

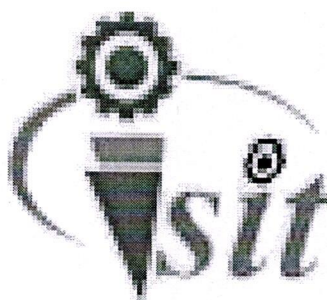


Shri Shamrao Patil (Yadravkar) Educational & Charitable Trust's
Sharad Institute of Technology College of Engineering
(An Autonomous Institute)
Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

Teaching and Evaluation Scheme as per NEP for T Y B. Tech.

Department of Automation and Robotics

Semester: V




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Yadav (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
23HSSM05	VEC	Aptitude Skill-III	2	0	0	25	25	-	-	50	Audit
23HSSM06	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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Solid Mechanics

23AR3501	PCC	Solid Mechanics	3-0-0	3 Credits
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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. Ramamrutham, Dhanpat Rai 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
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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

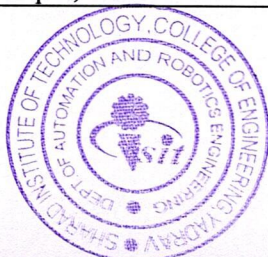
Pre-Requisites: Engineering Physics, Basic Mechanical Engineering

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 chip 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, I 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
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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

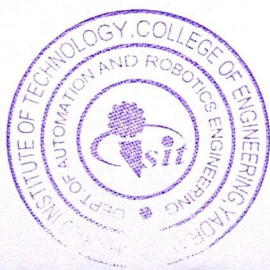
Pre-Requisites: CAD/CAM-Automation

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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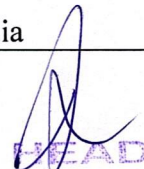


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the system, Comparison between Hydraulic, Pneumatic and Electrical system	
Unit 3: Design and Operation of Electro-Pneumatic Logic Control Circuits Electro-pneumatic systems, solenoid valves, different sensors, factory automation sensors, process automation 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 4: 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 and Process automation.	[6]
Text Books: 1. Antony Esposito, "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 Microprocessor by Ramchandran Willey India	




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| <p>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, Princes and Ashby J. G, - Prentice Hall, 1989 .</p> |
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Totally Integrated Automation Laboratory

23AR3504	PCC	Totally Integrated Automation Laboratory	0-0-2	1 Credits
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Teaching Scheme:	Evaluation Scheme:
Practical: 2 hrs /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 -

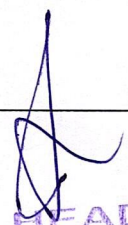
CO1	Select and specify various components for hydraulic and pneumatic systems
CO2	Evaluate the hydraulic and pneumatic systems based on various evaluation criteria
CO3	Develop the programming and implementation of programmable logic controllers.
CO4	Utilize the HMI/SCADA system for Various application

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

Pre-Requisites: Object Oriented Programming using C++

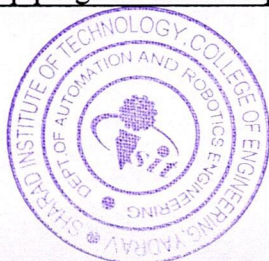
Course Outcomes: At the end of the course students will be able to -

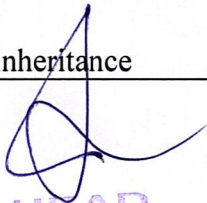
CO1	Apply the concept of multithreading and implement exception handling.
CO2	Apply and access data from a Database with java program
CO3	Develop java programs using interfaces

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
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Teaching Scheme:	Evaluation Scheme:
Practical: 2 hrs /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 |

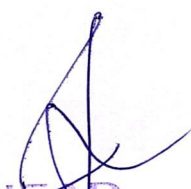
Text Books:

1. Strength of Materials, S. Ramamrutham, Dhanpat Rai 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. Beer, 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
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Teaching Scheme: Practical: 2 hrs /week	Evaluation Scheme: CA-I :15 Marks CA-II :15 Marks End Semester Exam: 20 Marks
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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:

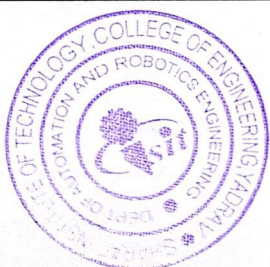
Group A

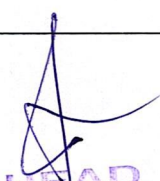
1. Programming and simulation of a lathe using any CAM package
2. Programming and operation of a CNC machining centre

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, "Machine 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", TATA Magraw hill, 2012.

Reference Books:

1. "Engineering Metrology", I.C. GUPTA, Dhanpat Rai 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
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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. • Prepare a questionnaire and try it out with your group members as mock.	[2]
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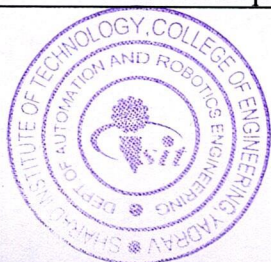
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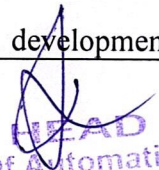


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Week 2: Survey Design-2 - Review survey questionnaire prepared by case study groups. - Decide sampling strategy. - Prepare a detailed schedule for fieldwork	[2]
Week 3: Fieldwork - Data Collection: Collect quantitative data (e.g., statistics, usage 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 Maintain comprehensive documentation of design, development, testing, and	[2]




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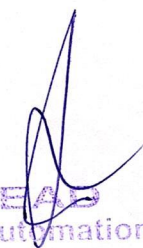


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validation processes	
• Provide detailed reports on test results, issues found, and corrective actions taken.	
Week 11: Final Presentation • 100% Presentation has to be conducted by mentor/guide based on above activity. • Prototype/Final Software solution 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
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Teaching Scheme:	Evaluation scheme:
Lecture: NA	End Semester Exam: 50 Marks

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

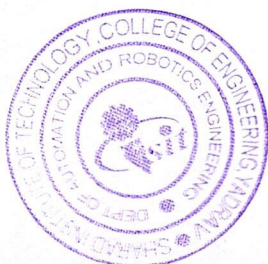
Course Description: - Industrial Training is educational and career development opportunity, providing practical experience in a field or discipline. At the end of the **Fourth semesters**, every student should undergo practical training in an industry / professional organization / Research laboratory 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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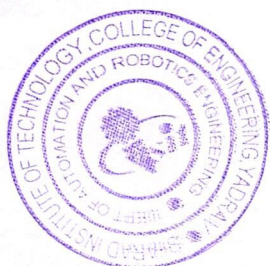
After completing the internship, the student should prepare a comprehensive report to indicate what he/she has observed and learned in the training period. The daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by 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
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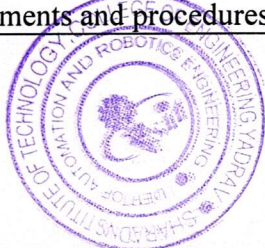
Teaching Scheme	Evaluation scheme
Lecture: 1hrs /week	CA-I:25 Marks CA-II :25 Marks

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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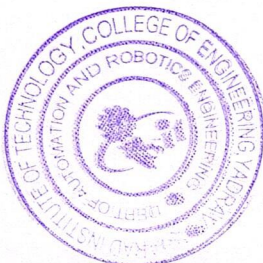


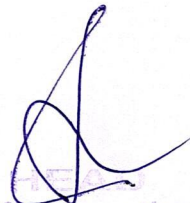
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Reference Books:

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
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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

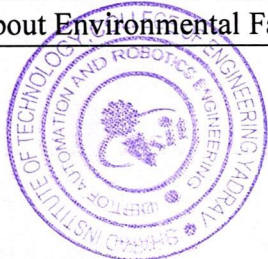
Pre-Requisites: Fundamentals of Automation and Robotics

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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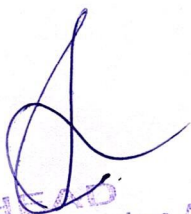


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Unit5: Control System and Manipulator Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - 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 RoboticsI, 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 RobotsI, Springer, 2014	




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Program Elective Course-I

B. Factory Automation

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



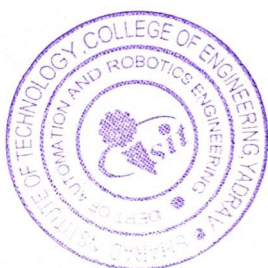
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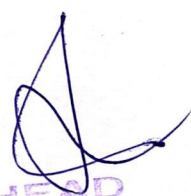


