KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

BE-MECHATRONICS ENGINEERING

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM

(V & VI semester)

VISION:

To make the Department of Mechatronics Engineering the unique of its kind in the field of Research and Development towards Industrial Automation & Robotics.

MISSION:

To impart highly innovative and technical knowledge in Mechatronics Engineering to the urban and unreachable rural student folks through "Total Quality Education"

PROGRAM EDUCATION OBJECTIVES:

Educational objectives of the course Bachelor of Mechatronics Engineering programme can be divided into

PEO 1: Graduates will be able to apply their multi-disciplinary knowledge to formulate, design, develop and analyse Mechatronics Systems.

PEO 2: Graduates will be able to come up with solution for any real time problems in the field of Mechatronics Engineering and allied areas demanded by the Industry and Society.

PEO 3: Graduates will be able to get familiarized with economical issues in Mechatronics Engineering and work in multi-disciplinary teams with ethical code of conduct.

PROGRAM OUTCOMES:

After going through the four years of study, the Mechatronics Engineering graduates will have the ability to

	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional

		engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1: Graduates will be able to apply their knowledge in sensors, drives, actuators, controls, mechanical design and modern software & hardware tools to design & develop cost effective Mechatronics systems.

PSO2: Graduates will be able to become Technocrats and Entrepreneurs, build the attitude of developing new concepts on emerging fields and pursuing higher studies.

BE-MECHATRONICS ENGINEERING

Regulation - 2020

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

CURRICULUM AND SYLLABI

(V & VI semester)

SEMESTER V

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	IT1471	Object Oriented Programming using JAVA (Theory Cum Lab)	PC	3	0	2	5	4
2.	MT1501	Machine Design	PC	3	0	0	3	3
3.	MT1502	Machine Dynamics for Mechatronics Engineers	PC	3	0	0	3	3
4.	MT1503	Power Electronic Converters and Drives	PC	3	0	0	3	3
5.	PE1	Professional Elective I	PE	3	0	0	3	3
6.	OE1	Open Elective I	OE	3	0	0	3	3
PRACTICAL								
7.	MT1511	Power Electronic Converters and	PC	0	0	4	4	2

		Drives laboratory						
8.	MT1512	Kinematics and Dynamics Laboratory	PC	0	0	4	4	2
9.	HS1521	Professional Communication	EE	0	0	2	1	1
TOTAL				**18**	**0**	**12**	**29**	**24**

SEMESTER VI

Sl. No.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PERIODS PER WEEK**			**TOTAL CONTACT PERIODS**	**CREDITS**
				L	**T**	**P**		
THEORY								
1.	MT1601	Design of Mechatronics System	PC	3	0	0	3	3
2.	MT1602	Fluid Power Systems (Theory Cum Lab)	PC	3	0	2	5	4
3.	MT1603	Industrial Automation (Theory Cum Lab)	PC	3	0	2	5	4
4.	PEII	Professional Elective–II	PE	3	0	0	3	3
5.	PEIII	Professional Elective–III	PE	3	0	0	3	3
6.		Online Course	OC	NPTEL/SWAYAM				3
PRACTICAL								
7.	MT1621	Design and Fabrication Project for Mechatronics Engineering	EE	0	0	4	4	2
TOTAL				**15**	**0**	**8**	**23**	**22**

PROFESSIONAL ELECTIVE COURSES (PE)

Professional Elective I, Semester V

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	EE1535	Special Electrical Machines	PE	3	3	0	0	3
2.	ME1505	Conventional and Electric Vehicle	PE	3	3	0	0	3
3.	MT1531	Computer Integrated Manufacturing systems	PE	3	3	0	0	3
4.	MT1532	Python Programming for Mechatronics Engineering	PE	3	3	0	0	3
5.	MT1533	Statistical Quality Control	PE	3	3	0	0	3

Professional Elective II, Semester VI

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	AD1201	Foundations for Data Science	PE	3	3	0	0	3
2.	MT1631	Autotronics	PE	3	3	0	0	3
3.	MT1632	Design of Experiment	PE	3	3	0	0	3
4.	MT1633	Medical Mechatronics	PE	3	3	0	0	3
5.	MT1634	Rapid Prototyping	PE	3	3	0	0	3

Professional Elective III, Semester VI

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	ME1637	Non-Destructive Testing and Evaluation	PE	3	3	0	0	3
2.	AD1371	Introduction to Artificial Intelligence	PE	3	3	0	0	3
3.	MT1635	Flexible Manufacturing System	PE	3	3	0	0	3

4.	MT1636	Service and Field Robotics	PE	3	3	0	0	3
5.	ME1737	Composites Materials	PE	3	3	0	0	3

OPEN ELECTIVE COURSES

(Offered by Mechatronics Engineering Department to other branches)

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	OFFERING TO
1.	OMT151	Low Cost Automation	OE	3	3	0	0	3	ECE, EEE, EIE, MECH

PROFESSIONAL CORE (PC)

SEMESTER V

IT1471 OBJECT ORIENTED PROGRAMMING USING JAVA (THEORY CUM LAB)

L	T	P	C
3	0	2	4

(Common to EEE / EIE / MTRE)

PRE-REQUISITE:

1. Fundamentals of Computing and Programming

COURSE OBJECTIVES:

Students should be made to

- Build software development skills using JAVA programming for real world applications
- Understand and apply the OOPs features like Arrays, Strings and Packages
- Use of inheritance and inner class to develop JAVA applications
- Develop JAVA applications using Exceptions, Generic Programming and Multithreading
- Apply the concepts of I/O streams and Event driven Programming

Unit 1 Fundamentals of JAVA and Object Oriented Programming

11 Hours + 4 Hours = 15 Hours

Theory Component:

JAVA as a Programming Platform – JAVA Buzzwords – History of JAVA –Introduction to Object Oriented Programming – Using Predefined Classes – Defining Your Own Classes - Static Fields and Methods – Method Parameters - A Simple JAVA Program – Comments – Data Types – Variables and Constants – Operators- Input and Output

Lab Component:

Implementation of the following problems using JAVA

1. **Using Predefined Classes of JAVA**
   a. Write a JAVA Program to add two big integer numbers using BigInteger class

b. Write a JAVA Program to display the calendar of the given month using LocalDate class

2. **Defining Your Own Classes for Simple JAVA Programs**
   a. Implement a JAVA program to find the area of rectangle and circle
   b. Implement a JAVA Program to find the sum and average of three numbers

Unit 2 Basic Characteristics of Object Oriented Programming

8 Hours + 12 Hours = 20 Hours

Theory Component:

Control Flow - Object Construction- Packages-Documentation Comments- Arrays- Strings

Lab Component:

Implementation of the following problems using JAVA

3. **Control Flow - Conditional Statements and Multiple Selection Statements**

a. Prepare Electricity bill using JAVA. Create a class with the following member: Consumer number, Consumer name, previous month reading, current month reading and type of EB connection.

Calculate the domestic connection bill amount using the following tariff:

First 100 units – Rs. 1.50 per unit
101-200 units – Rs. 3 per unit
201- 500 units – Rs. 4.50 per unit
>501 units – Rs. 7 per unit

Calculate the commercial connection bill amount using the following tariff:

First 100 units – Rs. 2.50 per unit
101-200 units – Rs. 5 per unit
201- 500 units – Rs. 6.50 per unit
>501 units – Rs. 9 per unit

4. **Control Flow – Looping Statements**
   a. Write a JAVA program to check whether the given number is Armstrong or not
   b. Write a JAVA program to find the factorial of a given number

5. **Object Construction**

a. Develop a JAVA program to define a class called Account which contains two private data elements, an integer account number and a floating point account balance, and three methods:

A constructor that allows the user to set initial values for account number and account balance and a default constructor that prompts for the input of the values for the above data members.

A method which reads a character value for transaction type (D for deposit and W for withdrawal), and a floating point value for transaction amount, and updates account balance.

A method, which prints on the screen the account number and account balance.

6. **Packages**
   a. Develop a JAVA application using packages to implement the following currency converter Dollar to Indian Rupees, Euro to Indian Rupees

7. **Arrays**

a. Develop a JAVA program to find the largest and smallest number in an array
b. Develop a JAVA program to perform matrix multiplication

8. **Strings**
   a. Write a JAVA program to check whether the given string is a palindrome or not.

Unit 3 Inheritance and Interfaces

9 Hours + 6 Hours = 15 Hours

Theory Component:

Classes, Super classes and Sub classes – The Cosmic Super class – Generic Array Lists – Object Wrappers and Autoboxing – Interfaces - Inner classes

Lab Component:

Implementation of the following problems using JAVA

9. **Inheritance**
    a. Use the abstract class Shape that include two integers and an empty method named printArea(). Construct the classes Rectangle, Triangle and Circle inherited from the class Shape. The Derived classes should include only the method printArea() that print the area of the given shape.

