COURES STRUCTURE & SYLLBUS

FOR

B. TECH. ROBOTICS & AUTOMATION

SEMESTER- III & IV

(CBCS 2023 COURSE AS PER NEP 2020 GUIDELINES)

Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune

Department of Robotics and Automation Engineering

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- *To provide quality technical education with advanced equipment, qualified faculty members,and infrastructure to meet needs of profession & society.*
- *To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.*
- *To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.*

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- *Recruiting experienced faculty.*
- *Organizing faculty development programs.*
- *Identifying socio-economically relevant areas & emerging technologies.*
- *Constant review &up gradation of curricula.*
- *Up gradation of laboratories, library & communication facilities.*
- *Collaboration with industry and research & development organizations.*
- *Sharing of knowledge, infra-structure and resources.*
- *Training, extension, testing and consultancy services.*
- *Promoting interdisciplinary research.*

Vision of the Robotics and Automation Engineering Department is:

To develop, high quality Robotics & Automation Engineers through dynamic education tomeet social and global challenges.

Mission Statements of the Robotics and Automation Engineering Department are:

- *To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.*
- *To inculcate aptitude for research, innovation and entrepreneurial qualities in students.*
- *To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.*

Program Educational Objectives (PEOs) of the B. Tech. Robotics and Automation are:

Graduates will be able,

- *To fulfill need of industry and society with theoretical and practical knowledge.*
- *To engage in research, innovation, lifelong learning and continued professional development.*
- *To fulfill professional ethics and social responsibilities.*

PROGRAM OUTCOMES

Engineering Graduates will be able to:

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 andleader 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.*

Statements of Programme Specific Outcomes (PSOs)

PSO1: *Apply the knowledge of Robotics, design, manufacturing, Automation engineering and computational sciences to solve Robotics & Automation Engineering problems.*

PSO2: *Apply Robotics & Automation Engineering principles for research, innovationand develop entrepreneurial skills.*

PSO3: *Apply concepts of Robotics & Automation engineering to asses' societal, environmental, health and safety issues with professional ethics.*

B. Tech. (Robotics & Automation Engineering): Semester –III (CBCS 2023 Course as per NEP 2020 Guidelines)

S. No.	Category	Course Code	Course	Teaching Scheme			Examination Scheme-Marks					Credits				
				L	P	T	ESE	IA	TW	PR	OR	Total	Th	Pr/Or	Tut	Total
1.	MJ	MJ1112301	Hydraulics & Pneumatics: Principles	3	2	-	60	40	25	-	25	150	3	1	-	4
2.	MJ	MJ1112302	Theory of Machines#	3	2	-	60	40	25	-	25	150	3	1	-	4
3.	ES	ES1108303	Embedded Systems	3	0	-	60	40	-	-	-	100	3	0	-	3
4.	MJ	MJ1112304	Strength of Machine Elements	3	0	1	60	40	-	-	25	125	3	0	1	4
5.	ES	ES1109305	Digital Electronics	3	2	-	60	40	25	-		125	3	1	-	4
7.	SE	SE1112306	MATLAB Programming	-	2	-	-	-	25	25		50	-	1	-	1
			Total	**15**	**08**	**01**	**300**	**200**	**100**	**25**	**75**	**700**	**15**	4	**1**	**20**
8.	*MOOC	AE1112307	MOOC-I	-	-	-	-	-	-	-	-	-	-	-	-	**2**
9.	*VAC	VA1112308	Value Aided Course -I	**2**	-	-	-	**100**	-	-	-	**100**	**2**	-	-	**2**