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Unit 4: Control Technologies in Automation: Control Technologies in Automation: Industrial Control Systems, Process Industries versus Discrete Manufacturing Industries, continuous Versus Discrete Control, Computer Process and its Forms.	[6]
Unit 5: 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 Carrouels 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
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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

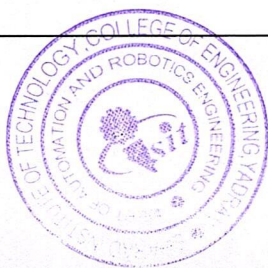
Pre-Requisites: Basic Electrical Engineering

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]



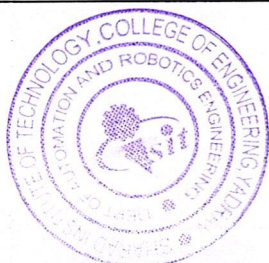
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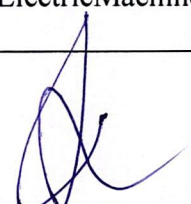


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Unit 3 : Principle of Rotating Machines Introduction, Energy in Magnetic System, Field Energy and Mechanical Force, Multiply-Excited Magnetic Field Systems, Forces/Torques in Systems with Permanent Magnets, Energy Conversion via Electric Field, Dynamical 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 induction motors. Cogging and Crawling. High torque-cage motors. Induction generator	[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, Electric Machinery Fundamentals 4th edition, McGraw Hill Education Pvt. Ltd, 2010. 2. P.C. Sen Principles of Electric Machines and power Electronics John Wiley & Sons ; 3rd Edition 2013 3. Nagrath, I.J. and Kothari, D.P., Electric Machines, McGraw-Hill Education, 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 International Publishers, 3rd Edition, Reprint 2015. 3. Surinder Pal Bali, Electrical Technology Machines & Measurements, Vol. II, Pearson, 2013 4. Fitzgerald, A.E., Charles Kingsley Jr, Stephen D. Umans, _Electric Machinery_, 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
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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. I.R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi, 4th Reprint, 2005. 2. John J. Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009. 3. M.P. Groover, M. Weiss, R.N. Nagel and N. G. Odrej, Industrial Robotics, McGraw Hill Singapore, 1996.	
Reference Books: 1. Groover M. P., "Automation, Production Systems, 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., Odrej N.G., "Industrial Robotics Technology - Programming and Applications & McGraw Hill Book Co. ISBN-10: 1259006212, ISBN-13: 978-1259006210 5. Fu K.S., Gonzalez 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
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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

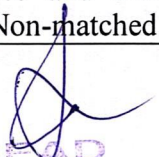
Course Outcomes: At the end of the course, students will be able to:

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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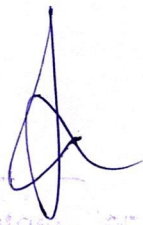


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Matched Filter with Non-white Noise.	
Unit 5: Tracking Radar Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar– Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse. Tracking in Range, 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
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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
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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

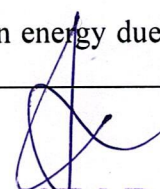
Course Outcomes: At the end of the course, students will be able to:

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

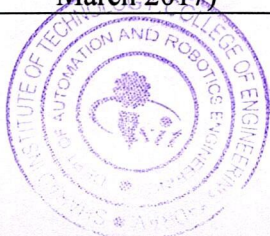
Pre-Requisites: Communication Skills, Aptitude Skills- I,II

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: - Raymond Murphy, Essential English Grammar with Answers, Murphy - 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
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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. ○ 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. ○ 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. ○ Objective: Looping with while.	[2]
11. Write a Python script to display the multiplication table of a number using a for loop. ○ Objective: Looping with for and range().	[2]
12. Write a program that uses break, continue, and pass statements in appropriate looping scenarios. ○ 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 2 nd Edition. Author: K.A. Kambert	




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Teaching and Evaluation Scheme as per NEP

for T Y B. Tech.

**Department of Automation and
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Semester: VI




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Department: Automation and Robotics

Rev: Course Structure/01/NEP/2023-24

Class: T.Y. B. Tech

Semester: VI

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation scheme					Credit
			L	T	P	CA 1	CA2	MSE	ESE	Total	
23AR3601	PCC	Design of Machine Elements and Transmission Systems	3	0	0	10	10	30	50	100	3
23AR3602	PCC	Control Systems	2	0	0	10	10	30	50	100	2
23AR3603	PCC	Robot Kinematics and Dynamics	3	0	0	10	10	30	50	100	3
23AR3604	VSEC	Control System (MATLAB) Laboratory	0	0	2	25	25	-	-	50	1
23AR3605	PCC	Robot Kinematics and Dynamics Laboratory	0	0	2	15	15	-	20	50	1
23AR3606	PCC	Design of Machine Elements and Transmission Systems Laboratory	0	0	2	15	15	-	20	50	1
23AR3607	ELC	Capstone Project-I	0	0	4	15	15	-	20	50	2
23AR3608	PCC	Robot Programming	1	0	0	25	25	-	-	50	Audit
23AR3609X	PEC	Program Elective Course -II	3	0	0	10	10	30	50	100	3
23AR3610X	PEC	Program Elective Course -III	3	0	0	10	10	30	50	100	3
23ARMDXX	MDM	Multidisciplinary Minor-IV	3	0	0	10	10	30	50	100	3
23HSSM05	VEC	Aptitude Skill-IV	2	0	0	25	25	-	-	50	Audit
23HSSM06	VEC	Language Skill-IV	0	0	2	25	25	-	-	50	Audit
Total			20	0	12	205	205	180	360	950	22

Multidisciplinary Minor-IV

Sem.	Basket 1 (A-Defense)	Basket 2 (B-Software)	Basket 3 (C-Space)
Sem.VI	Digital & satellite Communication and Navigation from Space (23ARMDA4)	R –Programming (23ARMDB4)	Aircraft Structures-II (23ARMDC4)



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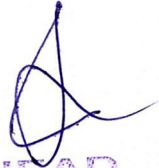
Program Elective Course-II

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)
Applied Robotics (23AR3609A)	Computer Integrated Manufacturing (23AR3609B)	Industrial Networking (23AR3609C)	Wireless Sensor Network for Robotics (23AR3609D)

Program Elective Course-III

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)
Field and service Robotics (23AR3610A)	Additive Manufacturing and Reverse Engineering (23AR3610B)	Data Analytics (23AR3610C)	Image Processing and Vision system (23AR3610D)




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Design of Machine Elements and Transmission Systems

23AR3601	PCC	Design of Machine Elements and Transmission Systems	3-0-0	3 Credits
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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

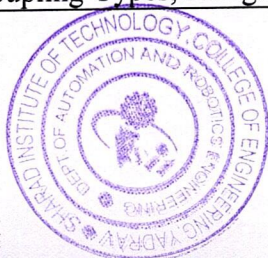
Pre-Requisites: Solid Mechanics, Fundamentals of Automation and Robotics

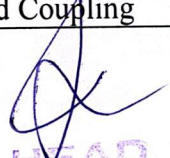
Course Outcomes: At the end of the course, students will be able to:

CO1	Illustrate the basic concept of machine design and evaluate dimensions of simple components
CO2	Relate the concept of Detachable and Permanent Joints and analyze when it is subjected to different loading conditions
CO3	Analyze and design the components for power transmission like shaft and couplings
CO4	Analyze and design different types of gears and belts for engineering applications.
CO5	Analyze and design mechanical springs and bearings.
CO6	Illustrate the concept of designing of Power Screws and analysis of clutches and brakes.