10. **Generic Array Lists**
    a. Write a JAVA program to perform string operations using ArrayList. Write functions for the following
        i) Append – add at end
        ii) Insert – add at particular index
        iii) List all string starts with given letter

11. **Interfaces and Inner Classes**
    a. Write a JAVA program with a class named as “circle” that implements an interface named as “circleinterface” and define the methods named as “area” and “circum” in the class to find the area and circumference of the circle.
    b. Write a JAVA program to perform subtraction of two numbers using inner class

Unit 4 Exception and Multithreading

8 Hours + 4 Hours = 12 Hours

Theory Component:

Dealing with Errors – Catching Exceptions – Using Exceptions – Why Generic Programming? – Defining a Simple Generic Class – Generic Methods – Bounds for Type Variables – What are Threads? – Thread States – Thread Properties – Synchronization

Lab Component:

Implementation of the following problems using JAVA

12. **Exception and Generic Programming**

a. Implement the exception handling for dividing two numbers
b. Create a JAVA program that finds the maximum value based on the given type of elements using generic functions in java.

13. Multithreading

a. Write a JAVA program that implements a multi-threaded application that has three threads.
   First thread generates a random integer every 1 second.
   If the value is even, second thread computes the square of the number.
   If the value is odd, the third thread will print the value of cube of the number.

Unit 5 - Streams and Event Driven Programming

9 Hours + 4 Hours = 13 Hours

Theory Component:

Byte Stream – Character Stream – Reading and Writing from console and files – Swing and the MVC design pattern - **Components:** Text field, Input, Choice, Text Area, Buttons, **Layout Management:** Border layout – **Listener:** ActionListener.

Lab Component:

Implementation of the following problems using JAVA

14. Streams

a. Create a JAVA program to write a student profile into a file and read the contents from the file and display it on the screen.

15. User Interface Components with Swing

a. Create a JAVA GUI application to convert miles to kilometres when pressing the “Convert!” button. Note that you need to implement the ActionListener interface and override the action Performed () method. Note that 1 mile is equal to 1.609 kilometres.

Total: **45 + 30 = 75 HOURS**

COURSE OUTCOMES:

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

CO1: Develop JAVA applications using Sequence statements

CO2: Apply the basic features of Object Oriented Programming to give solutions to simple JAVA applications

CO3: Build a JAVA application using Inheritance and Interface

CO4: Utilize the concept of Exception, Generic Programming and Multithreaded Programming of JAVA for developing console based applications

CO5: Design graphics-based JAVA applications using files and Event driven Programming

TEXT BOOK:

1. Cay S. Horstmann., 2019 , *Core JAVA Volume – I Fundamentals,* Eleventh Edition , Pearson Education.

REFERENCES:

1. Herbert Schildt.,2014, *Java: The Complete Reference*, Eleventh Edition, McGraw Hill Education.
2. Paul Deitel & Harvey Deitel.,2015, *Java SE8 for Programmers*, Third Edition, Pearson Education.
3. P.J.Deitel & H.M.Deitel.,2011, *Java: How to Program Java 2*", Seventh Edition, Prentice Hall.

SOFTWARE SPECIFICATIONS:

1. JDK8
2. Eclipse / Netbeans

MT1501 **MACHINE DESIGN**

L	T	P	C
3	0	0	3

(Use of P S G Design Data Book is permitted)

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape of a component to satisfy functional and strength requirements.
- To learn the principles involved in evaluating the dimensions of a component to satisfy functional and strength requirements
- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine component

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS **9**

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equation – calculation of principle stresses for various load combinations, eccentric loading - Factor of safety - Theories of failure – stress concentration – Design for variable loading.

UNIT II CURVED BEAMS, SHAFTS AND COUPLINGS **9**

Curved beams – crane hook and 'C' frame - Design of solid and hollow shafts based on strength, rigidity and critical speed - Rigid and flexible couplings

UNIT III JOINTS AND SPRINGS **9**

Threaded fasteners - Bolted joints including eccentric loading – Knuckle joints - Cotter joints - Various types of springs - Design of helical springs - Design of leaf spring.

UNIT IV GEARS **9**

Gear speed ratios and number of teeth – Force analysis – Tooth stresses – Factor of safety – Gear materials – Design of straight tooth spur & helical gear based on strength and wear

consideration. Introduction to design of micro gears and timing belts.

UNIT V BEARINGS AND SURFACE MOUNTING METHODS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings - Selection of Rolling Contact bearings. Selection of ball screw and guide rail system, Mechanism for securing for securing materials – Clamps, T-slots and Vises.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO1: Describe the various steps involved in the design process, identification of the steady stresses and variable stresses in machine members.

CO2: To calculate the design parameters of Shafts and couplings

CO3: Design the threaded fasteners, knuckle joint, cotter joint and springs.

CO4: Design the spur and helical gear based on strength.

CO5: Develop the design of sliding contact and selection of rolling contact bearing for machine members

TEXT BOOKS:

1. Bhandari V, 2021, *Design of Machine Elements,* 5th Edition, Tata McGraw-Hill Book Co.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, 2020, *Mechanical Engineering Design*, 11th Edition, Tata McGraw-Hill

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin,H., 2010, *Machine Desig*n, Tata McGraw-Hill Book Co.(Schaum's Outline).
2. Ansel Ugural, 2003, *Mechanical Design" – An Integral Approach,* 1st Edition, Tata McGraw-Hill Book Co.

3. P.C. Gope, 2012, *Machine Design – Fundamental and Application,* PHI learning private ltd, New Delhi.
4. Robert C. Juvinall and Kurt M.Marshek, 2018, *Fundamentals of Machine Design,* 6th Edition, Wiley.
5. Sundararajamoorthy T.V. Shanmugam.N, 2018, *Machine Design,* Anuradha Publications, Chennai.

MT1502 **MACHINE DYNAMICS FOR MECHATRONICS ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the effect of dynamics of free vibrations.
- To understand the effect of dynamics of forced vibrations.
- To understand the principles in mechanisms used for speed control and stability control

UNIT I FORCE ANALYSIS **9**

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle – Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- Follower mechanism

UNIT II BALANCING **9**

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of linkages – Balancing machines-Field balancing of discs and rotors

UNIT III FREE VIBRATION **9**

Basic features of vibratory systems – Degrees of freedom – Single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION **9**

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion –transmissibility – Vibration isolation vibration measurement.

UNIT V MECHANISM FOR CONTROL 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO1: Discuss the force and motion analysis of components subjected to external forces

CO2: Explain the undesirable effects of unbalanced forces in reciprocating and rotary machine components.

CO3: Calculate the natural frequencies for un damped and damped vibrating systems.

CO4: Solve problem on effect of harmonic disturbances, support motion and vibration isolation

CO5: Explain the principles in mechanisms used for speed control and stability control.

TEXT BOOKS:

1. Rattan, S.S, 2014, *Theory of Machines*, 4th Edition, Tata McGraw-Hill.
2. Uicker J.J., 2014, Pennock G.R and Shigley, J.E., *Theory of Machines and Mechanisms*,4th Edition, Oxford University Press.

REFERENCES:

1. Khurmi, R.S., 2005, *Theory of Machines*,14 Edition, S Chand Publications.

2. Thomas Bevan, 2005, *Theory of Machines*, 3rd Edition, CBS Publishers and Distributors.
3. Robert L. Norton, 2009, *Kinematics and Dynamics of Machinery*, Tata McGraw-Hill.

MT1503 POWER ELECTRONIC CONVERTERS AND DRIVES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand different types of power semiconductor devices and their switching
- To discuss the Operation, characteristics and performance parameters of controlled rectifiers
- To discuss the Operation, switching techniques and basics topologies of DC-DC switching regulators.
- To describe different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To explain the Operation of AC voltage controller and various configurations.

UNIT I POWER SEMI-CONDUCTOR DEVICES 9

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR- Introduction to Driver and snubber circuits.

UNIT II AC TO DC CONVERTERS 9

2-pulse, 3-pulse and 6-pulseconverters– performance parameters –Effect of source inductance Firing Schemes for converter–Dual converters, Applications-light dimmer, Converter fed DC drive.

UNIT III DC TO DC CONVERTERS 9

Step-down and step-up chopper-control strategy– Introduction to types of choppers-A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Application-Battery operated vehicles.

UNIT IV DC TO AC CONVERTERS 9

Single phase and three phase voltage source inverters (both1200 mode and 1800 mode)–Voltage& harmonic control--PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation –Current source inverter, Applications-Induction heating, Solar PV systems.

UNIT V AC TO AC CONVERTERS 9

Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control – Multistage sequence control -single phase and three phase cyclo converters –Introduction to Matrix converters, Application –welding .

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1: To describe the basic operation of various power semiconductor devices, driver and snubber circuits for various switching devices.

CO2: To interpret pulse converters, dual converters and analyze it's various performance parameters

CO3: To produce various DC to DC converters using power electronic switches for real time applications.

CO4: To apply various PWM techniques in single phase and three phase inverters.

CO5: To construct appropriate control strategy for AC to AC converter.

TEXTBOOKS:

1. Muhammad H.Rashid., 2017, *Power Electronics Circuits, Devices & Applications,* Pearson Education India Publication, New Delhi, 4th Edition.
2. P.S. Bimbra., 2018, *Power Electronics*- Khanna Publishers, 6th Edition.

REFERENCES :

1. Ned Mohan, Tore Undeland & William Robbins., 2018, *Power Electronics : converters Applications and Design* - John Willey and sons,3rdEdition.

