance - Case studies: tiered robot architectures.

UNIT IV FIELD ROBOTS **9**

Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

UNIT V HUMANOIDS **9**

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound,

Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.

TOTAL : 45PERIODS

OUTCOMES

At the end of the course, the students will be able to

- Explain the basic concepts of working of robot
- Analyze the function of sensors in the robot
- Write program to use a robot for a typical application
- Use Robots in different applications
- Know about the humanoid robots.

TEXT BOOKS

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004

2. Riadh Siaer, „The future of Humanoid Robots- Research and applications", Intech Publications, 2012.

REFERENCES

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.

2. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

19RMPX12 **AUTONOMOUS VEHICLES** **L T P C**
3 0 0 3

OBJECTIVES

.The main objective of this course is to:

- Introduce the fundamental aspects of Autonomous Vehicles
- Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles.
- Understand the Connectivity Aspects and the issues involved in driverless cars.
- Learn car technology
- Understand the Autonomous Vehicle Technology

UNIT I Introduction **9**

Evolution of Automotive Electronics -Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs -Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems-Autonomous Vehicles

UNIT II Sensor Technology for Autonomous Vehicles **9**

Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters

UNIT III Computer Vision and Deep Learning for Autonomous Vehicles **9**

Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing – TensorFlow -Overview of Deep Neural Networks -Convolutional Neural Networks

UNIT IV Connected Car Technology **9**

Connectivity Fundamentals - DSRC (Direct Short Range Communication) - Vehicle-to-Vehicle Technology and Applications -Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications - Security Issues.

UNIT V Autonomous Vehicle Technology **9**

Driverless Car Technology-Different Levels of Automation -Localization - Path Planning. Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers, ROS Framework -:Autonomous Vehicles' Biggest Challenges

TOTAL : 45PERIODS

OUTCOMES

At the end of the course, the students will be able to:

- Describe the evolution of Automotive Electronics and the operation of ECUs.
- Compare the different type of sensing mechanisms involved in Autonomous Vehicles.
- Discuss about the use of computer vision and learning algorithms in vehicles.
- Summarize the aspects of connectivity fundamentals existing in a driverless car.
- Identify the different levels of automation involved in an Autonomous Vehicle.

TEXT BOOKS

1. Hong Cheng, "Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation", Springer, 2011.

2. Williams. B. Ribbens: "Understanding Automotive Electronics", 7th Edition, Elsevier Inc, 2012.

REFERENCES

1. Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.

2. Marcus Maurer, J.ChristianGerdes, "Autonomous Driving: Technical, Legal and Social Aspects" Springer, 2016.

3. James Anderson, KalraNidhi, Karlyn Stanly, "Autonomous Vehicle Technology: A Guide for Policymakers", Rand Co, 2014.

19RMPX13 **VIRTUAL INSTRUMENTATION** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To introduce virtual instrumentation concepts and applications.
- To train to program virtual instrumentation software for biomedical applications
- To understand the data acquisition and control in VI
- To obtain the knowledge in instrument interfaces
- To analyze the applications of VI in Bio Medical Engineering

UNIT I INTRODUCTION **9**

History of Virtual Instrumentation (VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation – Lab VIEW software – Lab VIEW basics – Lab VIEW environment.

UNIT II VI USING LABVIEW **9**

Creating, Editing and debugging a VI in Lab VIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.

UNIT III DATA ACQUISITION AND CONTROL IN VI **9**

Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems

UNIT IV INSTRUMENT INTERFACES **9**

Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.

UNIT V APPLICATION OF VI IN BIOMEDICAL ENGINEERING **9**

Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- To comprehend and appreciate the significance and role of this course in the present contemporary world.
- Identify salient traits of a virtual instrument.
- Understand the use of VI for data acquisition.
- Experiment, analyze and document different types of interfaces.
- Apply the virtual instrumentation technologies for medical applications

TEXT BOOKS

1. Gary Johnson, "LABVIEW Graphical Programming", McGraw Hill, 4th edition, 2006.
2. Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997.
3. Skolkoff, "Basic concepts of LABVIEW 4", PHI, 1998.
4. Jerome, Jovitha, "Virtual Instrumentation and LABVIEW", PHI Learning, New Delhi, 1st Edition, 2010.

REFERENCES

1. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2003.
2. S. Gupta, J.P. Gupta, "PC Interfacing for Data Acquisition and Process Control", ISA, 2nd Edition, 1994.
3. Technical Manuals for DAS Modules of Advantech and National Instruments.

19RMPX14 PRODUCTION PLANNING AND CONTROL L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect - Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break even analysis Economics of a new design.

UNIT II WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production Machine capacity, balancing- Analysis of process capabilities in a multi product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-

Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMSFundamentals of MRP II and ERP.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- The students can able to prepare production planning and control act work study,
- The students can able to prepare product planning,
- The students can able to prepare production scheduling,
- The students can able to prepare Inventory Control.
- They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

TEXT BOOKS

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.

2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S.Chand and Company, 2000.

REFERENCES

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.

2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000

3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management",Khanna Publishers, 1990

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19RMPX15 **ADVANCED CONTROL SYSTEM** **LT P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To provide the knowledge on phase plane analysis.
- To provide the knowledge on describing function analysis.
- To introduce the optimal controller and optimal estimator including Kalman filter.
- To introduce the system identification and adaptive control techniques.
- To introduce the robust control techniques.

UNIT I PHASE PLANE ANALYSIS 9

Features of linear and non-linear systems – Common physical nonlinearities – Methods of linearization – Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT II DESCRIBING FUNCTION ANALYSIS 9

Basic concepts – Derivation of describing functions for common nonlinearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT III INTRODUCTION TO OPTIMAL CONTROL AND ESTIMATION 9

Introduction – Performance measures for optimal control problem – LQR tracking – LQR regulator – Optimal estimation – Discrete Kalman Filter.

UNIT IV INTRODUCTION TO SYSTEM IDENTIFICATION ADAPTIVE CONTROL 9

Introduction to system identification – The least squares estimation – The recursive least squares estimation – Introduction to adaptive control – Gain scheduling controller – Model reference adaptive controller – Self-tuning controller.

UNIT V INTRODUCTION TO ROBUST CONTROL 9

Introduction – Norms of vectors and matrices – Norms of systems – H2 optimal controller – H2 optimal estimation – H-infinity controller – H-infinity estimation.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- Ability to understand the physical nonlinearities, linearize and analyze nonlinear systems using phase plane technique.
- Ability to analyze nonlinear systems with the describing function technique.
- Ability to know the performance measures and use LQR controllers and Kalman filter for optimal control problems.
- Ability to identify a system using least squares and recursive least techniques and understand the need and techniques of adaptive control.
- Ability to understand the need for robust control and use them for control and estimation

TEXT BOOKS

1. M.Gopal, "Digital Control and State Variable Methods", 4th edition, Mc Graw Hill India, 2012
2. K. Ogata, 'Modern Control Engineering', 5th Edition, Pearson, 2012.
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

REFERENCES

1. Sinha A, "Linear Systems: Optimal and Robust Control", CRC Press, 2007.
2. Cheng D, Sun Y, Shen T and Ohmori H, "Advanced Robust and Adaptive Control Theory And Applications", NewAge International, 2010.
3. Astrom KJ &Wittenmark B, "Adaptive Control", Dover Publications, 2013. 4. Kirk DE, "Optimal Control Theory: An Introduction", Dover Publications, 2012.

PROFESSIONAL ELECTIVE – IV

19RMPX16 **NON DESTRUCTIVE TESTING** **LT P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.
- To study the methods of NDE
- To study the Radiography
- To study the Ultrasonic and Acoustic Emission Testing
- To study the Thermography and Eddy Current Testing

UNIT I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Welding Defects and standards and reports.

UNIT II SURFACE NDE METHODS 9

Visual inspection – Unaided and aided. Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III RADIOGRAPHY 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

UNIT IV ULTRASONIC AND ACOUSTIC EMISSION TESTING 9

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications

UNIT V THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students able to

- Explain the fundamental concepts of NDT
- Discuss the different methods of NDE
- Explain the concept of Thermography and Eddy current testing
- Explain the concept of Ultrasonic Testing and Acoustic Emission
- Explain the concept of Radiography

TEXT BOOKS

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.

2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

REFERENCES

1.ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

3. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.

4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005

19RMPX17 MAINTENANCE AND SAFETY ENGINEERING L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To impart knowledge in maintenance
- To know about the fundamentals of maintenance and to implement it.
- To study about safety engineering practices.
- To analyze the hazards in protection.
- To know about the safety in machine operation.

UNIT I INTRODUCTION TO MAINTENANCE 6

Types – breakdown, preventive, predictive, TPM; elements of preventive maintenance – checklist, schedule, procedure.

UNIT II TOTAL PRODUCTIVE MAINTENANCE 12

Principles; preparatory stages of implementation – TPM organisation structure, creation; basic TPM policies and aids, master plan. TPM IMPLEMENTATION: Small group activities, autonomous maintenance, establishing planned maintenance, training, developing equipment management program.

UNIT III SAFETY SYSTEM ANALYSIS 6

Definitions, safety systems; safety information system: basic concept, safety cost / benefit analysis; industrial safety engineering, OSHA regulations.