Course Contents:

Unit 1: Introduction Fundamentals of Machine Design-Basic procedure of machine design, Design Standards and Codes - Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Theories of Failure-Stress Concentration, Stress Concentration Factors, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria. Modified Soderberg and Goodman diagram.	[6]
Unit2: Detachable and Permanent Joints 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.	[6]
Unit 3: Shafts and Coupling Design of Shaft –For Static and Varying Loads, For Strength and Rigidity-Design of Coupling-Types, Flange, Muff and Flexible Rubber Bushed Coupling	[6]




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Unit 4: Gears and Belt Drives Classification of gear drives, Terminology of spur, helical, bevel and worm and worm wheel, Design of Spur and Helical Gears, Belt drives-Flat and V Belts, Selection of belts.	[7]
Unit 5: Springs and Bearings Design of Helical Spring-Types, Materials, Static and Variable Loads-Design of Helical Spring- Bearing-Rolling contact bearing and sliding contact bearing-Types, Stribeck's Equation, Dynamic Load Carrying Capacity, Equivalent Bearing Load, Load-Life Relationship, Selection of Bearing Life, Load Factor, Selection of Bearing from Manufacturer's Catalogue	[6]
Unit 6: Analysis and applications of Power Screw, Clutches and Brakes Power Screws- Forms of Threads, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Self-locking Screw, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency. Clutches - Torque Transmitting Capacity, Energy equation. Brakes – Types , Energy Equations	[6]
Text Books: 1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008. 2. R. L. Norton, " Machine Design: An Integrated Approach", Pearson Education Singapore, 2001 3. A Machine Design R.S. Khurmi&J.K.Gupta S. Chand publication. 4. Machine design S G Kulkarni McGraw Hill Education Publications 5. Introduction to Machine design V B Bhandari McGraw Hill Education Publications. 6. Design Of Machine Elements Vol I, Vol II J.B.K. Das , P.L. Srinivas Murthy Sapna publication	
Reference Books: 1. R. C. Juvinall, K. M. Marshek, " Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002. 2. J. Hamrock, B. Jacobson and Schmid Sr., " Fundamentals of Machine Elements", International Edition, New York, 2nd edition, 1999. 3. S. Hall, A. R. Holowenko, H. G .Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982. 4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004. 5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi. 6. Machine Design by Robert L.Norton, Tata Mc- Graw Hill Publication 6. Fundamentals of Machine Component Design by Junvinall Wiley India 7. Mechanical System Design by Anurag Dixit SCITECH publication 8. Design of Machine Element/Machine Design by Kannaiah SCITECH publication 9. Design of Machine Element by Spotts/Shoup/Hornberger/Jayram/Venketesh Pierson Education	



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Control Systems

23AR3602	PCC	Control Systems	2-0-0	2 Credits
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Teaching Scheme	Evaluation scheme
Lecture: 2 hrs/week	CA-I :10 Marks CA-II :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

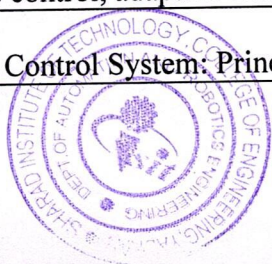
Pre-Requisites: Basic Electrical Engineering

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

CO1	Explain the basic concepts of control system.
CO2	Determine Time Domain characteristics of control systems.
CO3	Determine Frequency Domain characteristics of control systems.
CO4	Examine P, PI and PD controller on system.
CO5	Illustrate the concept of Stability Analysis.
CO6	Explain the concept of Proportional and Derivative control.

Course Contents:

Unit 1: Introduction to Control Systems: Open and Closed loop control systems, Transfer function of the system, State Variable Model, Mathematical Modeling-Mechanical- Spring, Damper, Mass; Electrical- Resistor, Capacitor and Inductor; Transfer function of AC Servomotor, Tachometer, Stepper Motor, Block Diagram Reduction- Signal Flow graph, Mason's Gain formula.	[6]
Unit 2: Time Domain Analysis: Time Response, Steady State Analysis, Transient Response Analysis, Feedback characteristics of Control systems.	[6]
Unit 3: Frequency Domain Analysis: Correlation between time domain and frequency domain specification, Polar Plot, Nyquist Plot and Bode Plot.	[6]
Unit 4: P,PI and PID Controller on system: Introduction to P, I & D controller, Individual effect on overall system performance, PI, PID Controller and effect on overall system performance.	[6]
Unit 5: Stability Analysis: Concept of Stability, Routh-Hurwitz Stability criteria, Root Locus Technique, Effect of Pole Zero addition on root locus.	[6]
Unit 6: Non Linear Control Systems: Proportional and Derivative control with gravity compensation, computed torque control, Sliding mode control, adaptive control, observer based control.	[6]
Text Books 1. M. Gopal: Control System: Principles and Design, Tata Mc Graw-Hill Publication.	



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| 2. I. J Nagrath, M. Gopal-Control System Engineering; New Age International Publishers-
5 th Edition 2008. |
| 3. K Ogata: Modern Control Engineering, Eastern Economy, 5 th Edition 2011. |

Reference Books:

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|--|
| 1. Katsuhiko Ogata", Modern Control Engineering", Prentice Hall, 2010 |
| 2. B C Kuo, Automatic Control System, Wiley Publication 8 th Edition. |
| 3. Norman S Nise, Control System Engineering, John Wiley and Sons, 6 th Edition, 2014. |
| 4. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw Hill, 3 rd Edition. |




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Robot Kinematics and Dynamics

23AR3603	PCC	Robot Kinematics and Dynamics	3-0-0	3 Credits
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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: Fundamental of Automation and Robotics

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

CO1	Explain the various components and basics of a robotics system
CO2	Explain the classification, application, and specifications of robots
CO3	Solve the problems related to rotation, translation, and transformation in robotics
CO4	Solve the problems related to forward and inverse kinematics in robotic systems
CO5	Identify the concepts of trajectory and motion planning in the robotics system.
CO6	Build the basics of dynamics analysis in the robotics system.

Course Contents:

Unit 1:Introduction Kinematics and dynamics, Kinematic joints, Link, Kinematic pair, Constrained motion, Mechanism and machines, Robotics system, Robot joints, Robotic Terminology, components of robotics, Robot manipulation, Future of robotics	[7]
Unit 2:Robot Kinematics Basics Robot configurations, Classification of robots, Robot End-effectors, Workspace, Specification of Robot, Application of Robots, Robotics sensors, sensor calibration, Grubler's Formula, Degrees of Freedom of robot manipulators	[7]
Unit 3:Kinematics Representation of Robot Manipulator Representation of planer motion, Representation of spatial motion, Descriptions: Positions, Orientations, and Frames, Representation: Rotation, translation, transformation, Homogeneous transformation, Rolling, Pitching, and Yawing	[7]
Unit 4: Kinematics Analysis of robotic manipulators Forward and Inverse kinematics of robotic manipulators, Denavit Hartenberg Parameters, Rules for coordinate assignments, Robot coordinate system.	[7]
Unit 5: Trajectory and Motion Planning Trajectory, General Considerations in Path Generation, work envelope of a robot,	[6]



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Cartesian space technique, Joint space technique- Cubic polynomial, Fifth order polynomial, Linear trajectory function, Robot motion planning, Sequence of robotic action, Motion planning approaches, classification of Robot motion planning	
Unit 6: Basics of Robotic Dynamics (Theory) Key aspects of the dynamics of robotics systems, Forces in Manipulator, Robot dynamics –Rigid body dynamics, Newton-Euler, Lagrange-Euler, generalized D'Alembert equations of motion.	[6]
Text Books: 1. Craig, John J. Introduction to robotics. Pearson Education, 2006. 2. Renfrew, Alasdair. "Introduction to robotics: Mechanics and control." International Journal of Electrical Engineering & Education 41.4 (2004): 388. 3. Lumelsky, Vladimir J. Sensing, intelligence, motion: how robots and humans move in an unstructured world. John Wiley & Sons, 2005. 4. Vukobratovic, Miodir. Introduction to robotics. Springer Science & Business Media, 2012.	
Reference Books: 1. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co. 2. J. E. Shigley and J.J. Uicker Jr., Theory of Machines and Mechanism, McGraw Hill [ISBN019515598X] 3. G K Grover, "Mechanical Vibration", Nemchand and brothers. [ISBN8185240752] 4. S.S. Ratan, Theory of Machines, Tata McGraw Hill [ISBN0070591202] 5. Deb S.R., —Robotics, Tata McGraw Hill Publications, New Delhi. 6. Yoram Koren, "Robotics for Engineers", McGraw Hill Book Co. 7. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology- Programming and Applications", McGraw Hill Book Co. elhi 6. Shah and Jadhawani, Theory of Machines, Dhanpat Rai & Sons 7. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009. 8. Lewis, Frank L., Darren M. Dawson, and Chaouki T. Abdallah. Robot manipulator control: theory and practice. CRC Press, 2003. 9. Robotics: Modelling, Planning and Control, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer Science & Business Media, 07-Nov-2008 - Technology & Engineering - 632 pages 10. Mueller, Andreas. "Modern robotics: Mechanics, planning, and control [bookshelf]." IEEE Control Systems Magazine 39.6 (2019): 100-102.	