2. Vedam Subrahmanyam., 2006, *Power Electronics*, New Age International (P) Limited, New Delhi, 2nd Edition.
3. Philip T Krein., 2017, *Elements of Power Electronics*, Oxford University Press.
4. Soumitra Kumar Mandal., 2014, *Power Electronics*, McGraw Hill publishers Pvt. Ltd.,
5. L. Umanand., 2009, *Power Electronics: Essentials and Applications*- Wiley India.

MT1511 POWER ELECTRONIC CONVERTERS AND DRIVES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- Understand different power electronics components and their use of in electronic circuits.
- Analyse different power electronic converters for various application.
- To design and analyze power converters such as AC-DC converters and their control circuits for real world applications
- To design and analyze power converters such as DC-DC converters and their control circuits for real world applications
- To design and analyze power converters such as DC-AC converters, AC- to AC converters and their control circuits for real world application

LIST OF EXPERIMENTS:

1. Study of SCR, MOSFET & IGBT characteristics
2. UJT, R, RC firing circuits for SCR
3. Voltage & current commutated chopper
4. SCR phase control circuit
5. TRIAC phase control circuit
6. Study of half controlled & fully controller converters
7. Study of three phase AC regulator
8. Speed control of DC shunt motor using three phase fully controlled converter.
9. SCR single-phase cyclo converter
10. SCR series and parallel inverters
11. IGBT Chopper
12. IGBT based PWM inverter (single phase)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Choose power electronic devices like SCR, MOSFET &TRIAC for various application.

CO2: Design firing circuit for thyristors

CO3: Develop power semiconductor circuits to electrical power system

CO4: Construct power semiconductor circuits for industrial applications

CO5: Analyse the operation of various converters

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Name of the Equipment	Qty
1	Study of SCR, MOSFET & IGBT characteristics module	1
2	UJT, R, RC firing circuits for SCR module	1
3	Voltage & current commutated chopper module	1
4	SCR phase control circuit module	1
5	TRIAC phase control circuit module	1
6	Study of half controlled & fully controller converters module	1
7	Study of three phase AC regulator module	1
8	Speed control of DC shunt motor using three phase fully controlled converter module	1
9	SCR single phase cyclo converter module	1
10	SCR series and parallel inverters module	1
11	IGBT chopper module	1
12	IGBT based PWM inverter (single phase) module	1
13	Ammeter (0-5A) MC, (0-2A) MC, (0-2A) MI, (0-5V) MI	15
14	Voltmeter (0-300V) MC, (0-600V) MC, (0-300V) MI, (0-600V) MI, Multimeter	16
15	CRO ,Transformer 1KVA, 1:1, 230V	Each 3

MT1512 **KINEMATICS AND DYNAMICS LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVES:

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To understand how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS

1) a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2) a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universal joints.
3) a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4) Motorized gyroscope – Study of gyroscopic effect and couple.
5) Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6) Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7) a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
8) a) Determination of torsional natural frequency of single and Double Rotor systems.- Un damped and Damped Natural frequencies.
   b) Vibration Absorber – Tuned vibration absorber.
9) Vibration of Equivalent Spring mass system – undamped and damped vibration.

10) Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

11) a) Balancing of rotating masses.
    b) Balancing of reciprocating masses.

12) a) Transverse vibration of Free-Free beam – with and without concentrated masses.
    b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
    c) Determination of transmissibility ratio using vibrating table.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Students will be able to

CO1: Students can able to analyze the kinematics principles of gears, mechanisms, cam profile.

CO2: Students will be able to understand the mass moment of inertia of connecting rod and turn table apparatus.

CO3: Students will be able to analyze the balancing of rotary masses.

CO4: Students can be able gain hands on experience in motorized gyroscopic effect, couple, whirling of shaft & governors.

CO5: Students can be able gain hands on experience to determine the frequency of free and forced vibration, torsional vibration and transverse vibration for shaft and spring.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	NAME OF THE EQUIPMENT	Qty.
1	Cam follower setup.	1 No.
2	Motorized gyroscope.	1 No.
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 No.
4	Whirling of shaft apparatus.	1 No.

5	Dynamic balancing machine.	1 No.
6	Two rotor vibration setup.	1 No.
7	Spring mass vibration system.	1 No.
8	Torsional Vibration of single rotor system setup.	1 No.
9	Gear Models	1 No.
10	Kinematic Models to study various mechanisms.	1 No.
11	Turn table apparatus.	1 No.
12	Transverse vibration setup of cantilever	1 No.

HS1521 PROFESSIONAL COMMUNICATION

L	T	P	C
0	0	2	1

OBJECTIVES:

The course aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

UNIT I **6**

Introduction to Soft Skills– Hard skills & soft skills – employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs- Error Spotting

UNIT II **6**

Self-Introduction-organizing the material – Introducing oneself to the audience – introducing the topic – answering questions with clarity and appropriate pharases – individual presentation practice— presenting the visuals effectively – 5 minute presentations

UNIT III **6**

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics – brainstorming the topic -– questioning and clarifying –GD strategies-activities to improve GD skills

UNIT IV **6**

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews

UNIT V **6**

Recognizing differences between groups and teams - managing stress- networking professionally- respecting social protocols-understanding career management- developing a long-term career plan-making career changes

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After successful completion of the course, the students will be able to:

CO1: Make effective presentations

CO2: Participate confidently in Group Discussions.

CO3: Participate confidently in Group Discussions.

CO4: Develop adequate Soft Skills required for the workplace

REFERENCES:

1. Butterfield, Jeff., 2015, *Soft Skills for Everyone*, Cengage Learning: New Delhi.
2. E. Suresh Kumar et al., 2015 , *Communication for Professional Success. Orient Blackswan*: Hyderabad.
3. OBS Exports ,2018 *Interact English Lab Manual for Undergraduate Students.* OrientBalckSwan: Hyderabad, .
4. Raman, Meenakshi and Sangeeta Sharma. 2014 *Professional Communication*. Oxford University Press: Oxford,
5. S. Hariharanet al , 2010 *Soft Skills.* MJP Publishers: Chennai,

SEMESTER VI

MT1601 DESIGN OF MECHATRONICS SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

To enable the students to

- To explain the basics and key elements of Mechatronics design process
- To provide information about basic system Modeling
- To teach the concepts of Engineering System and Dynamic response of the system
- To provide the concepts of Real Time Interfacing and Data acquisition
- To make them understand the concepts of design of Mechatronics system through case studies

UNIT I INTRODUCTION TO DESIGN OF MECHATRONICS SYSTEM 9

Key elements – Mechatronics design process – design parameters – mechatronics and traditional design – Advanced approaches in mechatronics design – Introduction to industrial design, modelling, simulation and analysis – Ergonomics and safety.

UNIT II BASIC SYSTEM MODELLING 9

Introduction – model catagories – model development – Simulation using softwares – verification and validation – Mathematical modelling : Basic system modelling – mechanical electrical, fluid and thermal.

UNIT III MECHATRONIC SYSTEM MODELLING 9

Engineering systems : Rotational – translational, electro-mechanical, pneumatic-mechanical, hydraulic-mechanical, micro electro mechanical system – Dynamic responses of system: first order, second order system – Performance measures

UNIT IV REAL TIME INTERFACING 9

Introduction – Selection of interfacing standards- elements of data acquisition and control systems –Overview of I/O process – general purpose I/O cards and its installation -TIA/EIA serial interface standards (RS232/422/485) – General Purpose Interface Bus (IEEE 488) – Data conversion process –Application softwares – Man machine interface

UNIT V CASE STUDIES ON DESIGN OF MECHATRONICS SYSTEM 9

Motion control using DC Motor, AC Motor and Servomotor - Temperature control of hot/cold reservoir – Pick and place robot – Car parking barriers – Motion and temperature control of washing machine – Auto focus camera, exposure control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: To explain the basics and key elements of Mechatronics design process

CO2: To provide information about basic system Modeling

CO3: To teach the concepts of Engineering System and Dynamic response of the system

CO4: To provide the concepts of Real Time Interfacing and Data acquisition

CO5: To make them understand the concepts of design of Mechatronics system through case studies

TEXT BOOKS:

1. Devdas Shetty, Richard A. Kolk., 2011, *Mechatronics System Design*, 2nd Edition,Cengage Learning.
2. Bolton W, 2019, *Mechatronics*, Pearson Education.

REFERENCES:

1. Bishop, Robert H.,2002, *Mechatronics Hand book*, CRC Press.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader.,2010 ,*Mechatronics: Electronics in Products and Processes*, CRC Press 1991 , First Indian print.

3. De Silva.,2013, *Mechatronics: A Foundation Course*, Taylor & Francis, Indian Reprint.
4. Georg pelz., 2003, *Mechatronic Systems: Modeling and Simulation* with HDL's, John wiley and sons Ltd, 2003.

MT1602 **FLUID POWER SYSTEMS (Theory cum lab)**

L	T	P	C
3	0	2	4

OBJECTIVES :

- To understand the fundamentals of fluid power principles and hydraulic pumps
- To understand working of hydraulic actuators and valves,
- To provide the knowledge on various hydraulic systems
- To provide the knowledge on various pneumatics systems
- To design and test the hydraulic and pneumatic circuits and simulate the circuits using Automation studio / AUTOSIM software.

UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS 9

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

UNIT II HYDRAULIC ACTUATORS AND VALVES 9

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 – Types of actuation. Accessories: Reservoirs, Pressure Switches-Applications- Fluid Power ANSI Symbols - Problems

UNIT III HYDRAULIC SYSTEMS 9

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, Mechanical Hydraulic servo systems.

UNIT IV PNEUMATIC SYSTEMS 9

Properties of air– Perfect Gas Laws - Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits. Introduction to Hydro-pneumatic system.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

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 a Pick and Place application and tool handling in a CNC machine. - Low cost Automation – Hydraulic and Pneumatic power packs- case studies.

UNIT VI FLUID POWER SYSTEMS LABORATORY: LIST OF EXPERIMENTS 30

Design and testing of hydraulic circuits

Design and testing of pneumatic circuits

Simulation of basic hydraulic, pneumatic and electrical circuits using AUTOMATION STUDIO / AUTOSIM software.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: Explain the basics fluid power principles and working of hydraulic pumps

CO2: Select the actuators and valves for the design of fluid power circuits.

CO3: Summarize the operating principles and constructional features of hydraulic system.

CO4: Summarize the operating principles and constructional features of pneumatic system.

CO5: Design and simulate the fluid power circuits using software tool.

TEXT BOOKS:

1. Anthony Esposito, 2009, *Fluid Power with Applications*, Prentice Hall.
2.. Shanmugasundaram.K, 2006, *Hydraulic and Pneumatic Controls*, Chand & Co.

REFERENCES:

1. Majumdar, S.R., 2001, *Oil Hydraulics Systems- Principles and Maintenance*, Tata Mc Graw Hill.
2. Majumdar, S.R., 2007, *Pneumatic Systems – Principles and Maintenance*, Tata Mc Graw Hill.
3. Srinivasan.R, 2008, *Hydraulic and Pneumatic Controls*, Vijay Nicole Imprints.
4. Joji.P, 2008, *Pneumatic Controls*, John Wiley & Sons India.

MT1603 **INDUSTRIAL AUTOMATION (Theory cum lab)**

L	T	P	C
3	0	2	4

OBJECTIVES:

- To understand the construction, operation and installation of PLCs.
- To provide the knowledge on interfacing the PLCs and field devices with communication protocols.
- To understand the various functions of SCADA System & its Architectures.
- To understand the functional blocks of Distributed Control System for Process Automation Industries
- To understand the concepts of industrial Process Control.

UNIT I PROGRAMMABLE LOGIC CONTROLLER 9

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

UNIT II PROGRAMMING & APPLICATIONS OF PLC 9

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

UNIT III SCADA SYSTEM & ARCHITECTURE 9

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

UNIT IV DISTRIBUTED CONTROL SYSTEM 9

Introduction to DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities Operator interfaces - Low level and high level operator interfaces – Displays - Engineering interfaces – Low level and high level engineering interfaces – Factors to be considered in selecting DCS – Case Studies – Sugar industry and Power plant..

UNIT V INDUSTRIAL PROCESS CONTROL 9

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

UNIT VI PLC PROGRAMMING LAB 30

1. Study of different PLCs and their specification.
2. Study of installations and troubleshooting of PLC.
3. Development of Ladder Diagram (LD) and Structured Text (ST), Functional Block Diagram programming in PLC for simple applications.
4. PLC for Simple Material Handling applications.
5. Development of an application by using timer and counter of PLC.
6. Verification and testing of PID controller in a Process loop.
7. Interfacing between PLC and Process loop (temperature)
8. Interfacing between PLC and Process loop (level)

9. Interfacing between PLC and Process loop (flow)
10. AC motor speed control using PLC and VFD.

TOTAL: 75 PERIODS

COURSE OUTCOMES

Students will be able to

CO 1 : Choose appropriate PLC and explain the architecture, installation procedures and trouble shooting.

CO 2 : Develop PLC programs using various functions of PLCs for a given application.

CO 3 : Explain the application development procedures in SCADA system.

CO 4 : Distinguish DCS, SCADA and PLC and explain the architecture of DCS

CO 5 : Develop simple applications using various PLC programming Languages. (Ladder Diagram, Structured Text, Functional Block Diagram).

TEXT BOOKS:

1. Frank D Petruzella., 2016, *Programmable logic controllers*, Fourth edition, McGraw Hill higher education.
2. Krishna Kant., 2010 ,*Computer Based Process Control*, Prentice Hall of India.

REFERENCES:

1. B. G. Liptak “Instrument Engineer’s Handbook.,2012*, Process Software and Digital Network*, 3rd edition, CRC Press.
2. Jose A. Romagnoli, Ahmet Palazoglu.,2020, *Introduction to Process control*, CRC Taylor and Francisgroup.
3. Richard Zurawski.,2015, *Industrial Communication Technology Handbook* 2nd edition, CRC Press.

4. William T. Shaw.,2021, *Cybersecurity for SCADA systems*, Penn Well Books.
5. Michael P. Lukas.,2016, *Distributed Control Systems: Their Evaluation and Design*, Van Nostrand Reinhold Co.

MT1621 DESIGN AND FABRICATION PROJECT FOR MECHATRONICS ENGINEERING

L	T	P	C
0	0	4	2

OBJECTIVE:

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

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: To identify specific problems prevailing in the society or industry in the field of Mechatronics Engineering& allied areas.

CO2: To carry out the literature survey for the identified problem.

CO3: Develop Mechatronics product from various systems.

CO4: To develop an appropriate solution for the identified problem using modern tool or methodology

CO5: To impart communication and presentation skills through effective documentation and delivery.

PROFESSIONAL ELECTIVE COURSE (PE)

Professional Elective I, Semester V

EE1535 SPECIAL ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on the following topics

- Construction, principle of operation, control and performance of stepping motor.
- Construction, principle of operation, control and performance of switched reluctance motors.
- Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- Construction, principle of operation and performance of permanent magnet synchronous motors.
- Construction, principle of operation and performance of other special machines

UNIT I STEPPER MOTORS 9

Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits and current suppression schemes for stepper motor – Closed loop control – Concept of lead angle – Applications of stepper motors in computer peripherals, robotics and 3D printers.

UNIT II SWITCHED RELUCTANCE MOTORS (SRM) 9

Constructional features –Principle of operation- Torque prediction–Characteristics - Steady state performance prediction – Analytical Method – Current control schemes- Hysteresis and PWM- Power controllers – Control of SRM drive- Sensor less operation of SRM – Applications.

UNIT III PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9

Disadvantages of BLDC motor-Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Power Converter

Circuits and their controllers - Characteristics and control- Applications.

UNIT IV PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM) **9**

Constructional features -Principle of operation – EMF and Torque equations - Sine wave motor with practical windings - Phasor diagram - Power controllers – performance characteristics -Digital controllers – Comparison of PMSM and PMBLDC -Applications.

UNIT V OTHER SPECIAL MACHINES **9**

Constructional features – Principle of operation and Characteristics of Hysteresis motor- Synchronous Reluctance Motor–Linear Induction Motor-Repulsion motor- AC series motor-Universal Motor-Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

- **CO1:** Interpret the various modes of excitations, drive circuits and control techniques of stepper motor.
- **CO2:** Explicate the Construction, working and Performance of Switched Reluctance Motor
- **CO3:** Analyze the various applications of PMBLDC Motor based on its performance.
- **CO4:** Apply Permanent Magnet Synchronous Motor Drive in an appropriate application based on its performance.
- **CO5:** Explicate the Construction, working and Performance of Hysteresis Motor, Synchronous Reluctance motor, Linear Induction Motor, AC series motor, Universal motor & Repulsion motor

TEXTBOOKS :

1. Veṅkaṭaratnam, K., 2009. Special electrical machines..

2. Kenjo, T., 1984. Stepping Motors and Their Microprocessor Controls, Clarendon. Oxford, UK, 4, pp.620-625.

REFERENCES:

1. Janardanan, E.G., 2014. Special Electrical Machines. PHI Learning Pvt. Ltd.
2. Krishnan, R., 2017. Switched reluctance motor drives: modeling, simulation, analysis,design, and applications. CRC press.
3. Kenjō, T. and Nagamori, S., 1985. Permanent-magnet and brushless DC motors (Vol. 18).Clarendon Press.
4. Miller, T.J., 1989. Brushless permanent-magnet and reluctance motor drives.

ME1505 CONVENTIONAL AND ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce about the automobile types and its layouts
- To discuss the power transmission systems, braking and steering geometry
- To Brief about the basics of electrical vehicles.
- To impart knowledge about electric vehicle operations and its respective control elements.
- To discuss the vehicle advanced management systems employed in recent days in automobiles.

UNIT I INTRODUCTION 9

Types of Automobiles - Vehicle construction and different layouts, Chassis, frame and Vehicle body aerodynamics - resistances and moments - IC engines –components-Functions and materials – MPFI – turbocharging – supercharging - Emission norms and standards.

