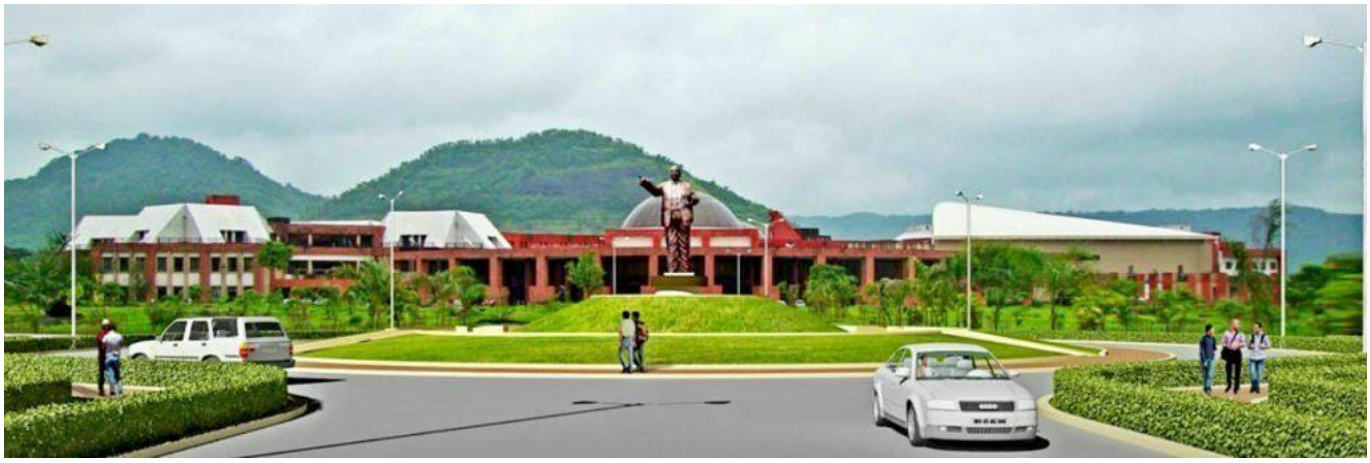
Dr. Babasaheb Ambedkar Technological University
(Established as a University of Technology in the State of Maharashtra)
(under Maharashtra Act No. XXIX of 2014)
P.O.: Lonere, Dist.: Raigad,
Pin 402 103, Maharashtra.
Telephone and Fax. : 02140 - 275142
www.dbatu.ac.in

Course Structure
for

M.Tech. in Automation & Robotics
(For Affiliated Institutes Only)

Syllabus as per the guidelines of National Education Policy 2020
To be implemented from Academic Year 2024-25.



Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need-based research and extension activities.

Program Educational Objectives

PEO1	To train students with in-depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areasof Robotics and Automation.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations todevelop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.

Program Outcomes

At the end of the program the student will be able to:

PO1	Acquire, demonstrate and apply advanced knowledge in the area of Robotics and Automation.
PO2	Identify problems in the field of Robotics and Automation and related areas, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, a d v a n c e d software and engineering tools to model, analyze and solve Robotics and Automation assignments/projects.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of Robotics and Automation.

PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity, ethics of research and scholarly standards.
PO10	Examine critically the outcomes of one's actions and make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
AC:	Audit Course
AEC:	Ability Enhancement Course
VEC:	Vocational Education Course
IKS:	Indian Knowledge Society
MDM:	Multidisciplinary Minor

SEM-I											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AFARPC101	PCC	Industrial Robotics	3	1	--	4	60	20	20		100
24AFARPC102	PCC	Industrial Hydraulics & Pneumatics	3	1	--	4	60	20	20		100
24AFARPC103	PCC	Mechatronics	3	1	--	4	60	20	20		100
24AFARPE104 A /B/C	PEC-I	Professional Elective-I	3			3	60	20	20		100
24AFARPE105 A/B/C	PEC-II	Professional Elective-II	3			3	60	20	20		100
24AFAROE106 A	OEC	Research Methodology	3	-	-	3	60	20	20		100
24AFARPC107	PCC	Automation & Robotics Lab	-	-	2	1		25			50
24AFARAU108 A/B	AC	Audit Course	2					20	20		40 AUDIT
			20		**Total Credit**	**22**	**300**	**165**	**140**		**640**

Professional Elective-I	**Professionl Elective-II**	**AC**
A.Metrology and Computer Aided Inspection	A. Automation inManufacturing	A. Universal Human Values & Professional Ethics
B.Product Design & Development	B. Finite ElementMethods	B. Plastic Waste Management
C. Design of Mechanism and Manipulator	C. Artificial Intelligence & Expert System in Automation	

SEM-II											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AFARPC201	PCC	Industrial Automation	3	1	--	4	60	20	20		100
24AFARPC202	PCC	Drives and Control System for Automation	3	1	--	4	60	20	20		100
24AFARPE203 A /B/C/D	PEC-I	Professional Elective-III	3			3	60	20	20		100
24AFARPE204 A/B/C	PEC-II	Professional Elective-IV	3			3	60	20	20		100
4AFAROE205 A/B/C	OEC-I		3	-	-	3	60	20	20		100
24AFARIK206 A/B/C	AEC/VEC/ IKS		2	-	-	2		20	20		40
24AFARAU207	AC	Research Paper Writing	2					20	20		40
24AFARPC208	PCC	Seminar			2	1			50	50	100
24AFARPC209	PCC	Mini project			2	1			50	50	100
			19		**Total Credit**	**21**	**300**	**140**	**240**	**100**	**780**

SEM-III											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AFAROE301 A/B/C	OEC-II		3			3	60	20	20		100
24AFARMD302 A/B	MDM		3		-	3	60	20	20		100
24AFARPC303	PC	Intellectual Property Rights	3			3	60	20	20		100
24AFARPC304	PCC	Project Stage -I				10		50		50	100
			9		**Total Credit**	**19**	**180**	**110**		**50**	**400**

Professional Elective-III	**Professionl Elective-IV**	**OEC I**	AEC/VEC/IKS
A. Additive Manufacturing	A. Design of Experiments	A. Understanding Incubation and Entrepreneurship	A. Indian Knowledge System: Concepts &Applications in Engineering
B. Process Control Automation	B. Product Life Cycle Management	B. Introduction to Machine Learning	B. Indian Knowledge System: Humanities & Social Sciences
C. Advanced CAD	C. Flexible Manufacturing System	C. Engineering Economic Analysis	C. Ancient Indian Management
D. Simulation, Modeling & Control			

OEC II	**MDM**
A. Python and data science	A. . Application of IoT and Industry 4.0
B. Project Management for managers	B. e-Commerce Technologies
C Industrial Safety Engineering	C. Data analytics

SEM-IV											
Course Code	**Type of Course**	**Course Name**	**L**	**T**	**P**	**Credit**	**ESE-Th**	**CA**	**Mid Sem**	**ESE-PR/OR**	**Total**
24AFARPC401	PCC	Project Stage -II				20		100		100	200
					Total Credit	**20**		**100**		**100**	**200**

Semester I

Industrial Robotics

24AFARPC101	Industrial Robotics	PCC	3-1-0	4 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites:

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

CO1	Classify various types of robotic configurations
CO2	Recommend appropriate robot configurations for various applications.
CO3	Solve problem based on Kinematics and dynamics
CO4	Select appropriate type of drive, gripper and sensor for Robot
CO5	Write program for specific application.
CO6	Understand various implementation issues for robotics

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Introduction

Introduction: Basic Concepts, laws of Robotics, Robot anatomy, links, joint and joint notation scheme, arm wrist and end effector configuration, work volume, Classification, structure of robots, point to point and continuous path robotic systems. Robot performance- resolution, accuracy, repeatability, dexterity, compliance, Applications.

Unit-II: Robot Kinematics and Dynamics

Kinematics: Forward and reverse kinematics (Transformation) of three DOF robot arm, Transformation of four DOF manipulator. Homogeneous transformation. Kinematic equation using homogeneous transformation. Transformation matrices and their arithmetic, link and joint description, Denavit– Hartenberg parameters, frame assignment to links, robot arm dynamics.

Unit-III: Robotic sensor and drive

Sensors in Robotics: sensory devices, types of sensors such as Position sensor, velocity sensor, proximity sensors, touch sensors, force sensors, robot vision system. Function of drive system, types and selection of

drives, drive mechanism, Actuators and transmission systems, Types of Controllers, closed loop control, Stepper motor, DC motors, AC motors.

Unit-IV: Robot End-Effector

Types of Grippers, Design of gripper, active and passive gripper, Force analysis for various basic gripper systems including Mechanical, vacuum gripper, magnetic, adhesive, hooks, scoops and other miscellaneous devices,

Unit-V: Robot Programming

Methods of robot programming, lead through programming subroutines, Programming Languages: Robot language structure, Introduction to various types such as RAIL and VAL, ROS. Coordinator system, Teach pendant functions, Types of modes, New program creation using different types of motion like PTP, Linear, Circular etc. Tool calibration, Base calibration, Base Shifting, axis limit, Safety interlock, digital input/output configuration, program in loop,

Unit-VI:

Applications of Robots & Implementation Issues

Application of robots in Material Handling, process operations and Assembly and inspection. Approach for implementing Robotics, Safety, Training and Maintenance Social Aspects of Robotics.

Text Books:

1. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.

References:

1. Groover M.P.-Automation, production systems and computer integrated manufacturing‘- Prentice Hall of India
2. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009
4. Mathia, Robotics for Electronics Manufacturing, Cambridge Uni. Press, India
5. A Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2013. 6. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015.