#: Theory course with 4 hours duration; *: Mandatory Additional Courses

B. Tech. (Robotics & Automation Engineering): Semester –III (CBCS 2023 Course as per NEP 2020 Guidelines)

S. No.	Category	Course Code	Course	Teaching Scheme			Examination Scheme-Marks					Credits				
				L	P	T	ESE	IA	TW	PR	OR	Total	Th	Pr/Or	Tut	Total
1.	MJ	MJ1112401	Instrumentation for Robotics & Automation	3	-	-	60	40	-	-	-	100	3	-	-	3
2.	ES	ES1107402	Power Electronics and Drives	3	-	-	60	40	-	-	-	100	3	-	-	3
3.	MJ	MJ1112403	Automatic Control Systems	3	2	-	60	40	25	-	25	150	3	1	-	4
4.	MJ	MJ1112404	Manufacturing Technology -I	3	2	-	60	40	25	25	-	150	3	1	-	4
5.	MJ	MJ1112405	Design & Analysis of Machine Components#	3	2	1	60	40	25	-	25	150	3	1	1	5
7.	SE	SE1112406	Python Programming	-	2	-	-	-	25	-	25	50	-	1	-	1
			Total	**15**	**08**	**01**	**300**	**200**	**100**	**25**	**75**	**700**	**15**	4	**1**	**20**
8.	*AC	AC1113407	Indian Knowledge System	**2**	-	-	-	**50**	-	-	-	**50**	**2**	-	-	**2**
9.	*EC	EC1112408	Social Activity	-	-	-	-		-	-	-	-	-	-	-	**2**

Course Codes and Definitions

Course Code	Definitions
AC	Audit Course
AE	Ability Enhancement Course
BC	Basic Chemistry Course
BM	Basic Mathematics Course
BP	Basic Physics Course
CC	Co-curricular Courses
EC	Extra-Curricular Course
EE	Electrical Engineering
ES	Engineering Science Course
ESE	End Semester Examination
GE	General Elective Course
ID	Inter-disciplinary Course
L	Lecture
MD	Multidisciplinary Course
MI	Minor Course
MJ	Major (Core) Course
MOOC	Massive Open Online Course
O	Oral
OE	Open Elective Course
P	Practical
PC	Practical Courses
RP	Research I Project Course
SE	Skill Enhancement Course
T	Tutorial
TW	Term Work
UH	Course Related to Universal Human Values
VAC	Value Added Course
VE	Vocational Enhancement Course
VS	Vocational Skill Courses

Designation of Course	**Hydraulics & Pneumatics: Principle (MJ1112301)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites:-	1. Engineering Mathematics. 2. Engineering Physics. 3. Engineering Mechanics.
Course Objectives:-	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics. 2. Concepts of fluid power and pumps and its control. 3. Hydraulics and Pneumatics – Actuators and Circuits.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** properties of fluids and **analyze** concepts of fluid statics. 2. **Understand** concepts related to fluid kinematics and **analyze** practical problems. 3. **Understand** concepts related to fluid dynamics, flow through pipes and **analyze** practical problems. 4. **Understand** concepts related to fluid power system, Power units and accessories and **analyze** pump performances. 5. **Understand** concepts related to Control of fluid power and Control valves. 6. **Understand** concepts related to Hydraulics and Pneumatics – Actuators and Circuits and its application.

Course Contents

Unit 1	**Properties of Fluids & Fluid Statics**	**(6 Hrs.)**

Properties of Fluid:-Definition of fluid, Density, Specific Weight, Specific Gravity, Dynamic Viscosity, Kinematic Viscosity, Newton's law of viscosity, types of fluid, Classification of fluid.

Fluid Statics: Hydrostatic law, Pascal's Law, Pressure at a point, Total Pressure, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.

Unit 2	**Fluid Kinematics**	**(6 Hrs.)**

Description of fluid motion- Eulerian and Langragian approach, Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational), Continuity equation in Cartesian co-ordinates, flow net, Control volume, Material derivative and acceleration.

Unit 3	**Fluid Dynamics and Losses in Pipes**	**(6 Hrs.)**

Linear momentum Equation using differential Approach, Introduction to Navier-Stoke's Equation, Euler equation of motion, Derivation of Bernoulli's equation along a stream line, application of Bernoulli's equation to Pitot tube .**Losses in Pipes:** Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation

Unit 4	**Basics of Fluid Power and Pumps**	**(6 Hrs.)**

Components of fluid power system, advantages, and limitations. Difference between electrical, pneumatic, and fluid power systems. Seals, sealing materials. Types of pipes, hoses, material. Fluid conditioning through filters, strainers, sources of contamination and contamination control.