UNIT II POWER TRANSMISSION, STEERING AND BRAKING SYSTEMS 9

Clutch-types and construction, Gear boxes- manual and automatic, Gear shift mechanisms, Propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive. Steering geometry and steering gear box, Pneumatic and Hydraulic Braking Systems

UNIT III ELECTRIC VEHICLES AND CONVERSION 9

History of electrical vehicles, Electric and hybrid vehicles, flexible fuel vehicles (FFV), solar powered vehicles, fuel cells vehicles. fuel cells, flexible fuel systems. Series and parallel hybrid vehicles. High energy and power density batteries. Conversion of conventional vehicles as hybrid vehicles – Conversion kit and economics of conversion.

UNIT IV ELECTRIC VEHICLE OPERATION CONTROL 9

Dynamics and architecture of hybrid and electrical vehicles, DC-DC converters, DC-AC converters, AC electrical machines and permanent magnet for hybrid and electrical vehicles, Control system for electrical and hybrid electric vehicles – Energy management strategies and its general architecture, Rule and optimization-based energy management strategies (EMS), EMS based on deterministic rule

UNIT V VEHICLE MANAGEMENT SYSTEMS 9

ABS system, Regenerative braking, layout – working and Electronic control of suspension – Damping control, Electric power steering, Cruise control. Vehicle security systems- alarms, vehicle tracking system. On board diagnostics. Collision avoidance Radar warning system – E-charging solutions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO 1 : Classify the automobiles and its types.

CO 2 : Infer the transmission parts along with the steering column and braking.

CO 3 : Obtain the outline about the basic knowledge in Electric vehicles

CO 4 : Acquire the understanding about the electric vehicle operation control elements and its respective working procedures

CO 5 : Familiarize about the recent vehicle management control systems.

TEXT BOOKS:

1. Kirpal Singh, 2014, *Automobile Engineering* – Vol. 1 & 2, Standard Publishers, New Delhi.
2. Bosch Hand Book, SAE Publication, 2000
3. Eric Chowanietz, 1995, *Automobile Electronics*, SAE Publications.

REFERENCES:

1. Advance hybrid vehicle power transmission, SAE.
2. Ron Hodkinson and John Fenton, 2000, *Light weight electric for hybrid vehicle design*, Elsevier.
3. Branek L.L., 1993, *Noise reduction*, McGraw Hill Book company, New York.
4. Heinz, 2002, *Modern Vehicle Technology*, Second Edition, Butter worth-Heinemann, Elsevier.

MT1531 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gain knowledge about the basic fundamental of CAD.
- To provide knowledge on how computers are integrated at various levels of planning and manufacturing understand computer aided planning and control and computer monitoring.
- To gain knowledge on different coding systems used in group technology.
- To provide knowledge on flexible manufacturing systems and automatic guided vehicle system.
- To gain knowledge of robots used in industries.

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Manufacturing Control – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II PROCESS PLANNING AND CONTROL AND PRODUCTION PLANNING 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule– Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

UNIT III CELLULAR MANUFACTURING 9

Group Technology (GT), Part Families – Parts Classification and coding –Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEMS (FMS) AND MATERIAL HANDLING SYSTEMS 9

Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control – Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application –Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Student will able to:

CO1: Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems.

CO2: Illustrate the production planning and control and computerized process planning.

CO3: Differentiate the different coding systems used in group technology.

CO4: Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system.

CO5: Classify of robots used in industrial applications.

TEXT BOOKS:

1. Mikell.P.Groover., 2019, *Automation, Production Systems and Computer Integrated Manufacturing* , Prentice Hall of India.
2. Radhakrishnan P, Subramanyan S, and Raju V., 2007 , *CAD/CAM/CIM*, 2nd Edition, New Age International (P) Ltd, New Delhi.

REFERENCES:

1. Gideon Halevi and Roland Weill.,1995, *Principles of Process Planning – A Logical Approach,* Chapman & Hall, London.
2. Kant Vajpayee S., *Principles of Computer Integrated Manufacturing*", Prentice Hall India.
3. Rao. P, N Tewari &T.K. Kundra., 2000, *Computer Aided Manufacturing*, Tata McGraw Hill Publishing Company.

MT1532 PYTHON PROGRAMMING FOR MECHATRONICS ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

To enable the students to

- Identify and execute basic syntax and programs in Python.
- Solve problems using Python built-in data types and their methods.
- Create user-defined functions, modules and packages.
- Implement exception and file handling operations.
- Design an application using various libraries in python.

UNIT I PYTHON FUNDAMENTALS 9

Introduction to Object Oriented Programming concepts: Objects-Classes-Encapsulation-Inheritance-Data Abstraction, Message Passing & Dynamic binding. Started with Python: Keywords and identifiers- Syntax and Semantics- Statements & Comments-Variables, Operators, Data types, Strings and String Methods, Conditional Looping and Control statements.

UNIT II LISTS, TUPLES & DICTIONARIES 9

Lists: list operations, Indexing, Slicing, and Matrixes, Tuples: Tuple operations – Dictionaries – Dictionaries in action – Basic dictionary operations –Dictionary methods. Functions– Nested functions– Recursive functions – Anonymous functions

UNIT III PYTHON FUNCTIONS 9

Coding functions –Scopes and Nested functions – Non local statement – Argument passing basics –Function design concepts - Recursive functions –Anonymous functions – Mapping functions.

UNIT IV CLASSES, OBJECTS & ERROR HANDLING 9

Classes in Python– Creating Classes – Instance Methods– Class Variables–Objects– Constructor, destructors and Inheritance. Introduction–Data streams –File Operations– Reading Data From a File – Writing Data to a File – Access Modes – Exceptions– Exception Hierarchy – Handling IO Exceptions.

UNIT V PYTHON LIBRARIES FOR MECHATRONICS APPLICATIONS 9

Robot Framework-Pyro-DART- PyRobot- PyDy- SOFA-Klamp't -Pybotics - Siconos-iDynTree

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: Explain the fundamental concepts of python programming.

CO2: Explicate python data types Lists, Tuples and Dictionaries.

CO3: Describe python functions.

CO4: Write simple python code using classes and objects.

CO5: Implement I/O and Error handling concepts in Python

TEXT BOOKS:

1. Y. Daniel Liang.,2013, *Introduction to Programming Using Python*, Pearson Education.
2. Jason Cannon., 2010, *Python Programming for Beginners*, O,Reilly.

REFERENCES:

1. David Beazley, Brain K Jones., 2013 ,*Python CookBook* , Third edition.
2. Chun, Wesley J.,2012,*Core Python Programming*, Pearson Education.

3. Guttag, John V.,2014, *Introduction to Computation and Programming Using Python*, PHI Learning Private Limited, New Delhi.
4. Allen B. Downey.,2016,*Think Python: How to Think Like a Computer Scientist*', 2nd edition, updated for Python 3' O'REILLY Shroff Publishers & Distributors Pvt. Ltd.
5. Guidovan Rossum and Fred L. Drake Jr., 2011,*An Introduction to Python – Revised and updated for Python 3.2*, Network Theory Ltd.

MT1533 **STATISTICAL QUALITY CONTROL**

L	T	P	C
3	0	0	3

OBJECTIVES

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students to understand the application of control charts
- Developing the special control procedures for service and process-oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

UNIT I INTRODUCTION 9

Quality Dimensions – Quality definitions – Inspection - Quality control – Quality Assurance – Quality planning - Quality costs – Economics of quality – Quality loss function

UNIT II CONTROL CHARTS 9

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u-Construction and application.

UNIT III SPECIAL CONTROL PROCEDURES 9

Warning and modified control limits, control chart for individual measurements, multi-vari chart, X chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

UNIT IV STATISTICAL PROCESS CONTROL 9

Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

UNIT V ACCEPTANCE SAMPLING 9

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS2500 standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: Control the quality of processes using control charts for variables in manufacturing industries.

CO2: Control the occurrence of defective product and the defects in manufacturing companies.

CO3: Control the occurrence of defects in services.

CO4: Analyze and understand the process capability study.

CO5: Develop the acceptance sampling procedures for incoming raw material.

TEXT BOOKS:

1. Douglas C Montgomery, 2019, *Introduction to Statistical Quality Control*, Eighth Edition, John Wiley & Sons, Inc.
2. M.Mahajan, 2016, *Statistical Quality Control*, Dhanpat Rai & Company, New Delhi.

REFERENCES:

1. E.L. Grant and R.S. Leavenworth, 2000, *Statistical Quality Control*, Seventh Edition, TMH.
2. IS2500 Standard Sampling plans.
3. K.Krishnaiah, 2014, *Applied Statistical Quality Control and Improvement*, PHI.