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Control System (MATLAB) Laboratory

23AR3604	VSEC	Control System (MATLAB) Laboratory	0-0-2	1 Credits
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Teaching Scheme:	Evaluation Scheme:
Practical: 2 hrs /week	CA-I :25 Marks CA-II :25 Marks

Pre-Requisites: Engineering Mathematics-III

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

CO1	Determine the system response in both time domain.
CO2	Determine the stability by Applying Routh Hurwitz Criteria and Root Locus Method.
CO3	Determine the stability and response by constructing Polar, Nyquist and Bode Plot.

List of Experiments:

1. Different Tool Boxes in MATLAB, Introduction to Control Systems Tool Box, transpose and inverse values of given matrix.
2. Plot the pole and zero configuration in s-plane for the given transfer function.
3. Plot Module Step Response of given transfer function and find delay time, rise time, peak time and peak overshoot.
4. Determine the time response of the given system subjected to any arbitrary input.
5. Simulation of Step Response and Impulse Response for Type-0, Type-1 and Type-2 system with Unity Feedback using MATLAB.
6. Determination of stability by using Root Locus using MATLAB for 2nd, 3rd and 4th order system of a linear time invariant system.
7. Determination of stability by using Bode Plot using MATLAB for 2nd, 3rd, 4th order system of Linear Time Invariant system.
8. Determination of stability by using Nyquist plot using MATLAB for 2nd, 3rd and 4th order system.

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
4. Nagrath & Gopal, "Modern Control Engineering", New Age International, New Delhi.
5. Ambikapathy A., Control System, Khanna Book Publishing Company, 2018.



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Reference Books:

1. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 7th Edition, 1995.
2. Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill, 2007.
3. John J. D'Azzo & Constantine H. Houpis, "Linear Control System Analysis and Design", Tata McGraw-Hill, Inc., 1995.
4. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Addison – Wesley, 1999.




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Robot Kinematics and Dynamics Laboratory

23AR3605	PCC	Robot Kinematics and Dynamics Laboratory	0-0-2	1 Credits
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Teaching Scheme:	Evaluation Scheme:
Practical: 2 hrs /week	CA-I :15 Marks CA-II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Fundamentals of Automation and Robotics

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

CO1	Demonstrate analysis of robot manipulators.
CO2	Illustrate the functionality and limitations of robot actuators.
CO3	Develop program a robot to perform a specified task in a target environment and solve problems in areas such as robot control and navigation.

List of Experiments:

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

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 any industrial process (Packaging, Assembly)
5. Demonstration of various robotic configurations using an industrial robot
6. Demonstration components of a real robot and its DH parameters.
7. One Industrial visit for Industrial robotic application
8. Case study for industrial robotics.
9. Virtual Modeling For Kinematic And Dynamic Verification Any One Robotic Structure Using Suitable Software

Text Books:

1. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3. Groover M.P.-Automation, production systems and computer integrated manufacturing- Prentice Hall of India.



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Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
2. Mikell P. Groover, Automation, Production Systems & Computer Integrated Manufacturing, PHI Learning Pvt. Ltd. , New Delhi, ISBN:987-81-203-3418-2, 2012
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5. Mike Wilson, Implementation of Robotic Systems, ISBN: 978-0-124-04733-4




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Design of Machine Elements and Transmission Laboratory

23AR3606	PCC	Design of Machine Elements and Transmission Laboratory	0-0-2	1 Credits
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Teaching Scheme:	Evaluation Scheme:
Practical: 2 hrs /week	CA-I :15 Marks CA-II :15 Marks End Semester Exam: 20 Marks

Pre-Requisites: Solid Mechanics

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

CO1	Demonstrate understanding of various design considerations.
CO2	Apply basic principles of machine design
CO3	Acquire skill in preparing production drawings of various components designed.
CO4	Design concept of welded & threaded joint, and analyze when it is subjected to different loading condition

List of Experiments:

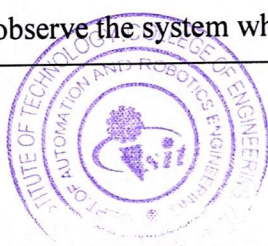
Design exercises in the form of design calculations with sketches and or drawings on following machine system with using 3D software

1. Design of coupling system.
2. Design of screw jack.
3. Design of welded joints
4. Design of threaded joints

A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file

Minimum 2 exercises from the following list

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys,



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coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials

3. To develop a demonstration models of different types of couplings.

4. To develop a demonstration models of different types of key

5. Stress analysis of any machine element mentioned in the syllabus using any application software and programming language

6. Design a Mini-Project to develop and apply the knowledge of Machine Design and drafting software for any mechanical system on the basis of: (a) Idea generation, (b) Creativity, Reliability and safety, (c) Design parts of the system (d) Ergonomic Considerations (e) Use of International standards

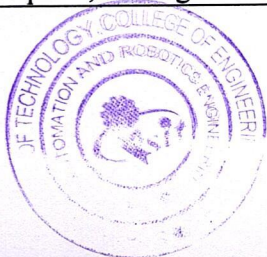
7. Design a Mini-Project to develop and apply the knowledge of Machine Design for Two stage Gear Box

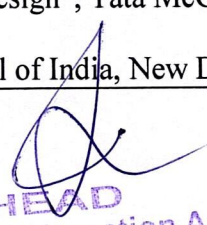
Text Books:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008.
2. R. L. Norton, "Machine Design: An Integrated Approach", Pearson Education Singapore, 2001
3. A Machine Design R.S. Khurmi & J.K. Gupta S. Chand publication.
4. Machine design S G Kulkarni McGraw Hill Education Publications
5. Introduction to Machine design V B Bhandari McGraw Hill Education Publications.
6. Design Of Machine Elements Vol I, Vol II J.B.K. Das, P.L. Srinivas Murthy Sapna publication
7. Machine Component Design William Orthwein Jaico publication

Reference Books:

1. R. C. Juvinall, K. M. Marshek, "Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002.
2. J. Hamrock, B. Jacobson and Schmid Sr., "Fundamentals of Machine Elements", International Edition, New York, 2nd edition, 1999.
3. S. Hall, A. R. Holowenko, H. G. Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982.
4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004.
5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi. 6.




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- Machine Design by Robert L.Norton, Tata Mc- Graw Hill Publication
6. Fundamentals of Machine Component Design by Junvinall Wiley India
 7. Mechanical System Design by Anurag Dixit SCITECH publication
 8. Design of Machine Element/Machine Design by Kannaiah SCITECH publication




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Capstone Project Phase-I

23AR3607	ELC	Capstone Project Phase-I	0-0-4	2 Credits
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Teaching Scheme:	Evaluation scheme:
Practical: 4 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Examination: 20 Marks

Pre-Requisites: All courses

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

CO1	State the exact title of the project and problem definition.
CO2	Explain the motivation, objectives, and scope of the project.
CO3	Review the literature related to the selected topic of the project.
CO4	Design the mechanism, and components of the system and prepare detailed drawings.
CO5	Evaluate the cost considering different materials/manufacturing processes.

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The completion of work and the submission of the report and assessment should be done at the end of VII Sem. The project work should consist of any of the following or an appropriate combination:

1. A comprehensive and up-to-date survey of literature related to the study of a phenomenon or product.
2. Design of any equipment and/or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing the same.
4. Experimental verification of principles used in applications related to various specializations related to Mechatronics Engineering.
5. Software development for particular applications.
6. A combination of the above.



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It is expected that the students should complete at least 50% of the total project work in the VI Semester. The objective is to prepare the students to examine any design or process or phenomenon from all angles, to encourage the process of independent thinking and working, and to expose them to industry. The students may preferably select the project works from their opted elective subjects. The students should submit the report in a prescribed format, before the end of the VIIth semester. The report shall be comprehensive and presented typed on A₄ size sheets and bound. The number of copies to be submitted is the number of students plus two. The assessment would be carried out by the panel of examiners for both, term work and oral examinations.