UNIT IV HAZARD ANALYSIS 10

General hazard analysis: electrical, physical and chemical hazard, detailed hazard analysis. Cost effectiveness in hazard elimination. Logical analysis: map method, tabular method, fault tree analysis and hazop studies. FIRE PROTECTION SYSTEM: Chemistry of fire, water sprinkler, fire hydrant, alarm and detection system. Suppression system: CO_2 system, foam system, Dry Chemical Powder (DCP) system, halon system, portable extinguisher.

UNIT V SAFETY IN MACHINE OPERATION 10

Design for safety, lock out system, work permit system, safety in use of power press, cranes. Safety in foundry, forging, welding, hot working and cold working, electroplating and boiler operation. SAFETY AND LAW: Provisions in factory act for safety, explosive act, workmen compensation act, compensation calculation. Boiler act and pollution control act.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- Maintain the industry without any risk in its operation
- Improve the production
- Analyze the hazards in maintenance and to solve it.
- Identify and prevent chemical, environmental mechanical, fire hazard through analysis
- Apply proper safety techniques on safety engineering and management.

TEXT BOOKS

1. John Ridley, "Safety at Work", Butter Worth Publisher, Oxford, 1997.
2. Robinson C J and Ginder A P, "Implementing TPM", Productivity Press, USA, 1995.

REFERENCES

1. Dhillon B S, "Maintainability, Maintenance and Reliability for Engineers", CRC Press, 2006.
2. Heinrich H W, "Industrial Accident Prevention", National Safety Council, Chicago, 1998.
3. National Safety Council, "Personal Protective Equipment", Bombay, 1998.
4. National Safety Council, "Accident Prevention Manual for Industrial Operations", Chicago, 1995.

19RMPX18 **OPTIMISATION TECHNIQUES** **LT P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To introduce the basic concepts of linear programming
- To educate on the advancements in Linear programming techniques
- To introduce non-linear programming techniques
- To introduce the interior point methods of solving problems
- To introduce the dynamic programming method

UNIT I LINEAR PROGRAMMING 9

Introduction - formulation of linear programming model-Graphical solution–solving LPP using simplex algorithm – Revised Simplex Method.

UNIT II ADVANCES IN LPP 9

Dualit theory- Dual simplex method - Sensitivity analysis–-Transportation problems– Assignment problems-Traveling sales man problem -Data Envelopment Analysis.

UNIT III NON LINEAR PROGRAMMING 9

Classification of Non Linear programming – Lagrange multiplier method – Karush – Kuhn Tucker conditions–Reduced gradient algorithms–Quadratic programming method – Penalty and Barrier method.

UNIT IV INTERIOR POINT METHODS 9

Karmarkar's algorithm–Projection Scaling method–Dual affine algorithm–Primal affine algorithm Barrier algorithm.

UNIT V DYNAMIC PROGRAMMING 9

Formulation of Multi stage decision problem–Characteristics–Concept of sub-optimization and the principle of optimality–Formulation of Dynamic programming–Backward and Forward recursion–Computational procedure–Conversion of final value problem in to Initial value problem.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- To understand ethical issues, environmental impact and acquire management skills.
- To Understand about LLP
- To Understand Linear programming
- To Understand the algorithm
- To Understand Programming

TEXT BOOKS

1. Hillier and Lieberman "Introduction to Operations Research", TMH, 2000.
2. R.Panneerselvam, "Operations Research", PHI, 2006
3. Hamdy ATaha, "Operations Research –An Introduction", Prentice Hall India, 2003.

REFERENCES

1. Philips, Ravindran and Solberg, "Operations Research", John Wiley, 2002.
2. Ronald L.Rardin, "Optimization in Operation Research" Pearson Education Pvt. Ltd. New Delhi, 2005

19RMPX19 **INTERNET OF THINGS** **LT P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT **9**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack — Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

UNIT II IoT PROTOCOLS **9**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

UNIT III DESIGN AND DEVELOPMENT **9**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES **9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS 9

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plant wide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- Explain the concept of IoT.
- Analyze various protocols for IoT.
- Design a PoC of an IoT system using Rasperry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT.
- Analyze applications of IoT in real time scenario

TEXT BOOKS

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

REFERENCES

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015

2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012 (for Unit 2).

3. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

19RMPX20 UNCONVENTIONAL MACHINING PROCESSES LT P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications
- To learn about Mechanical Energy Based Processes
- To learn about Electrical Energy based Processes
- To learn about Electrical Energy based Processes
- To learn about Thermal energy based Processe

UNIT I INTRODUCTION 6

Unconventional machining Process – Need – classification – Brief overview .

UNIT II MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining.(AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM)- working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

UNIT IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 11

Chemical machining and Electro-Chemical machining (CHM and ECM)-Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH - Applications.

UNIT V THERMAL ENERGY BASED PROCESSES 10

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques – Applications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students able to

- Understand the Unconventional machining Process
- Understand the Mechanical Energy Based Processes
- Understand the Energy based Processes
- Understand the Electrical Energy based Processes
- Understand the Thermal energy based Processes

TEXT BOOKS

1. Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007

2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill, New Delhi,2007.

REFERENCES

1. Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York, 1987.

2. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.

3. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, "Material and Processes in Manufacturing"Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001

PROFESSIONAL ELECTIVE – V.

19RMPX21	**EMBEDDED SYSTEM DESIGN**	**L T P C** **3 0 0 3**

OBJECTIVES

The main objective of this course is to

- To provide the overview of embedded system design principles
- To understand the concepts of real time operating systems
- To understand PIC Microcontroller
- To understand embedded networking
- To provide exposure to embedded system development tools with hands on experience in using basic programming techniques.

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Overview of embedded systems, embedded system design process, challenges - common design metrics and optimizing them. Hardware - Software code sign embedded product development.

UNIT II REAL TIME OPERATING SYSTEM 9

Real time operating systems Architecture - Tasks and Task states - Tasks and Data – Semaphone and shared data - Message queues, mail boxes and pipes - Encapsulating semaphores and queues - interrupt routines in an RTOS

UNIT III PIC MICROCONTROLLER 9

Architecture - Instruction set - Addressing modes - Timers - Interrupt logic - CCP modules - ADC.

UNIT IV EMBEDDED NETWORKING 9

Introduction - CAN BUS - I2C - GSM - GPRS - Zig bee.

UNIT V EMBEDDED PROGRAMMING 9

I/O Programming, Interrupts and Timer application ,Interfacing Keypad, Interfacing LCD, Interfacing ADC/DAC

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- Explain the need of embedded systems and their development procedures.
- Summaries the concepts involved in Real time operating systems.
- Use various tools for developing embedded applications.
- Explain the construction, addressing modes and instructions sets of PIC micro controller.
- Conduct experiments with I/O systems used in embedded systems.

TEXT BOOKS

1. Frank Vahid, Tony John Givargis, Embedded System Design: A Unified Hardware/ Software Introduction - Wiley & Sons, Inc.2002 .
2. Rajkamal, 'Embedded System – Architecture, Programming, Design', Tata Mc Graw Hill, 2011
3. John B. Peatman, "Design with PIC Microcontrollers" Prentice Hall, 2003.

REFERENCES

1. Steve Heath, 'Embedded System Design', II edition, Elsevier, 2003.
2. David E. Simon, "An embedded software primer", Addison – Wesley, Indian Edition Reprint (2009).
3. Robert Foludi "Building Wireless Sensor Networks", O'Reilly, 2011.

19RMPX22 WIRELESS SENSORS NETWORKS FOR ROBOTICS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- 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 8

Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks.

UNIT II ARCHITECTURES 9

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

OUTCOMES

At the end of the course students able to

- Ability to know about the different techniques used in networking
- To expose basic knowledge about wireless sensor networks
- Ability to know about the tools in networking
- Understand the basic in wireless architecture
- Ability to know about the protocols used in networking

TEXTBOOKS

1. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.

2. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

REFERENCES

1.KazemSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols, And Applications", John Wiley, 2007.

2. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.

19MEPX23 COMPUTER INTEGRATED MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- Provide knowledge on production planning and control and computer aided process planning.
- Impart knowledge on group technology and cellular manufacturing.
- Learn the flexible manufacturing system and various AGVS techniques.
- Understand the functions of the basic components of a robot.

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM - Manufacturing planning and control- Introduction to CAD/CAM - Concurrent Engineering - CIM concepts - Computerised elements of CIM system - Types of production - Basic elements of an automated system - Levels of automation - Lean production and Just-In-Time production.

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 9

Process planning - Computer Aided Process Planning (CAPP) - Logical steps in Computer Aided Process Planning - Aggregate Production Planning - Master Production Schedule (MPS) - Material Requirement Planning-I (MRP-I) - Capacity Planning - Control Systems - Shop Floor Control (SFC) - Inventory Control - Manufacturing Resource Planning-II (MRP-II) - Enterprise Resource Planning (ERP).

UNIT III CELLULAR MANUFACTURING 9

Group Technology (GT) - Part Families - Parts classification and coding - Production Flow Analysis (PFA) -Cellular Manufacturing - Composite part concept - Machine cell design and layout - Quantitative analysis in cellular manufacturing - Rank order clustering method - Arranging machines in a GT cell - Hollier Method.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM AND AUTOMATED GUIDED VEHICLE SYSTEM 9

Types of flexibility - FMS - FMS components - FMS application and benefits - FMS planning and control -Quantitative analysis in FMS - Automated Guided Vehicle System (AGVS) - Application - Vehicle guidance technology - Vehicle management and safety.