Professional Elective II, Semester VI

AD1201 FOUNDATIONS FOR DATA SCIENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

The students will be able to:

- Learn the data analysis basics with Python
- Study Data Analysis and interpretation with Numpy on statistical parameters
- Understand various methods of Data Preparation and Manipulation with Pandas
- Learn Data Visualization using matplotlib and seaborn
- Learn Machine learning fundamentals concepts such as Feature Engineering and various techniques

UNIT I INTRODUCTION TO DATA ANALYSIS 9

Data Analysis - Mathematics and Statistics Basic Concepts - The Data Analysis Process – Data Extraction - Data Pre-processing/Cleaning – Data Preparation/Visualization - Data Modelling / Visualization - Quantitative and Qualitative Analysis - Errors and Debugging - Profiling and Timing Code

UNIT II INTRODUCTION TO NUMPY 9

Python data types - NumPy Arrays with Computations - Aggregations: Min, Max, and Everything In Between-Broadcasting - Comparisons, Masks, and Boolean Logic - Sorting Arrays - Structured Data with NumPy's Arrays

UNIT III DATA MANIPULATION WITH PANDAS 9

Introducing Pandas Objects - Data Indexing and Selection - Operating on Data in Pandas – Handling Missing Data - Hierarchical Indexing - Combining Datasets - Vectorized String Operations – Working with Time Series - High-Performance Pandas: eval() and query()

UNIT IV VISUALIZATION WITH MATPLOTLIB 9

Various Plots - Simple Line - Scatter Plots - Error Visualization - Density and Contour Plots - Histograms, Binnings, and Density - Customizing Plots-Multiple Subplots - Three-Dimensional Plotting in Matplotlib - Geographic Data with Basemap - Visualization with Seaborn

UNIT V MACHINE LEARNING FUNDAMENTALS 9

Machine Learning concepts using Scikit-learn- Hyperparameters and Model Validation – Feature Engineering - Basics of Classification, Clustering - Support Vector Machines - Decision Trees and Random Forests- Principal Component Analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO1 : Understand the various analysis methods in Numpy and Pandas

CO2 : Perform calculations that measure the central tendency and dispersion of data

CO3 : Solving the problems based on Time series analysis data

CO4 : Visualize various statistical quality control charts

CO5 : Apply the concepts of various machine learning techniques to solve problems

TEXT BOOKS:

1. Jake VanderPlas, 2016, Python Data Science Handbook: Essential Tools for Working with Data, 1st ed, O'Reilly Media, Inc.

REFERENCES:

1. Nelli, F 2015, Python Data Analytics, 1st ed, Apress, USA.

2. McKinney, W 2017, Python for Data Analysis, 2nd ed, O'Reilly Media, Inc.

3. John V Guttag 2013, Introduction to Computation and Programming Using Python, Revised and Expanded Edition, MIT Press.

4. Timothy A. Budd 2015, Exploring Python, Mc-Graw Hill Education Private Ltd.

MT1631 **AUTOTRONICS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the construction and working principle of various parts of an automobile.
- To describe the practice for assembling and dismantling of engine parts and transmission system
- To gain knowledge of various sensors and actuators used in an automobile.
- To learn the engine control systems in modern automobiles.
- To learn the chassis and safety system used in an automobile

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT II ENGINE AUXILIARY SYSTEMS 9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT III SENSOR AND ACTUATORS IN AUTOMOTIVES 9

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

UNIT IV ENGINE CONTROL SYSTEMS 9

Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU's used in the engine management – block diagram of the engine management system– diagnostics systems in modern automobiles- Introduction to AUTOSAR-CAN standard, format of CAN Standard -Introduction to CAN tools- CANoe, CANalyzer.

UNIT V CHASSIS AND SAFETY SYSTEMS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: To discuss different types of automobiles and the usage of different materials in vehicle construction.

CO2: To explain the working of injection and ignition system, turbocharger, emission control methods and Euro/BS norms.

CO3: To explain the function of sensors and actuators used in an automobile

CO4: To explain the working of engine control systems in modern automobile

CO5: To explain the function of chassis and safety system used in an automobile

TEXT BOOKS :

1. Ribbens.,2013 , *Understanding Automotive Electronics*, 8th Edition, Elsevier, Indian Reprint.
2. Kirpal Singh, 2014, *Automobile Engineering Vol 1 & 2*, Standard Publishers, 13th Edition, New Delhi.

REFERENCES:

1.Barry Hollembeak., 2001, *Automotive Electricity, Electronics & Computer Controls*, Delmar Publishers, 2001.

2.Richard K. Dupuy., 2000, Fuel System and Emission controls", Check Chart Publication.

3.Ronald. K. Jurgon.,1999, *Automotive Electronics Handbook*, McGraw-Hill.

4.Tom Denton., 2000, *Automobile Electrical and Electronics Systems*, Edward Arnold Publishers.

MT1632 DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn about the fundamentals of experimental design
- To provide knowledge on single factor experiments
- To provide knowledge on multi factor factorial experiments
- To impart knowledge to design experiments to a problem situation using traditional experimental designs as well as Taguchi methods.
- To develop skill to conduct experiments and analyse the data to determine the optimal process parameters that optimize the process.

UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS 9

Experimentation: Conventional test strategies – Analysis of variance – Basic principles of design– Steps in experimentation – Choice of sample size – Normal probability plot – Linear Regression: simple linear and multiple linear regression.

UNIT II SINGLE FACTOR EXPERIMENTS 9

Completely Randomized Design: Effect of coding the observations – Estimation of model parameters – Model validation – Analysis of treatment means– Duncan's multiple range test – Newman-Keul's test – Fisher's Least Significant Difference(LSD) test – Turkey's test – Randomized Complete Block Design – Latin Square Design – Case studies.

UNIT III MULTI- FACTOR FACTORIAL EXPERIMENTS 9

Two factor Experiments – Three factor factorial experiments– Randomized Block Factorial Experiments– Experiments with Random factors : Random effects model – Rule for Deriving degrees of freedom and sum of squares– 2^k Design with two and three factors– Yate's Algorithm for the 2^k design–The regression model – Case studies.

UNIT IV SPECIAL EXPERIMENTAL DESIGN 9

Blocking and Confounding in 2^k Designs: blocking in replicated design– Confounding – 2^K Factorial Design in two blocks– Complete and partial confounding– Confounding 2^K Design in four blocks – Case studies.

UNIT V TAGUCHI METHODS 9

Design of experiments using Orthogonal Arrays: Assignment of factors and Interactions– Selection and application of orthogonal arrays- Data analysis from TAGUCHI experiments: Variable data with main factors only – Variable data with interactions– Variable data with a single replicate and vacant column – Attribute data analysis – Robust design– noise factors, Signal to noise ratios, Inner/outer OA parameter design – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

Students should be able to:

CO1: Explain the fundamentals of experimental design

CO2: Apply experimental techniques to single factor factorial problems

CO3: Apply experimental techniques to multi factor factorial problems

CO4: Apply the special experimental design in 2^K design

CO5: Apply Taguchi Methods to practical problems to improve quality of processes / products by optimizing the process / product parameters.

TEXT BOOKS:

1. Krishnaiah K, and Shahabudeen P., 2011, *Applied Design of Experiments and Taguchi Methods*, PHI, India.
2. Douglas C. Montgomery., 2012, *Design and Analysis of Experiments*, John Wiley & sons.

REFERENCES:

1. Box, G. E., Hunter,W.G., Hunter, J.S., Hunter,W.G., 2005, *Statistics for Experimenters: Design, Innovation and Discovery*, 2nd Edition, Wiley.
2. Phillip J. Ross., 2005, *Taguchi Techniques for Quality Engineering*, Tata McGraw-Hill, India.

MT1633 MEDICAL MECHATRONICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand how to measure biochemical parameters and various physiological information.
- To study sensors and transducers used in Biomedical System Design.
- To describe in the potential use of signal conditioning and displays.
- To study about recorders and advanced equipments in medicine.
- To study the use of computers for diagnostic and therapy.

UNIT I INTRODUCTION 9

Cell structure – electrode – electrolyte interface, electrode potential, resting and action potential – electrodes for their measurement, ECG, EEG, EMG – machine description – methods of measurement – three equipment failures (ECG, EEG, EMG) and trouble shooting

UNIT II TRANSDUCERS FOR BIO-MEDICAL INSTRUMENTATION 9

Basic transducer principles Types – source of bioelectric potentials – resistive, inductive, capacitive, fiber-optic, photoelectric and chemical transducers – their description and feature applicable for biomedical instrumentation – Bio & Nano sensors & application

UNIT III SIGNAL CONDITIONING, RECORDING AND DISPLAY 9

Input isolation, DC amplifier, power amplifier, and differential amplifier – feedback, op-Amp-electrometer amplifier, carrier Amplifier – instrument power supply. Oscillograph – galvanometric - X-Y, magnetic recorder, storage oscilloscopes – electron microscope – PMMC writing systems – Telemetry principles – Bio telemetry.

UNIT IV MEDICAL SUPPORT 10

Electrocardiograph measurements – blood pressure measurement: by ultrasonic method – plethysmography – blood flow measurement by electromagnetic flow meter cardiac output measurement by dilution method – phonocardiography – vector cardiography.

Heart lung machine – artificial ventilator – Anesthetic machine – Basic ideas of CT scanner – MRI and ultrasonic scanner – Bio-telemetry – laser equipment and application – cardiac pacemaker – DC– defibrillator patient safety - electrical shock hazards. Centralized patent monitoring system.

UNIT V BIO-MEDICAL DIAGNOSTIC INSTRUMENTATION 8

Introduction – computers in medicine – basis of signal conversion and digital filtering data reduction technique – time and frequency domain technique – ECG Analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Students should be able to

CO1: Comprehend the knowledge of electro physical measurement system.