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Robot Programming

23AR3608	PCC	Robot Programming	1-0-0	Audit
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Teaching Scheme	Evaluation scheme
Lecture: 1 hrs/week	CA-I :25 Marks CA-II :25 Marks

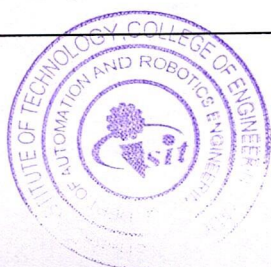
Pre-Requisites: Fundamentals of Automation and Robotics

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

CO1	Explain robot programming methods and components of robot programming
CO2	Develop programs using VAL Language to simulate robot movements.
CO3	Create programs using VAL-II Language to simulate robot movements.
CO4	Develop programs using RAPID Language to simulate robot movements.
CO5	Develop robot programmes for specific application using AML Language
CO6	Interpret Practical study of virtual robot software

Course Contents:

Unit 1: Introduction to Robot Programming 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.	[2]
Unit 2: VAL Language Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, WAIT, SIGNAL and DELAY command for communications using simple applications.	[3]
Unit 3: VAL-II VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications- Robot welding application using VAL program, Production rate calculations using robot.	[3]
Unit 4: RAPID Language RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot manual mode, automatic mode, subroutine command based programming. Move master command language-Introduction, syntax, simple problems	[3]
Unit 5: AML Language AML Language - General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands- Data processing.	[3]



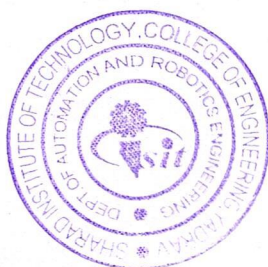
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Unit 6: Practical Study of Virtual Robot Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning ,program modules, input and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics.	[3]
Text Books: 1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987. 2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985 3. J.J. Craig, Robotics, Addison-Wesley, 1986. 4. Saeed B. Niku, "Introduction to Robotics – Analysis, Systems and Application" : PHI 2006. 5. Richard D, Klafter, Thomason A Chmiel Owski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005. 6. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007. 7. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.	
Reference Books: 1. Cameron Hughes Tracey Hughes, Robot Programming: A Guide to Controlling Autonomous Robots, 1/e First Edition, 2016, ISBN: 9789332577442 2. S. R. Deb, Robotics Technology and Flexible Automation, 2010. McGraw Hill ISBN: 9780070077911 3. Mikell. P. Groover, Industrial Robotics: Technology, Programming, and Applications 2nd Edition, McGraw Higher Ed. 2012, ISBN: 9781259006210, 4. Industrial Robotics Technology, Programming and Applications, McGraw Hill Co, 1995. 5. Robotics Lab manual, 2007.	




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Program Elective Course-II

A. Applied Robotics

23AR3609A	PEC	Applied Robotics	3-0-0	3 Credits
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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

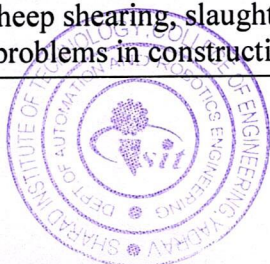
Pre-Requisites: Fundamentals of Automation and Robotics, Mobile Robotics

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

CO1	Apply various types of Industrial, field and service Robots and their characteristics and
CO2	Identify with the knowledge of Mathematical modeling of specialized Robots.
CO3	Organize the operation of Robots and processes involved
CO4	Select the right Robot with required configurations and specifications for applications.
CO5	Explain with the applications of various field and service Robots.
CO6	Summarize with the applications of Future of robotics .

Course Contents:

Unit 1: Applications of Robots in Industries Introduction to robotics - overview, A short history of industrial Robots - Applications of Robots in Welding, car body assembly, painting- Applications of Robot in Machining, material transfer- Kinematics and mechanisms review, tasks descriptions, teaching and programming- End-effectors and system integration	[8]
Unit 2: Cooperative and Swarm Robots 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.	[7]
Unit 3: Field Robotics Forestry, Robot locomotion, forestry automation, SLAM in forestry- autonomous Robots for silviculture and treatment- 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, unsolved problems in construction,	[8]



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Unit 4: Robots In Surgery And Rehabilitation Medical robotics, Core concepts, Technology- Medical robotic systems, Research areas and applications- Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.	[7]
Unit 5: Entertainment and Personal Robotics Cleaning Robots, lawn moving Robots- Smart appliances and smart homes- The role of Robots in education, Educational robotic platforms-. Robots and informal learning venues	[6]
Unit 6: Future Robotics 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.	[6]
Text Books: 1. Bruno Siciliano, Oussama Khatib, —Springer Handbook of Robotics, Springer-Verlag Berlin Heidelberg 2008. 2. Yangsheng Xu Huihuan Qian Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.	
Reference Books: 1. Aleksandar Lazinica, —Mobile Robots Towards New Applications, Advanced Robotic Systems International, 2006. 2. Gregory Dudek, Michael Jenkin, —Computational Principles of Mobile Robotics, 2nd edition, Oxford University Press, 2010. 3. L Marques, A de Almeida, Mo Tokhi, GSVirk, —Advances in Mobile Robotics, World Scientific Publishing Co. Pte. Ltd. 2008.	




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Program Elective Course-II
B. Computer Integrated Manufacturing

23AR3609B	PEC	Computer Integrated Manufacturing	3-0-0	3 Credits
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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	Explain the basic concepts of CAD, CAM and computer integrated manufacturing system
CO2	Summarize the production planning and control and computerized process planning
CO3	Differentiate the different coding systems used in group technology
CO4	Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system
CO5	Illustrate automated material handling and storage systems for a typical production system
CO6	Apply the industrial robotics

Course Contents:

Unit 1 Introduction Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system – Types of production -Manufacturing Control –Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.	[7]
Unit 2 Production Planning And Control And Computerized Process Planning Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP).	[7]
Unit 3 Cellular Manufacturing Group Technology(GT), Part Families – Parts Classification and coding –Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and	[7]



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layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell.	
Unit 4 Flexible Manufacturing System (FMS) and Automated Guided Vehicle System (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS –Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.	[7]
Unit 5 Automatic Material Handling and Storage system 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.	[6]
Unit 6 Smart Manufacturing Introduction to additive manufacturing, IoT, Smart Sensing, Smart Machines, Data Visualization and Analysis, Augmented Reality, Cyber-security for manufacturing.	[6]
Text Books: 1“Automation, Production Systems and Computer Integrated Manufacturing”, Groover, M.P. Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004). 2. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies	
Reference Books: 1. Mikell P Groover, Automation, production Systems and Computer Integrated Manufacturing, 3rd Edition, Prentice Hall Inc., New Delhi, 2012. 2. Nanua Singh, System Approach to Computer Integrated Manufacturing, Wiley & Sons Inc., 1996. 3. Andrew Kusiak, Intelligent Manufacturing System, Prentice Hall Inc., New Jersey, 1992 4. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover, Pearson Education. 5. Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd edition, 2010 6. An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk 7. Performance Modeling of Automated Manufacturing Systems,- Viswanandham	




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Program Elective Course-II
C. Industrial Networking

23AR3609C	PEC	Industrial Networking	3-0-0	3 Credits
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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

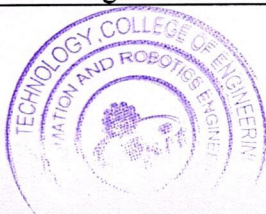
Pre-Requisites: Digital Electronics and Microprocessor

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

CO1	Apply the concepts of data communications and to design computer networks using subletting and routing concepts.
CO2	Compare the various medium access control techniques.
CO3	Compare and contrast the characteristics of physical layer.
CO4	Analyze the different protocols.
CO5	Compare and contrast the different network components.
CO6	Make use of about wireless sensor networks

Course Contents:

Unit 1: Introduction Modern instrumentation and control systems – OSI model – Protocols – Standards – Common problems and solutions – Grounding/shielding and noise - EIA-232 interface standard – EIA-485 interface standard – Current loop and EIA-485 converters. FIBRE OPTICS: Introduction – Fibre optic cable components and parameters – Basic cable types – Connection fibres – troubleshooting.	[7]
Unit 2 MODBUS Overview – Protocol structure – Function codes – Modbus plus protocol –Data Highway – AS interface (AS-i) –Device Net: Physical layer – Topology – Device taps – Profibus PA/DP/FMS:Protocol stack – System operation.	[7]
Unit 3: Ethernet and CAN Bus Systems IEEE/ISO standards – Medium access control – frames – Reducing collisions – Auto negotiation –LAN system components – Structured cabling – Industrial Ethernet – Troubleshooting Ethernet. CAN BUS: Concepts of bus access and arbitration – CAN: Protocol-Errors: Properties – detection –processing – Introduction to CAN 2.0B	[8]
Unit 4: Wireless Communications Radio spectrum – Frequency allocation – Radio modem – Intermodulation – Implementing a radio link,– RFID: Basic principles of radio frequency identification –	[7]