Semester-I

Industrial Hydraulics & Pneumatic

24AFARPC102	Industrial Hydraulics & Pneumatic	PCC	3-1-0	4 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Define pump, motor and to understand the applications of different pump and motor
CO2	Understand different actuator and control system
CO3	Design pneumatic and hydraulic circuits for a given application
CO4	Understand applications of different direction control valve
CO5	Analyze the use of different sensor and actuator for a given application
CO6	Perform different Trouble Shooting and Remedies in Hydraulic and Pneumatic systems,

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Fluid Power Principles and Hydraulic Pumps

Types of fluids, Properties of fluids and selection, Pascal's Law, Principles of flow, Friction loss, Work, Power and Torque, Pump Classification , Construction, Working, Design, Advantages, Disadvantages, Selection criteria of Linear and Rotary, Fixed and Variable displacement pumps.

Unit II: Hydraulic Actuators and Control Components

Hydraulic Actuators: Cylinders, Types and construction, Application, Hydraulic cushioning , Hydraulic motors , Control Components : Direction Control, Flow control and pressure control valves, Types, Construction and Operation, Servo and Proportional valves, Applications, Accessories : Reservoirs, Pressure Switches, Applications, Fluid Power ANSI Symbols

Unit III: Hydraulic Circuits and Systems

Accumulators, Intensifiers, Industrial hydraulic circuits, Regenerative, Pump Unloading, Double- Pump,

Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits

Unit IV: Pneumatic and Electro Pneumatic Systems

Properties of air , Perfect Gas Laws , Compressor , Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit , Cascade method, Electro Pneumatic System

Unit V: Industrial Circuits

Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit

Unit VI: Trouble Shooting and Applications

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools,

Text books:

1. Esposito, Fluid Power with application, Prentice Hall

2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance, Tata McGraw Hill

3. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw Hill

4. H.L.Stewart, Hydraulics and Pneumatics, Taraporewala Publication

Reference books:

1. J. J. Pipenger, Industrial Hydraulics, McGraw Hill

2. Pinches, Industrial Fluid Power, Prentice Hall

3. D. A. Pease, Basic Fluid Power, Prentice Hall

4. B. Lall, Oil Hydraulics, International Literature Association

5. Yeaple, Fluid Power Design Handbook

6. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books.

7. ISO - 1219, Fluid Systems and components, Graphic Symbols

8. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall.

9. Dr. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.

10. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics

Semester-I
Mechatronics

24AFARPC103	**Mechatronics**	**PCC**	**3-1-0**	**4 Credits**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Basic Electronics

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

CO1	Define sensor, transducer and understand the applications of different sensors and transducers
CO2	Explain the signal conditioning and data representation techniques
CO3	Analyze PI, PD and PID controllers for a given application
CO4	Understand applications of microprocessor and micro controller

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Introduction

Introduction to Mechatronic systems, elements, advantages and practical examples of Mechatronic systems.

Unit II: Sensors and Transducers: Various types of sensors and transducers used in Mechatronic system such as pressure sensors, temperature sensors, velocity sensors, Acceleration sensors, proximity sensors, position sensors, force sensors, Optical encoders, Capacitive level sensor, tactile sensors, Selection of sensors.

Unit III: Signal Conditioning and Data Representation

Types of electronic signals, Need for signal processing, Opto-isolators, Protection devices, Analogue to Digital and Digital to Analog Converters, Relays, Contactor, display

Unit IV: Electrical Drives: Types of Electrical Motors, AC and DC motors, servomotors, Stepper motors, linear motors, etc.

Unit V: System Model On/Off controller, Proportional Control, Integral control, Derivative Control; PI, PD and PID Controllers.

Unit VI: Microprocessor and Microcontroller

8085 microprocessor architecture, Instruction sets, various pins and their functions 8081 microcontroller architecture, Instruction sets, various pins and their functions

Texts:

1. HMT Limited, “Mechatronics”, Tata McGraw Hill Publications, 1998.

2. W. Bolton, “Mechatronics; Electronic Control System in Mechanical Engineering”, Pearson Education Asia, 1999.

3. Raven, “Automatic Control Engineering”, Tata McGraw Hill Publications, New York, 1986.

References:

1. R. K. Rajput, “A textbook of Mechatronics”, S. Chand and Co., 2007.

2. Michael B. Histand, David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, Tata McGraw Hill International Editions, 2000.

3. D. A. Bradley, D. Dawson, N. C. Buru, A. J. Loader, “Mechatronics”, Chapman and Hall, 1993

Semester-I

Metrology and Computer Aided Inspection

24AFARPE104A	Metrology and Computer Aided Inspection	PEC-I	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Explain high precision measurement requirements of industry and select instruments for highprecision.
CO2	Using various measuring standards and instruments for different applications.
CO3	Calibrate basic metrology instruments used in machine shop, and Identify techniques to minimize the errors in measurement.
CO4	Employing limits and design gauges
CO5	Explain the different instruments used for linear and angular measurements, surface finish and form features of a component
CO6	Identify the advanced measurement principles with ease and operate sophisticated measurement machines.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I

Metrological concepts, Abbe's principle, need for high precision measurements, problems associated with high precision measurements.

Unit II

Standards for length measurement, shop floor standards and their calibration, light interference, method of coincidence.

Unit III

Slip gauge calibration, measurement errors, various tolerances, and their specifications, gauging principles.

Unit IV

Selective assembly, comparators, angular measurements, principles and instruments, gear and thread measurements.

Unit V

Surface and form metrology, computer aided metrology, principles and interfacing, software metrology, laser metrology, CMM, types, probes used applications.

Unit VI

Non-contact CMM using electro-optical sensors for dimensional metrology, non-contact sensors for surface finish measurements, image processing and its applications in metrology.

TEXTS / REFERENCES:

1. D.J.Whitehouse, *Handbook of Surface Metrology*, Inst. of Physics Bristol and Philadelphia, 1994.
2. R.K.Jain, *Engineering Metrology*, Khanna Publishers, 2000.
3. Galleyer and Shotbolt, *Metrology for Engineers*, ELBS, 1998

Semester-I
Product Design and Development

24AFARPE104B	Product Design and Development	PEC-I	3-0-0	3 Credits

Mid Semester20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Create new product based on mechanical design engineering.
CO2	Understand all mechanical aspects of product design by incorporating concept, creativity, structural, manufacturing, aesthetic etc.
CO3	Solve open-ended problem belongs to design engineering that meet the requirements.
CO4	Understand contemporary issues and their impact on provided solution.

Mapping of course outcomes with program outcomes

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

Course contents:

Unit: I Design Fundamentals

The importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

Unit II: Customer oriented design & Societal Considerations

Identification of customer needs- customer requirements- Quality Function Deployment Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics. Stress, Strain in 2-d and 3-d, relation between stress and strain, theories of failure.

Unit III: Material selection processing and Design

Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding – Residual Stresses – Fatigue, Fracture and Failure. 08 Hrs.

Unit IV: Design Methods

creativity and problem solving- creative thinking methods- generating design concepts - systematic methods for designing –functional decomposition – physical decomposition – functional representation – morphological methods-TRIZ- axiomatic design. Decision making theory- utility theory –decision trees – concept evaluation methods. - 10 Hrs.

Unit V: Industrial Design concepts

human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost –overhead costs – activity based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing. Dimensioning and tolerancing a product-functional production and inspection datum-tolerance analysis.

Texts/References

1. Product Design, by Kevin Otto, Kristin wood, Pearson Education Inc.
2. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill
3. Product Development, by Chitale & Gupta, Tata McGraw Hill
4. The Mechanical Process Design, by David Ullman, McGrawhill Inc
5. Product design & process Engineering by Niebel & deeper, McGraw hill
6. Value Management by Heller, Addison Wasley
7. Value engineering a how to Manual S.S.Iyer, New age International Publishers
8. New Product Development Timjones. Butterworth Heinmann, Oxford.
9. Assembly automation and product design – by Geoffrey Boothroyd, CRC Taylor & Francis

Semester-I
Design of Mechanisms and Manipulators

24AFARPE104C	Design of Mechanisms and Manipulators	PEC-I	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Understand the basic concepts of kinematics.
CO2	Aware Link coordinate diagram and arm matrix
CO3	Recognize Structural Analysis and Synthesis of mechanisms
CO4	Understand the basic concepts of Manipulators.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2			1								1
CO3	2		1	1								1
CO4	2											1

Course Contents:

Unit I: Kinematics

Mobility analysis, Degree of Freedom (DOF), Mixed Mobility, Total, Partial and Fractional DOF, Closed and Open Chain Systems, Application of D-H representation for 1) Kinematic parameter tables for standard robot structures.

Unit II: Link coordinate diagram and arm matrix

Link coordinate diagram and arm matrix of SCARA, Alpha II, PUMA articulated robot, standard robot, polar frame, structure robot, Enter transform solution, Arm matrix of standard Robots, Polar frame, structure robots

Unit III: Structural Analysis and Synthesis of mechanisms

Structural Analysis and Synthesis of mechanisms, Alternative design solutions; Coding, evaluation and selection of optimum mechanism. Type synthesis, number synthesis and design of mechanisms. Indexes of merit; Graphical, Algebraic and Optimization techniques, Matrix methods of design and analysis; Design of function, Path and Motion Generators; Structural and Mechanical error; Design and Analysis using software.

Unit IV: Manipulators

Classifications, actuation and transmission systems; Coordinate Transformation – DH notations, Inverse and Forward kinematics, Manipulator dynamics from Lagrangian and Newtonian point of view.

Unit V: Dynamic Analysis of manipulator

Forces in Manipulator, manipulate Dynamics, selecting of robots for Robot Application Reliability of

Robotic & Automation systems and their evaluation.