UNIT V INDUSTRIAL ROBOTICS 9

Robot anatomy and related attributes - Classification of robots - Robot control systems - End effectors -Sensors in robotics - Robot accuracy and repeatability - Industrial robot applications - Robot part programming.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Clarify the basic concepts of CAD, CAM and Computer Integrated Manufacturing Systems.
- Summarize the production planning and control and computerized process planning.
- Differentiate the different coding systems used in group technology.
- Enumerate the concepts of Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS).
- Understand the various types of robots in industrial applications.

TEXT BOOKS

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 3rd Edition, 2012.
2. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", New Age International (P) Ltd., New Delhi, 4 th Edition , 2018.

REFERENCES

1. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2013.
2. Rao.P, N Tewari & T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2012.

E-RESOURCES

1. https://nptel.ac.in/courses/112/104/112104289/ - (Computer Integrated Manufacturing)
2. https://onlinecourses.nptel.ac.in/noc20_me44/preview - (Computer Integrated Manufacturing)

19RMPX24 **SUPPLY CHAIN MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To provide an insight on the fundamentals of supply chain networks, tools and techniques.
- To Learn Network design
- To learn Logistics
- To Learn Coordination chain
- To learn the information technology

UNIT I INTRODUCTION **9**

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

UNIT II SUPPLY CHAIN NETWORK DESIGN **9**

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

UNIT III LOGISTICS IN SUPPLY CHAIN **9**

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

UNIT IV SOURCING AND COORDINATION IN SUPPLY CHAIN **9**

Role of sourcing supply chain supplier selection assessment and contracts - Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

UNIT V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 9

The role IT in supply chain - The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain –E-Business in supply chain.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Understand the framework and scope of supply chain networks and functions.
- Ability to design supply chain networks to enhance supply chain performance
- Understand the role of logistics in supply chain
- Understand the Role of sourcing supply chain
- Understand the Information Technology of supply chain

TEXT BOOKS

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and operation", Pearson Education, 2010.

2. Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management", PHI, 2010

REFERENCES

1 David J.Bloomberg , Stephen Lemay and Joe B.Hanna, "Logistics", PHI 2002.

2 James B.Ayers, "Handbook of Supply chain management", St.Lucle press, 2000.

3 Jeremy F.Shapiro, "Modeling the supply chain", Thomson Duxbury, 2002.

19RMPX25 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication techniques.
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

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 – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS-I 9

Electrostatic sensors – Parallel plate capacitors – 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 – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT III SENSORS AND ACTUATORS-II 9

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT IV MICROMACHINING **9**

Silicon Anisotropic Etching – Anisotrophic 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 Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS **9**

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- Ability to understand and apply basic science, circuit theory, Electro-magnetic field theory control theory and apply them to electrical engineering problems.
- Ability to understand and analyse, linear and digital electronic circuits.
- Ability to understand Sensors and actuators
- Ability to understand Micromachining
- Ability to understand Polymers

TEXT BOOKS

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
2. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.
3. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi,2002.

REFERENCES:

1. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010
2. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son LTD,2002
3. Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2000
4. Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer 2012.

19RMOX01 AIR POLLUTION AND CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.
- Understand the Metrology
- Understand the Particulate Contaminants
- Understand the Gaseous
- Understand the Air Quality Management

UNIT I INTRODUCTION 7

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

UNIT II METEOROLOGY 6

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 11

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

UNIT V INDOOR AIR QUALITY MANAGEMENT 10

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- an understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
- ability to identify, formulate and solve air and noise pollution problems
- ability to design stacks and particulate air pollution control devices to meet applicable standards.
- Ability to select control equipments.
- Ability to ensure quality, control and preventive measures.

TEXTBOOKS

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

REFERENCES

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution",Tata Mcgraw Hill Publishing Company limited,2007.

19RMOX02 **FIBER REINFORCED PLASTICS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To introduce the various materials for composite structure.
- To equip with the knowledge of sandwich structure technology.
- To provide knowledge in fracture mechanics of composites.
- To impart knowledge in fatigue and damping capacity of composite materials.
- To provide understanding of various manufacturing/fabricating techniques for composite structures

UNIT I Introduction **9**

Definition, Reason for composites, Classifications of composites, Thermosets - Epoxy; Unsaturated polyester resin; vinyl ester,polyimides etc.,- preparation, properties, and uses.

UNIT II Reinforcements **9**

Types, Properties, chemistry and applications of fillers such as silica, titanium oxide, talc, mica etc., Manufacturing process, Properties, structure and uses of Glass fiber-. Carbon, Aramid, Boron, jute, sisal, cotton

UNIT III Fabrications of Thermoset composites **9**

Hand lay up method, compression and transfer moulding, pressure and vacuum bag process, filament winding, protrusion, reinforced RIM, RRIM, Injection moulding, of thermosets, SMC and DMC, Advantages and disadvantages of each method.

UNIT IV Testing of composites **9**

Destructive and non-destructive tests; Destructive- tensile, compression, flexural, impact strength, Hardness — Fatigue- toughness HDT ,basic concepts of fracture mechanisms

UNIT V Applications of composites **9**

Aerospace, land transport, marine, structural, chemical plants and corrosion resistant products, mechanical engineering and energy applications sports, electrical, electronic and communication applications, biomedical applications, repairs and maintenance etc.,

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Select various materials for designing composite structures.
- Apply knowledge of fracture mechanics of composites during designing of composite structures.
- Analyze critically the damping capacity of composite materials.
- Correlate various manufacturing/fabricating techniques for composite structures based on design

TEXTBOOKS

1. Hand book of composite by G. Lubin, Van Nostrand Co., New York 1969.
2. Polymers and Polymer Composites in Construction by L.C. Holleway, 1990
3. Designing with Reinforced composites- Technology-Performance, Economics-Rosato, 2st Ed. 1997.

REFERENCES

1. Delwane Composite design Encyclopedia – (Vol 3 Processing and Fabrication / Technology _ Ed. Leif Carlssen. And Joahn W. Hillispie, Technomic Publishing Ah. Lancaster U.S.A.
2. Fiber glass Reinforce Plastics – Nicholas P. Cheremisinoff and Composites Paul N. Cheremmisin off.,Noyes Publications, N.J. U.S.A. 1995.
3. Polymer layered silicate and silica nano composites, Y.C. Ke, P. Stroeve and F.S. Wang, Elsevier, 2005

19RMOX03 **INDUSTRIAL SAFETY ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To provide in depth knowledge in Principles of Environmental safety and its applications in various fields.
- To provide the knowledge of air and water pollution and their control.
- To expose the students to the basics in hazardous waste management.
- To expose the inspection and testing
- To expose industrial safety

UNIT I SAFETY IN METAL WORKING AND WOOD WORKING MACHINES 9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. Inspection of material handling equipments.

UNIT II SAFETY IN WELDING AND GAS CUTTING 9

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

UNIT III SAFETY IN COLD FORMING AND HOT WORKING OF METALS 9

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes - Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures - Safety in Gas Furnace Operation, Cupola, Crucibles, Ovens, Foundry Health Hazards, Work Environment, Material Handling in Foundries, Foundry Production Cleaning And Finishing Foundry Processes.

UNIT IV SAFETY IN FINISHING, INSPECTION AND TESTING 9

Heat treatment operations, Electro Plating, Paint Shops, Sand And Shot Blasting, Safety In Inspection And Testing, Dynamic Balancing, Hydro Testing, Valves, Boiler Drums And Headers, Pressure Vessels, Air Leak Test, Steam Testing, Safety In Radiography, Personal Monitoring Devices, Radiation Hazards, Engineering And Administrative Controls, Indian Boilers Regulation.

UNIT V INDUSTRIAL SAFETY 9

Advances in Industrial Ergonomics and safety, Work and protective clothing, Theory and practice of Industrial safety, Industrial Noise and Vibration, Machine Guarding and Industrial machine safety, Manual material handling, Modeling for safety and health.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Illustrate and familiarize the basic concepts and scope of engineering safety.
- Understand the standards of professional conduct that are published by professional safety organizations and certification bodies.
- Illustrate the importance of safety of employees while working with machineries.
- Understand the inspection and testing
- Understand the industrial safety

TEXTBOOKS

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly, Accident Prevention Manual – NSC, Chicago, 2009.
2. Charles D. Reese, Occupational Health and Safety Management, CRC Press, 2003.

REFERENCES

1. John V. Grimaldi and Rollin H. Simonds Safety Management by All India Travelers Book seller, New Delhi, 1989.
2. John Davies, Alastair Ross, Brendan Wallace, Safety Management: A Qualitative Systems Approach, CRC Press, 2003.

19RMOX04 ROBOTICS APPLICATION FOR DISASTER MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders – Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA **9**

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS **9**

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- To Differentiate the types of disasters, causes and their impact on environment and society
- Understand the Disaster cycle
- Ability to Development projects
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarious in the Indian context, Disaster damage assessment and management.

TEXTBOOKS

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011

REFERENCES

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy,2009

19RMOX05 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Understand the human values and ethical theory.
- Provide basic knowledge about engineering ethics, variety of moral issues and moral dilemmas, professional ideals and virtues.
- Provide basic familiarity about engineers as responsible experimenters, research ethics, codes of ethics, industrial standards, exposure to safety and risk, risk benefit analysis.
- Understand the relationship between the engineer and the society.
- Have an adequate knowledge about MNC"s, business, environmental, computer ethics, moral leadership, sample code of conduct.