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Transponders – Interrogators	
Unit 5: Applications Automotive communication technologies – Design of automotive X-by-Wire systems, - The LIN standard – The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations.	[6]
Unit 6: Overview Of Wireless Sensor Networks Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks	[6]
Text Books: 1. Steve Mackay, Edwin Wright, Deon Reynders and John Park, “Practical Industrial Data Networks: Design, Installation and Troubleshooting”, Newnes (Elsevier), 2004 2. Albert Lozano-Nieto, “RFID Design Fundamentals and Applications”, CRC Press, 2011	
Reference Books: 1. Richard Zurawski, “The Industrial Communication Technology Handbook”, Taylor and Francis, 2005 2. Dominique Paret, “Multiplexed Networks for Embedded Systems”, John Wiley & Sons, 2007	




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Program Elective Course-II
D. Wireless Sensor Networks for Robotics

23AR3609D	PEC	Wireless Sensor Networks for Robotics	3-0-0	3 Credits
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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 the know about the different techniques used in networking
CO2	Identify about basic knowledge about wireless sensor networks
CO3	Interpret know about the tools in networking
CO4	Apply the basic in wireless architecture
CO5	Extend the Know about the protocols used in networking
CO6	Illustrate about Mobile Ad-hoc network

Course Contents:

Unit 1: Overview of Wireless Sensor Networks Challenges for Wireless Sensor Networks, Enabling Technologies For Wireless Sensor Networks.	[7]
Unit 2: Architecture 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.	[6]
Unit 3: Networking Sensors Physical Layer and Trans-receiver 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	[7]
Unit 4: Infrastructure Establishment Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	[7]
Unit5: Sensor Network Platforms And Tools	[7]



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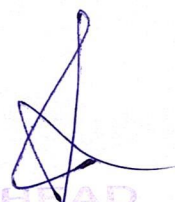


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Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.	
Unit6:Mobile Ad hoc Network Introduction, Routing Protocol ,Dynamic source routing ,Distination sequence,distance vector, Overview ad-hoc rotuting protocol ,Application RFID,Bluetooth,Zigbee	[6]
Text Books: 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	
Reference Books: 1. Joseph Bronzio, “Biomedical Engineering and Instrumentation” ,PWS Engg. Bostan 2. J.Webster “Bioinstrumentation “,Wiley and Sons 3. Joseph Bronzi “Biomedical Engineering handbook”,CRC Press	




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Program Elective Course-III

A. Field services and Robotics

23AR3610A	PEC	Field and Service Robotics	3-0-0	3 Credits
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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: Fundamental of Automaton and Robotics

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

CO1	Explain the basic concepts of working of robot.
CO2	Illustrate about Challenges of Localization
CO3	Summarize about planning and Navigation
CO4	Identify about Robots in different applications.
CO5	Make use of the humanoid robots functions & its operations.
CO6	Extend challenges in developing autonomous mobile Robots.

Course Contents:

Unit 1: Introduction 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.	[7]
Unit 2: Localization 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.	[6]
Unit 3: Planning and Navigation Introduction-Path planning overview- Road map path planning- Cell decomposition path planning-Potential field path planning-Obstacle avoidance - Case studies: Tiered robot architectures.	[7]
Unit 4: Field Robots Ariel robots- Collision avoidance-Robots for agriculture, mining, exploration, underwater, Civilian and military applications, Nuclear applications, Space applications.	[7]
Unit5: Humanoids Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control, Facial expression, Hands and manipulation, Sound and speech	[7]



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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.	
Unit6: 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	[6]
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.	
Reference Books: 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	




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Program Elective Course-III
B. Additive Manufacturing

23AR3610B	PEC	Additive Manufacturing	3-0-0	3 Credits
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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

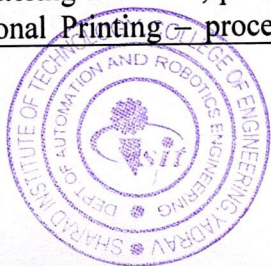
Pre-Requisites: Manufacturing Technology

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

CO1	Explain the fundamentals of rapid prototyping techniques
CO2	Explain the techniques of Liquid Based and Solid Based Rapid Prototyping Systems
CO3	Explain the techniques of Powder Based Rapid Prototyping Systems
CO4	Use appropriate tooling for rapid prototyping process
CO5	Use rapid prototyping techniques for reverse engineering.
CO6	Make use of the RP Applications.

Course Contents:

Unit 1 Introduction History – Development of RP systems – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle – Fundamental – File format Other translators – medical applications of RP – On demand manufacturing – Direct material deposition – Shape Deposition Manufacturing.	[6]
Unit 2 Liquid Based and Solid Based Rapid Prototyping Systems Classification – Liquid based system – Stereo Lithography Apparatus (SLA), details of SL process, products, Advantages, Limitations, Applications and Uses. Solid based system – Fused Deposition Modelling, principle, process, products, advantages, applications and uses – Laminated Object Manufacturing	[6]
Unit 3 Powder Based Rapid Prototyping Systems Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, applications and uses. Three Dimensional Printing process, major applications, research and development. Direct	[6]



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shell production casting – key strengths, process, applications and uses, case studies, research and development. Laser Sintering System, e-manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing – Laser Engineered Net Shaping (LENS).	
Unit 4 Rapid Tooling Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods RP Applications Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.	[7]
Unit 5 Reverse Engineering Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.	[6]
Unit 6 Reverse Engineering Methodology Detailed study of Reverse Engineering for Branch Specific learning Disassemble the existing selected artefact/ product/ component/ process/ system to study technical aspects and design detail, Reverse engineering in various computer software/ application	[6]
Text Books: 1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003. 2. Ian Gibson, David W. Rosen, Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2nd edition, 2010.	
Reference Books: 1. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific. 2. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer. 3. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons. 4. Hilton P, Jacobs P F, Rapid Tooling: Technologies and Industrial Applications, CRC press. 5. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press. 6. Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer, 2006 7. Reverse Engineering, Wills, Linda M., Newcomb, Philip (Eds.), Springer, 1996, ISBN 978-0-585-27477-5 8. Practical Reverse Engineering: x86, x64, ARM, Windows® Kernel, Reversing Tools, and Obfuscation, Bruce Dang, Alexandre Gazet, Elias Bachaalany, John Wiley & Sons, Inc, ISBN: 978-1-118-78731-1.	



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Program Elective Course-III

C. Data Analytics

23AR3610C	PEC	Data Analytics	3-0-0	3 Credits
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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

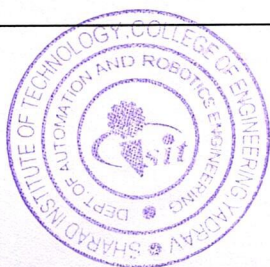
Pre-Requisites: Engineering Mathematics III

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

CO1	Explain the effectively visualize and interpret the data
CO2	Apply the Descriptive analytics
CO3	Make use of Predictive analytics
CO4	Make use of Classification techniques
CO5	Apply the prescriptive analytics
CO6	Use data analysis for Reinforcement learning

Course Contents:

Unit I: Introduction to data analytics Significance & applications of data analytics, Data collection, data processing, data transformation, data integration, data visualization, basic statistics, inferential statistics	[6]
Unit 2 Descriptive analytics Uni-variate/multi-variate statistics, bi-variate associations, correlations, covariance, analysis of variance (ANOVA)	[6]
Unit 3 Predictive analytics Multiple regression, conjoint analysis, neural networks, data clustering, Data mining	[6]
Unit 4 Classification techniques Linear classifiers, Quadratic classifiers, Support vector machines, Random forests.	[7]
Unit 5 Prescriptive analytics Decision tree analysis, Expert system, principal component analysis, genetic algorithms	[7]
Unit 6 Reinforcement learning Markov chain analysis, Monte Carlo simulation, Q learning, State action reward state action (SARSA) learning	[6]



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Text Books:

