Shri Shamrao Patil (Yadravkar) Educational & Charitable Trust's
Sharad Institute of Technology College of Engineering
(An Autonomous Institute)
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Department of Automation and Robotics

Third-Year B. Tech.

Semester -V

Teaching and Evaluation Scheme

and

Syllabus

as per New Education Policy 2020

Abbreviations

L: Lecture

T: Tutorial

P: Practical

CA1- Continuous Assessment 1

CA2- Continuous Assessment 2

MSE: Mid Semester Exam

ESE: End Semester Exam

BSC: Basic Science Course

ESC: Engineering Science Course

PCC: Programme Core Course

PEC: Programme Elective Course

MDM: Multidisciplinary Minor

OE: Open Elective

VSEC: Vocational and Skill Enhancement Course

AEC: Ability Enhancement Course

IKS: Indian Knowledge System

VEC: Value Education Course

RM: Research Methodology

CEP: Common Engineering Project

FP: Field Project

CC: Co-curricular Courses

ELC: Experimental Learning Course

HSSM: Humanity Social Science and Management

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Sharad Institute of Technology College of Engineering

(An Autonomous Institute)

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Department: Automation and Robotics **Rev:** Course Structure/01/NEP/2023-24

Class: T.Y. B.Tech **Semester:** V

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation scheme					Credit
			L	T	P	CA1	CA2	MSE	ESE	Total	
23AR3501	PCC	Solid Mechanics	3	0	0	10	10	30	50	100	3
23AR3502	PCC	Manufacturing Technology and Metrology	3	0	0	10	10	30	50	100	3
23AR3503	PCC	Industrial Automation	3	0	0	10	10	30	50	100	3
23AR3504	PCC	Totally Integrated Automation Laboratory	0	0	2	15	15	-	20	50	1
23AR3505	PCC	Internet Tools and Java Programming Laboratory	0	0	2	15	15	-	20	50	1
23AR3506	VSEC	Materials Science and Testing Laboratory	0	0	2	25	25	-	-	50	1
23AR3507	PCC	CNC and Metrology Laboratory	0	0	2	15	15	-	20	50	1
23AR3508	CEP	Mini Project-IV	0	0	2	25	25	-	-	50	Audit
23AR3509	VSEC	Industrial/Field Training	0	0	0	25	25	-	-	50	Audit
23AR3510	CEP	Robot System Reliability and Safety	1	0	0	25	25	-	-	50	Audit
23AR3511	PEC	Program Elective Course-I	3	0	0	10	10	30	50	100	3
23OEAR33	OE	Open Elective-III *	3	0	0	10	10	30	50	100	3
23ARMDXX	MDM	Multidisciplinary Minor-III	3	0	0	10	10	30	50	100	3
23HSSM03	VEC	Aptitude Skill-III	2	0	0	25	25	-	-	50	Audit
23HSSM04	VEC	Language Skill-III	0	0	2	25	25	-	-	50	Audit
Total			21	0	12	255	255	180	360	1050	22

Multidisciplinary Minor-III

Basket 1 (A-Defense)	Basket 2 (B-Software)	Basket 3 (C-Space)
Radar Technologies (23ARMDA3)	Cloud computing (23ARMDB3)	Aircraft Structures-I (23ARMDC3)

Program Elective Course-I

Basket A (Field / Service Robotics)	Basket B (Advanced Manufacturing Technologies For Automation)	Basket C (Advanced Data science ,Sensors, Drive and Communication Systems)	Basket D (Advanced Robotic Technologies)
Mobile Robotics (23AR3511A)	Factory Automation (23AR3511B)	Electrical Drives and System (23AR3511C)	Industrial Robotics & Material Handling Systems (23AR3511D)

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verified

Solid Mechanics

23AR3501	PCC	Solid Mechanics	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Mechanics

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

CO1	Explain various types of loading and stresses induced in components.
CO2	Develop SFD and BMD for different types of loads and support conditions.
CO3	Analyze bending and shear stresses induced in mechanical components
CO4	Analyze principal stresses & strains by analytical and graphical method.
CO5	Evaluate torsional shear stress in shaft and strain energy in beams
CO6	Evaluate Buckling on Column

Course Contents:

Unit 1: Review of stress, strain & Elastic Constants: Concept of Stress and Strain, (Linear, Lateral, Shear and Volumetric), Hooke's Law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Stress-strain diagram for ductile and brittle material, Factor of safety, Working stress, Normal and shear stresses, Thermal stresses and strains . Concept, Numerical problems	[6]
Unit 2: Bending moment and shear force in Mechanical Elements Introduction, Types of beams, Loads and Reactions, Shear forces and bending moments, Rate of loading, Sign conventions, Relationship between shear force and bending moments, Shear force and bending moment diagrams subjected to concentrated loads, uniform distributed load (UDL) for different types of beams.(UVL not included)	[7]
Unit 3: Stresses in Mechanical Elements **Bending Stresses:** Symmetric pure bending of beams, Flexure formula, moment of resistance of cross-sections, Simple built-up section, Design of rectangular and circular(solid and hollow) sections; L, I and T sections **Shear Stresses**: Distribution of shear stresses in beams of various commonly used sections such as circular. I, T, and angles.	[7]
Unit 4: Principal Stresses and Strains Normal and shear stresses on any oblique planes, Concept of Principal planes,	[7]

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Derivation of expression for Principal stresses and maximum shear stress, Positions of principal planes and planes of maximum shear, Graphical solutions using Mohr's circle of stresses, Combined effect of shear and bending in Beam,	
Unit 5:Torsion& Energy Methods Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at ends Energy Methods: Concept of strain energy, Resilience, Proof resilience, Modulus of resilience, derivation for deformation of axially loaded members under gradual, sudden and impact loads	[6]
Unit 6: Buckling of Column Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, safe load on columns.	[7]
Text Books: 1. Strength of Materials, S. Ramamruthum, DhanpatRai and Sons, New Delhi. 2. Strength of Materials, R. K. Bansal, Laxmi Publication, 4th Edition. 3. Strength of Materials, Khurmi Gupta, S. Chand Publication. 4. Strength of Materials, R.K. Rajput, S. Chad Publication 5. Mechanics of structure, S.B Junnerkar,Charotar Publication House 6. Strength of Materials, S. S. Bhavikatti, Vikas Publication House 7. Strength of Materials, Timoshenko and Young, CBS Publication 8. Mechanics of Materials, S. S. Ratan, Tata McGraw Hill Publication, 2009 9. Strength of Materials,B. K. Sarkar, McGraw Hill Publication, 2003.	
Reference Books: 10. Strength of Materials, Beer and Johnson, CBS Publication 11. Strength of Materials, G.H. Rider,MacMillan India Ltd 12. Strength of Materials, Nag and Chanda, Willey India Publication 13. Advanced Mechanics of Materials, Boresi, Willey India Publication 14. Strength of Materials, Den Hartong, McGraw Hill Publication	

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Manufacturing Technology and Metrology

23AR3502	PCC	Manufacturing Technology and Metrology	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Physics, Basic Mechanical Engineering