Power units and accessories: Types of power units, reservoir assembly, sizing of reservoirs, constructional details, pressure switches, temperature switches. Accumulators: Types, selection procedure, applications of accumulators. ISO symbols for hydraulic and pneumatic Components

Pumps: Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves

Unit 5	**Fluid Power Control**	**(6 Hrs.)**

Necessity of fluid control through pressure control, directional control and flow control valves.

Control valves:

i) Principle of pressure control valves, direct operated and pilot operated pressure relief valves, pressure reducing valve, sequence valve.

ii) Principle of flow control valves, pressure compensated and non-compensated flow control valves.

iii) Principle of directional control valves, types of directional control valves, two-way, three-way, four-way valves, check valve and shuttle valve. Open center, close center, tandem center valves. Actuating devices- manually operated, mechanically operated, solenoid operated, pilot operated, lever operated.

Unit 6	**Hydraulic & Pneumatic Circuits**	**(6 Hrs.)**

Linear and rotary actuators: Types, construction and characteristics. Cylinder mountings, cushioning of cylinders.

Hydraulic & Pneumatic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.

shuttle valve, two pressure valve, quick exhaust valve and time delay valves. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low-cost automation and in industrial automation

Term Work: (Any 8 experiments needs perform during practical's)

1. Study of Pressure Measuring Devices.
2. Measurement of Viscosity using Redwood Viscometer
3. Stability of Floating Bodies and Optimum Loading Capacity.
4. Verification of Modified Bernoullis Equation.
5. Calibration of Venturi meter.
6. Calibration of Orifice meter.
7. Laminar and Turbulent Flow by Reynold's Apparatus.
8. Discharge over Notches.
9. Study of Minor Losses due to Pipe Fitting.
10. Study of flow control valves (Meter in, Meter out Circuits).
11. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.
12. Following experiments to be done on hydraulic trainer
    a) Regenerative circuit b) Speed control circuit
    c) Sequencing circuit d) Traverse and feed circuit etc.
13. Following experiments to be done on pneumatic trainer
    a) Automatic reciprocating circuit
    b) Speed control circuit
    c) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
14. Design of simple hydraulic/pneumatic systems used in practice such as hydraulic clamp, jacks, dumper, forklift etc by using fluid simulation software's such as LVSIM®-HYD & PNEU, AUTOMATION STUDIO.
15. Study of accumulators/actuators/intensifiers/hydraulic and pneumatic power brakes.
16. Industrial visit to study Hydraulic / Pneumatic based Automation systems

Text Books:

1. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.
2. Dr. R.K. Bansal, "Fluid Mechanics and Hydraulic Machines – l", Laxmi Publication Pvt. Ltd., New Delhi.
3. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
4. Garde R. J. and Mirajgaonkar, Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill. 8. Irving Shames, "Mechanics of Fluid", McGraw Hill Publication
6. Esposito A, Fluid Power with application, Prentice Hall
7. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
8. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
9. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Book:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Project Based Learning

Topics for the project-based learning will be given by respective faculty member.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Theory of Machines (MJ1112302)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
Tutorial: - ------	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics 3. Mechanisms of Machines
Course Objectives:-	1. To develop competency in understanding of theory of different types of gear. 2. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications. 3. To develop the competency to analyse the velocity and acceleration in mechanisms using analytical and graphical approach. 4. To develop understanding of static and dynamic balancing and gyroscopic effect.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the fundamental concept of Lower pair mechanisms and **apply** to real life and industrial applications. 2. **Understand** the basic concept of kinematic analysis and **evaluate** forces acting on reciprocating engine by graphical and analytical method. 3. **Understand** the concept of velocity and acceleration of any planar mechanism and **analyse** it graphically by using relative velocity - acceleration method and ICR method, Coriolis component of acceleration. 4. **Understand** the gear theory which will be the prerequisite for gear design. 5. **Apply** the principles of balancing of masses to various links, mechanisms and engines. 6. **Apply** the principles of gyroscopic effects and stabilization on various transport vehicles.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(06 Hrs)**
Introduction, Hook Joint, Double Hook's Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifiler suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(06 Hrs)**
Analytical method for displacement, velocity and acceleration analysis of slider cranks Mechanism. **Klein's construction.** **Dynamics of Reciprocating Engines:** Two mass statically and dynamically equivalent system, static and dynamic force analysis of reciprocating engine mechanism, Torque Exerted on crankshaft.		
Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(06 Hrs)**
Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms. **Coriolis component of acceleration.** **Instantaneous Centre of Rotation (ICR) Method** (limit to only 6 link mechanisms)- Kennedy's Theorem.		
Unit-IV	**Gears**	**(06 Hrs)**
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, contact ratio, minimum number of teeth, interference and under cutting.		