1. Bhattacharjee Vandana, Bishnu Partha Sarathi, Data Analysis : Using Statistics And Probability With R Language, Phi Learning, ISBN: 9789387472655.
2. Bharti Motwarni Data Analytics with R, 2019, Wiley, ISBN: 9788126576463

Reference Books:

1. Acharya Seema and Chellappan, Big Data and Analytics, Willey India Pvt. Ltd. (2015), ISBN: 9788126554782
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Willey India Pvt. Ltd. (2016), ISBN: 978-1-118-87622-0
3. Michael Minelli, Michale Chambers, Ambiga Dhiraj, Big Data Analytics: Emerging Business Intelligence and analytics trends for today's business, Willey India Pvt. Ltd. (2015)




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Program Elective Course-III
D .Image Processing and Vision Systems

23AR3610D	PEC	Image Processing and Vision Systems	3-0-0	3 Credits
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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

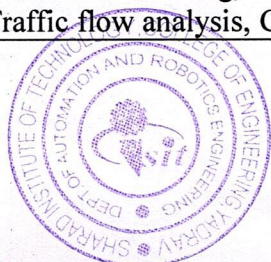
Pre-Requisites: Control Systems, Basics of Digital Signal Processing

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

CO1	Identify the geometric relationship of pixels.
CO2	Apply different image transforms and filtering techniques on an image.
CO3	Apply the knowledge of simple codes for improving image quality
CO4	Performs operations on color image processing.
CO5	Demonstrate applications based on image processing.
CO6	Identify the Machine vision in robotics

Course Contents:

Unit 1: Vision System Basic Components Fundamental steps in DIP, Components of image processing system, Elements of visual perception: structure of human eye, Image formation Image formation model –Image sensing and Acquisition– Basic relationship between pixels	[6]
Unit 2: Low-Level Vision Image representation – Gray level transformations- Image Negation, log transformation, power law transformation, piecewise linear transformation functions, Histogram equalization, Filters: Smoothing spatial filters, sharpening spatial filters smoothing frequency domain filters, sharpening frequency domain filters.	[7]
Unit 3: Higher-Level Vision Segmentation: Detection of discontinuities- Point detection, line detection, edge detection, Thresholding, Region-oriented segmentation: region growing, region splitting and merging.	[6]
Unit 4: Color Image Processing Color Fundamentals, color models, pseudocolor image processing Morphological image processing: Dilation & erosion, opening and closing operation, Hit-or-miss transformations.	[7]
Unit 5: Applications K-means Clustering, Road condition monitoring, Cancer detection using computer vision, Traffic flow analysis, Computer vision in healthcare, Computer vision in sports, Computer	[7]



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vision in security sector, Computer vision in education.	
Unit 6: Robot and Machine Vision Basic introduction to Robotic operating System (ROS), Object detection and tracking, Object recognition, motion detection	[6]
Text Books 1. K.S.Fu, R.C.Gonzalez, CSG. Lee, —Robotics control, sensing, vision and Intelligencel, McGraw Hill Education Pvt. Ltd., 2013. 2. Richard D Klafter, Thomas A Chmielewski, Michael Negin, —Robotics Engineering: An Integrated Approachl, PHI Learning, New Delhi, 2009.	
Reference Books: 1. Damian M Lyons,—Cluster Computing for Robotics and Computer Visionl, World Scientific, Singapore, 2011 2. RafelC.Gonzalez, Richard E.Woods, Steven L.Eddins,lDigital ImageProcessing using MATLABl,2nd edition, Tata McGraw Hill, 2010. 3. Carsten Steger, Markus Ulrich, Christian Wiedemann, —Machine Vision Algorithms and Applicationsl, WILEY-VCH, Weinheim, 2008. 4. Kenneth Dawson-Howe, —A Practical Introduction to Computer Vision with OpenCVl, Wiley, Singapore, 2014.	




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Multidisciplinary Minor-IV
Digital & Satellite Communication and Navigation from Space

23ARMDA4	MDM	Digital & Satellite Communication and Navigation from Space	3-0-0	3 Credits
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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, Radar Technologies

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

CO1	Understand the Communication Techniques
CO2	Evaluate the Performance of Communication Systems
CO3	Design the Analogue and Digital Communication Systems
CO4	Analyze the Signal Transmission Effects
CO5	Make use of Different types of Navigation Techniques
CO6	Identify the Global Navigation Satellite System

Course Contents:

Unit 1: Introduction Elements of a communications system and their relationship to system performance. Digital Communication System , Communication Channels and their Characteristics, Mathematical Models for Communication Channels, Design challenges, message sources, Channel effect, signal to noise ratio and capacity	[6]
Unit 2: Digital Data Communication Systems Digital signaling techniques, Link budget calculations telemetry and control and IO/IW implications, Antenna types –wire antennas, Horn Antennas, Reflector Antennas, phased array antennas. Free space optical communication, Fiber optics communication, Wireless/cellular communications	[6]
Unit 3: More on Fundamentals Fundamental concepts such as current/voltage relationships, time and frequency domains, power spectral density, random signals, Communications system components and functions, analog and digital communications systems	[6]
Unit 4: Modulation Transmission and Reception Baseband and passband digital modulation; system noise, transmission lines, waveguides and antennas, FEC techniques for mitigating channel errors	[6]



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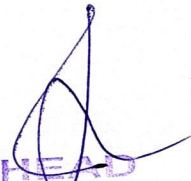


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Unit 5: Propagation effects on signal transmission End-to-end path calculations for wire/coax, and RF systems including terrestrial ground links and satellite communications, Spread spectrum, concept of frequency hopping. Navigation techniques from space regarding functioning of GPS, GLONASS, IRNSS & Galileo	[6]
Unit 6: Global Navigation Satellite System Fundamentals, Signals, and Satellites: Fundamentals of Satellite Navigation, Inertial Navigation, Advanced satellite Navigation, Principles of radio Positioning, Terrestrial radio Navigation, Short-Range Positioning, Satellite Navigation Processing	[6]
Text Books: 1. T. Pratt, C. W. Bostian, J. E. Allnut, Satellite communication, Publisher: John Willey and sons 2. G. Maral, M. Bousquet, Z. Sun. Satellite Communications Systems: systems, techniques and technology, Publisher: John Willy and sons	
Reference Books: 1. B. Sklar, Digital Communications: Fundamentals and Applications, . Prentice-Hall, Inc. 2. E. Kaplan and C. Hegarty, Understanding of GPS/GNSS: Principles and Applications,. Publisher: Artech House Publishers	




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Multidisciplinary Minor-IV

R-Programming

23ARMDB4	MDM	R-Programming	3-0-0	3 Credits
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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

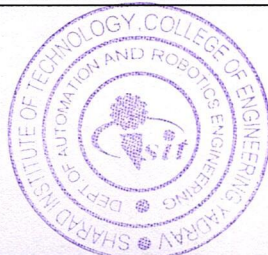
Pre-Requisites: Programming Skills

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

CO1	Apply R programming and understand different data sets
CO2	Apply R Programme and construct graphs and charts
CO3	Analyze the data and know descriptive statistics by using R Programming
CO4	Apply R Programming to test the hypothesis of the study
CO5	Predict the data and take decisions through R programming.
CO6	Apply Advanced Data Visualization and Integration

Course Contents:

Unit 1: Introduction to R programming: What is R? - Installing R and R Studio – R Studio Overview - Working in the Console - Arithmetic Operators - Logical Operations - Using Functions - Getting Help in R and Quitting R Studio Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values	[6]
Unit 2: Data Visualization using R Scatter Plots - Box Plots - Scatter Plots and Boxand-Whisker Plots Together -Customize plot axes, labels, add legends, and add colours.	[6]
Unit 3: Descriptive statistics in R Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.	[6]
Unit 4: Testing of Hypothesis using R T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation	[6]
Unit 5: Predictive Analytics linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models, VIF model	[6]
Unit 6: Advanced Data Visualization and Integration	[6]



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Advanced Visualization Techniques in R. - Integrating R with Power BI: Using R scripts and calculations. - Data Visualization Ethics and Best Practices. - Capstone Project: Applying skills using R and Power BI.

Text Books:

1. Crawley, M. J. (2006), "Statistics - An introduction using R", John Wiley, London 32.
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), "Statistics using R", second edition. Narosa Publishing House, New Delhi.
3. Shahababa B. (2011), "Biostatistics with R", Springer, New York.
4. Braun & Murdoch (2007), "A first course in statistical programming with R", Cambridge University Press, New Delhi.