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

CO1	Explain suitable material for different engineering applications
CO2	List different casting processes for manufacturing
CO3	Examine methods and devices for measurement of length, angle, and gear
CO4	Analyze main parts of machine tools for metal cutting operations
CO5	Categorize unconventional machining processes and various applications.
CO6	Simplify Nano Materials & PCB manufacturing

Course Contents:

Unit 1:Properties of Engineering materials and Smart Material: Historical Perspective, Importance of Engineering Materials, Classification of Materials, for Chemical, Electrical and magnetic materials, Material selection criteria Design considerations, Needs of Modern Materials, Composite materials: advantages and application of composites. Smart materials: Shape Memory Alloy, Piezoelectric and Magneto-strictive	[6]
Unit 2: Casting: Definition, classification of manufacturing processes. Casting: Introduction to casting, patterns, types, pattern materials, allowances, molding sand, Gating and riser , Cores & Core making Special Casting Process- Shell, Investment, Die casting, Centrifugal Casting, Melting furnaces- -crucibles oil fired furnaces-electric furnaces, cupola, and selection of furnace.	[6]
Unit 3: Metrology Need of measurement, possible errors in measurement. Unilateral and bilateral tolerances, Limits, Fits, Types of Fits, IS specifications of limits. Importance's of limits, System in mass production, limit gauges used for plain and taper works **Interferometer and Limits, Fits, Tolerances** Principle, NPL Interferometer, Flatness measuring using slip gauges, Parallelism, Laser	[6]

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Interferometer, Surface Finish Measurement, Design of Gauges: Types of Gauges, Taylor's Principle.	
Unit 4: Theory of Metal Cutting & Total Productive Maintenance Cutting tools and tool geometry ,tool materials-HSS ceramics, tool nomenclature, selection of tool materials and tool life, tool wear and machinability Mechanics of clip formation, types of chips and conditions Orthogonal vs. oblique cutting- merchant's force circle diagram. **Total Productive maintenance; Maintenance concepts,** Preventive maintenance, breakdown maintenance, Zero Defects, Human factors in maintenance, Condition Monitoring Techniques	[6]
Unit 5:Modern machining processes: Classification according to type of energy used for machining, basic principles, machines and applications of, Electrical discharge machining (EDM), Laser beam machining (LBM), Electrochemical machining (ECM), Ultrasonic machining (USM). **Additive Manufacturing:** Fundamentals of rapid prototyping, stereo lithography, laminated object manufacturing, fused deposition modeling,	[6]
Unit6: Nano Materials & PCB manufacturing **Nano-materials**–History, Classification of nano materials, Properties thermal, mechanical, chemical, optical and applications of nano-materials automotive, electronic, food ,textile industry **Electronic assembly and packaging:** PCB structure, types and materials. Processes used in PCB fabrication, PCB assembly	[6]

Text Books:

1. V.D. Kodgire and S.V. Kodgire, —Material Science and Metallurgy for Engineers, Everst publishing house, pune, 2008

Reference Books:

1. Elements of Workshop Technology (Volume -1 & 2) by S. K. HajraChoudhary, A. K. HajraChoudhary, Nirjhar Roy, Media promoters (2010).
2. A Course in Workshop Technology (Vol. I & II) by B. S. Raghuwanshi, DhanpatRai& CO. (2001).
3. Workshop Technology Part 1, 2 and 3. By W. A. J. Chapman, Taylor & Francis (1972).
4. Production Technology – HMT, Tata McGraw-Hill (1980).
5. Manufacturing, Engineering and Technology, 4th Edition, by SeropeKalpakjian, Steven R. Schmid, published by Pearson (2005).
6. Fundamentals of Modern Manufacturing- Materials, Processes and Systems, 3rd Edition by Mikell P. Groover, Wiley India (2002).
7. 7.Terry Wireman, "Total Productive Maintenance", 2nd Edition, Industrial Press, 2004
8. Manufacturing Processes for Engineering Materials, 4th Edition, by SeropeKalpakjian, Steven R. Schmid, published by Pearson (2007).
9. V.D. Kodgire and S.V. Kodgire, —Material Science and Metallurgy for Engineers, Everst publishing house, pune, 2008
10. 10.Raghavan V., —Materials science and Engineering- A first course,‖ 5th edition, ISBN: 978-81-203-2445-8, 2011
11. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-

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Pearson India, 2014.
12. Kalpakjian and Schmid, Manufacturing Engineering and Technology, 6 ed., Pearson.
13. Lindberg, Processes & Materials of Manufacture, Prentice Hall India.
14. Kumar & Gupta, Manufacturing Processes, Prentice Hall India.

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Industrial Automation

23AR3503	PCC	Industrial Automation	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: CAD/CAM-Automation

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

CO1	Identify the automation need, type, automation technologies and control systems
CO2	Develop Hydraulics and Pneumatics circuits used for automatic process controls of industrial systems.
CO3	Develop the Electro-Pneumatic circuits used for automatic process controls of industrial systems.
CO4	Create ladder diagrams from process control techniques.
CO5	Choose an appropriate SCADA architecture based on industry needs and requirements.
CO6	Identify key features and functionalities of various HMI types in industrial applications.

Course Contents:

Unit 1: Factory Automation and Integration and Control system Basic concepts, Elements of Automation , Advanced Automation system, Level of Automation, automation principles and strategies ,types of automation, Reasons for automation ,Automation Technologies used in manufacturing Industry, Automation in manufacturing .Benefits of Manufacturing Automation. Introduction to Programmable Logic Controllers (PLC), Human Machine Interface (HMI) & Supervisory Control and Data Acquisition System (SCADA); motion controller RFID technology	[7]
Unit 2: Design and Operation of Logic Control Circuits for Hydraulics and Pneumatics Basic elements of hydraulics/pneumatics, Application of Hydraulic system, Various elements with their function, Properties of hydraulic fluid ,Various types of pump, Hydraulic actuator, Design consideration for hydraulic cylinder, Rotary Actuator ,Hydraulic Motor, Fluid Power control unit-Pressure control valve, flow control valve & direction control, General layout of Pneumatic System, Compressor, selection of air compressor, Pneumatic Valve ,FRL Unit, Circuit design approach and real time examples; sequence operation of two cylinders as per the design requirement to automate	[7]

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the system, Comparison between Hydraulic, Pneumatic and Electrical system	
Unit 4: Design and Operation of Electro-Pneumatic Logic Control Circuits Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, process automation sensors, Electro pneumatic systems using relay logic circuits ,Direct control and Indirect control, Logic operations-OR circuit, AND circuit, Multi-track gravity Feed Magazine, Sorting devices, Circuit protection against high pressure and low pressure, Sequencing circuit /Cascade circuit-,Electro-hydraulic circuit Double acting cylinder with reed switch	[8]
Unit 5: Programmable Logic Controllers (PLC) Introduction, Definition, PLC system and components of PLC Input output module, PLC advantages and disadvantages. Ladder diagram and PLC programming fundamentals: Basic components and other symbols, Fundamentals of ladder diagram, Light control example, Internal relays, Disagreement circuit, Majority circuit, Holding (sealed or latches) contacts, Always ON always OFF contacts, Fail safe circuits, PLC timer counters functions and its industrial applications	[7]
Unit 5: Basics of SCADA System Industrial automation Hierarchy, Typical SCADA Architecture, Components of SCADA system-Master Terminal Unit, Remote Terminal Unit, HMI-Operator Interface, Communication Interface , Commercially available SCADA Softwares-InTouch, Vijeo Citec	[6]
Unit 6: HMI Systems and NETWORKING Need for HMI in Industrial Automation, Types of HMI – Configuration of HMI, Screen development and navigation, Configuration of HMI elements / objects and Interfacing with PLC PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet -CAN Open. APPLICATIONS OF PLC: Case studies of manufacturing automation andProcess automation.	[6]

Text Books:

1. Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003.
2. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - PrenticeHall - 2013 - 5 th Edition Singh, Shio Kumar.
3. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010
4. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing"Pearson Education, New Delhi, 2001.