UNIT I HUMAN VALUES 9

Morals, values and ethics - Integrity - Work ethic - Service learning - Civic virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Cooperation - Commitment - Empathy - Self confidence - Character - Spirituality - Introduction to yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of „Engineering Ethics" - Variety of moral issues - Types of inquiry - Moral dilemmas - Moral autonomy - Kohlberg"s theory - Gilligan"s theory - Consensus and controversy - Models of professional roles - Theories about right action - Self-interest - Customs and religion - Uses of ethical theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - Engineers as responsible experimenters - Codes of ethics - A balanced outlook on law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - Assessment of safety and risk - Risk benefit analysis and reducing risk - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights - Intellectual Property Rights (IPR) - Discrimination.

UNIT V GLOBAL ISSUES **9**

Multinational corporations - Environmental ethics - Computer ethics - Weapons development - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership - Code of conduct - Corporate social responsibility.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Understand human values.
- Realize professional, ethical values and the knowledge of contemporary issues.
- Excel in competitive and challenging environment and contribute to industry through professional careers.
- Update and maintain the technical skills and continuing their education throughout their professional careers.
- Apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2014.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2014.

REFERENCES

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics - Concepts and Cases", Cengage Learning, 2014.
2. Subramaniam R, "Professional Ethics", Oxford University Press, 2013.

E-RESOURCES

1. https://nptel.ac.in/courses/110/105/110105097/ - (Ethics in Engineering Practice)
2. https://spocathon.page/video/lecture-11-professional-ethics-values-teaching - (Professional Ethics and Values in teaching

OPEN ELECTIVE – II

19RMOX06 ENTERPRENEURSHIP DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- 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.
- Understand the underlying principles of management.
- To develop and enhance one's decision making skills amidst competitive business market
- Understand the underlying principles of management.
- To analyze and identify the functions of entrepreneurial activities and its prerequisites under practical conditions.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management ofworking Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 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

OUTCOMES

At the end of the course students able to

- Understand the Entrepreneur
- Understand the Entrepreneurship Development Programs
- Understand the Business
- Ability to Financing and Accounting
- To gain knowledge and skills needed to runa business successfully.

TEXT BOOKS

1. Donald F Kuratko, "Entreprenuership — Theory, Process and Practice", 9th Edition, CengageLearning, 2014.
2. Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.
3.

REFERENCES

1. EDII "Faulty and External Experts — A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.
2. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
3. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2 nd Edition Dream tech, 2005.

19RMOX07 **FUNDAMENTALS OF ROBOTICS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Understand the Fundamentals Of Robots
- Study the components of robots
- Study the Principles of robots
- Study the Robot programming
- Study the robot Application

UNIT I Introduction **9**

Brief history, Classification of robot, Elements of robots joints, links, actuators, and sensors

UNIT II Components of the Industrial Robotics (Architecture of industrial robots) **9**

Position and orientation of a rigid body, Homogeneous transformations, Introduction to D-H parameters and its physical significance, Orientation of Gripper, Direct and inverse kinematics serial robots, Examples of kinematics of common serial manipulators.

UNIT III Principles of Robot Control **9**

Planning of trajectory, Calculation of a link velocity and acceleration, Calculation of reactions forces, Trajectory-following control.

UNIT IV Robot programming **9**

Robot programming methods, Robot programming languages, Requirements of a programming robots system, The robot as a multitasking system: Flow Control, Task Control.

UNIT V System integration and robotic applications **9**

Robot system integration, Robotic applications.

TOTAL : 45 PERIODS

OUTCOMES

At the end of the course students able to

- To know the classification of Robot

- Able to Architecture Of Industrial Robots
- Understand the principles of robot
- Understand the Robot Programming
- Able to Robot Application

TEXT BOOKS

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Robot technology fundamentals / James G. Keramas / Cengage Publications

REFERENCE BOOKS

1. Introduction to Robotics / John J Craig / Pearson Edu.
2. Applied Robotics / Edwin Wise / Cengage Publications.
3. Robotic Engineering / Richard D. Klafter, Prentice Hall.

19RMOX08 **SENSORS AND TRANSDUCERS** **L T P C**
3 0 0 3

OBJECTIVES

The main objective of this course is to:

- Introduce the sensors, transducers and their types.
- Acquire knowledge on Mechanical and electromechanical sensors.
- Study about thermal sensor.
- Understand the magnetic sensor and its types.
- Initiate the sensors and their applications.

UNIT I INTRODUCTION **9**

Definition, classification, static and dynamic parameters, Characterization - Electrical, mechanical, thermal and chemical. Classification of errors - Error analysis, Static and dynamic characteristics of transducers

UNIT II MECHANICAL AND ELECTROMECHANICAL SENSORS **9**

Resistive Potentiometer - strain gauge - Inductive sensors and transducer - capacitive sensors - ultrasonic sensors

UNIT III THERMAL SENSORS **9**

Gas thermometric sensors - acoustic temperature sensors - magnetic thermometer, resistance change - type thermometric sensors

UNIT IV MAGNETIC SENSORS **9**

Force and displacement measurement - Magneto resistive sensors - Hall Effect sensor, Inductance and eddy current sensors - Angular/rotary movement transducer - Electromagnetic flow meter, squid sensor

UNIT V SENSORS AND THEIR APPLICATIONS **9**

Automobile sensor - Home appliance sensor - Aerospace sensors - sensors for manufacturing medical diagnostic sensors - environmental monitoring.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Know basic concepts of various sensors and transducers
- Develop knowledge in mechanical and electromechanical sensor
- Differentiate the types of thermal sensor which are used in various applications
- List the types of magnetic sensors and working principles
- Recommend an sensor and its applications

TEXT BOOKS

1. Ernest O Doebelin, Measurement Systems – Applications and Design, Tata McGraw-Hill, 4thedition, 2016.

2. Sawney A K and Puneet Sawney, A Course in Mechanical Measurements and Instrumentation and Control, 14th edition, Dhanpat Rai and Co, New Delhi, 2016.

REFERENCES

1. Patranabis D, Sensors and Transducers, 6th Edition, PHI, New Delhi, 2015.

2. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

E-RESOURCES

1. https://nptel.ac.in/courses/108/108/108108147/
2. https://www.youtube.com/watch?v=1uPTyjxZzyo

19RMPX09 **INTELLECTUAL PROPERTY RIGHTS** **L T P C**
3 0 0 3

OBJECTIVE:

- The main objective of this course is to:
- To understand the basic concepts of IPR
- To learn the basic concepts of Registrations of IPRs
- To study the concepts of Agreements and Legislations
- To apply the knowledge of digital products andlaw
- To apply the concepts of enforcement of IPRs.

UNIT I INTRODUCTION **9**

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs **10**

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS **10**

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW **9**

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs **7**

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL :45 PERIODS

OUTCOMES

At the end of the course students able to

- Understanding the basic concepts of IPR
- Learning the basic concepts of Registrations of IPRs
- Studying the concepts of Agreements And Legislations
- Applying the knowledge of digital products and law
- Applying the concepts of enforcement of IPRs

TEXT BOOKS

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
2. S.V. Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi,2002

REFERENCES

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
3. Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.

19RMOX10 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

The main objective of this course is to

- Acquire various concepts of quality management.
- Apply the various principles of quality management.
- Impart quality using statistical process.
- Make use of the various tools to maintain quality
- Implement the quality system for ISO certification.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality statements - Strategic quality planning - Quality councils - Employee involvement -Motivation, empowerment, team and teamwork, recognition, reward and performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership, partnering, supplier selection, supplier rating.

UNIT III TQM TOOLS AND TECHNIQUES - I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, methodology, applications to manufacturing, service sector including IT - Bench marking , reason to bench mark, bench marking process - FMEA - Stages, types.

UNIT IV TQM TOOLS AND TECHNIQUES - II 9

Quality circles - Cost of quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM -Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction - Benefits of ISO registration - ISO 9000 series of standards - Specific standards - AS

9100, TS16949 and TL 9000 - ISO 9001 requirements - Implementation - Documentation - Internal audits -Registration - Environmental Management System: Introduction - ISO 14000 series standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course students able to

- Demonstrate various concepts of quality management.
- Elaborate the various principles of quality management.
- Inspect quality using statistical process.
- Select the various tools to maintain quality.
- Evaluate the quality system for ISO certification.

TEXT BOOKS

1. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia, Revised, Indian Reprint, Sixth Impression, 3rd Edition, 2013.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2011.

REFERENCES

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", First Indian Edition, Cengage Learning, 8th Edition, 2012.
2. Subburaj ramasamy, " Total Quality Management", McGraw Hill Education, Noiad, 2011.