Reference Books:

1. Jared P Lander, R for everyone: advanced analytics and graphics, Pearson Education, 2013
2. Dunlop, Dorothy D., and Ajit C. Tamhane. Statistics and data analysis: from elementary to intermediate. Prentice Hall, 2000.
3. G Casella and R.L. Berger, Statistical Inference, Thomson Learning 2002.
4. P. Dalgaard. Introductory Statistics with R, 2nd Edition. (Springer 2008)
5. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer
6. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.
7. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010
8. Joseph F Hair, William C Black et al, "Multivariate Data Analysis", Pearson Education, 7th edition, 2013.
9. Mark Gardener, "Beginning R - The Statistical Programming Language", John Wiley & Sons, Inc., 2012.
10. W. N. Venables, D. M. Smith and the R Core Team, "An Introduction to R", 2013




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Multidisciplinary Minor-IV

Aircraft Structures-II

23ARMDC4	MDM	Aircraft Structures-II	3-0-0	3 Credits
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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: Aircraft Structures-I

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

CO1	Analyze and investigate the normal stress variation on unsymmetrical sections subjected to bending moments.
CO2	Determine the shear flow variation in thin-walled open sections with skin effective and
CO3	Calculate the shear flow variation in single-cell and multi-cell tubes subjected to shear and
CO4	Investigate the behavior of buckling of simply supported plates and also to know the effective width of sheet stringers combination
CO5	Solve the problems related to the shear and bending moment variation of aircraft wing and fuselage also to know the characteristics of thin webbed beams.
CO6	Apply Aircraft Structures-II ideas to solve practical problems in the society

Course Contents:

Unit 1: Introduction Features of aircraft structures, monocoque and semi-monocoque structures, Idealization nomenclature and layout function, static equilibrium, statically determinate and indeterminate structures. Concept of static stability. Maxwell's reciprocal theorem.	[6]
Unit 2: Unsymmetrical Bending General, Principal axis and neutral axis methods, bending stresses in beams of symmetric sections with skew loads, Bending stresses in beams of unsymmetrical sections.	[6]
Unit 3: Shear Flow in Open Sections Thin-walled beams, Concept of shear flow, shear centre, Elastic axis with one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.	[6]
Unit 4: Shear Flow in Closed Sections Bredt – Batho formula, Single and multi-cell structures, Shear flow in single & multicell structures under torsion. Shear flow in single and multicell under bending with walls is effective and ineffective	[6]



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Unit 5: Buckling of Plates Rectangular sheets under compression, local buckling stress of thin-walled section Crippling stresses by Needham's and Gerard's methods, Thin-walled column	[6]
Unit 6: Stress Analysis in Wing And Fuselage Shear resistant web beams-Tension field web beams (Wagner's), Loads on aircraft, lift distribution, V-n diagram, Gust loads.	[6]
Text Books: 1. Donaldson B K.; "Analysis of Aircraft Structures"; Cambridge Aerospace Series; 2 nd Edition, 2008. 2. Megson, T.H.G.; "Aircraft Structures for Engineering Students"; Elsevier Ltd; 2 nd Edition 2010	
Reference Books: 1. Sun C T; "Mechanics of Aircraft Structures"; Wiley India; 2 nd Edition; 2010. 2. Peery, D.J; "Aircraft Structures"; McGraw-Hill, N.Y.; 2nd Edition, 2011. 3. Stephen P. Timoshenko & S.Woinovsky Krieger;" Theory of Plates and Shells"; McGraw-Hill,Singapore; 2nd Edition, 1990. 4. Rivello R.M.; "Theory and Analysis of Flight structures"; McGraw-Hill, N.Y.; 1 st Edition, 1993.	




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Aptitude Skills-IV

23HSSM05	VEC	Aptitude Skills-IV	2-0-0	Audit
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Teaching Scheme:	Evaluation Scheme:
Lecture: 2 hrs/week	CA-I :25 Marks CA-II :25 Marks

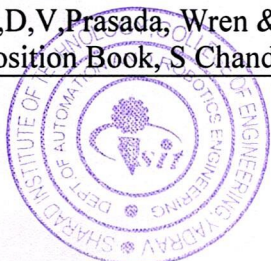
Pre-Requisites: Aptitude Skills-III

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

CO1	Solve the problems on system of equation
CO2	Solve the problems on seating arrangement
CO3	Solve the logical reasoning problems
CO4	Solve the critical analysis problems
CO5	Solve the problems of Data interpretation
CO6	Solve the Permutation and combination

Course Contents:

Unit 1: System of equations quadratic equations, Surds and indices, solution of equations, Ages	[2]
Unit 2: Seating Arrangements Linear seating Arrangement, Circular seating arrangement, Complex seating arrangement	[2]
Unit 3: Logical Reasoning Numerical based on sense of direction, Blood relations, Odd man Out	[2]
Unit 4: Critical analysis Clocks and Calendar based problems, Cryptarithmic, heights and distances	[2]
Unit 5: Data Interpretation Table form, Bar form, Line for Pi chart form	[2]
Unit 6: Permutation and combination Permutation and combinations	[2]
Text Books: 1. RS Aggarwal "A Modern Approach to Verbal & Non-Verbal Reasoning ", S. Chand a. Publisher; 2016 edition 2. RS Aggarwal, " Quantitative Aptitude for Competitive Examinations ", S. Chand a. Publisher; 2016 edition 3. Raymond Murphy "Essential English Grammar with Answers", Murphy	
Reference Books: 1. Rao N,D,V,Prasada, Wren & Martin High School English Grammar and Composition Book, S Chand Publishing, 2017	





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| <ol style="list-style-type: none">2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press; Second edition3. RS Aggarwal, Objective General English, S. Chand Publisher; 2016 edition |
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Language Skills- IV

23HSSMO6	VEC	Language Skills- IV	0-0-2	Audit
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Teaching Scheme:	Evaluation scheme:
Practical: 2 hrs/week	CA-I :25 Marks CA-II :25 Marks

Pre-Requisites: Language Skills- III

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

CO1	Make use of Function in Python Programming.
CO2	Make use of Python collections.
CO3	Make use of classes and its objects in python.
CO4	Make use of file and it's handling functions.

1. Write a Python program to define a user-defined function that takes a number as input and returns whether it is even or odd. Call the function and display the result. o Concepts: Function definition, arguments, return value.	[2]
2. Create a Python program to define and call a function with default arguments and keyword arguments. o Concepts: Function calling, argument types.	[2]
3. Write a Python program using a lambda function to compute the square, cube, and factorial of a given number. o Concepts: Lambda function basics	[2]
4. Write a Python program to demonstrate list operations such as creation, adding items, removing an item, slicing, and sorting. o Concepts: List constructor, change, remove, sort, list comprehension	[2]
5. Write a Python program to demonstrate the use of tuples and sets. Perform operations such as checking membership, adding/removing elements (set), and iterating. o Concepts: Tuple immutability, set operations.	[2]
6. Write a Python program to create a dictionary of employees with their ID as key and name as value. Perform operations like adding a new entry,	[2]



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updating existing, and deleting one. ○ Concepts: Dictionary operations, loop through dictionary.	
7. Write a Python program to create a class Student with attributes name, roll_no, and a method display(). Create an object and access its members. ○ Concepts: Class, object, method access.	[2]
8. Create a class with an __init__() constructor to initialize data members and a destructor to display a message when the object is deleted. ○ Concepts: Constructor, destructor.	[2]
9. Write a program to demonstrate single inheritance where a class Vehicle is inherited by a class Car. Use super() to access base class methods. ○ Concepts: Inheritance, super().	[2]
10. Write a Python program to open a text file in write mode and write your personal information (name, age, department). Then, read and display the content of the file. ○ Concepts: File open, write, read, file modes.	[2]
11. Write a program to read a file line by line using readline() and count the number of characters in each line. ○ Concepts: File reading, character offset.	[2]
12. Create a program to open a file in append mode and add new content. Use exception handling to manage file not found or access errors. ○ Concepts: File handling with exception management.	[2]
Text Books: 1. Python Projects (Author: Laura Cassell, Alan Gauld) Wrox publication 2. Murach's Python Programming. Aut.: Michael Urban, Joel Murach, murach's Publication.	
Reference Books: 1. Fundamentals of Python (First Program) Cengage MINDTAP Publication 2nd Edition. Author: K.A. Kambert	




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