Reference Books:

1. Mechatronics – W. Bolton, Pearson education
2. Mechatronics – Mahalik, TATA McGraw Hill
3. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill ,New York, USA. 2000.
4. Mechatronics – Appu Kuttam, Oxford publications
5. Introduction to PLC programming, NIIT,
6. Programmable logical controller, Hackworth, Pearson Education
7. Programmable logical controller, Reis Webb, Prentice Hall
8 Mechatronics and Microproceesor by Ramchandran Willey India

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9 Mechatronics : Integrated Mechanical Electronic System by Ramchandran Willey India
15. Programmable logical controller,3e Gary Dunning Cengage Learning
16. 11.Mechatronics Source Book by N C Braga Cengage Learning
17. Fluid Power with Applications by Anthony Esposito - Pearson Education 2000.
13. Power Hydraulics by Michael J, Prinches and Ashby J. G, - Prentice Hall, 1989 .

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Totally Integrated Automation Laboratory

23AR3504	PCC	Totally Integrated Automation Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week	CA–I :15 Marks CA–II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Basic knowledge of Semiconductor Physics and Basic Electronics.

Course Outcomes: At the end of the course students will be able to -

CO1	Select and specify various components for hydraulic and pneumatic systems
CO2	Evaluate the hydraulic and pneumatic systems based on various evaluation criteria
CO3	Develop the programming and implementation of programmable logic controllers.
CO4	Utilize the HMI/SCADA system for Various application

List of Experiments:

At least minimum 8 experiments should be performed from the following list

1 Minimum two circuits on Pneumatics to be developed on Pneumatic trainer kit

2. Minimum two circuits on Electro-Pneumatics to be developed on Electro Pneumatic trainer kit

3. Minimum two circuits on Hydraulics to be developed on Hydraulic trainer kit

4. Demonstration of different types of control valves used in hydraulic and pneumatic system.

5. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.

6 PLC Programming on Industrial Applications based on Timers, Counters, Internal Relays (Minimum 4 applications)

7. Demonstration of SCADA system with any one application

8. Develop HMI implementation of any application

9. Industrial visit to Automation Plant and submission of visit report

10. Modeling and analysis of basic hydraulic, pneumatic and electrical circuits using AUTOMATION STUDIO' Software

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Text Books:

1. "Programmable Logic Controller – Principles and Applications", 5/e, J. W. Webb, R.A. Reis; Prentice Hall of India Ltd. ISBN 81-203-2308-4.
2. "Programmable Logic Controller – Principles and Applications, by NIIT; Prentice Hall Publications Pvt. Ltd. India, ISBN 81-203-2525-7.
3. "Programmable Logic Controller – Programming methods and Applications", Hackworth
4. John R. and Hackworth Frederick D. Jr.; Pearson Education LCE, ISBN 81-297-0340

Reference Books:

1. Introduction to PLC – Gary Dumming – Delmar Pub.
2. Various PLC manufacturers catalogue.
3. Programmable Logic Controller – FESTO Pneumatics, - Bangalore
4. SCADA, Stuart A. Boyer (ISA Publi.) ISBN 1-55617-660-0.
5. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

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Internet Tools and Java Programming Laboratory

23AR3505	PCC	Internet Tools and Java Programming Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week	CA–I :15 Marks CA–II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Object Oriented Programming using C++

Course Outcomes: At the end of the course students will be able to -

CO1	Apply the concept of multithreading and implement exception handling.
CO2	Apply and access data from a Database with java program
CO3	Develop java programs using interfaces

List of Experiments:

At least minimum 10 experiments should be performed from the following list.

1. Setup java programming environment by using:
   a)Command Prompt Any IDE(Eclipse, J creator etc.)
2. Test the IDE setup by implementing small program.
3. Develop program to demonstrate use of IF statement and its different forms.
4. Develop programs to demonstrate use of
   a)Switch Case statement
   b)Conditional If(?:)
5. Develop programs to demonstrate use of looping statement 'for'
6. Develop programs to demonstrate use of 'while' , 'do while'
7. Develop program for implementation of implicit type casting and explicit type conversion in Java
8. Develop program for implementation of different functions of String
9. Develop program for an implementation of arrays in java
10. Develop program for an implementation of vectors in java
11. Develop program for an implementation of wrapper class to convert object into primitive.
12. Develop program for an implementation of wrapper class to convert primitive into objects
13. Develop program which implements concept of overriding
14. Develop program which implements single and multilevel inheritance

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Text Books:

1. Herbert Schildt, The Complete Reference Java2.0, Fifth edition, TATA McGraw-Hill Company.
2. Phil Hanna, JSP : Complete Reference, TATA McGraw-Hill Company
3. Debasish Jana, Java and Object-Oriented programming Paradigm, PHI. 4. Jana, Java and Object Oriented Programming Paradigm, PHI (2007).

Reference Books:

1. Professional Java Programming by Brett Spell, WROX Publication
2. Advanced Java 2 Platform, How to Program, 2nd Edition, Harvey. M. Dietal, Prentice Hall.
3. Advanced Java, Gajendra Gupta , Firewall Media.

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Materials Science and Testing Laboratory

23AR3506	VSEC	Materials Science and Testing Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Evaluation Scheme:**
Practical: 2 hours/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Fundamentals of Mechanical Engineering, Solid Mechanics

Course Outcomes: At the end of the course students will be able to -

CO1	Perform tensile, compression, shear, flexure, torsion, thermal, deflection and impact test on a material to understand the behavior of stresses and strains respectively.
CO2	Analyze the stress and strain for different loading conditions
CO3	Apply the different Sand Testing Properties for Pattern making
CO4	Analyze the stress and strain for different loading condition using software

List of Experiments:

At least minimum 8 experiments should be performed from the following list.