E- RESOURCES

1. https://www.youtube.com/watch?v=UOuTBCrW2kY - (Total Productive Maintenance)
2. https://www.youtube.com/watch?v=ksR4Xy6tFcM - (Total Quality Management)

NATURE OF THE COURSE: GENERAL ELECTIVE COURSE

19NCCL01 : NCC AIRFORCE LEVEL-1 L T P C

Course Prerequisites : 75% Attendance in First Year of NCC 2 0 2 3

Course Objectives

The course is intended to ,

- Learn about the basic structure of NCC and its organization, Incentives, duties of Cadets, imbibe the knowledge of various types of Camp.
- Motivate the cadets as confidence leaders by refining their personality and self awareness, with the help of Communication skills and aware of creative, critical thinking abilities.
- Create a pool of organized, trained and motivated youth with leadership qualities in all walks of life rom the exposure of great leaders and their history.
- Inspire the cadets to take part in the Social Service Activities and also motivate them to know about their role in the society towards the development of Nation.
- Acquire knowledge about the basics of health and hygiene, yoga, environment cleanliness and motivate young Indians towards the path of clean India and acquaint about obstacle training.

UNIT I NCC General **7**

Aims, objectives and Organization of NCC-incentives-duties of NCC Cadets-NCC camps- types - onduct.

UNIT II PERSONALITY DEVELOPMENT

Personality Development -Factors-Self Awareness-Communication skills-Empathy-Critical and Creative thinking-Decision making.

UNIT III LEADERSHIP

Leadership Capsule-Traits- Case studies-leaders like APJ Abdul Kalam, RatanTata, shivaji, Tipu Sultan, Rabindranath Tagore, N Narayana murthy.

UNIT IV SOCIAL SERVICE

Social Service Capsule-Basics-Rural development programmes - NGOs-Contribution of Youth - Swatch Bharath Abhiyan, Social evils-Drug Abuse-Digital Awareness-Waste Management-WomenHealth and Sanitation-Tree Plantation-Traffic Awareness-Pollution.

UNIT V HEALTH AND HYGIENE

Hygiene and sanitation – First Aid – Introduction to Yoga – Adventure – Environmental

awareness andconservation – Obstacle Training -Adventure

PRACTICAL COMPONENT

S. No.	Name of the Experiment	CO Mapping	RBT
1	Foot Drill	CO1	Apply
2	Rifle Drill	CO1	Apply
3	Ceremonial Drill	CO2	Understand
4	Social Service and Community Development	CO4	Apply

TOTAL : 35+10=45 PERIODS

OUTCOMES

Upon the successful completion of this course students will be able to,

- Understand the basic organization of NCC and roles, responsibilities of cadets for the smoothfunctioning of all camps
- Develop the cadets personality and to think divergently to break functional fixedness
- Identify the Leadership traits from the admiration and qualities of great leaders
- Understand the concept and important of Social service and influence them to spreadawareness about various activities
- Practice healthy practices to improve the personal sanitation and hygiene and get into theadventurous activities

TEXT BOOKS

1. Text Books Cadet Hand Book (Specialized Subjects), published by DGNCC.
2. ANO Handbook

REFERENCES

1. Grooming tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG,NCC.
3. The Cadet, Annual Journal of the NCC.
4. Précis Issued by respective Service Headquarters on specialized subject vailable to PIStaff as reference material.

E-RESOURCES

1. https://www.indiancc.nic.in
2. https://www.indiancc.mygov.in
3. https://www.play.google.com/MY_IAF
4. https://www.play.google.com/DGNCC_Training

NATURE OF THE COURSE: GENERAL ELECTIVE COURSE

19NCCL02 : NCC AIRFORCE LEVEL - 2 **L T P C**

Course Prerequisites : 75% Attendance in Second Year Of NCC **2 0 2 3**

Course Objectives

The course is intended to

- Realize the importance of national security and threats for the nation and aware of NationalIntegration.
- Create interest in cadet to develop into great leaders by teaching them about problemsolvingtechniques, handling emotions, time management skills.
- Aware of disaster management and motivate the young minds to help during the time ofdisasters.
- Create a pool of organized, trained and motivated youth with authoritative qualities to serve inIAF and to know the significance of Airmanship, Air Campaigns
- To learn about the Aero Modelling for better understanding of flying and also to choose theArmed Forces as a career.

Course Theory Contents

UNIT-I NATIONAL INTEGRATION AND AWARENESS **7**

National Integration and Awareness - importance and necessity-factors affecting National integration- Unity inDiversity-Threats to National Security.

UNIT-II PERSONALITY DEVELOPMENT **7**

Problem solving- - Group discussions-Coping with stress and emotions-Change your mindset-Time management-Social skills-Team work-public speaking.

UNIT-III DISASTER MANAGEMENT **7**

Disaster Management Capsule — Organization - Types -Essential services — Assistance - Civil Defence Organization. Initiative training-organizing skills-Dos and Don"t"s. Fire Services and Fire Fighting

UNIT-IV GENERAL SERVICE KNOWLEDGE ON AIRCRAFT AND AIRMANSHIP **7**

Armed forces and IAF Capsule-Modes of Entry in IAF-Aircraft types, capabilities and role-AirCampaigns-Principle of Flight-Forces acting on Aircraft-Airmanship – Navigation.

UNIT-V AERO MODELLING **7**

Introduction and Types of Aero Engine – Aircraft Controls – Introduction to Radars – Aero modelling capsule –Flying/Building of Aero models – Micro Light Flying – Simulator Flying

PRACTICAL COMPONENT

TOTAL: 35+10=45 PERIODS

S.No	Name of the Experiment	CO Mapping	RBT
1	Foot Drill	CO1	Apply
2	Rifle Drill	CO1	Apply
3	Weapon Assembling and Reassembling	CO2	Understand
4	Basics of Aero modelling	CO4	Apply

OUTCOMES

Upon the successful completion of this course students will be able to,

- Realize the importance of National integration, threats and factors affecting the NationalSecurity.
- Demonstrate their public speaking skills and problem solving techniques
- Identify the problems during Disaster type and to give solutions during the emergencyperiods with their divergent thinking
- Grasp the concept of IAF and its importance to the nation and detailed Knowledge on Aircraft and Airmanship
- Obtain knowledge on Aero Modelling, handle of radars and insight about Aircraft, Aero modelsand flying.

TEXT BOOKS

1. Cadet Hand Book (Common Subjects), published by DGNCC.
2. Cadet Hand Book (Specialized Subjects), published by DGNCC.
3. ANO Hand Book

REFERENCES

1. Grooming tomorrow's Leaders, published by DG, NCC.
2. Youth in Action, published by DG, NCC.
3. The Cadet, Annual Journal of the NCC.
4. Précis Issued by respective Service Headquarters on specialized subject available to PIStaff as reference material.

E-RESOURCES

1. https://www.indiancc.nic.in
2. https://www.indiancc.mygov.in
3. https://www.play.google.com/MY_IAFs
4. https://www.play.google.com/DGNCC_Training

LIST OF HUMANITIES AND SOCIAL SCIENCES (HS) COURSES

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19HST101	Communicative Techno English - I	HS	3	0	0	3	40	60	100
19HST201	Communicative Techno English - II	HS	3	0	0	3	40	60	100
19CYT201	Environmental Science and Engineering	HS	3	0	0	3	40	60	100

LIST OF BASIC SCIENCES (BS) COURSES

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19MAT101	Engineering Mathematics - I	BS	3	1	0	4	40	60	100
19CYE101	Engineering Chemistry	BS	3	0	2	4	50	50	100
19PHE101	Engineering Physics	BS	3	0	2	4	50	50	100
19MAT201	Engineering Mathematics - II	BS	3	1	0	4	40	60	100
19PHT201	Physics of Materials	BS	3	0	0	3	40	60	100
19MAT301	Transforms and Partial Differential Equations	BS	3	1	0	4	40	60	100
19MAT404	Statistics and Numerical Methods	BS	3	1	0	4	40	60	100

LIST OF ENGINEERING SCIENCES (ES) COURSES

Course Code	Name of the Subject	Category	Periods /Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
19GET101	Engineering Graphics	ES	3	0	0	3	40	60	100
19GEE101	Computer Fundamentals and Python Programming	ES	3	0	2	4	50	50	100

LIST OF EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	Name of the Subject	Category	Hours / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19EEC101	Life Skills for Engineers	EEC	0	0	2	0	100	-	100
2	19EEC201	Technical Skill (AutoCAD)	EEC	0	0	2	0	100	-	100
3	19EEC302	Entrepreneurship Development Activity	EEC	0	0	2	0	100	-	100
4	19EEC301	Communication Skills	EEC	0	0	2	0	100	-	100
5	19EEC501	Quantitative Aptitude Learning	EEC	0	2	0	0	100	-	100
6	19MEJ605	Mini Project	EEC	0	0	2	1	100	-	100
7	19RMJ701	Industrial Training	EEC	0	0	2	2	100	-	100
8	19MEJ805	Project Work	EEC	0	0	20	12	40	60	100

LIST OF MANDATORY COURSES (MC)

Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CIA	ESE	TOT
Semester - I									
19MDC101	Induction Program (2 Weeks)	MC	-	-	-	-	-	-	-
Semester - II									
19MDC201	NSS/YRC/RRC	MC	-	-	-	-	100	-	100
Semester - III									
19MDC301	Leadership Enhancement Programme	MC	1	0	0	0	100	-	100
Semester - IV									
19MDC401	Value Added Course-I	MC	0	0	2	0	100	-	100
Semester - V									
19MDC501	Value Added Course-II	MC	0	0	2	0	100	-	100
Semester - VI									
19MDC601	Constitution of India	MC	3	0	0	0	100	-	100

CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(For the Students Admitted in the Academic Year 2019-2020 onwards)