Unit VI: Gripper Design

Linkage activated grippers: kinematic and dynamic design, other principles of gripping like, magnetic grippers, adhesive grippers, internally expanding grippers, mandrels, etc. their static and dynamic analysis.

Text Books / References:

Andeen, G.B., "Robort Design Hand Book", SRI International, McGraw Hill,
Craig, J.J., "Introduction to Robotics", Mechanics and Control, Addison Wesley
Spong, M., and Vidyasagar, M. "Robot Dynamics and Control", John Wiley, NY, 1989.
Venkataraman. S.T., and liberall. T., "Dextrous Robot Hands", S
AppuKuttan, "Robotics", I.K. International Publishing house

Semester I
Automation in Manufacturing

24AFARPE105A	Automation in Manufacturing	PEC-II	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Understand the technical, economic and human factors in automation
CO2	Apply the automation technologies like electrical, hydraulic, pneumatic, electronic
CO3	Demonstrate small automation systems
CO4	Learn Circuit optimization techniques
CO5	Design logical programming for automation
CO6	Do cost-benefit analysis

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT 1

Product cycle, manufacturing functions, types of automation, degree of automation, technical, economic and human factors in automation.

UNIT 2

Technologies- mechanical, electrical, hydraulic, pneumatic, electronic, hybrid systems, comparative evaluation.

UNIT 3

Development of small automation systems using mechanical devices, synthesis of hydraulic circuits.

UNIT 4

Circuit optimization techniques, illustrative examples of the above types of systems

UNIT 5

Industrial logic control systems logic diagramming, programmable controllers.

UNIT 6

Applications, designing for automation, cost-benefit analysis

Texts/References:

1. A.N.Gavrilov, Automation and Mechanization of Production Processes in Instrument Industry, Pergaman Press, Oxford, 1967.

2. G.Pippengerm, Industrial Hydraulics, MGH, New York, 1979.

3. F.Kay , Pneumatics for Industry, The Machining Publishing Co., London,1969.

4. Ray, Robots and Manufacturing Assembly, Marcel Dekker, New York, 1982

Semester-I
Finite Element Methods

24AFARPE105B	Finite Element Methods	PEC-II	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Understand the basics principle of FE method
CO2	Identify mathematical model for solution of common problems
CO3	Solve structural, thermal problem using FE in 1D Case
CO4	Derive element stiffness matrix by different methods
CO5	Understand the formulation for 2D and 3D case
CO6	Recognize need for and engage in lifelong learning

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I

1-D Problems: Introduction to structural analysis and FEM, Introduction to approximate solutions and FEM, summary of linear elastic mechanics.

Unit II

1-D Problems: Principles of linear elastic mechanics, principles of virtual displacements and minimum potential energy, Rayleigh Ritz method, exact v/s approximate solution, beam elements.

Unit III

2-D Problems: Plane stress and plane strain conditions, triangular elements, constant strain triangle, linear strain triangle, Boundary conditions, body forces and stress recovery, quadrilateral elements.

Unit IV

2-D Problems: Lagrange and Serendipity shape functions, isoparametric formulation, numerical integration, modeling with isoparametric elements, requirements for convergence, patch test, nonconforming elements, reduced integration.

Unit V

3-D Problems: Axisymmetric solids, governing equations, axisymmetric elements and their applications, mixed formulations, bending of flat plates (Kirchhoff Theory), continuity requirements and boundary conditions.

Unit VI

3-D Problems: Discrete Kirchhoff's elements, thick plate elements, plate bending applications, shells as assemblage of flat plates, finite element formulation for dynamic problems, mass properties, introduction to elastic stability for frames and plates.

TEXTS / REFERENCES:

1. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons,second edition, 1981.
2. C.S. Krishnamurti, Finite element method; Tata Mc-Graw Hill Publication.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice hall, 1996.
4. Tirupathi, R., and Chandrupatla, Finite Elements in Engineering; PHI Publication, NewDelhi.
5. Bruce Irons and Soharab Ahmed, Techniques of Finite Elements; John Wiley and Sons,New York.
6. K.J. Bathe, Finite Element Method; Prentice Hall, 1987.
7. O.P., Goptha, Finite and Boundary Element Methods in Engineering; Oxford and IBH.

Semester-I
Artificial Intelligence & Expert System in Automation

24AFARPE105C	Artificial Intelligence & Expert System in Automation	PEC-II	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Know the expert system architecture
CO2	Select appropriate AI technique for a given problem
CO3	Develop neural network or fuzzy logic or genetic algorithm for a given situation
CO4	Understand the basics of machine learning
CO5	Apply the principles of machine learning and AI for practical applications.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Expert system Architecture

Expert system Architecture, knowledge base, inference engine, expert system shell,applications.

Unit II: Fuzzy Logic

Fuzzy sets, membership functions, operation on fuzzy sets; fuzzy control system, Fuzzyfication, knowledge base, inference, defuzzification, application.

Unit III: Neural Network

Neuron structure, classification, artificial neural network, back propagation training and algorithm, neuro-fuzzy controllers, applications.

Unit IV Genetic algorithms

Concepts, encoding and selection methods, genetic operators (crossover and Mutation),applications.

Unit V Hybrid systems

Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images

with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

Unit VI: Artificial intelligence and machine learning:

Definition, knowledge representation techniques, problem solving, search techniques, game playing , knowledge and logic, learning methods, applications of AI.

Text Books / References:

1. Haykin "Neural Networks – A comprehensive Foundation" (Mc-millan)
2. J.M. Zureda "Introduction to artificial neural networks" (Jaico)
3. A Cichocki& R Unbehauen " Neural Networks for optimization and signal Processing" John Wiley
4. George J. Klin& Tina A Polgar "Fuzzy sets, uncertainty and Information"
5. BaertKosko "Neural network and fuzzy systems"
6. Peterson "Introduction to Artificial Intelligence and expert system (PHI)
7. Michell "Introduction to Genetic Algorithm" (PHI)
8. Vidyasagar M "Theory of learning and generalization" Springer
9. S. Rajasekaran, G.A. VijaylakshmiPai "Neural Networks, Fuzzy Logic and GeneticAlgotithm", PHI.
10. T.J. Ross: "Fuzzy Logic with Engineering Applications" Second Edition John WileyIndia.

Semester-I
Research Methodology

24AFAROE106A	Research Methodology	OEC	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understand and Describe importance of research.
CO2	Classify and select appropriate resources for Research.
CO3	Analyze the contents of literature and identify further scope.
CO4	Formulate a Research Problem.
CO5	Develop effective written and oral Presentation skills.

Mapping of course outcomes with program outcomes

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

Course contents:

Unit I

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit II

Research process – Criteria for good research – Problems encountered by Indian researchers. Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit III

Hypothetical proposals for future development and testing, selection of Research task.

Unit IV

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit V

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation –Significance of report writing – Different steps in report writing – Layout of research report –Mechanics of writing research report – Layout and format – Style of writing – Typing –References – Tables – Figures – Conclusion – Appendices.

Texts/References

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Semester-I
Automation and Robotics Laboratory

24AFARPC107	**Automation and Robotics Laboratory**	**PCC**	**0-0-2**	**1 Credits**

Continuous Assessment 25 Marks	PR/OR 25Marks	Total 50 Marks

Pre-Requisites: None

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

CO1	Student will able to explain working of sensors
CO2	Student will be able to design pneumatic and electro- pneumatic circuit for given application
CO3	Student will be able to design hydraulic electro-hydraulic circuit for given application
CO4	Student will be able to program drive to control speed of electric motor.
CO5	Student will be able to write a PLC program for automation project using ladder logic
CO6	Student will be able to calibrate tool and base for industrial robots.
CO7	Student will be able to write new program for different types of motion in industrial robot.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2			1								
CO3	2			1								
CO4	2											
CO5	2	1		1	1							
CO6	2											
CO7	2			1								

Course Contents:

At least six of the following experiments should be conducted on the appropriate hardware

1. Study and demonstration of various types of sensors.
2. Minimum two circuits on Pneumatics and Electro-Pneumatics to be developed on Pneumatic trainer kit
3. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit
4. Design Hydraulic /Pneumatic circuit for different automation projects.
5. Speed control of various types of Electrical Motors.
6. Write PLC program for automation project using ladder logic.
7. Design pneumatic cascade circuit for automation projects.
8. Calibrate tool and base for industrial robot.
9. Create new program for different types of motion (PTP, Linear, Circular etc)

Semester I

Universal Human Values & Professional Ethics

24AFARAU108A	**Universal Human Values & Professional Ethics**	**AC**	**2-0-0**	**Audit Course**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam ----	Total 40 Marks

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course contents:

Unit 1: Need, basic guidelines, contents and process for value education

- Understanding the need
- basic guidelines
- content and process for Value Education
- Self-Exploration-what is it? – its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self- exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding
- Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
- Method to fulfil the above human aspirations: understanding & living in harmony at various levels.

Unit 2: Understanding harmony in human being- harmony in myself YSELF

- The understanding human being as a co-existence of the sentient 'T' and the material 'Body
- Understanding the needs of Self ('T') and 'Body' – Sukh and Suvidha
- Understanding the Body as an instrument of 'T' (I being the doer, seer, and enjoyer)
- Understanding the characteristics and activities of 'T' and harmony in T
- Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs
- Meaning of Prosperity in detail
- Programs to ensure Sanyam & Swasthya.

Unit 3: Understanding harmony in family and society - harmony in human relationship.

- Understanding harmony in the Family- the basic unit of human interaction.

- Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay tripti; Trust (Vishwas) and Respect (Samman) as the foundational vales of relationship.
- Understanding the meaning of Vishwas; Difference between intention and competence.
- Understanding the meaning of Samman.
- Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in the society (society being an extension of
- family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals.
- Visualizing a universal harmonious order in society.
- Undivided Society (Akhand Samaj).
- Universal Order (Sarvabhaum Vyawastha) – from family to world family.