CO2: Explain the principle and operation of bio electrodes and transducers

CO3: Understand the need for signal conditioning and recording and displaying of the bio signal.

CO4: Differentiate the working of advanced medical equipments used in medicine.

CO5: Understand about various Bio- medical diagnostics instrumentation.

TEXT BOOKS:

1. Khandpur, R.S., 2014 “Handbook of Biomedical Instrumentation and Measurements”, Tata Mc Graw Hill.
2. Cromwell, Weibell and Pfeiffer, 2012, *Biomedical Instrumentation and Measurements*, 2nd Edition, Prentice Hall of India.

REFERENCE BOOKS:

1. SiamakNajarian., 2011, *Mechatronics in Medicine – A Bio medical Enggapproach* , McGraw – Hill Education .
2. Arumugam M.,2011 ,*Bio Medical Instrumentation*, Anuradha agencies Pub.

MT1364 RAPID PROTOTYPING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the principle Rapid Prototyping
- To understand the concept of liquid and solid based Rapid Prototyping
- To understand the concept of powder based Rapid Prototyping
- To know about various materials available for Rapid Prototyping
- To familiar with the concept of reverse engineering

UNIT I INTRODUCTION 9

History – Development of RP systems – Rapid Prototyping Versus Subtractive Manufacturing – Drawback of Subtractive Manufacturing – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle – Fundamental – File format – Other translators – medical applications of RP - On demand manufacturing – Direct material deposition - Shape Deposition Manufacturing.

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 9

Classification – Liquid based system - Stereolithography Apparatus (SLA), details of SL process, products, Advantages, Limitations, Applications and Uses. Solid based system - Fused Deposition Modeling, principle, process, products, advantages, applications and uses - Laminated Object Manufacturing

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 9

Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, applications and uses. Three-Dimensional Printing – process, major applications, research and development. Direct shell production casting – key strengths, process, applications

and uses, case studies, research and development. Laser Sintering System, e-manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing - Laser Engineered Net Shaping (LENS).

UNIT IV MATERIALS FOR RAPID PROTOTYPING SYSTEMS 9

Nature of material – type of material – polymers, metals, ceramics and composites-liquid based materials, photo polymer development – solid based materials, powder-based materials - case study.

UNIT V REVERSE ENGINEERING AND NEW TECHNOLOGIES 9

Introduction, measuring device- contact type and non-contact type, CAD model creation from point clouds-pre-processing, point clouds to surface model creation, medical data processing - types of medical imaging, software for making medical models, medical materials, other applications - Case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO 1 : Describe the Principles of Rapid Prototyping

CO 2 : Apply the concept of liquid and solid based Rapid Prototyping for manufacturing

CO 3 : Apply the concept of powder based Rapid Prototyping for manufacturing

CO 4 : Describe the various materials used for Rapid Prototyping

CO 5 : Apply the concept of reverse engineering for CAD models

TEXT BOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., 2010, *Rapid prototyping: Principles and applications: a training guide*, Wiley, 3rd edition World Scientific Publishers NewJersey.
2. Rafiq I. Noorani, 2006, *Rapid Prototyping – Principles and Applications*, Wiley & Sons.
3. Ian Gibson, David W.Rosen, Brent Stucker, 2010, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing,* Springer.

REFERENCES:

1. Andreas Gebhardt, 2011, *Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing,* Hanser Gardner Publication.
2. Kamrani A.K. and Nasr E.A., 2006, *Rapid Prototyping: Theory and practice*, Springer.
3. Liou L.W. and Liou F.W., 2007, *Rapid Prototyping and Engineering applications: A tool box for prototype development*, CRC Press.
4. Tom Page, 2012, *Design for Additive Manufacturing*, LAP Lambert Academic Publishing.
5. Ibrahim Zeid, 2007, *Mastering CAD CAM,* Tata McGraw-Hill Publishing Co.

Professional Elective III, Semester VI

ME1637	NON DESTRUCTIVE TESTING AND EVALUATION (COMMON to MECH & MTRE)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study and understand the various Non-Destructive Evaluation and Testing methods,
- To make the students to understand the importance of NDT in quality assurance
- To imbibe the students the basic principles of various NDT techniques, it's application, limitations, codes and standards.
- To equip the students with proper competencies to locate a flaw in various materials, products.

UNIT I INTRODUCTION & VISUAL INSPECTION METHODS 9

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

Visual Inspection -Unaided, Aided- Borescopes -Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography, Case study

UNIT II LIQUID PENETRANT TESTING& MAGNETIC PARTICLE TESTING 9

LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipment, Advantages and limitations, Inspection and Interpretation, Applications and case study.

MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation – need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting, Case study.

UNIT III THERMOGRAPHY & EDDY CURRENT TESTING 9

Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods and applications, Case study.

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications, Case study

UNIT IV ULTRASONIC TESTING & ACOUSTIC EMISSION TESTING 9

Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B-Scan & C-Scan, Phased Array Ultrasound & Time of Flight Diffraction,

Advantages & Limitations, Interpretation of Results & Applications, Case study

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications, Case study.

UNIT V RADIOGRAPHY AND APPLICATIONS OF NDT 9

Principles of radiography – Sources of X-rays and rays – Equipment – general radiographic procedure - Radiographic film, paper and screens – radiographic

attenuation and penetration – Acceptance standards – Safety in radiography – Special radiography techniques (Fluoroscopy, Xeroradiography)

Applications of NDT in railways, nuclear, chemical, aerospace, automobile and coal mining industries – case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO 1 : Apply the concept of visual inspection method for finding the defect in the material

CO 2 : Determine the defect by applying the standard procedures of Liquid penetrant test and Magnetic particle testing for leakage in in tank and industrial applications

CO 3 : Find the defect by making use of thermography and eddy current test.

CO 4 : Apply the concept of Ultrasonic testing and Acoustic emission test for industrial applications

CO 5 : Apply the concept of Radiography for finding the defect in a material and applications such as railways, nuclear, chemical, aerospace, automobile and coal mining industries as case study.

TEXT BOOKS:

1. Paul E Mix, "*Introduction to Non-destructive testing: a training guide*", Wiley, 2nd edition NewJersey, 2005
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu "*Practical Non-Destructive Testing*", Narosa Publishing House, 2009.
3. ASM Metals Handbook, "*Non-Destructive Evaluation and Quality Control*", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17

REFERENCES:

1. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, N*DT Handbook*, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4,Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
2. Charles, J. Hellier,“ *Handbook of Non-destructive evaluation*”, McGraw Hill, New York 2001.
3. G. Gaussorgues, “*Infrared Thermography*”, Chapman & Hall, University Press, Cambridge,1994.
4. Ravi Prakash, “*Non-Destructive Testing Techniques*”, New Age International Publishers, 1st revised edition, 2010.

AD1371 INTRODUCTION TO ARTIFICIAL INTELLIGENCE

L	T	P	C
3	0	0	3

OBJECTIVES:
To enable the students to

- Understand the various characteristics of Intelligent agents
- Learn the different search strategies in Artificial Intelligence
- Be familiar with represent knowledge in solving Artificial Intelligence problems
- Understand the agent communication and Trust and Reputation
- Know about the various applications of Artificial Intelligence.

UNIT I INTRODUCTION 9

Introduction–Definition - The Foundations of Artificial Intelligence- Characteristics of Intelligent Agents -Turing test – Agents and Environments - Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents; Problem Solving Approach to Typical AI problems

UNIT II PROBLEM SOLVING USING SEARCHING 9

Problem-Solving Agents, Formulating problems, searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, searching with Partial Information, Informed Search Strategies, Greedy best-first search, A* Search-IDA*-Heuristic Functions, Local Search Algorithms and Optimization Problems - Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning.

UNIT III LOGIC AND INFERENCES 9

Propositional Logic - First Order Logic – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories.

UNIT IV AGENT COMMUNICATION **9**

Architecture for Intelligent Agents – Agent communication - Agents and Objects – Negotiation and Bargaining –Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V APPLICATIONS **9**

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the various characteristics of intelligent agents.
CO2: Interpret appropriate search algorithms for Artificial Intelligence problem.
CO3: Illustrate a Knowledge Representation using first order logic.
CO4: Infer different ways of the agent communication and Trust and Reputation in Multi-agent systems.
CO5: Summarize the various application of AI.

TEXTBOOKS:

1. S. Russell & P. Norvig, 2020, Artificial Intelligence: A Modern Approach, Fourth edition, Prentice Hall.

REFERENCES:

1. Elaine Rich & Kevin Knight, 2008, "*Artificial Intelligence*", Tata McGraw- Hill,3rd Edition.

2. Tim Jones, M, 2008, *Artificial Intelligence: A Systems Approach (Computer Science),* Jones and Bartlett Publishers, Inc.; First Edition.
3. Nils J, Nilsson, 2009, The Quest for Artificial Intelligencell, Cambridge University Press.
4. Gerhard Weiss, 2013, *Multi Agent Systems*, Second Edition, MIT Press.
5. David L, Poole & Alan K, Mackworth, 2010,*Artificial Intelligence: Foundations of Computational Agents*, Cambridge University Press.