CREDIT SUMMARY

DEPARTMENT OF ROBOTICS AND AUTOMATION

Category	Credits Per Semester								Credit Total
	I	II	III	IV	V	VI	VII	VIII	
HS	3	6	-	-	-	-	-	-	09
BS	12	7	4	4	-	-	-	-	27
ES	7	-	-	-	-	-	-	-	07
PC		8	16	19	24	15	4		86
PE	-	-	-	-	-	3	6	6	15
OE	-	-	-	-	-	3	3		06
EEC	-	-	-	-	-	1	2	12	15
MC	-	-	-	-	-	-	-	-	-
Total	22	21	20	23	24	22	15	18	165

DEPARTMENT OF ROBOTICS AND AUTOMATION

REGULATION-2019

MINOR DEGREE / HONOURS

INDUSTRIAL ROBOTICS

CURRICULUM AND SYLLABI

CURRICULUM AND SYLLABI

FOR B.E. / B.Tech. DEGREE PROGRAMMES

(MINOR DEGREE / HONOURS)

INDUSTRIAL ROBOTICS

B.E- ROBOTICS AND AUTOMATION

S.No	Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19RMIT01	Introduction to Robotics	PC	3	0	0	3	40	60	100
2	19RMIT02	Principles of Industrial Robotics	PC	3	0	0	3	40	60	100
3	19RMIT03	Applied and Industrial Robotics	PC	3	0	0	3	40	60	100
4	19RMIE01	Robotic Automation Process	PC	3	0	2	4	50	50	100
5	19RMIP01	Project Work	EEC	0	0	12	6	40	60	100
TOTAL CREDITS				19						

PC :Professional Core
EEC :Employability Enhancement Courses
L :Lecture
T :Tutorial
P :Practical
C :Credit Point
CIA :Continuous Internal Assessment
ESE :End Semester Examination
TOT :Total

SEMESTER III

19RMIT01	INTRODUCTION TO ROBOTICS	LT P C 3 0 0 3

OBJECTIVES

- To introduce the functional elements of Robotics
- To impart knowledge on the Grippers and sensors
- To educate on various drives and control
- To introduce the Programming and Languages
- To introduce AI for Robotics

UNIT I INTRODUCTION TO ROBOTICS **9**

Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

UNIT II GRIPPERS AND SENSORS FOR ROBOTICS **9**

Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.

UNIT III DRIVES AND CONTROL FOR ROBOTICS **9**

Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control.

UNIT IV PROGRAMMING AND LANGUAGES FOR ROBOTICS **9**

Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., Development of languages since WAVE till ROS.

UNIT V ARTIFICIAL INTELLIGENCE IN ROBOTICS **9**

Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.

TOTAL = 45 PERIODS

OUTCOMES

Upon completion of this course, the students will be able to;

- Interpret terminologies related to Robotics technology.
- Analyze the various grippers and sensors for robotics.
- Apply logic for drives and control robotic systems
- Apply the Programming and Languages
- Integrate knowledge of AI techniques in the area of robotic technology.

TEXT BOOKS

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006).
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019).

REFERENCES

1. S. B. Niku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
2. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009)

E-RESOURCES

1. https://www.youtube.com/watch?v=M0fjtV9nPJY
2. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-me05/

19RMIT02 PRINCIPLES OF INDUSTRIAL ROBOTICS LT P C
3 0 0 3

OBJECTIVES

- To Introduction to automation
- To learn Fluid power and fluid power systems
- To Assembly automation equipment
- To learn Programmable Logic Controllers
- To learn Microprocessors and Microcontrollers

UNIT I INTRODUCTION TO AUTOMATION 9

History, Elements of Automation, Types of Automation systems, Applications of Automation, Goals of Automation, low cost automation, Hierarchical levels in industrial automation systems.

UNIT II FLUID POWER AND FLUID POWER SYSTEMS 9

Introduction to fluid power- Classification of fluid power systems, comparison of electrical, hydraulic and Pneumatic systems; Basic circuit diagram of Hydraulic fluid power and pneumatic power systems, Components of Hydraulic fluid power systems, Components of Pneumatic power system, Logic Gates, Truth tables and Boolean algebra.

UNIT III ASSEMBLY AUTOMATION EQUIPMENT 9

Material Handling: Principles of Material Handling, Material handling equipment- Wheel conveyor, Gravity Roller conveyor, Chain conveyor, Flat belt conveyor, Magnetic belt conveyor, bucket conveyor, Vibrating conveyor, screw conveyor, vertical lift conveyor, trolley conveyor, Sortation conveyor, cranes and Hoists, storage equipment, AS/RS, AGV.

Transfer and assembly equipment: Introduction to feeder units, Cycled transfer equipment and non-cycled transfer equipment. Automated assembly machines: Dial indexing machine, In-line machine, and floating work platform machines.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable Logic Controllers (PLC): Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Applications.

PLC hardware Components: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, Typical Discrete I/O Module Specifications, Typical Analog I/O Module Specifications, The Central Processing Unit (CPU),Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

UNIT V MICROPROCESSORS AND MICROCONTROLLERS 9

Evolution of microprocessors and microcontrollers; Architectures of microprocessors and microcontrollers; Integration of mechanical systems with computer and electronic systems (Mechatronic systems). Feedback devices: LVDT, Linear/Rotary encoders, absolute encoders, resolvers and potentiometers, Fundamentals of SCADA and Data Acquisition Systems.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of this course, the students will be able to;

- Demonstrate knowledge of automation and its different applications.
- Analyze functional characteristics of power systems for industrial applications.
- Apply knowledge of assembly automation equipment and its related components.
- Demonstrate the knowledge of programming logic controller units for industrial applications.
- Apply the knowledge of microprocessors and microcontrollers in integrating mechanical systems with computer and electronic systems.

TEXT BOOKS

1. Khushdeep Goyal, Industrial Automation and Robotics, S.K.Kataria & Sons, 4th Edition, 2013.
2. Frank. D.Petruzella, Programmable Logic Controllers, Tata McGraw-Hill Education, 4th Edition, 2011.

REFERENCES

1. M.P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Fourth edition, PHI Learning, 2016.
2. Geoffrey Boothroyd, Assembly Automation and Product design, Taylor and Francis Publishers, Second edition 2005.

E-RESOURCES

1. https://www.youtube.com/watch?v=M0fjtV9nPJY – (Theories of accident causation)
2. https://www.safetyproresources.com/blog/9-steps-for_accident-investigations - (OSHA inspection process)

SEMESTER V

19RMIT03 APPLIED AND INDUSTRIAL ROBOTICS LT P C
3 0 0 3

OBJECTIVES

- To General considerations in Robot material handling Sysytem
- To learn Expert system
- To study the Cooperative and Swarm Robot
- To understand the Field Robotics
- To Learn health care Robot

UNIT I ROBOT MATERIAL HANDLING 10

General considerations in Robot material handling, material transfer application, machine loading and unloading, CNC machine tool loading, Robot centered cell Assembly and parts presentation methods, Assembly operation, Compliance and the Remote center compliance (RCC) Device, Assembly system configurations, Adaptable programmable assembly system, Designing for robotic assembly, Inspection automation - vision inspection system, robot - manipulated inspection.

UNIT II EXPERT SYSTEMS 9

Factors influencing the choice of a robot, Robot performance testing - Path/point accuracy and repeatability, Maximum working envelop, Kinematic and State values. Robot safety Considerations, Factors affecting robot safety measures, Safety features built into industrial robot, Safety barriers and other devices.

UNIT II COOPERATIVE AND SWARM ROBOTS 7

Cooperative manipulation, Challenges in cooperative manipulation- Case studies for Cooperative manipulation for Industrial and Service applications; Introduction to swarm Robots, Comparison with other multi-agent systems, challenges and benefits of swarm systems- Algorithms for swarm Robots, application, case study of swarm Robots.

UNIT IV FIELD ROBOTS 10

Forestry, Robot locomotion, Forestry automation, Broad acre Applications- Automatic guidance, sowing, weeding, spraying and broad-acre harvesting; Horticulture, Picking of fruits, Robot milking, Sheep shearing, Slaughtering, livestock inspection, Robots in construction, Future directions; Robots for hazardous applications, Enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots, Robots actually used at disaster, Promising robots, open issues – Case studies; Cleaning Robots, lawn moving Robots- Smart appliances and smart homes.

UNIT V ROBOTS IN HEALTH CARE 9

Medical robotics, Core concepts, Technology- Medical robotic systems, Research *areas and*

applications; Rehabilitation and Health care robotics- Overview, physical therapy and training Robots; Robotic aid for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.

TOTAL = 45 PERIODS

OUTCOMES

Upon completion of this course, the students will be able to;

- Apply the knowledge of robotic material handling and assembly systems.
- Analyze the expert systems in robotic performance testing and safety
- Demonstrate knowledge of various cooperative and SWARM robots and its applications.
- Analyze robotic configurations and specifications for field and service applications.
- Demonstrate the core concepts of robots in medical applications.

TEXT BOOKS

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, Mc Graw Hill Book company, 4th edition, 2016.
2. Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing House, 1993.
3. Bruno Siciliano, OussamaKhatib, —Springer Handbook of Robotics, Springer-Verlag Berlin Heidelberg, 2008

REFERENCES

1. Yangsheng Xu Huihuan Qian Xinyu Wu, Household and Service Robots, Elsevier Ltd, 2015.
2. L Marques,A de Almeida,Mo Tokhi,GSVirk, —Advances in Mobile Robotics, World Scientific Publishing Co. Pte. Ltd. 2008.