1. Tensile test for Ductile and Brittle Material& Compression test of Mild Steel, Cast iron using Universal Testing machine
2. Torsion test on Mild Steel circular sections using Torsion Testing Machine
3. Bending Test of Wood Material on Universal Testing Machine
4. Shear test of ductile material on Universal Testing Machine.
5. Experiment on Thermal stresses.
6. Impact test on mild steel, brass, aluminum, and cast iron specimens
7. Different Sand Testing Properties like Permeability test and Moisture content etc.
8. One job of plain turning, taper Turning, external threading and knurling operation
9. Carpentry shop: one Job of Pattern Making
10. Analyze the stress and strain for different loading condition in any analysis software

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11. Analyze the thermal analysis of a 2D component by using any analysis software
12. Analyze the convective heat transfer analysis of a 2D component using analysis software

Text Books:

1. Strength of Materials, S. Ramamruthum, DhanpatRai and Sons, New Delhi.
2. Strength of Materials, R. K. Bansal, Laxmi Publication, 4th Edition.
3. Strength of Materials, Khurmi Gupta, S. Chand Publication.
4. Strength of Materials, R.K. Rajput, S. Chad Publication
5. Mechanics of structure, S.B Junnerkar,Charotar Publication House

Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. D.S. Bedi, Strength of Materials, Khanna Book Publishing Company, 2018.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGrawHill Publishing Co. Ltd., New Delhi 2005

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CNC and Metrology Laboratory

23AR3507	PCC	CNC and Metrology Laboratory	0-0-2	1 Credits

Teaching Scheme:	Evaluation Scheme:
Practical: 2 hours/week	CA–I :15 Marks CA–II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Manufacturing Technology

Course Outcomes: At the end of the course students will be able to -

CO1	Explain the significance of measurement system, errors, and calibration of measuring devices.
CO2	Make use of metrological tools for linear, angular measurements
CO3	Make use of the programming and simulation using CAM Packages

List of Experiments:

Group A

1. Programming and simulation of a lathe using any CAM package
2. Programming and operation of a CNC machining centre

Group B

At least minimum 7 experiments should be performed from the following list

1 Study & Use of various linear measuring instruments (Vernier and micrometers)
2. Calibration of Dial Indicator using slip gauge.
3. Study and use of mechanical & pneumatic comparator
4. Study & use of Bevel protractor and Sine Bar for measurement of Angle.
5. Measurements of Screw thread parameters using Profile Projector
6. Measurement of gear tooth thickness using gear tooth Vernier caliper.
7. Demonstrate use of Gear Measuring Instruments
8. Study & use of Variable (X-Bar) chart

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9. Study & use of Attribute (P) chart

10.Caliper checker, Calibration of LVDT, Electronic comparator

11.Floating Carriage Micrometer, Laser Scan Micrometer, Ultrasonic thickness gauge

Text Books:

1. R.K. Jain, "Engineering Metrology", Khanna Publisher,
2. I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications.
3. N Sidheshwar,P Kannaiah,"Machie Drawing",TATA Magraw hill,2009.
4. Anand Bewoor, Vinay Kulkarni, " Metrology & Measurement" The McGraw-Hill Comp.
5. B.C. Nakara & K. K. Choudhari , "Instrumentation Measurement & Analysis", TATAMagraw hill,2012.

Reference Books:

1. "Engineering Metrology", I.C. GUPTA, DhanpatRai and Sons, 1988, 2nd Edition.
2. "Practical Engineering Metrology", Sharp K.W.B. Pitman, London, 1973, 1st Edition.
3. Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition
4. N.V Raghavendra and L. Krishnamurthy, Engineering Metrology and Measurements, Oxford

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Mini Project-IV

23AR3508	CEP	Mini Project-IV	0-0-2	01 Credit

Teaching Scheme	Evaluation scheme
Practical: 2hrs/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Mini Project-I, Mini Project II

About Hackathon

The project is a part of addressing societal and industrial needs. Hackathon is one of the platforms where students will solve real world challenges. This Course focuses on the selection of methods/engineering tools/analytical techniques for problem solving.

Through this course, students will gain the understanding of engineering basics and ideas, gain practical experience, have the opportunity to display their skills and learn about teamwork, financial management, communication skills and responsibility

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

CO1	Select the appropriate method for solving the problem
CO2	Make use of various engineering techniques and tools to give a solution
CO3	Justify the methods /tools used to develop the solution
CO4	Design / simulate the model/ project work
CO5	Describe the solution with help of a project report and presentation
CO6	Conclude the outcomes of project.

Course Contents:

Week 1:Survey Design-1 • Ensure case study group students have made necessary communication and done a preparatory visit. • Watch the lecture on survey design and study the notes.	[2]

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• Prepare a questionnaire and try it out with your group members as mock.	
Week 2: Survey Design-2 • Review survey questionnaire prepared by case study groups. • Decide sampling strategy. • Prepare a detailed schedule for fieldwork	[2]
Week 3: Fieldwork • Data Collection:Collect quantitative data (e.g., statistics, usage metrics) and qualitative data (e.g., user stories, testimonials). • Use data collection tools like questionnaires, observation checklists, and digital analytics. • Ensure data accuracy and reliability through proper sampling and recording methods. • 25% Presentation has to be conducted by mentor/guide based on above activity.	[2]
Week 4: Trails and Experimentation-1 • Initial Setup and Configuration • Concept Validation • Feasibility Testing	[2]
Week 5: Trails and Experimentation-2 • Prototyping • Functionality Testing	[2]
Week 6: Trails and Experimentation-3 • Bug Identification and Fixing • Integration Testing • Security Testing • 75% Presentation has to be conducted by mentor/guide based on above activity.	[2]
Week 7: Results • Coordinator has to check and verify below points in term of result: • Functional Performance • Accuracy and Precision • Efficiency • Safety	[2]
Week 8: Validation • Coordinator has to check and verify below points in term of validation: • Testing and Verification • Compliance with Standards • 75% Presentation has to be conducted by mentor/guide based on above activity.	[2]
Week 9: Integration Testing • Validate that the hardware integrates seamlessly with other systems or components as intended • Perform compatibility tests with software, other hardware, and network systems.	[2]
Week 10:Documentation and Reporting	[2]

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• Maintain comprehensive documentation of design, development, testing, and validation processes • Provide detailed reports on test results, issues found, and corrective actions taken.	
Week 11: Final Presentation • 100% Presentation has to be conducted by mentor/guide based on above activity. • Prototype/Final Software solution is mandatory at the time of final presentation along with report	[2]
Week 12: Exhibition • Mini project exhibition will be schedule with interdepartmental evaluation.	[2]

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Industrial/Field Training

23AR3509	VSEC	Industrial Training /Field Training	0-0-0	Audit

Teaching Scheme:	**Evaluation scheme:**
Lecture: NA	End Semester Exam: 50 Marks

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

Course Description: - Industrial Training is educational and career development opportunity, providing practical experience in a field or discipline. At the end of the **Fourth semesters**, every student should undergo practical training in an industry / professional organization / Research laboratory with the prior approval of the HoD /TPO/Principal of the college and submit the report along with the completion certification from the Industry/ Organization. The report will be evaluated during the **Fifth** semester by the department.
Course Learning Outcomes: -
After successful completion of the course, students will be able to
1. Verify the Technical knowledge in real industrial situations.
2. Develop interpersonal communication skills.
3. Discuss activities and functions of the industry in which the Internship/training has done.
4. Write the technical report.
Prerequisite: - Good written and Oral Communication.