Unit 4: Understanding harmony in the nature and in existence DERSTAINY

- Understanding the harmony in the Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature –recyclability and self-regulation in nature.
- Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space.
- Holistic perception of harmony at all levels of existence.

Unit 5: Implications of the above holistic understanding harmony on professional ethics,

- Natural acceptance of human values
- The definitiveness of Ethical Human Conduct,
- The basis for Humanistic Education,
- Humanistic Constitution and Humanistic Universal Order,
- Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems
- Technologies and management models,
- Case studies of typical holistic technologies,
- Management models and production systems,
- Strategy for the transition from the present state to Universal Human Order: a) At the level of the individual: as socially and ecologically responsible engineers, Technologists and Managers, b) At the level of society: as mutually enriching institutions and organizations.

Textbooks/Reference Books:

1. A Foundation Course in Human Values and Professional Ethics, R. R. Gaur,

R. Asthana, G. P. Bagaria, 2nd Revised Edition, Excel Books, New Delhi,

2019, ISBN 978-93-87034-47-1

2. Teachers' Manual for A Foundation Course in Human Values and

Professional Ethics, R. R. Gaur, R. Asthana, G. P. Bagaria, 2nd Revised

Edition, Excel Books, New Delhi, 2019, ISBN 97893- 87034- 53-2

Semester I
Plastic Waste Management

24AFARAU108B	Plastic Waste Management	AC	2-0-0	Audit Course

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam ----	Total 40 Marks

Pre-Requisites: None

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

CO1	Discuss the plastic waste sources nationally and worldwide and their production
CO2	Understand plastic waste management policy and its rules and regulations
CO3	Study the effect of plastic waste on health, environment of human and wildlife
CO4	Explain the recycling and energy conversion from plastic waste and application of waste plastics
CO5	Identify the alternatives to plastic as green resource and its economic impact

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Plastic and plastic types, uses of plastics, global statistics, plastic waste sources. Plastic waste sources production, Global sources of plastic waste and national sources of plastic waste

Unit 2

Plastic waste management rules 2016, Global rules and regulations, plastic bans including china sword policy implication on plastic global waste management, Plastic bans- global examples, plastic bans- china sword policy imparts, impact on global plastic waste management.

Unit 3

Impact of plastic pollution on marine life, plastic pollution impact on marine and wildlife, health and environmental impact of plastic pollution

Unit 4

Plastic waste management practices- recycling and waste plastic, Mechanical and feedstock recycling, pyrolysis and waste to energy, landfilling, other applications, use of waste plastic in road construction.

Unit 5

Possible alternate materials to plastics – Greener alternatives, Biodegradable plastics, Greener plastic products, Biobased plastic products, How to quantify something is green, plastic resource recovery and circular economy, plastics and circular economy – case studies.

TEXTS/REFERENCES:

1. Plastic Waste Management by Murali Srinivasan and Natamai Subramaniam
2. The Circular Economy A User's Guide by Walter R Stahel. CRC Press 2019.
3. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist, 2015
4. Sustainable Practices for Landfill Design and Operation,Townsend, T.G., Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Reinhart, D. (2015), Springer, USA
5. Recycling and recovery of plastics, Hanser Publishers, New York, 1996-R. Johanner Brandrup
6. Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc.New York,1993-Nabil Mustafa
7. Plastics and the Environment, Wiley Inter Science, New York (2003) – Anthony L.Andrady (Ed)
8. Plastics Recycling, Products and Processes, Hanser Publishers, New York,1992 –R.J. Ehrig

Semester II
Industrial Automation

24AFARPC201	Industrial Automation	PCC	3-1-0	4 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understand the need of automation
CO2	Classify various types of automated transmission lines and components of automation.
CO3	List and understand various material handling systems.
CO4	Design various types of automated assembly systems
CO5	Explain different control technologies in automation system
CO6	Explain various automatic inspection systems

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-I: Introduction

Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break- Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in process.

Unit-II: Detroit-Type Automation

Automated Flow lines, Methods of Work-part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations, Design and Fabrication Considerations.

Analysis of Automated Flow Lines: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers,

Unit-III: Material handling and Identification Technologies

The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.

Unit-IV: Automated Assembly Systems

Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

Unit-V: Control Technologies in Automation

Industrial Control Systems, Process Industries Verses Discrete- Manufacturing Industries, Continuous Verses Discrete Control, Computer Process Control and its Forms. Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation System: LAN, Analog & Digital I/O Modules, and SCADA System & RTU.

Unit-VI: Automated Inspection and Testing

Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

Text Books:

1. "Automation, Production Systems and Computer Integrated Manufacturing"- M.P. Grover, Pearson Education.

Reference Books:

1. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI
2. Principles and Applications of PLC – Webb John, Mcmillan 1992
3. "An Introduction to Automated Process Planning Systems" – Tiess Chiu Chang &Richard A. Wysk
4. "Anatomy of Automation" – Amber G.H & P.S. Amber, PrenticeHall.

Semester-II

Drives and Control System for Automation

24AFARPC202	Drives and Control System for Automation	PCC	3-1-0	4 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	To understand working principles of various types of motors, differences, characteristic and selection criteria.
CO2	To apply the knowledge in selection of motors, heating effects and braking concepts various industrial applications
CO3	To elucidate various linear and rotary motion principles and methods and use the same to application areas
CO4	To carry out programming using PLC and use of various PLCs to Automation problems Industries.
CO5	To discuss supervisory control and data acquisition method and use the same in comple automation areas
CO6	To understand and use logical elements and use of Human Machine Interfacing devices to enhance control & communication aspects of Automation

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Introduction

Working principle of synchronous, Asynchronous & stepper motors, Torque v/s speed characteristics, Power v/s. motor rating, heating effects, electric braking, Speed characteristics, variable frequency drive, servo drive

Unit II: Motion laws for rotary and linear systems

Converting rotary to linear system, concepts and principles of ball screws, rack and pinion, belt and pulley,

chain drives, gear drives

Unit III: Introduction to Programmable Logic Controllers

Definitions of PLC, basic structure of PLC, difference between relay logic and PLC, software, programming software tool and interfacing with PC (RS232 & TCP-IP), methods of PLC programming, types of tasks and configuration,

Unit IV: Logic, instructions and its Application

Logic gates: OR, AND,NOT logic, Ex Or logic, Analysis of rung. Timer and Counter Instructions; on delay and Off delay and retentive timer instructions, PLC counter up and down instructions, combining counters and timers, Comparison and data handling instructions, Sequencer instruction.

Unit V: Visualization Systems

Visualization Systems, Types of visualization system, PC based Controller, Applications of HMI's, and Interfacing of HMI with controllers.

Unit VI: Supervisory control & data Acquisitions

Introduction to Supervisory control & data Acquisitions, distributed Control System (DCS): computer networks and communication in DCS. different BUS configurations used for industrial automation – GPIB, HART and OLE protocol, Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus. Interfacing of SCADA with controllers, Basic programming of SCADA, SCADA in PC based Controller / HMI,

Text Books:

1. Process Control Instrumentation Technology, Johnson Curties, Prentice hall of India, 8thedition
2. Andrew Parr, Industrial drives, Butterworth – Heineamann3.G.K.Dubey.Fundamentals of electrical drives 4.Programmable Logic Controllers by W.Bolton

References:

1. Introduction to Programmable Logic Controllers by Garry Dunning, 2nd edition, Thomson, ISBN:981-240-625-5
2. Instrumentation Engineers Hand Book - Process Control, Bela G Liptak, Chilton book company, Pennsylvania
3. A.E. Fitzerald ,C.Kingsley and S.D Umans, Electric Machinery - McGraw Hill Int. Studentedition
4 S.K.Pillai. A First course on electric drives –Wiley Eastern 1990

Semester-II

Additive Manufacturing

24AFARPE203A	Additive Manufacturing	PEC-III	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Understand the basics of additive manufacturing
CO2	Understand the types and working of additive manufacturing processes.
CO3	Study and understand the additive manufacturing systems
CO4	Understand the pre-processing of additive manufacturing system
CO5	Understand the post-processing of additive manufacturing system

Mapping of course outcomes with program outcomes

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

Course content:

Unit I: Introduction **[8 L]**

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

Unit II: Additive Manufacturing Processes **[8 L]**

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

Unit III Additive Manufacturing Machines and Systems [8 L]

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

Unit IV: Pre-Processing in Additive Manufacturing [8 L]

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

Unit V: Post-Processing in Additive Manufacturing [8 L]

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

TEXT BOOKS:

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing,Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003

REFERENCE BOOK:

1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, “Laser Cladding”, CRC Press, 2004

Semester-II
Process Control Automation

24AFARPE203B	**Process Control Automation**	**PEC-III**	**3-0-0**	**3 Credits**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Student will able to explain Process Modeling
CO2	Student will able to design PID controller for given application
CO3	Student will able to solve problems related to frequency response analysis
CO4	Student will able to simulate control system for given application
CO5	Student will able to use tools and techniques for advances process control
CO6	Students will be able to discuss issue related to plant control

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Process Modeling

Introduction to Process control and process instrumentation-Hierarchies in process control systems-Theoretical models-Transfer function-State space models-Time series models- Development of empirical models from process data-chemical reactor modeling-. Analysis using softwares.

Unit II: Feedback &Feedforward Control

Feedback controllers-PID design, tuning, trouble shooting, Cascade control, Selective control loop, Ratio control.

Unit III: Frequency Response

Control system design based on Frequency response Analysis, Direct digital design, Feed- forward and ratio control. State feedback control. LQR problem, Pole placement.