E-RESOURCES

1. https://nptel.ac.in/courses/120108004 - (Environment Management)
2. https://www.youtube.com/watch?v=9QM-3LMeBQA–(FactoriesAct)

SEMESTER VI

19RMIE01	**ROBOTIC PROCESS AUTOMATION**	**L T P C**
	(Lab Embedded Theory Course)	**3 0 2 4**

OBJECTIVES

- To understand the basic concepts of Robotic process automation (RPA) is a software technology
- To learn Basics of RPA Tool in Robotics
- To Study Advanced Automation and its Techniques
- To explore the Exception Handling, Debugging and Logging operations in RPA
- To learn to deploy and maintain the software bot.
- To learn and understand the basics of fundamentals of robotics systems

UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 7

History of Automation - What is RPA - RPA vs Automation - Processes & Flowcharts - Programming Constructs in RPA - What Processes can be Automated - Types of Bots - Workloads which can be automated - RPA Advanced Concepts - Standardization of processes - RPA Development methodologies - Difference from SDLC - Robotic control flow architecture - RPA business case - RPA Team - Process Design Document/Solution Design Document - Industries best suited for RPA - Risks & Challenges with RPA - RPA and emerging ecosystem.

UNIT II RPA TOOL INTRODUCTION AND BASICS 10

Introduction to RPA Tool - The User Interface - Variables - Managing Variables - Naming Best Practices - The Variables Panel - Generic Value Variables - Text Variables - True or False Variables - Number Variables - Array Variables - Date and Time Variables - Data Table Variables - Managing Arguments - Naming Best Practices - The Arguments Panel - Using Arguments - About Imported Namespaces - Importing New Namespaces- Control Flow - Control Flow Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - About Control Flow - Control Flow Activities - The Assign Activity - The Delay Activity - The Do While Activity - The If Activity - The Switch Activity - The While Activity - The For Each Activity - The Break Activity - Data Manipulation - Data Manipulation Introduction - Scalar variables, collections and Tables - Text Manipulation - Data Manipulation - Gathering and Assembling Data.

UNIT III DVANCED AUTOMATION CONCEPTS & TECHNIQUES 10

Recording Introduction - Basic and Desktop Recording - Web Recording - Input/output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Image based automation - Keyboard based automation - Information Retrieval - Advanced Citrix Automation challenges - Best Practices - Using tab for Images - Starting Apps - Excel Data Tables & PDF - Data Tables in RPA - Excel and Data Table basics - Data

Manipulation in excel - Extracting Data from PDF - Extracting a single piece of data - Anchors - Using anchors in PDF.

UNIT IV HANDLING USER EVENTS & ASSISTANT BOTS, EXCEPTION HANDLING 9

Monitoring system event triggers - Hotkey trigger - Mouse trigger - System trigger - Monitoring image and element triggers - An example of monitoring email - Example of monitoring a copying event and blocking it - Launching an assistant bot on a keyboard event.

EXCEPTION HANDLING: Debugging and Exception Handling - Debugging Tools - Strategies for solving issues - Catching errors.

UNITV DEPLOYING AND MAINTAINING THE BOT 9

Publishing using publish utility - Creation of Server - Using Server to control the bots - Creating a provision Robot from the Server - Connecting a Robot to Server - Deploy the Robot to Server - Publishing and managing updates - Managing packages - Uploading packages - Deleting packages

TOTAL = 45+15=60 PERIODS

OUTCOMES

Upon completion of this course, the students will be able to;

- Describe RPA, where it can be applied and how it's implemented.
- Describe the different types of variables, Control Flow and data manipulation techniques.
- Identify and understand Image, Text and Data Tables Automation.
- Describe how to handle the User Events and various types of Exceptions and strategies.
- Understand the Deployment of the Robot and to maintain the connection.
- Identify and understand the unique characteristics and components of robotics systems

TEXT BOOKS

1. Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018.
2. Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes", Packt Publishing, 1st Edition 2018.
3. Srikanth Merianda,"Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018.

REFERENCES

1. Frank Casale , Rebecca Dilla, Heidi Jaynes , Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant", Independently Published, 1st Edition 2018.

E-RESOURCES

1. https://www.uipath.com/rpa/robotic-process-automation
2. https://www.academy.uipath.com

Fundamentals of Robotics Lab
List of Experiments

1. Study and analysis of robot grippers (includes the problems based on gripper force)
2. Demonstration of various robotic configurations using industrial robot
3. MATLAB program for simple kinematics of simple robot configuration
4. MATLAB program for inverse kinematics of simple robot configuration
5. To demonstrate simple robotic system using Matlab/ MscAdam / Robo Analyser software
6. Study of configuration of robots and motion of robot manipulator
7. Study of pick and place industrial robot
8. One Industrial visit for Industrial robotic application

SEMESTER VII

19RMIP01	**PROJECT WORK**	**L T P C**
		0 0 12 6

OBJECTIVES

The main objective of this course is to:

- Develop skills to formulate a technical project.
- Develop the ability to solve specific problem.
- Teach use of new tools, algorithms and techniques required to carry out the projects.
- Give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- Provide guidelines to prepare technical report of the project.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares 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 jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

OUTCOMES

At the end of the project, the students will be able to:

- Formulate a real world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies.
- Test and validate through conformance of the developed
- Prototype and analysis the cost effectiveness.
- Prepare technical report and oral presentations.
- On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering and find better solutions to it.

DEPARTMENT OF ROBOTICS AND AUTOMATION

REGULATION-2019

MINOR DEGREE/HONOURS

AI FOR ROBOTICS

CURRICULUM AND SYLLABI

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FOR B.E. / B.Tech. DEGREE PROGRAMMES

(MINOR DEGREE / HONOURS)

AI FOR ROBOTICS

B.E- ROBOTICS AND AUTOMATION

S.No	Course Code	Name of the Subject	Category	Periods / Week			Credit	Maximum Marks		
				L	T	P	C	CIA	ESE	TOT
1	19RMAT01	Fundamentals of Robotic System and Robot Programming	PC	3	0	0	3	40	60	100
2	19RMAT02	Fundamentals of Artificial Intelligence for Robotics	PC	3	0	0	3	40	60	100
3	19RMAT03	Machine Learning for Robotics	PC	3	0	0	3	40	60	100
4	19RMAE01	Advanced Control Systems Drivers for Robots	PC	3	0	2	4	50	50	100
5	19RMAP01	Project Work	EEC	0	0	12	6	40	60	100
TOTAL CREDITS				19						

PC :Professional Core
EEC : Employability Enhancement Courses
L :Lecture
T :Tutorial
P :Practical
C :Credit Point
CIA :Continuous Internal Assessment
ESE : End Semester Examination
TOT : Total

SEMESTER III

19RMAT01	**FUNDAMENTALS OF ROBOTIC SYSTEM AND ROBOT PROGRAMMING**	**LT P C 3 0 0 3**

OBJECTIVES

- To understand fundamentals of robotic systems
- To understand the basics of robot controls
- To introduce the concept of robot kinematics and Sensors
- To learn Robot cell Design
- To learn Basic robot Program

UNIT I INTRODUCTION **9**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

UNIT II END EFFECTORS AND ROBOT CONTROLS **9**

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

UNIT III ROBOT TRANSFORMATIONS AND SENSORS **9**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

UNIT IV ROBOT CELL DESIGN AND MICRO/NANO ROBOTICS SYSTEM **9**

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot. Micro/Nano Robotics system overview-Scaling effect-Top down and bottom up approach- Actuators of Micro/Nano robotics system- Nano robot communication techniques-Fabrication of micro/Nano grippers-Wall climbing micro robot working principles-Bio mimetic robot-Swarm robot-Nano robot in targeted drug delivery system.

UNIT V BASICS OF ROBOT PROGRAMMING **9**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands..

TOTAL: 45 PERIODS

OUTCOMES

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

- Apply the basic Concept of robot
- Analyze End Effectors and Robot Controls
- Apply the Robot Transformations and Sensors
- Explain about the Robot Cell Design
- Apply the Robot Programming

TEXT BOOKS

1. Craig. J. J. "Introduction to Robotics mechanics and control", Addison- Wesley,1999.
2. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009
3. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta,
4. Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012

REFERENCES

1. Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995.
2. Klafter. R.D, Chmielewski.T.A. and Noggin"s., "Robot Engineering : An Integrated Approach", Prentice Hall of Indiaz Pvt. Ltd.,1994.

E-RESOURCES

1. https://onlinecourses.nptel.ac.in/noc20_de11/preview

SEMESTER IV

19RMAT02	**FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE FOR ROBOTICS**	**LT P C 3 0 0 3**

OBJECTIVES

- To Introduce the Artificial Intelligence.
- To learn about Methods of Solving problems.
- To Understand the Programming and Logics
- To Introduce the concepts of Expert Systems
- To understand the basic concepts of Artificial Intelligence.

UNIT I INTRODUCTION **9**

Introduction – History, Definition of AI, Emulation of human cognitive process, Intelligent agents – The concept of rationality, the nature of environments, the structure of agents.