MT1635 FLEXIBLE MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the planning and control of flexible manufacturing systems.
- To understand computer control and software for flexible manufacturing systems.
- To understand the flexible manufacturing system simulation and data base.
- To know the concept of graph formulation and economic justification of FMS.
- To provide the knowledge on concepts and applications of flexible manufacturing systems.

UNIT I PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction to FMS / FMC– Development of manufacturing systems – Benefits – Major elements – Types of flexibility – FMS application and flexibility –Single product, Single batch, n – batch scheduling problem – Knowledge based scheduling system.

UNIT II COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction – Composition of FMS– Hierarchy of computer control –Computer control of work center and assembly lines – FMS supervisory computer control – Types of software specification and selection – trends.

UNIT III FMS SIMULATION AND DATA BASE 9

Application of simulation – model of FMS– Simulation software – limitation – Manufacturing data systems – data flow – FMS database systems – Planning for FMS database.

UNIT IV GROUP TECHNOLOGY AND JUSTIFICATION OF FMS 9

Introduction – Matrix formulation – Mathematical programming formulation –Graph formulation – Knowledge based system for group technology – Economic justification of FMS- Application of possibility distributions in FMS systems justification.

UNIT V APPLICATIONS OF FMS AND FACTORY OF THE FUTURE 9

FMS application in machining, sheet metal fabrication, Prismatic component production – Aerospace application – FMS development towards factories of the future – Artificial intelligence and expert systems in FMS – Design philosophy and characteristics for future.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Student will be able to:

CO1: Describe the process of planning, scheduling and control of FMS.

CO2: Identify the computer control and software for FMS.

CO3: Apply the simulation and data base concepts in FMS.

CO4: Understand the matrix formulation, graph formulation and knowledge based group technology systems.

CO5: Understand the various applications of FMS systems and development towards factories of the future.

TEXT BOOKS:

1. Jha, N.,2012, *Handbook of flexible manufacturing systems*, Academic Press Inc.
2. William W. Luggen, 1991, *Flexible Manufacturing Cells and Systems*, Prentice-Hall.

REFERENCES:

1. Radhakrishnan P. And Subramanyan S.,2016, *CAD/CAM/CIM*, Wiley Eastern Ltd., New Age International Ltd .
2. Raouf, A. And Ben-Daya, M., Editors., 1995 , *Flexible manufacturing systems: recent development*, Elsevier Science.

3. Groover M.P.,2019, *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice Hall of India Pvt., New Delhi.
4. Kalpakjian.,2018,*Manufacturing Engineering and Technology*", Addison-Wesley Publishsing Co.
5. Taiichi Ohno., 1992, *Toyota Production System: Beyond large-scale Production*", Productivity Press (India) Pvt. Ltd

MT1636 **SERVICE AND FIELD ROBOTICS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on basic concepts of working of robot.
- To provide about the concept of localization.
- To impart knowledge on planning and navigation.
- To provide knowledge on different types of field robots.
- To provide knowledge on different types of humanoid robots.

UNIT I INTRODUCTION 9

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

UNIT II LOCALIZATION 9

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

UNIT III PLANNING AND NAVIGATION 9

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

UNIT IV FIELD ROBOTS 9

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

UNIT V HUMANOIDS 9

Wheeled and legged - Legged locomotion and balance - Arm movement - Gaze and auditory orientation control - Facial expression - Hands and manipulation - Sound and speech generation - Motion capture/Learning from demonstration - Human activity

recognition using vision, touch, sound – Vision - Tactile Sensing - Models of emotion and motivation. Performance – Interaction - Safety and robustness – Applications - Case studies.

TOTAL : 45PERIODS

COURSE OUTCOMES:

Student will be able to:

CO1: Illustrate the basic concepts of working of robot

CO2: Explain about the concept of localization

CO3: Explain about the path planning and obstacle avoidance

CO4: Illustrate about the different types of field robots

CO5: Illustrate about the different types of humanoid robots

TEXT BOOKS:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzz., 2004,*Introduction to Autonomous Mobile Robots*, Bradford Company Scituate, USA.

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

REFERENCES:

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

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

ME1737	COMPOSITE MATERIALS (Common to Mech & MTRE)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To summarize the classification of composite and effect of reinforcement in composite materials.
- To extend a knowledge of selection and applications of different composites in consideration of the properties and characteristics.
- To understand the processing of composite materials.
- To test the polymer composite materials as per the standards.
- To impart knowledge of composite materials and its application in manufacturing.

UNIT I INTRODUCTION TO COMPOSITE MATERIALS **9**

Introduction to Composites: Matrices, Reinforcements - types of reinforcement– Classifications of composite materials - based on matrix and reinforcement – Selection & functional requirements of matrix and reinforcement - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance – Wettability, Interfaces - Rule of mixture - volume and mass fractions – density - void content - advantages and application of composites.

UNIT II PROCESSING OF POLYMER MATRIX COMPOSITES **9**

Thermoset matrix composites: hand layup, spray, filament winding, pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding- Thermoplastic matrix composites: film stacking, diaphragm forming, thermoplastic tape laying, injection moulding - interfaces in PMCs - application of PMCs - recycling of PMCs.

UNIT III PROCESSING OF METAL AND CERAMIC MATRIX COMPOSITES **10**

Processing of MMCs: liquid state- infiltration – squeeze, casting – rheo casting – compocasting, solid state– diffusion bonding – powder metallurgy techniques- in situ fabrication techniques- interfaces in MMCs – applications.

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs –applications.

UNIT IV TESTING OF POLYMER COMPOSITE MATERIALS 9

ASTM standards for physical and mechanical testing of polymer composites. Physical testing - density, void content, water absorption, hardness, and scratch resistance.

Mechanical Testing – Tensile, Compressive and flexural testing, Impact testing, shear testing, fatigue testing - Friction and Wear testing.

UNIT V ADVANCED COMPOSITE MATERIALS 8

Environmental effects in Composites, advanced composite materials, Green composites, Carbon-carbon Composites, Nanocomposites, Self-Healing Composites, Self-Reinforced Composites, Surface Composites, Laminate composites, Bio-composites, Hybrid Composites.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

CO 1 : Explain the matrix, reinforcement and their characteristic performance with functionality

CO 2 : Summarize the Thermoset and Thermoplastic processing techniques

CO 3 : Comprehend the different processing techniques of MMC’s and CMC’s.

CO 4 : Understand the concepts in testing of composite materials

CO 5 : Interpret the advanced composite materials such as Green composites, nano composites & hybrid composites

TEXT BOOKS:

1. Krishnan K Chawla., 2012, *Composite Materials: Science and Engineering*, International Edition, Springer.
2. Mallick, P.K. and Newman.S., 2003, *Composite Materials Technology*, Hanser Publishers.

REFERENCES:

1. *ASM Handbook Composites*, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Peters, S.T., 1998, *Handbook of Composites*, Springer, ISBN 978-1-4615-6389-1.
3. ASTM Annual Book of Standards (2002)
4. Hull D and T.W. Clyne., 1996, *An Introduction to Composites Materials*, Cambridge University Press.

OPEN ELECTIVE

SEMESTER V

(Offered by Mechatronics Engineering Department to other branches)

OMT151 LOW COST AUTOMATION

L	T	P	C
3	0	0	3

OBJECTIVES:

To enable the students to

- Learn basic knowledge about automation
- Understand the basic hydraulics systems for automation
- Understand the basic pneumatics systems for automation
- Learn about use of electronic system in automation
- Understand the assembly automation

UNIT I AUTOMATION OF ASSEMBLY LINES 9

Concept of automation - mechanization and automation - Concept of automation in industry - mechanization and automation - classification, balancing of assembly line using available algorithms - Transfer line-monitoring system (TLMS) using Line Status - Line efficiency - Buffer stock Simulation in assembly line.

UNIT II AUTOMATION USING HYDRAULIC SYSTEMS 9

Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. - Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications.

UNIT III AUTOMATION USING PNEUMATIC SYSTEMS 9

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design

- combination circuit design. Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

UNIT IV AUTOMATION USING ELECTRONIC SYSTEMS 9

Introduction - various sensors – transducers - signal processing - servo systems - programming of microprocessors using 8085 instruction - programmable logic controllers

UNIT V ASSEMBLY AUTOMATION 9

Types and configurations - Parts delivery at workstations - Various vibratory and non vibratory devices for feeding - hopper feeders, rotary disc feeder, centrifugal and orientation - Product design for automated assembly.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

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

CO1: Explain the concept of automation in industries.
CO2: Summarize the usage of hydraulic system in automation
CO3: Explain the usage of pneumatic system in automation
CO4: Explain the usage of electronic system in automation
CO5: Summarize the type and configuration of assembly automation

TEXTBOOKS :

1. Anthony Esposito, 2009, *Fluid Power with applications*, Prentice Hall international.
2. Mikell P Groover, 2007, *Automation, Production System and Computer Integrated. Manufacturing*, Prentice Hall Publications.

REFERENCES :

1. Kuo .B.C, 2007, *Automatic control systems*, Prentice Hall India, New Delhi.

2. Peter Rohner, 1995, *Industrial hydraulic control*, Wiley Edition.
3. Mujumdar.S.R, 2006,*Pneumatic System*, Tata McGraw Hill.