Unit IV: Software Simulations of control system

Simulation using softwares, Control system instrumentation, Control valves, Codes and standards, Preparation of P& I Diagrams.

Unit V: Advanced process control

Multi-loop and multivariable control, Process Interactions, Singular value analysis, tuning of multi loop PID control systems, decoupling control, strategies for reducing control loop interactions, Real-time optimization.

Unit VI: Plant Control

Model predictive control-Batch Process control-Plant-wide control & monitoring- Plant wide control design- Instrumentation for process monitoring-Statistical process control- Introduction to Fuzzy Logic in Process Control-Introduction to OPC.

Introduction to environmental issues and sustainable development relating to process industries. Comparison of performance different types of control with examples on softwares

References

1. Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, John Wiley , 2004
2. Johnson D Curtis, Instrumentation Technology, (7th Edition) Prentice Hall India, 2002. 3.Bob Connel, Process Instrumentation Applications Manual, McGrawHill, 1996.
4. Edgar, T.F. & D.M. Himmelblau, Optimization of Chemical Processes, McGrawHill Book Co, 1988.
5. Macari Emir Joe and Michael F Saunders, Environmental Quality Innovative Technologies

Semester-II

Advanced CAD

24AFARPE203C	Advanced CAD	PEC-III	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understand conceptual design process and geometric transformation techniques in CAD.
CO2	Develop mathematical models to represent curves.
CO3	Design surface and solid models for engineering applications.
CO4	Apply CAD techniques for engineering analysis and geometry processing

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2		2							
CO2	2		2	2	2							
CO3	3		3	3	2							
CO4	3		2	2	2							

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, Geometric modelling

Unit 2

Transformations in Geometric Modelling: Introduction, Translation, Scaling, Reflection, 85 Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Implementation of the transformations using computer codes

Unit 3

Design of Curves: Analytic Curves, PC curve, Ferguson, Composite Ferguson, curve Trimming and Blending, Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier subdivision, Degree elevation, Composite Bezier, Splines, Polynomial Splines, B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS, Developing algorithms/computer codes for Design of Curves

Unit 4

Design of Surfaces: Differential geometry, Parametric representation, Curves on surface, Classification of points, Curvatures, Developable surfaces, Surfaces of revolution, Intersection of surfaces, Surface modelling, 16-point form, Coons patch, B-spline surfaces, Developing algorithms/computer codes for

Design of Surfaces.

Unit 5

Design of Solids: Solid entities, Boolean operations, B-rep of Solid Modelling, CSG approach of solid modelling, advanced modelling methods, Applications of CAD Applications: Data exchange formats, Finite element analysis, mesh generation for finite element analysis, reverse engineering, modelling with point cloud data, working with .STL files, Additive Manufacturing.

TEXTS/REFERENCES:

1. Mathematical Elements for Computer Graphics, David F. Rogers, J. A. Adams, TMH, 2008.
2. Geometric Modeling", Michael E. Mortenson, Wiley, NY, 1997.
3. Product Design", Kevin N. Otto, Kristin L. Wood, Pearson Education, 2004.
4. CAD/CAM Theory and Practice, Ibrahim Zeid and Sivasubramanian, R., TataMcGraw Hill Publications, New Delhi, 2009.
5. Computer Aided Engineering Design", Anupam Saxena, BirendraSahay, Springer, 2005.

Semester-II
Simulation Modeling & Control

24AFARPE203D	Simulation, Modeling & Control	PEC-III	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Define simulation, its limitations and applications.
CO2	Apply simulation to queuing and inventory situations.
CO3	Acquire knowledge to generate the random numbers for simulation models.
CO4	Analyze the data and verify model of simulation.
CO5	Learn software's and programming languages for developing simulation model.
CO6	Discuss case studies in manufacturing simulation.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I

Introduction to systems and modeling – discrete and continuous system - Limitations of simulation, areas of application - Monte Carlo Simulation.

Unit II

Discrete event simulation and their applications in queueing and inventory problems.

Unit III

Random number generation and their techniques - tests for random numbers. Random variable generation.

Unit IV

Analysis of simulation data. - Input modeling – verification and validation of simulation models – output analysis for a single model.

Unit V

Simulation languages and packages - FORTRAN, C, C++, GPSS, SIMAN V, MODSIM III, ARENA, QUEST, VMAP - Introduction to GPSS – Case studies.

Unit VI

Simulation of manufacturing and material handling system, Caste studies.

TEXTS / REFERENCES:

1. Jerry Banks and John S, Carson II “Discrete Event System Simulation”, Prentice Hall, 1984.
2. Geoffrey Gordon., “System Simulation”, Prentice Hall, 1978.
3. Francis Neelamkovil, “Computer Simulation and Modelling”, John Willey and sons, 1987.

Semester-II
Design of Experiments

24AFARPE204A	Design of Experiments	PEC-IV	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None
Course Outcomes: At the end of the course, the student will be able to:

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1

- Introduction: Modern quality control, quality in engineering design, history of quality engineering.
- The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi`s quality philosophy.

Unit 2

- Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit 3

- Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over an

sixteen run experimental design, blocking two level designs, other two level designs.

Unit 4

- Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.
- Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit 5

- Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels.
- Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance, Computer Software for Experimental Design: Role of computer software in experimental design, summery of statistical packages, example of use of software packages.

TEXTS / REFERENCES:

1. D.C. Montgomery, Design and Analysis of Experiments, 5th Edition, John Wiley and Sons, New York, 2004.

2. R.H.Lochner and J.E.Matar, Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design, Chapman and Hall, London, 1983.

Semester-II

Product Life Cycle Management

24AFARPE204B	Product Life Cycle Management	PEC-IV	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understand need, opportunities and benefits of PLM
CO2	Understand financial and human aspects of PDM
CO3	Apply engineering design aspects for Modeling and simulation in product design
CO4	Understand new product design and development
CO5	Apply the concepts of PLM for forecasting and use of softwares

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1

- Introduction

Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2

- Product Data Management (PDM)

Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3

- Product Design

Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4

- New Product Development

Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product.

Unit 5

- Technology Forecasting and PLM Software and Tools

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

- PLM Software and Tools

Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications.

TEXTS/REFERENCES

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. Antti Saaksvuori, Anselmi Immonen, "Product Life Cycle Management", Springer, 1 st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21stCentury Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes"

Semester-II

Flexible Manufacturing Systems

24AFARPE204C	Flexible Manufacturing Systems	PEC-IV	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understanding the fundamentals of Flexible Manufacturing Systems (FMS)
CO2	Study the economic analysis of FMS
CO3	Study and Application of FMS equipment
CO4	Understand the FMS group technology
CO5	Understand the Plant layout, FMS and GT layouts
CO6	Study the communication networking of FMS

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I: Introduction

FMS definition and classification of manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

Unit II: Economic Analysis

Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS.

Unit III: FMS Equipment

Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management,

Work holding considerations, Fixture considerations in FMS environment.

Unit IV: Group Technology

GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part-machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, CellularVs FMS production.

Unit V: Plant layout, FMS and GT layouts

FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system,

Unit VI: Communication networks

FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems. Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control. FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

TEXTS/REFERENCES

1. Automation, Production System & Computer Integrated Manufacturing Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag
4. FMS in Practice Bonctto Northox Ford
5. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
6. Performance Modelling of Automated Manufacturing Vishwanathan & NaraharPrentice Hall India

Semester-II
Understanding Incubation and Entrepreneurship

24AFAROE205A	Understanding Incubation and Entrepreneurship	OEC-I	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Understand the Entrepreneurship GDC Program
CO2	Correlate entrepreneurship with innovation
CO3	Apply innovation for Health care
CO4	Create innovative product ideas
CO5	Prepare and present a proposal for Start-up

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				1			1			1	
CO2	1	1	1		1			1			1	1
CO3	1		1		1							
CO4	1		1		1						1	
CO5	1	1	1		1						1	

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Introduction to Entrepreneurship, Hand holding for Entrepreneurship GDC start-up stories, What is Entrepreneurship GDC Program

Unit 2

Entrepreneurship Types, Team Building, Methodology for innovation, Innovation and Entrepreneurship, Solar Oven case-study Paradigm shift from Design to Entrepreneurship, team building, problem statement presentation, IDEAS program, From users to customers- solar oven case study, student projects-customers discovery

Unit 3

Health care and innovation, Bio-Med Innovation and Entrepreneurship, Mad Tech success story, The innovation process, Human centered innovation, creating human experience design, New-age

Entrepreneurship, Humanizing technology, Business model canvas, Technology led Entrepreneurship, Introduction to SINE incubator, Lean model Canvas SINE, start-up success story

Unit 4

Entrepreneurship as Academic Program - IITH case study, ITIC Incubator, Success stories of CHfE, Entrepreneurship – Plan to action, Creativity and Generating Product Ideas, From Idea to Proof of Concept, Network Entrepreneurship, From corporate to Entrepreneurship, Creative Ideation, Building proof of concept

Unit 5

Learning from examples Start-up PITCHES - Using Lean Canvas Model Part 1, Start up project presentation by students

TEXTS/REFERENCES:

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup by Bill Aulet

2. The Essence of Medical Device Innovation by B Ravi

3. The Fortune At Bottom of Pyramid: Eradicating Poverty Through Profits by C.K.Prahalad

4. Stay Hungry Stay Foolish by Rashmi Bansal

5. The Entrepreneurial Connection: East Meets West in the Silicon Valley by Gurmeet Naroola

6. Innovation By Design: Lessons from Post Box Design & Development by B. K. Chakravarthy, Janaki Krishnamoorthi

Semester-II

Introduction to Machine Learning

24AFAROE205B	Introduction to Machine Learning	OEC-I	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
CO2	Perform evaluation of learning algorithms and model selection.
CO3	Apply knowledge representation, reasoning, and machine learning techniques to real-world problems
CO4	Proficiency with a variety of classifier methods including decision trees, neural networks, naïve bayes learning, nearest neighbor methods.
CO5	Illustrate hybrid learning methods involving domain theories and adaptive learning methods, and create algorithm by using this.
CO6	Apply these techniques to control and teach something to robot