Unit-V	Balancing	(06 Hrs)
Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multicylinder in-line engines.		
Unit-VI	**Gyroscope**	**(06 Hrs)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane, Stability of four-wheel drive vehicle moving on curved path, Stability of a two-wheel vehicle.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. To draw conjugate profile for any general type of gear tooth
2. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
3. To study various types of gearboxes- constant mesh, sliding mesh, synchromesh gear box, Industrial gearbox, differential gearbox.
4. To measure holding torque of the epicyclic gear train.
5. To find the percentage of slip of belt material
6. To perform the experiment of Balancing of rotating parts and find the unbalanced couple and forces.
7. To perform experiment on various types of Governors to prepare performance characteristics curves, and to find stability and sensitivity.
8. To perform experiment on Cam Analysis Machine to find out cam and follower behaviour at different follower moment and jump phenomenon.
9. To draw the cam profiles and study the effect of Different follower motions, and Different follower (roller) dimensions
10. To determine gyroscopic couple on Motorized Gyroscope.
11. Study of Continuous Variable Transmission and Infinite Variable Transmission.
12. Mini Project based on the contents of the syllabus.

Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Spur Gears
2. Gear Trains
3. Balancing
4. Gyroscope
5. Cam and Follower
6. Governors

Text Books

1. Rattan S. S., “Theory of Machines”, Tata McGraw Hill.
2. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
3. R. S. khurmi, “Theory of Machines’, S Chand Publication.

Reference Books

1. Thomas Bevan, “Theory of Machines”, CBS Publishers & Distributors, Delhi.
2. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, Inc.
3. Ghosh Amitabh and Malik A.K., “Theory of Machines and Mechanisms”, East-west Press.
4. Hall A.S., “Kinematics and Linkages Design”, Prentice-Hall.

5. Hartenberg and Denavit, “Kinematic Analysis and Synthesis of Mechanisms”.
6. Erdman, A. G. & Sandor, G.N., “Mechanism design, Analysis and synthesis”, Vol 1, Prentice – Hall of India.

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on comparison among different types of gears
2. To prepare a chart to understand various terminology of spur gear.
3. To prepare a chart to understand different methods to avoid interference in spur gear.
4. To develop a mechanical system using simple gear train.
5. To develop a mechanical system using compound gear train.
6. To develop a mechanical system using reverted gear train.
7. To develop a mechanical system using epicyclic gear train.
8. To prepare a chart comparison among different types of gear trains.
9. To develop demonstration model of static and dynamic balancing systems.
10. To develop demonstration model of balancing of rotating masses.
11. To develop demonstration model of balancing of reciprocating masses.
12. Case study on real life applications of various types of governors.
13. To develop demonstration model of a Watt Governor/Portal Governor/Proell Governor.
14. To prepare a charton compression among different types of governors.
15. To prepare a chart to understand various terminology of Cam profile.
16. To prepare a chart on comparison among different types of followers.
17. To prepare a chart on comparison among different types of follower motions.
18. To develop demonstration model on real life applications of gyroscopic effect such as Ship, aeroplane,automobile, etc.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	EMBEDDED SYSTEMS (ES1109303)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Assignments Internal	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	Electronics Engineering Systems
Course Objectives:-	1. To familiarize students with architecture and features of typical Microcontrollers. 2. To learn interfacing of real-world input and output devices and use Embedded C to interface the microcontrollers to various applications.
Course Outcomes:-	1. Use Hardware and software tools for microcontrollers. 2. Write programs using features of 8051 microcontroller. 3. Write programs using features of PIC microcontroller. 4. Develop interfacing of microcontrollers with real world devices. 5. Develop interfacing with PIC I 6. Develop interfacing with PIC –II