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Guideline for Students: -
1. Arrive at work as per schedule, ready to work and stay for the agreed-upon time.
2. Present yourself in a professional manner at all times, including being appropriately dressed at the workplace.
3. Communicate any concerns with your supervisor and the internship/Training coordinator in a timely manner and respectfully.
4. Demonstrate enthusiasm and interest in what you are doing, ask questions and take the initiative as appropriate.
5. Complete and submit assigned tasks by designated timelines. Meet all deadlines.
Student's Diary/ Daily Log
The main purpose of writing a daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the student's thought process and reasoning abilities. The students should record in the daily training diary the day-to-day account of the observations, impressions, and information gathered and suggestions given if any. It should contain sketches & drawings related to the observations made by the students.
The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor.
Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the SITCOE immediately after the completion of the training. It will be evaluated on the basis of the following criteria:
• Regularity in the maintenance of the diary.
• Adequacy & quality of information recorded.
• Drawings, sketches, and data recorded.
• Thought process and recording techniques used.
• Organization of the information.
Internship Report

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After completing the internship, the student should prepare a comprehensive report to indicate what he/she has observed and learned in the training period. The daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The competent authority should sign the training report. The Internship report should be evaluated on the basis of the following criteria:
I. Originality.
II. Adequacy and purposeful write-up.
III. Organization, format, drawings, sketches, style, language, etc.
IV. Variety and relevance of learning experience.
V. Practical applications and relationships with basic theory and concepts taught in the course.
Evaluation of Internship/Training

The student should be evaluated based on his training report and presentation before an expert committee constituted by the concerned department as per norms. The evaluation will be based on the following criteria:
• Quality of content presented.
• Proper planning for presentation.
• Effectiveness of presentation.
• Depth of knowledge and skills.
• Attendance records, daily diary, and departmental reports shall also be analyzed along with the Internship Report.

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Robot System Reliability and Safety

23AR3510	CEP	Robot System Reliability and Safety	1-0-0	Audit

Teaching Scheme	**Evaluation scheme**
Lecture: 1hr/week	CA-I:25 Marks CA-II :25 Marks

Pre-Requisites:

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

CO1	Illustrate safety and hazards in industrial robots.
CO2	Identify the different reliability methods in robots.
CO3	Examine behavior and survival of robots in various environments.
CO4	List different standards and testing methods of industrial robots

Unit 1:Robot Safety Introduction to robot safety, different features in robot safety, need for safety in robotics, methods for performing safety analysis, role of robot manufacturers and users in robot safety, robot safeguard approaches , Interrelationship of safety, quality, Electrical Hazards- Crane Safety Toxic gas Release. Preliminary Hazard Analysis	[2]
Unit 2: Robot System Reliability Basics of Reliability, methods for performing Reliability analysis , classification of robot failures and their causes, corrective measures to avoid robot failure, robot effectiveness, reliability life characteristic phases	[2]
Unit 3:Robot Ethics Robot ethics and level of robot morality, ethics and fundamental elements in robots , top down and bottom up robot ethics approach , ethics in human robot symbiosis, robot rights, specialized robot ethics, ethical issues of socialized robot, case studies on robot ethics.	[2]
Unit 4:Robot Standards Different standards in robots, characteristics and benefits of standardization, standardization bodies, standard setting, robot standards : electrical interferences on robots for industrial environments, end effectors in industrial robots, safety requirements for robotics in industrial environments, safety design for industrial robot system, performance criteria and related test methods for service robots. **Robot Testing** Different robots performance testing methods , tests – robot program method, ford method, IPA – Stuttgart method, national bureau of standards methods , testing equipments and procedures, test reports , Hazard Identification and Risk Assessment	[2]

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Reference Books:

1. Dhillon, B.S.,Robot System Reliability and Safety: A Modern Approach", CRC Press, Boca Raton, Florida, 2015.
2. Kapur Reliability in engineering Design‖, Wiley india
3. Chandrupatla, — Quality and Reliability in Engineering‖ Cambridge Uni. Press, India
4. S S. Rao, Reliability Based Design, McGraw Hill Inc. 1992

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Program Elective Course-I
A. Mobile Robotics

23AR3511A	PEC	Mobile Robotics	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Automation and Robotics

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

CO1	Interpret the role of unmanned aerial vehicles (UAVs) in past, present, and future society
CO2	Choose appropriate payload types based on operational requirements.
CO3	Apply knowledge of UAS components to design and operational planning.
CO4	Choose appropriate types of underwater robots based on operational needs.
CO5	Build control architectures for underwater robots, considering environmental constraints.
CO6	Identify key features and capabilities of modern subsea manipulators.

Course Contents:

Unit 1: Overview and Background Definitions History of UAVs - classifications of UAVs scale- lift generation method contemporary applications- military- government- civil-societal impact and future outlook operational considerations- liability / legal issues-insurance- ethical implications- human factors- LOS / BLOS.	[7]
Unit 2: Payload For UAV Introduction – Types – Non dispensable Payloads - Electro-optic Payload Systems - Electrooptic Systems Integration - Radar Imaging Payloads - Other Non dispensable Payloads -Dispensable Payloads - Payload Development	[6]
Unit 3: Unmanned Aerial System (UAS) Components Platform configurations- characteristics-applications- propulsion- Internal combustion - on-board flight control- payloads- sensing / surveillance- weaponized- delivery communications- command/control- telemetry - launch / recovery systems- Ground control stations.	[7]
Unit 4: Underwater Robotics Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - Overview about Environmental Factors affecting object in water.	[7]

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Unit5: Control System and Manipulator Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles.	[7]
Unit6: Autonomous Underwater Systems Introduction to AUVS - Development of RA E12 MOBILE ROBOTICS ,AUVs,ROV in Market - Case Study on AUV Control System Basics - Case Study on Subsea Manipulator - Case Study on Technologies Used.	[6]

Text Books:

1. Roland Siegwant & Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004.
2. Bruno Siciliano, OussamaKhatib, —Springer Handbook of Robotics‖, Springer-Verlag Berlin Heidelberg 2008.
3. Yangsheng Xu Huihuan Qian Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015

Reference Books:

1. ASA Test Prep. Remote Pilot Test Prep — UAS: Study & Prepare. Wellfleet Press, 2016. 978-1577151326
2. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0-470-05819-0
3. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing,2016. 978-0789755988
4. Beard & McLain, Small Unmanned Aircraft: Theory and Practice. Princeton University Press, 2012. 978-0691149219
5. Cares & Dickmann, Operations Research for Unmanned Systems. Wiley, 2016. 978-1-118-91894-4 6. Gianluca Antonelli, —Underwater Robots‖, Springer, 2014

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Program Elective Course-I
B. Factory Automation

23AR3511B	PEC	Factory Automation	3-0-0	3Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: CAD/CAM-Automation, Manufacturing Technology
Course Outcomes: At the end of the course, students will be able to:

CO1	Identify potential areas for automation and justify need for automation
CO2	Apply suitable major control components required to automate a process or an activity
CO3	Make use of automation to translate and simulate a real time activity using modern tools
CO4	Evaluate suitable automation hardware for the given application
CO5	Apply the principles of automated material handling and storage systems in industrial settings.
CO6	Choose appropriate material handling solutions based on operational needs.