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Statistical basics for Machine Learning Introduction, Statistical Decision Theory, Regression, Classification, Bias Variance, Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Partial Least squares

Unit 2

Neural Network Learning Linear Classification, Logistic Regression, Linear Discriminant Analysis, Week 4: Perceptron, Support Vector Machines, Neural Networks - Introduction, Early Models, Perceptron Learning, Backpropagation, Initialization, Training & Validation, Parameter Estimation - MLE, MAP, Bayesian Estimation

Unit 3:

Decision Trees, Regression Trees, Stopping Criterion & Pruning loss functions, Categorical Attributes, Multiway Splits, Missing Values, Decision Trees - Instability Evaluation Measures, Bootstrapping & Cross Validation, Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting

Unit 4:

Gradient Boosting, Random Forests, Multi-class Classification, Naive Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation, Partitional Clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Densitybased Clustering

Unit 5:

Gaussian Mixture Models, Expectation Maximization, Learning Theory, Introduction to Reinforcement Learning, Optional videos (RL framework, TD learning, Solution Methods, Applications)

TEXTS/REFERENCES:

1. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, “Learning from Data”, AMLBook Publishers, 2012.

2. P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.

3. K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.

4. C. M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.

5. D. Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, 2012.

M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.

6. T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997. 8. S. Russel and P. Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Prentice Hall, 2009.

7. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman

8. NPTEL Resource: Introduction to Machine Learning, By Prof. Balaraman Ravindran from IIT Madras

Semester-II

Engineering Economic Analysis

24AFAROE205C	**Engineering Economic Analysis**	**OEC-I**	**3-0-0**	**3 Credits**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: None

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

CO1	Study the steps in economic analysis and the various costs involved
CO2	Understand time value of money and cash flows
CO3	Explain the various cash flows of economic analysis
CO4	Discuss the aspects of money management
CO5	analyze the worth of investments using different methods

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1									
CO2	1	1	1									
CO3	1	1	1									
CO4	1	1										
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1: Introduction

Project Life Cycle Stages, What is a Feasibility Study?, Feasibility Study Process, What is Engineering Economic Analysis?, Engineering Economic Analysis Steps, Cost Terminologies.

Unit-2: Time Value of Money

Time Value of Money Concept, Cash Flow Diagrams, Interest and Interest Rate, Types of Interest Rates

Unit-3: Economic Equivalence

Economic Equivalence Concept, Uniform (Equal) Series Cash Flow, Uneven (Irregular) Series Cash Flow, Arithmetic (Linear) Gradient Series Cash Flow, Geometric Gradient Series Cash Flow, Composite Cash Flow

Unit-4: Money Management

Money Management Aspects, Multiple Compounding Periods Concept, Nominal and Effective Interest Rates, Changing Interest Rates, Amortized Loans, Add-On Loans, Inflation, Customized Loans

Unit-5: Measuring Worth Investments

Project Cash Flow, Measuring Worth of Investments Methods, Payback Period Method, Net Present Worth Method, Net Future Worth Method, Net Annual Worth Method, Internal Rate of Return (IRR) Method, IRR Direct Solution Method, IRR Trial and Error Method, External Rate of Return Method. Types of Projects/Investments, Independent and Mutually Exclusive Projects, Ranking Approach, Time Span Equalizing.

Texts/References:

1. Engineering Economic Analysis, Donald G. Newman, Jerome P. Lavalle and Ted G. Eschenbach, Oxford University Press, 12th Edition.

Semester-II

Indian Knowledge System: Concepts and Applications in Engineering

24AFARIK206A	**Indian Knowledge System: Concepts and Applications in Engineering**	**IKS**	**2-0-0**	**2 Credits**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam----	Total 40 Marks

Pre-Requisites: None

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

CO1	Discuss need, history and features of IKS and various aspects of vedas, kalpa and jyotisa
CO2	Understand the number system, indian mathematics and astronomy and their contribution
CO3	Explain ancient metals and metal working practices and applications of engineering and technology
CO4	Describe town planning and architecture of ancient india and ancient knowledge system
CO5	Understand various features of linguistics and Sanskrit role in language processing

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Subclassification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2

Number Systems and Units of Measurement: 1. Number systems in India - Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Mathematics: 1. Introduction to Indian Mathematics 2. Unique aspects of Indian Mathematics 3. Indian Mathematicians and their Contributions 4. Algebra 5. Geometry 6. Trigonometry 7. Binary mathematics

and combinatorial problems in Chandaḥ Śāstra 8. Magic squares in India

Astronomy: 1. Introduction to Indian astronomy 2. Indian contributions in astronomy 3. The celestial coordinate system 4. Elements of the Indian calendar 5. Notion of years and months 6. Pañcāṅga – The Indian calendar system 7. Astronomical Instruments (Yantras) 8. Jantar Mantar of Rājā Jai Singh Sawai.

Unit-3

Engineering and Technology: Metals and Metalworking: 1. Wootz Steel: The rise and fall of a great Indian technology 2. The Indian S & T heritage 3. Mining and ore extraction 4. Metals and metalworking technology 5. Iron and steel in India 6. Lost wax casting of idols and artefacts 7. Apparatuses used for extraction of metallic components

Engineering and Technology: Other applications: 1. Irrigation systems and practices in South India 2. Literary sources for science and technology 3. Physical structures in India 4. Irrigation and water management 5. Dyes and painting technology 6. The art of making perfumes 7. Surgical techniques 8. Shipbuilding 9. Sixty-four art forms (64 Kalās) 10. Status of Indigenous S & T.

Unit-4

Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstuśāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography.

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Unit-5

Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing.

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), “Introduction to Indian Knowledge System: Concepts and Applications”, PHI Learning Private Ltd. Delhi.

For additional reading:

1. Pride of India: A Glimpse into India’s Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). “The Wonder that is Sanskrit”, Sri Aurobindo Society, Puducherry.
3. Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
4. Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
5. Kak, S.C. (1987). “On Astronomy in Ancient India”, Indian Journal of History of Science, 22(3), pp. 205–221.
6. Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.
7. Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.

8. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
9. Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
10. Kapoor Kapil, Singh Avadhesh (2021). “Indian Knowledge Systems Vol – I & II”, Indian Institute of Advanced Study, Shimla, H.P.

Semester-II

Indian Knowledge System: Humanities and Social Sciences

24AFARIK206B	**Indian Knowledge System: Humanities and Social Sciences**	**IKS**	**2-0-0**	**2 Credits**

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam ----	Total 40 Marks

Pre-Requisites: None

Course Objectives:

To provide a general introduction to Indian Knowledge System (IKS) and sensitize the students to the contributions made by ancient Indians in the field of Science, Philosophy and related applications and concepts

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

CO1	Discuss need and salient features of IKS and various vedas
CO2	Understand ancient philosophical systems and wisdoms of ages like itihas, shastra, puranas
CO3	Classify Indian knowledge framework and linguistics
CO4	Explain number systems and measurement units, Ayurvedic and disease management
CO5	Explain town planning and Architecture practices of vastu and temples and public administration

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												3
CO2												3
CO3												3
CO4												3
CO5												3

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS

The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Subclassification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2

Philosophical Systems: 1. An introduction to philosophical systems 2. Development of philosophy 3. Unique features of philosophy 4. Sāṅkhya approach of philosophy 5. Introduction to Yoga 6. Tenet of Nyāya philosophy 7. Principles of Vaiśeṣika 8. Doctrine of Pūrva-Mīmāṃsā Darśana 9. Thesis of Vedānta and synopsis of Advaita 10. Philosophy of Viśiṣṭādvaita 11. Ideology of Dvaita 12. Tenets of Jaina 13. Doctrine of Buddhism 14. Notions of Cārvāka

Wisdom through the Ages: 1. Gateways of ancestral wisdoms 2. Introduction to Purāṇa 3. The Purāṇic repository 4. Issues of interest in Purāṇas 5. Introduction to Itihāsas 6. Key messages in Itihāsas 7. Wisdom through Nīti-śāstras 8. Wisdom through Subhāṣita

Unit-3

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas –the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing

Unit-4

Number Systems and Units of Measurement: 1. Number systems in India – Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system

Health Wellness and Psychology: 1. Introduction to health 2. Āyurveda: approach to health 3. Sapta-dhātavaḥ: seven-tissues 4. Role of agni in health 5. Tri-doṣas 6. Āyurveda: definition of health 7. Psychological aspects of health 8. Disease management elements 9. Dinacaryā: daily regimen for health & wellness 10. Importance of sleep 11. Food intake methods and drugs 12. Approach to lead a healthy life 13. Indian approach to psychology 14. The tri guṇa system & holistic picture of the individual 15. The Nature of Consciousness 16. Consciousness studies and issues

Unit-5

Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstu-śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography

Governance and Public Administration: 1. Introduction to raja dharma 2. Arthaśāstra: a historical perspective 3. Elements of a kauṭilyan state 4. The king & the amātya 5. Janapada & durga 6. Treasury and the State Economy (Kośa) 7. Danda 8. Mitra 9. The Administrative Setup 10. Relevance of Arthaśāstra 11. Public Administration in Epics

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

Additional Readings:

1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.

2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.

3. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.

4. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

5. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.

6. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

Semester-II

Ancient Indian Management

24AFARIK206C	Ancient Indian Management	IKS	2-0-0	2 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam----	Total 40 Marks

Pre-Requisites: None

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

CO1	Understand nature and art of management
CO2	Explain about the jain and vedantic literature and its code of conduct
CO3	Understand management from Bhagwat Gita
CO4	Discuss the management lessons from Ramayana
CO5	Explain the economics from Koutilya and Mahavira Dynasty

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Introduction

Understanding management: Defining management, Nature of management, Management: Science or art?

Ancient Indian Management

Unit-2

Management Perspective of Ancient Indian Literature: What is Jain Literature?, What is Vedantic Literature?, code of conduct in vedantic literature, code of conduct in Jain Literature, Four pillars of human labor in ancient Vedantic and Jain Literature

Management lessons from Mahabharata

Unit-3

Management in Bhagavad Gita:

- Introduction to Gita

- Management Lessons from Bhagavad Gita,

Unit-4

Management lessons from Ramayana:

- Introduction to Ramayana,
- Management Lessons from Ramayana

Unit-5

Ancient Indian Economics:

- Kautilya's economics
- Mahavira's economics

TEXTBOOKS / REFERENCES:

1. Indian Management by Subhash Sharma. New Age International (P) Limited Publishers< New Delhi ISBN: 978-93-89802-41-2

2. Management Concepts - In Ancient Indian Psycho-Philosophic Thought &Thier Significance for Present Day Organisations by Ipshita Bansal, Popular Book Depo

3. In Indian Logic: Modern Management Philosophies as derived from Ancient Indian Philosophies, by Aparna Singh.

Semester-II

Research Paper Writing

24AFARAU207	Research Paper Writing	AC	2-0-0	Audit Course

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam----	Total 40 Marks

Pre-Requisites: Communication skills

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

CO1	Classify the research and their purpose
CO2	Understand tools, techniques and databases for collecting research information
CO3	Explain the methods of literature review, references and citing of sources
CO4	Formulate the research topic and understand hypothesis and editing of research paper
CO5	Discuss the ethical issues in data collection and its use in research paper

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Types of Research

Role & purposes of Research Designs, Defining and differentiating research: Descriptive Research, Analytical Research, Applied Research, Fundamental Research, Quantitative Research, Qualitative Research, Conceptual Research, and Empirical Research

Unit 2

Sources of Information

Finding/Gathering information for research, using information, using research tools, Using Library and electronic databases

Unit 3

Writing research literature review

Need for a literature review, Strategies for writing literature review, reviewing skills, Literature search and evaluation, Method of conducting a literature review, Organizing the literature review

Unit 4

Citing sources/references and maintaining Academic honesty Referencing and in-text citations, Styles of referencing, Paraphrasing and summarizing, citing sources, Developing academic honesty

Unit 5

Writing, refining and editing a research paper

Writing a Research Proposal, developing objectives of the research topic, Developing logical research statements and hypotheses, Editing the research paper, Proofreading techniques, Revision of the research paper

Unit 6

Ethical issues in collecting data

Ethics, stakeholders in research, ethical issues concerning participants, seeking consent, providing incentives, confidentiality, bias, incorrect reporting, issues with sponsoring organizations, Study of research papers in the respective areas of specialization.

TEXTS/REFERENCES:

1. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi: New Age International.

2. Kumar, R. (2005). Research Methodology-A Step-by-Step Guide for. Singapore: Pearson Education.

3. Saravanavel, P. (2012). Research Methodology. Allahabad: Kitab Mahal Publishers. Page 3 of 3

Semester-II
Seminar

24AFARPC208	Seminar	PCC	0-0-2	1 Credit

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses

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

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Prepare a well-organized report employing elements of technical writing and critical thinking.
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1	2		2	2	2	1	2
CO2		2				2		1	2	1		1
CO3						1	1	2	2	2		2
CO4	1	2	1	1		1	1	1	2	1		1

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Objective:

To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer.

Individual students are required to choose a topic of their interest from Automation & Robotics related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a automation or robotics organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Semester-II

Mini Project

24AFARPC209	Mini Project	PCC	0-0-2	1 Credit

Continuous Assessment 50 Marks	PR/OR 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses

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

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objectives:

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities.

Individual students are required to choose a topic of their interest. The course content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organizations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.

Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, beforethe committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded

as follows.
Report = 25 marks
Concept/knowledge in the topic = 15 marks, Presentation = 10 marks,
Total marks = 50 marks

Semester-III

Python for Data Science

24AFAROE301A	Python for Data Science	OEC-II	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites:

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

CO1	Understand the various script files, data types, variable creation and spyder for data science
CO2	Describe about the sequence and random numbers, arrays and operators, numpy files and scipy.stats modules
CO3	Explain data preparation and processing using various plots, loops, pandas data frame and related operations
CO4	Study advanced data visualization techniques, supervised learning, feature reduction and data mining technique
CO5	Understand unsupervised learning, data mining, regression techniques for data science

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1:

Basics of Data Science and Python Spyder

Basics of data analysis and data modeling methodologies; and techniques for approaching data science, Spyder introduction, Setting working Directory, Creating and saving a script file, File execution, clearing console, removing variables from environment, clearing environment, Commenting script files, Variable creation, Arithmetic and logical operators, Data types and associated operations

Unit 2:

Python notebook using Google Colab; instructions using built-in Python data and control structures; random numbers within the random module; and basic plotting and data rendering instructions using the matplotlib module, Sequence data types and associated operations: Strings, Lists, Arrays, Tuples, Dictionary, Sets, Range, instructions to create numpy arrays; instructions to index arrays using slicing; demonstrate computation and visualization using array operations; and instructions to load and save data using numpy file formats, random numbers within the numpy module; statistical methods within the scipy.stats module; and scipy.stats module for solving data science problems.

Unit 3:

•Pandas dataframe and dataframe related operations on Toyota Corolla dataset- Reading files, Exploratory data analysis, Data preparation and preprocessing, Data visualization on Toyoto Corolla dataset using matplotlib and seaborn libraries- Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot, Control structures using Toyota Corolla dataset- if-else family, for loop, for loop with if break, while loop, Functions, similarities and differences between dataframes and arrays; instructions for cleaning data sets; implement operations on dataframes; Python instructions for interacting with spreadsheet files; and built-in pandas visualization methods to visualize pandas dataframe data.

Unit 4:

Seaborn commands to visualize pandas dataframe data; advanced data visualization techniques; and seaborn module to solve data science problems, supervised learning techniques; scikit-learn module to supervised learning; Python scripts that extract features and reduce feature dimension; and models using data mining techniques.

Unit 5

Unsupervised learning concepts; scikit-learn module to perform unsupervised learning; similarities and differences between hierarchical clustering and K-means clustering; and validate models using clustering techniques, linear regression concepts; scikit-learn module to build linear regression models; scikit-learn module to validate linear regression models; and data overfitting, statsmodels module; autoregressive and moving average models; and AR, MA, and
ARIMA models

Books and references

1. Introduction to linear algebra - Gilbert Strang
2. Applied statistics and probability for engineers –Douglas Montgomery
3. Mastering python for data science, Samir Madhavan
4. Python Data Analytics, With Pandas, NumPy, and Matplotlib, Fabio Nell, Apress publisher, 2018.

Semester-III

Project Management for Managers

24AFAROE301B	Project Management for Managers	OEC-II	3-0-0	3 Credits

Mid Semester 20 Marks	Continuous Assessment 20 Marks	End-Semester Exam 60 Marks	Total 100 Marks

Pre-Requisites: Engineering Mathematics-I

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

CO1	Understand the project types and their selection methods
CO2	Understand the marketing and demands of project and risk analysis
CO3	Understand decision trees, and project team issues
CO4	Understand the project scheduling and probability networks
CO5	Identify the floats and crash cost and time management of the project

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit 1

Introduction to project management, project success, types of structure organizations, project management office, stake holders management, types of projects and project life cycle, project life cycle phases and project appraisal, methods of project selection –I, methods of project selection – II, MCDM-I, Methods of project selection MCDM- II, MCDM –III

Unit 2

Market and demand analysis – I, market and demand analysis – II, Financial analysis, capital budgeting techniques – I, capital budgeting techniques –II, Financing of projects, Risk management I and Risk management II, Risk management (Control and documentation), stand alone risk analysis I, stand alone risk analysis II, Hilier model.

Unit 3

Simulation analysis, decision tree analysis –I, decision tree analysis –II, Abandonment analysis, Technical analysis, product mix and plant capacity analysis, Project team building, conflict and negotiation, HRM Issues and time management.