UNIT II SEARCH METHODS **9**

Problem – Solving Agents : Problem Definitions, Formulating Problems, Searching for solutions – Measuring Problem – Solving Performance with examples. Search Strategies : Uninformed search strategies – Breadth – first Search, Uniform – Cost Search, depth –first search, depth – limited search, Iterative deepening depth – first search, bidirectional search, comparing uniformed search strategies. Informed search strategies – Heuristic information, Hill climbing methods, best – first search, branch – and – bound search, optimal search and A* and Iterative deepening A*.

UNIT III PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE **9**

LISP and other programming languages – Introduction to LISP, Syntax and numerical function, LISP and PROLOG distinction, input, output and local variables, interaction and recursion, property list and arrays alternative languages, formalized symbolic logics – properties of WERS, non-deductive inference methods.

UNIT IV EXPERT SYSTEM **9**

Potential of AM, Potentials and Resulting Perspectives - Complex Geometries, Integrated Geometry, Integrated Functionalities, Multi-Material Parts and Graded Materials. AM-Based New Strategies – Customization.

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

OUTCOMES

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

- Explain the Artificial Intelligence.
- Identify appropriate AI methods to solve a given problem.
- Apply the Programming and Logics for AI
- Analyze the Expert Systems
- Apply for AI in Robots

TEXT BOOKS

1. Russell Stuart, Norvig Peter, "Artificial Intelligence Modern Approach", Pearson Education series in AI, 3rd Edition, 2010.
2. Dan.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI Learning, 2009.

REFERENCES

1. Donald.A.Waterman, "A guide to Expert Systems", Pearson, 2002.
2. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1992..

E-RESOURCES

1. https://onlinecourses.nptel.ac.in/noc21_ge20/preview

SEMESTER V

19RMAT03	**MACHINE LEARNING FOR ROBOTICS**	**LT P C 3 0 2 4**

OBJECTIVES

- To Introduce Machine Learning
- To understand Foundation of Learning
- To Understand the Advanced Learning
- To Learn Unsupervised Learning
- To understand Neural Networks

UNIT I INTRODUCTION **9**

Machine learning – Varieties of Machine learning – Learning Input- Output functions: Types of learning – Input Vectors – Outputs – Training regimes – Noise – Performance Evaluation.

UNIT II FOUNDATIONS OF SUPERVISED LEARNING **9**

Decision trees and inductive bias – Geometry and nearest neighbour's – Logistic regression – Perceptron – Binary classification.

UNIT III ADVANCED SUPERVISED LEARNING **9**

Linear models and gradient descent – Support Vector machines – Naïve Bayes models and probabilistic modelling – Model selection and feature selection – Model Complexity and Regularization.

UNIT IV UNSUPERVISED LEARNING **9**

Curse of dimensionality, Dimensionality Reduction, PCA, Clustering – K- means – Expectation Maximization Algorithm – Mixtures of latent variable models – Supervised learning after clustering – Hierarchical clustering.

UNIT V NEURAL NETWORKS **9**

Network Representation, Feed-forward Networks, back propagation, Gradient- descent method. Case Studies: Line following using Supervised Learning techniques – A simulation model for understanding both regression and classification techniques - Study of the effectiveness of the Bias-variance. Obstacle avoidance and navigation of a mobile robot in an unknown environment with the help of Neural Network -Use of stochastic PCA and the PCA neural network to find low dimensional features. Building a feed- orward neural network to ascertain automatic navigational queries.

TOTAL: 45 PERIODS

OUTCOMES

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

- Analyze the Machine Learning
- Analyze the types of trees and bias
- Apply the supervised learning methods with various case studies
- Compare the learning methodologies and dimensionality concepts
- Summarize the applications of neural networks in robotic applications.

TEXT BOOKS

1. Michalski, Carbonell, Tom Mitchell, 'Machine Learning', Springer, 2014.
2. Peter Flach, 'Machine Learning: The Art and Science of Algorithms that make sense of data',Cambridge, 2014.

REFERENCES

1. Hal Daume III, 'A Course in Machine Learning', Todo, 2015.
2. Ethem Alpaydin,'Introduction to Machine Learning', The MIT Press, 2004
3. Bruno Apolloni, Ashish Ghosh, Ferda Alpasian, "Machine Learning and Robot Perception", Springer, 2005.

E-RESOURCES

1. Introduction to Machine Learning By Prof. Balaraman Ravindran, IIT Madras

SEMESTER VI

19RMAE01 ADVANCED CONTROL SYSTEMS DRIVERS FOR ROBOTS LT P C
(Lab Embedded Theory Course) **3 0 2 4**

OBJECTIVES

- To Introduce the Digital control systems.
- To knowledge of Stability theory of Digital systems
- To understand the Models of Digital Control Systems.
- To learn the control system analysis
- To study the Stable Variable Analysis
- To learn various Control system and drivers

UNIT I INTRODUCTION 9

Configuration of the basic Digital Control Systems, types of sampling operations, Sample and Hold operations, Sampling theorem, Basic discrete time signals.

UNIT II STABILITY METHODS 9

Mapping between s-plane and z-plane, stability methods: Modified Routh Criterion, Jury‟s method, modified Schur-Cohn criterion.

UNIT III MODELS OF DIGITAL CONTROL SYSTEMS 9

Digital temperature control System, Digital position control system, stepping motors and their control. Design of Digital compensator using frequency response plots.

UNIT IV CONTROL SYSTEMS ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation, conversion of state variable models to transfer function and vice-versa, Eigen values and eigen vectors, Solution of state equations, Concepts of controllability and observability.

UNIT V STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS 9

State variable description of digital control systems, conversion of state variable models to pulse transfer function and vice versa, solution of state difference equations, controllability and observability.

ADVANCED CONTROL SYSTEM& DRIVES FOR ROBOTS LAB
List of Experiments (Any 7)

1. Determination of Transfer functions of an Electrical System.
2. Time Response Characteristics of a Second order System (Typical RLC network).
3. Characteristics of Synchros:
   (a) Synchro transmitter characteristics.
   (b) Implementation of error detector using synchro pair.
4. Determination of Magnetic Amplifier Characteristics with different possible connections.

5. Process Control Simulator:

(a) To determine the time constant and transfer function of first order process.
(b) To determine the time response of closed loop second order process with Proportional Control.
(c) To determine the time response of closed loop second order process with Proportional-Integral Control.
(d) To determine the time response of closed loop second order process withProportional-Integral-Derivative Control.
(e) To determine the effect of disturbances on a process.

6. To study the compensation of the second order process by using:
(a) Lead Compensator.
(b) Lag Compensator.
(c) Lead- Lag Compensator

7. Realization of AND, OR, NOT gates, other derived gates and ladder logic on Programmable Logic Controller with computer interfacing.
8. To determination of AC servomotor Characteristics.
9. To study the position control of DC servomotor with P, PI control actions.
10. Analog Computer:
(a) To examine the operation of potentiometer and adder.
(b) To examine the operation of integrator.
11. To solve a second order differential equation.

TOTAL: 45 + 15 = 60 PERIODS

OUTCOMES

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

- Analyze the Control system
- Analyze the Stability methods of Plan
- Apply the models of digital control system
- Explain the State variable control system
- Explain the State variable analysis of Digital control systems
- To Practice the various Control system and drivers

TEXT BOOKS

1. M. Gopal, Digital Control and State Variable Methods, Tata Mc-Graw-Hill.
2. K.Ogata, Discrete Time Control Systems, Pearson Education, (Singapore) (Thomson Press India).

REFERENCES

1. B.C Kuo, Digital Control Systems, Prentice Hall.
2. I.J. Nagrath & M.Gopal, Control System Engg., John Wiley & sons.
3. K.K. Aggarwal, Control System Analysis and Design, Khanna Publishers.

E-RESOURCES

1. https://nptel.ac.in/courses/108103007
2. https://nptel.ac.in/courses/101108047

SEMESTER VII

19RMAP01	**PROJECT WORK**	**L T P C**
		0 0 12 6

OBJECTIVES

- Develop skills to formulate a technical project.
- Develop the ability to solve specific problem.
- Teach use of new tools, algorithms and techniques required to carry out the projects.
- Give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
- Provide guidelines to prepare technical report of the project.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 works on a topic approved by the head of the department under the guidance of a faculty member and prepares 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 jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

OUTCOMES

At the end of the project, the students will be able to:

- Formulate a real-world problem, identify the requirement and develop the design solutions.
- Identify technical ideas, strategies and methodologies.
- Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
- Prepare technical report and oral presentations.
- On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering and find better solutions to it

CREDIT SUMMARY

FOR B.E. / B.Tech. DEGREE PROGRAMMES

MINOR DEGREE / HONOURS

(INDUSTRIAL ROBOTICS / AI FOR ROBOTICS)

B.E. ROBOTICS AND AUTOMATION

Category	Semester								Credit Total
	I	II	III	IV	V	VI	VII	VIII	
HS	-	-	-	-	-	-	-	-	-
BS	-	-	-	-	-	-	-	-	-
ES	-	-	-	-	-	-	-	-	-
PC	-	-	3	3	3	4	-	-	13
PE	-	-	-	-	-	-	-	-	-
OE	-	-	-	-	-	-	-	-	-
EEC	-	-	-	-	-	-	6	-	6
MC	-	-	-	-	-	-	-	-	-
Total	-	-	3	3	3	4	6	-	19