Course Contents:

Unit 1: Introduction Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.	[6]
Unit 2: Material handling and Identification Technologies Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.	[7]
Unit 3: Automated Manufacturing Systems Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies. capabilities of a Machining Centers	[6]

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Unit 4: Control Technologies in Automation: Control Technologies in Automation: Industrial Control Systems, Process Industries versus Discrete Manufacturing Industries, continuous Versus Discrete Control, Computer Process and its Forms.	[6]
Unit 5: Automated Material Movement and Storage System-I Introduction, Types of AGV and Their principle of working, Advantages, Limitation and General AGV Guide path, Robots, Benefits of using Industrial Robots, Basic components and benefits of Automated Storage and Retrieval Systems, Conveyors and Pallet Flotation System, Queuing Carrousels and Automatic Work Changers, Coolant and Chip Disposal and Recovery system.	[6]
Unit 6: Automatic Material Handling and Storage systems-II Design Considerations in Material Handling, Material Transport Equipment-Industrial Trucks, Automated Guided Vehicles, Monorails and Other Rail-Guided Vehicles, Conveyors, Cranes and Hoists, Analysis of Vehicle Based Systems, Conveyor Analysis. Automated Storage/Retrieval Systems, Carousel Storage Systems, Engineering Analysis of AS/RS and Carousel Systems	[7]
Text Books: 1. S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York, 2010. 2. M. P. Grover, Zimmer, "CAD/CAM/CIM", Prentice Hall India.	
Reference Books: 1. H. K. Shivanand, M. M. Benal, Flexible Manufacturing System, V. Koti, New Age Pub. ISBN:9386070227 2. Automation, Production Systems and Computer Integrated Manufacturing, Groover M.P, Prentice Hall of India, ISBN: 9789332572492 3. CAD/CAM, Groover M.P, Zimmers E.W, Prentice Hall of India, ISBN: 9780132440813 4. Approach to Computer Integrated Design and Manufacturing, Nanua Singh, John Wiley and Sons,ISBN:9780471585176 5. Principles of CIM, Vajpayee, PHI, ISBN: 9788120314764 6. Flexible Manufacturing Cells and Systems	

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Program Elective Course-I
C. Electrical Drives and System

23AR3511C	PEC	Electrical Drives and System	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Electrical Engineering

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

CO1	Explain construction and working principle of various electric machine
CO2	Build an understanding of transformer construction and practical design considerations.
CO3	Apply fundamental principles of rotating machines in electromechanical energy conversion.
CO4	Apply fundamental principles of induction machines in electrical power and industrial applications.
CO5	Identify key parameters affecting the operation of synchronous generators and motors.
CO6	Utilize electrical drives in various industries, including manufacturing, transportation, and energy sectors.

Course Contents:

Unit 1 :Introduction to Electric Machine Basic Principle, Types and constructional Features of Electric machines, Recent Trends in Research and Development in Electrical Machines, Magnetic circuit, Magnetic Materials and their properties ,Magnetically Induced EMF and Force, AC operation of Magnetic circuit, Hysteresis and Eddy-Current Losses Permanent Magnet ,Application of Permanent Magnet Materials	[7]
Unit 2: Transformers Introduction,TransformerConstructionandPracticalConsiderations,Transformerload,Ideal Transformer,RealTransformerandEquivalentCircuit ,Transformer Losses, Transformer Testing, Efficiency and Voltage Regulation, Excitation Phenomenon in Transformers, Autotransformers, Variable Frequency Transformer	[6]

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Unit 3 : Principle of Rotating Machines Introduction, Energy in Magnetic System, Field Energy and Mechanical Force, Multiply-Excited Magnetic Field Systems, Forces/Torques in Systems with Permanent Magnets, Energy Conversion via Electric Field, Dynamical Equations of Electromechanical Systems **DC Machines** Basic principles of electromagnetic energy conversion, Construction ,operation, characteristics, performance of dc generators and motors, testing of dc machines, applications	[7]
Unit 4 :Induction machines Construction, working principle, equivalent circuit, torque-slip curves, performance calculation, starting, speed control of three-phase inductionmotors.CoggingandCrawling.Hightorque-cagemotors.Inductiongenerator	[7]
Unit 5: Synchronous Machines Construction, basic principles and theory of cylindrical and salient pole synchronous machines. Equivalent circuit, Working principle, starting, Operation and applications of synchronous motors **Special Machines: Stepper Motor and Servo Motor** Stepper motor general construction, working principle, electric circuit and applications Servo motor general construction, working principle, electric circuit and applications	[7]
Unit 6:Electrical Drives Type of Electrical Drives – Selection & factors influencing the selection – heating and cooling curves – loading condition and classes of duty – determination of power rating – simple problems Solid State Drives -Advantages of solid state drives – D.C. motor control using rectifiers and choppers – control of induction motor by V, V/f and slip power recovery scheme using inverters and A.C. power regulators.	[6]

Text Books:

1. Stephen J. Chapman, ElectricMachineryFundamentals'4thedition,McGrawHillEducation Pvt.Ltd, 2010.
2. P.C.bSen Principles of Electric Machines and power Electronics John Wiley & Sons ;3rd Edition 2013
3. Nagrath,I.J.andKothari.D.P.,ElectricMachines',McGraw-HillEducation,2004

Reference Books:

1. Theodore Wildi, -Electrical Machines, Drives, and Power Systems ,Pearson Education.,(5th Edition), 2002.
2. B.R. Gupta , 'Fundamental of Electric Machines' New age InternationalPublishers,3rd Edition ,Reprint 2015.
3. Surinder Pal Bali ,Electrical Technology Machines& easurements,Vol.II,Pearson,2013
4. Fitzgerald.A.E.,CharlesKingselyJr,StephenD.Umans,_ElectricMachinery',Sixth edition McGraw Hill Books Company, 2003.

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Program Elective Course-I
D. Industrial Robotics and Material Handling Systems

23AR3511D	PEC	Industrial Robotics and Material Handling Systems	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Fundamentals of Automation and Robotics

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

CO1	Explain about material handling system
CO2	Apply knowledge of conventional and automated storage systems in industrial and logistics applications.
CO3	Build knowledge of different types of industrial robots and their applications.
CO4	Choose suitable end-effectors based on material handling requirements and environmental conditions.
CO5	Identify key benefits of robotics in assembly and mega-assembly operations.
CO6	Organize strategies for integrating robots into modern manufacturing lines.