Unit 4

Introduction to project time management, project scheduling, node numbering, PERT Networks, CPM, Laddering in PERT/CPM, probability models in networks-I, probability models in network –II

Unit 5

Probability models in network –III and IV, simulations of networks I and II, Slacks and floats, time and cost relationship, crashing of networks, Free float method, Introduction to project crash management, cost control tools and techniques, cost estimation, introduction to quality management

TEXTS/REFERENCES:

1. “Project Management- A Managerial Approach”, Jack Meredith, Samuel J. Mantel Jr.,John Wiley and Sons

2. Project Management For Engineering, Business And Technology, John M. Nicholas (Author), Herman Steyn (Author), Routledge; 6th edition (August 3, 2020)

3. Engineering Project Management by Neil G. Siegel, Wiley 1st edition (February 18, 2020).

4. Project Management: The Managerial Process, 8th Edition, By Erik Larson and Clifford Gray, McGraw Hill

5. Mitra, Amitava. Fundamentals of Quality Control and Improvement, Wiley India Pvt Ltd.

6. Evans, J R and W M Lindsay, An Introduction to Six Sigma and Process Improvement, CENGAGE Learning

Semester-III

Industrial Safety Engineering

24AFAROE301C	Industrial Safety Engineering	OEC-II	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: Engineering Mathematics-I

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

CO1	Understand hazard identification, analysis and control and safety aspects
CO2	Understand fault tree and event tree analysis and identify safety barriers
CO3	Quantify the safety and reliability for non-repairable components, hazard rate, exponential distribution, Weibull distribution)
CO4	Understand the quantification of basic events
CO5	Understand human error identification, analysis and accident investigation, OSHAS

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Introduction, key concepts, terminologies, safety domain ontology, and safety quantification, safety by design, Application of hazard identification techniques (e.g., HAZOP, FMEA, etc.) -preliminary hazard list, preliminary hazard analysis, Risk assessment and Control, Safety engineering and accident causing mechanism

Unit-2

Fault tree Analysis- construction, gate by gate method, cut set method, importance measures, and event tree analysis (qualitative & quantitative), Bow-tie tool, common cause cut sets, cut sets for accident scenarios, identification of safety barriers

Unit-3

Risk assessment, Consequence assessment, Energy control model and hazard control hierarchy, Safety function deployment, Ranking of design solution using AHP, Safety vs reliability –quantification of basic events (for non repairable components, hazard rate, exponential distribution, Weibull distribution)

Unit-4

Quantification of basic events -repair to failure, repair-failure-repair, and combined processes, Computation of combined process parameters – Laplace transform and Markov analysis, Safety vs reliability – quantification of basic events, Systems safety quantification (e.g., truth tables, structure functions, minimal cut sets)

Unit-5

Human error -classification and causes, Human error identification, Human reliability assessment, analysis and safety, Accident investigation and analysis, control chart analysis, regression and classification tree, OSHAS 18001 and OSHMS- part I, II, III and safety performance indicators, Energy isolations, Application of virtual reality.

Books and references:

1. Probabilistic Risk Assessment for Engineering and Scientists, Komamoto and Henley, IEEE Press, 1995.

2. Industrial Accident Prevention, Heinrich et al., McGraw Hill, 1980.

3. Techniques for safety management - A systems approach, Petersen D, ASSE 1998.

Semester-III

Application of IoT and Industry 4.0

24AFARMD302A	Application of IoT and Industry 4.0	MDM	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites: None

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

CO1	Understand the globalization, emerging issues, smart factories
CO2	Develop cyber physical systems and next generation sensors
CO3	Examine the IoT-Business Models
CO4	Apply Big Data Analytics and software defined networks
CO5	Explore the Industrial IoT- application domains

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1:
Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories

Unit 2:
Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artifical Intelligence, Big Data and Advanced Analysis, Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems.

Unit 3:
IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II, Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I, Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III.

Unit 4:
Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop, Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II, Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry.

Unit 5:
Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management, Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies, Case studies in Milk Processing and Packaging Industries, Manufacturing Industries, Student Projects

Books and references:

1. Industry 4.0: The Industrial Internet of Things Alasdair Gilchrist Publications: Apress

2. The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production

Logistics Authors: Bartodziej, Christoph Jan Springer: Publication in the field of economic science.

3. Embedded System: Architecture, Programming and Design by Rajkamal, TMH3.

4. Dr. OvidiuVermesan, Dr. Peter Friess, “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers

Semester-III

e-Commerce Technologies

24AFARMD302B	e-Commerce Technologies	MDM	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites:

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

CO1	Understand advantages, limitations and applications of e-commerce techniques
CO2	Explain the role of internet in e-commerce and secure transactions
CO3	Understand the privacy issues, digital signature, safety and threats related to e-commerce
CO4	Develop the e-commerce websites and understand electronic payments systems
CO5	Explain the on-line shopping, internet marketing and e-commerce personalization

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Introduction to e-commerce, technical components and functions of e-commerce, Advantages and disadvantages of e-commerce, Scope and applications of e-commerce, E-commerce and e-business

Unit-2

Evolution of internet, Domain names and internet organization, Types of networks, Role of internet in B2B application and building own website, Web promotion, Target email, Banner exchange and Shopping Bots, Secure transaction over internet

Unit-3

Privacy issues, Computer crime, Threats and attacks on computer system, Software packages for privacy, Hacking and computer virus, Security algorithms, Authorization and authentication, digital signature, Firewall, Basic concepts of EDI

Unit-4

Applications of EDI, EDI model and Disadvantages of EDI model, Introduction to electronic payment

systems, Payment types, Planning e-commerce initiates, linking objectives to business strategies, managing costs, Strategies for developing e-commerce websites

Unit-5

Pros and cons of online shopping, Case study- cons of online shopping, E-cycle of internet marketing, Internet marketing techniques, Personalization of e-commerce.

TEXTS/REFERENCES:

1. C.S.V.Murthy, E-Commerce Concepts, Models, Strategies- :- Himalaya Publishing House, 2011.
2. Kamlesh K Bajaj and Debjani Nag , E- Commerce , 2005.
3. Gary P. Schneider , Electronic commerce, International Student Edition, 2011.
4. Electronic Commerce: The Strategic Perspective, Richard T.Watson, Pierre Berthon,Leyland F. Pitt, George M. Zinkhan.
5. Rana tassabehji, Applying E-commerce in business, 2003.
6. Kalakota, Ravi and Whinston, Andrew B., Electronic Commerce – A Manager‘s Guide, Pearson Education, Inc.
7. William Stallings, Cryptography and Network security Principles and practice, Fifth edition.
8. Bharat Bhasker, Electronic commerce-framework, technologies and applications, 3rd edition.

Semester-III

Data Analytics

24AFARMD302C	Data Analytics	MDM	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites:

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

CO1	Analyze several key technologies used in manipulating, storing, and analyzing big data
CO2	Acquire clear understanding of processing data
CO3	Acquire clear understanding of Hadoopmap reduce
CO4	Categorize and Summarize Big Data and its importance
CO5	Manage Big Data and analyze Big Data
CO6	Apply tools and techniques to analyze Big Data.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit I: Introduction to big data

Big Data and its Importance – Four V's of Big Data – Drivers for Big Data –Introduction to Big Data Analytics – Big Data Analytics applications. Hadoop's Parallel World – Data discovery – Open source technology for Big Data Analytics – cloud and Big Data –Predictive Analytics – Mobile Business Intelligence and Big Data – Crowd Sourcing Analytics – Interand Trans-Firewall, Analytics - Information Management. (SLE: Predictive Analytics)

Unit II: Processing big data

Integrating disparate data stores - Mapping data to the programming framework Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce. (SLE: Data Preparation for Map Reduce)

Unit III: Hadoop map reduce

Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms -Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed. (SLE: Applications of HadoopMapreduce)

Unit IV: Database Management System

Comparison of File System, Database Management System, Characteristic Features of Database Management Systems, Relational Databases. (SLE: Logical Database Design) Unit V: Data Base Models DBMS Languages and Interfaces. Data Base Security and Authorization. (SLE: Data Ware House)

Unit VI: Big data tools and techniques

Installing and Running Pig – Comparison with Databases – Pig Latin – User-Define Functions – Data Processing Operators – Installing and Running Hive – Hive QL – Tables – Querying Data – User-Defined Functions – Oracle Big Data. (SLE: Installing and Running Hive)

Text Books:

1. Fundamentals of DBMS – RamezElmasri and Navathe, Addison Wesley, 5th edition, 2009.
2. Michael Minelli, Michehe Chambers, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today’s Business”, 1st Edition, AmbigaDhiraj, Wiely CIO Series, 2013.
3. ArvindSathi, “Big Data Analytics: Disruptive Technologies for Changing the Game”, 1st Edition, IBM Corporation, 2012.
4. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, 1st Edition, Wiley and SAS BusinessSeries, 2012.
5. Tom White, “Hadoop: The Definitive Guide”, 3rd Edition, O’reilly, 2012.

References:

1. Introduction to DBMS – Date C.J, Addison Wesley, 3rd edition, 1981.

Semester-III

Intellectual Property Rights

24AFARPC303	Intellectual Property Rights	PC	3-0-0	3 Credits

Mid Semester	Continuous Assessment	End-Semester Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Pre-Requisites:

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

CO1	Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,
CO2	Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
CO3	Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO4	Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property Audits, Manage and safeguard the intellectual property

Mapping of course outcomes with program outcomes

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

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Contents:

Unit-1

Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement ;searching & filing; Utility Models an introduction;

Unit-2

Copyrights ; their definition; granting; infringement ;searching & filing, distinction between related and copy rights; Trademarks ,role in commerce ,importance , protection, registration; domain names;

Unit-3

Industrial Designs ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; ; legal issues, enforcement ;Case studies in IPR.

TEXT BOOKS/REFERENCES:

1. Prabuddha Ganguli, IPR: Unleashing the Knowledge Economy, published by Tata McGraw Hill 2001.

Semester-III

Project Stage -I

24AFARPC304	Project Stage -I	PCC		10 Credits

Continuous Assessment 50 Marks	End Sem Evaluation 50 Marks	Total 100 Marks

Pre-Requisites: Previously studied courses

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

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research. The project work can be a design project, experimental project, computer simulation project or an empirical study involving data collection and analysis from Automation and Robotics organizations. The topic should be on Automation and Robotics or any of the topics related with Automation or Robotics stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute. If found essential they may be permitted to continue their project outside the parent institute subject to the conditions of MTech. regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members. The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4th semester (Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Semester-IV

Project Stage -II

24AFARPC401	**Project Stage -II**	**PCC**		**20 Credits**

Continuous Assessment 100 Marks	End Sem Evaluation 100 Marks	Total 200 Marks

Pre-Requisites: Previously studied courses

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

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

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

Objectives:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.