Course Contents:

Unit 1: Introduction to Material handling Principles of Material Handling, Unit load concept, Material Handling equipment, Material transport systems: AGVs, Monorails, Conveyor systems, Cranes and hoists, Analysis of material transport systems: Charting technique, analysis of vehicle based systems, Conveyor analysis	[7]
Unit 2: Storage and Data capturing systems Conventional storage methods and equipments Storage system performance, Analysis of Automated storage/retrieval systems (ASRS) and Carousel Storage system. Automatic data capturing system (ADC), Bar coding, Radio frequency identification (RFID), Optical character recognition, Magnetic stripes	[6]
Unit 3: Introduction Industrial Robots Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool	[7]

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loading, Robot centered cell.	
Unit 4: End Effectors Classification Design consideration, Materials for hostile operation. Cylindrical Cam type; Grippers using pneumatic, hydraulic and electrical motor for transmission; Vacuum Grippers, Ultrasonic grippers. Gripper force analysis and gripper design, design of multiple degrees of freedom, active and passive grippers. Selection of Robot: Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society	[7]
Unit5: Applications of Robots in Manufacturing Pick and place Robot, Application of Robots in Arc Welding Robots, Assembly and mega-assembly Robots continuous arc welding, Spot welding, Spray painting, assembly operation, Other industrial applications: Coating, Deburring, cleaning, Die Casting, Moulding, Material handling, Picking, Palletizing, Packaging Robots For Inspection : Robotic vision systems, image representation, object recognition and categorization, depth measurement	[7]
Unit6: Advanced Applications of robots Military and medical applications, robot for underwater applications Robots, Climbing Robots, Machine mounted Robots. Interfacing Robots with computers. Obstacle Avoidance: Lee's Algorithm; Counter Path Defining using 'via' point, blending	[6]

Text Books:

1. 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, McGrawHill Singapore, 1996.

Reference Books:

1. Groover M. P., "Automation, Production Sysytems, and Computer –Integrated Manufacturing",Pearson Education,ISBN-81-7808-511-9
2. Deb S.R., "Robotics", Tata McGraw Hill Publications, New Delhi. ISBN 13: 9780070077911
3. Yoram Koren, & quot; Robotics for Engineers", McGraw Hill Book Co. ISBN-10: 0070353999, ISBN-13: 978-0070353992
4. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology - Programming and Applications & McGraw Hill Book Co. ISBN-10: 1259006212, ISBN-13: 978-1259006210
5. Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co. ISBN 10: 0070226253 / ISBN 13: 9780070226258 7.
6. Hall A.S. Kinematics and Linkage Design", Prentice Hall. ISBN-10: 0881332720, ISBN-13: 978- 0881332728

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Multidisciplinary Minor-III

Radar Technologies

23ARMDA3	MDM	Radar Technologies	3-0-0	3 Credits

Teaching Scheme	Evaluation scheme
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Communication System for Robotics

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

CO1	Explain RADAR, radar frequencies and applications
CO2	Identify False Alarm Time and Probability, Radar Cross Section, system losses
CO3	Analyze the principle of FM-CW radar and apply it in FM-CW Altimeter
CO4	Apply the principles of radar signal detection in noisy environments.
CO5	Choose appropriate tracking methods for different radar applications.
CO6	Build knowledge of different display types used in radar systems

Course Contents:

Unit 1: Basics of Radar Introduction, Maximum Unambiguous Range, Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation, Related Problems	[6]
Unit 2: Radar Equation SNR, Envelope Detector-False Alarm Time and Probability, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, conesphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Related Problems.	[6]
Unit 3: FM-CW Radar Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW altimeter, Multiple Frequency CW Radar. MTI and Pulse Doppler Radar: Introduction, Principle, MTI Radar with -Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, And Staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. MTI versus Pulse Doppler Radar.	[6]
Unit 4: Detection of Radar Signals in Noise Introduction, Matched Filter Receiver – Response Characteristics and Derivation, Correlation Function and Cross-correlation Receiver, Efficiency of Non-matched Filters,	[6]

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Matched Filter with Non-white Noise.	
Unit 5: Tracking Radar Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar– Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse. Tracking in Range, Acquisition and Scanning Patterns. Comparison of Trackers.	[6]
Unit 6: Radar Receivers Noise Figure and Noise Temperature. Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Applications, Advantages and Limitations. Electronic Warfare: Introduction to ESM, ECM and ECCM systems.	[6]
Text Books: 1 .Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, Tata McGraw-Hill, 2007	
Reference Books: 1. Introduction to Radar Systems – Merrill I. Skolnik, 3rd Edition Tata McGraw-Hill, 2001. 2. Radar: Principles, Technology, Applications-Byron Edde, Pearson Education, 2004. 3. Principles of Modern Radar: Basic Principles-Mark A. Richards, James A. Scheer, William A. Holm, Yesdee,2013. 4. 'Radar Hand Book ' Ed. By M.I Skolnik, 2nd Edition, Tata McGraw Hill. 5. 'Understanding Radar Systems' by Simon Kinsley and Shaun Quegan, Scitech Publishing, McGraw-Hill.	

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Multidisciplinary Minor-III
Cloud computing

23ARMDB3	MDM	Cloud computing	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Database management system

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

CO1	Choose appropriate system models for distributed and cloud computing applications.
CO2	Build an understanding of different implementation levels of virtualization.
CO3	Identify key design considerations in cloud data center infrastructure.
CO4	Apply cloud security principles to mitigate risks associated with cloud computing.
CO5	Select suitable trust models for securing cloud platforms and services.
CO6	Make use of distributed computing techniques to optimize cloud application performance.

Course Contents:

Unit 1: Distributed System Models and Enabling Technologies Scalable Computing Over the Internet, Technologies for Network Based Systems, System Models for Distributed and Cloud Computing, Software Environments for Distributed Systems and Clouds, Performance, Security and Energy Efficiency.	[6]
Unit 2: Virtual Machines and Virtualization of Clusters and Data Centers Implementation Levels of Virtualization, Virtualization Structure/Tools and Mechanisms, Virtualization of CPU/Memory and I/O devices, Virtual Clusters and Resource Management, Virtualization for Data Center Automation.	[6]
Unit 3: Cloud Platform Architecture over Virtualized Datacenters Cloud Computing and Service Models, Data Center Design and Interconnection Networks, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms: GAE, AWS and Azure, Inter-Cloud Resource Management.	[6]
Unit 4: Cloud Security Top concern for cloud users, Risks, Privacy Impact Assessment, Cloud Data Encryption, Security of Database Services, OS security, VM Security, Security Risks Posed by Shared Images and Management OS, XOAR, A Trusted Hypervisor, Mobile Devices and Cloud Security	[6]

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Unit 5: Cloud Security and Trust Management Cloud Security Defense Strategies, Distributed Intrusion/Anomaly Detection, Data and Software Protection Techniques, Reputation-Guided Protection of Data Centers.	[6]
Unit 6: Cloud Programming and Software Environments Features of Cloud and Grid Platforms, Parallel and Distributed Computing Paradigms, Programming Support for Google App Engine, Programming on Amazon AWS and Microsoft, Emerging Cloud Software Environments.	[6]
Text Books: 1 . Kai Hwang, Geoffrey C Fox, and Jack J Dongarra, Distributed and Cloud Computing, Morgan Kaufmann, Elsevier 2012 2. Dan C. Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, 2nd Edition, Elsevier 2018 3. Google Cloud Teaching Resources – LMS [for practical component] 4. AWS Cloud Developing – AWS Academy Courses [for practical component]	
Reference Books: 1. Rajkumar Buyya, Christian Vecchiola, and Thamrai Selvi, Mastering Cloud Computing McGrawHill Education, 1st Edition, 2017 2. Toby Velte, Anthony Velte, Cloud Computing: A Practical Approach, McGraw-Hill Education, 2017. 3. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Publication, 1st Edition, 2009 4. John Rhoton, Cloud Computing Explained: Implementation Handbook for Enterprises, Recursive Press, 2nd Edition, 2009	

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Multidisciplinary Minor-III
Aircraft Structures-I

23ARMDC3	MDM	Aircraft Structures-I	3-0-0	3 Credits

Teaching Scheme	**Evaluation scheme**
Lecture: 3 hrs/week	CA–I :10 Marks CA–II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Aerospace Engine Design System

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

CO1	Apply fundamental principles of structural analysis to assess different types of structures.
CO2	Choose appropriate methods for calculating slope and deflection in beams.
CO3	Apply fundamental concepts to analyze perfect pin-jointed frames.
CO4	Choose appropriate methods to calculate strain energy for different loading conditions.
CO5	Apply fundamental principles of column buckling in structural analysis and design.
CO6	Identify the effects of inertia, damping, and external forces on rigid body vibration.

Course Contents:

Unit 1: Introduction of structure and structural analysis Types of Structure, basic concept of determinate and indeterminate structure, static and kinematic indeterminacy of structure, Introduction to stability of structure, Elastic theorems (Principal of superposition, Maxwell's Reciprocal Theorem), Principal of Virtual work.	[6]
Unit 2: Slope and deflection of determinate beams Differential equation of the elastic curve, relation between momentslope and deflection, Double Integration Method, Macaulay's method, Conjugate Beam Method, Moment area Method	[6]
Unit 3: Analysis of perfect pin-jointed frames Classification of truss (simple truss, compound truss, complex truss). Analysis of statically determinate plane and space truss using Tension Co-efficient Method and Graphical Method. Identification of zero force members in truss.	[6]
Unit 4: Strain Energy Concept of strain energy, resilience and proof resilience, strain energy due to axial load, bending, torsion, shear, sudden loads and impact load	[6]

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Unit 5: column buckling Introduction to column buckling, slenderness ratio and effective length. Euler's theory for buckling of long column. Rankine formula	[6]
Unit 6: Vibration of rigid body Terms related to rigid body vibration, D'alembert principal, single degree rigid body vibration using equilibrium approach and energy theorem.	[6]
Text Books: 1 . D.S. Bedi, Strength of Materials, Khanna Book Publishing, 2017.	
Reference Books: 1.Aircraft Structures for Engineering Students: T.H.G.Megson, Edward Arnold, Butterworth-Heinemann 2. Aircraft Structures: D.J.Peery, McGraw Hill 3.Fundamentals of aircraft structural analysis: Howard D. Curtis, McGraw Hill 4. Theory and Analysis of Flight Structures: RM Rivello, McGraw Hill	

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Aptitude Skills–III

23HSSM03	VEC	Aptitude Skills- III	2-0-0	Audit

Teaching Scheme	Evaluation scheme
Lecture: 2 hr/week	CA-I:25 Marks CA-II :25 Marks

Pre-Requisites: Communication Skills, Aptitude Skills- I,II

Verbal Ability (12Hrs) (Compulsory)

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

CO1	Solve the questions on ordering of words & Parts of Speech
CO2	Organize contents of Business Communications such as CV, emails and letters.
CO3	Solve the questions based on jumbled paragraphs and reading comprehension.
CO4	Solve the questions on spotting error and sentence correction.
CO5	Summarize proceedings of any event or conference.
CO6	Discuss about current and critical issues during group discussion.

Unit 1: Parts of Speech Punctuation ,Word Family (Using the same word as different Parts of Speech),	[2]
Unit 2: Analogy Letter Writing (Formal), E-Mail Writing, CV Writing	[2]
Unit 3: Reading Comprehension Reading Comprehension, Paragraph Jumbles	[2]
Unit 4: Spotting Errors (in different parts of sentence) Spotting Errors (in different parts of sentence), Subject-Verb Agreement, Sentence Correction, Sentence Completion	[2]
Unit 5: One Word Substitution One Word Substitution, Narrating Events/ReportsSummary/Precis Writing	[2]
Unit 6: Dialogue Writing Dialogue Writing, Group Discussion, Interview Skills (Using formal notations & gestures etc.)	[2]

Text Books:

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S. Aggarwal, S Chand Publishing; Revised edition (15 March 2017)

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Reference Books:

1. Rao N, D, V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press;Second edition

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Language Skills- III

23HSSM04	VEC	Language Skills- III	0-0-2	Audit

Teaching Scheme:	**Evaluation scheme:**
Practical: 2 hrs/week	CA–I :25 Marks CA–II :25 Marks

Pre-Requisites: Language Skill I &II

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

CO1	Develop a program to read input and return output.
CO2	Develop a program using datatypes,Strings and variables
CO3	Develop a program using Unary, Binary and Ternary operator
CO4	Develop a program using Conditional and Logical statements.

1. **Write a Python program to print "Hello, World!"** o Objective: Understand basic syntax, indentation, and output.	[2]
2. **Write a program to demonstrate the use of different types of comments in Python.** o Objective: Single-line and multi-line comments.	[2]
3. **Write a Python program that declares different types of variables and displays their data types using the type() function.** o Objective: Variables, data types, and type identification.	[2]
4. **Write a program to demonstrate type casting and type conversion between int, float, and string.** o Objective: Type conversion, casting functions.	[2]
5. **Write a Python script to perform string operations such as slicing, concatenation, upper(), lower(), and len().** o Objective: String manipulation and built-in functions.	[2]
6. **Write a program to demonstrate the use of all arithmetic, logical, and bitwise operators.** o Objective: Operator functionality.	[2]
7. **Write a Python program to use membership and identity operators with examples.** o Objective: in, not in, is, is not.	[2]
8. **Write a Python program using a ternary operator to find the larger of two**	[2]

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numbers. o Objective: Conditional (inline) expressions.	
9. **Write a program that takes user input for age and prints whether the person is a child, teenager, adult, or senior citizen using if-elif-else.** o Objective: Conditional statements and user input.	[2]
10. **Write a program to find the sum of the first 10 natural numbers using a while loop.** o Objective: Looping with while.	[2]
11. **Write a Python script to display the multiplication table of a number using a for loop.** o Objective: Looping with for and range().	[2]
12. **Write a program that uses break, continue, and pass statements in appropriate looping scenarios.** o Objective: Loop control statements.	[2]
Text Books: 1. Python Projects (Author: Laura Cassell, Alan Gauld) Wrox publication 2. murach's PythonProgramming.Aut.:MichaelUrban,JoelMurach,murach'sPublication.	
Reference Books: 1. Fundamentals of Python(First Program) Cengage MINDTAP Publication 2nd Edition. Author: K.A. Kambert	

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