Unit-I	**Introduction to Microcontrollers**	**(06 Hrs)**
Comparison of Microprocessor & Microcontroller. Difference between RISC & CISC architectures, Harvard & Von Neumann architectures. 8051 Microcontroller: architecture, family devices & its derivatives. Ports, registers, memory organization, Programming in Embedded C.		
Unit-II	**8051 Microcontroller features**	**(06 Hrs)**
Timers and its modes, Delay generation using timers, Serial Communication with RS232,Interrupt structure, Timers programming with interrupts, Programming in Embedded C.		
Unit-III	**Peripheral Interfacing With 8051**	**(06 Hrs)**
8051 based system design – Address decoding, data memory space Interfacing & Applications –LED, LCD, Stepper motor, DAC/ADC, Sensors, Keyboard. Programming in Embedded C.		
Unit-IV	**PIC Microcontroller**	**(06 Hrs)**
Comparison of Features of different PIC series, PIC 18F architecture, registers, memory Organization, oscillator options, BOD, power down modes and configuration bit settings, Port structure, interrupts & timers of PIC18F,All programs in embedded C.		
Unit-V	**Peripheral Interfacing With PIC-I**	**(06 Hrs)**
Interfacing of PIC18F with LED, Seven segment display, LCD and Keypad. Use of timers with interrupts, PWM generation. All programs in embedded C.		
Unit-VI	**Peripheral Interfacing With PIC-II**	**(06 Hrs)**
MSSP structure, CCP and ECCP, Study of UART, SPI, I2C, ADC. Interfacing serial port, ADC, RTC, EEPROM. Motor Control using PIC. All programs in embedded C.		

Text Books:

1. Mazidi, "8051 microcontroller & embedded system" 3rd Edition ,Pearson
2. Mazidi, "PIC microcontroller & embedded system" 3rd Edition ,Pearson

Reference Books:

1. Ajay V. Deshmukh, “Micro-controllers - Theory and Applications”, Tata McGraw Hill.
2. Kenneth J. Ayala, “The 8051 Micro-controller – Architecture, Programming & Applications”, Penram International & Thomson Asia, Second Edition.
3. John B. Peatman, “Design with PIC Micro-controllers”, Pearson Education Asia, Low Price Edition.
4. 18F xxx reference manual

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

To prepare a demonstration model on:

1. Finger Print based attendance management system
2. LPG gas leakage detection system
3. Automatic motor control for filling water tank
4. Fire detection and alert system
5. Room temperature maintenance by automatically adjusting fan speed / AC
6. Home automation
7. Automatic maintenance of green house
8. Alcohol detection and alert family members in case of drunk and drive
9. Patient monitoring through GSM
10. Digital Notice board for college students
11. Line follower robot
12. Path follower robot
13. Public garden automation
14. Voting machine with digital display
15. Design Real Time Clock
16. Automatic City Street Lights control system

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Strength of Machine Elements (MJ1112304)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - 01 Hours/ Week	Assignments Internal	40 Marks	
	Oral	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Understand simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical method. 3. Able to draw shear force and bending moment diagram and find slope and deflection of beam 4. Able to draw bending stress and shear stress diagram at different cross section in I and T section beam. 5. Able to find stresses in shaft in torsional, combined torsional and bending, combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the concept of simple stress and strain and apply to find it for simple component. 2. **Understand** the concept of principal stress analytical and graphical by Mohr's circle; and apply it to find stresses on any oblique plane inclined to principal plane. 3. **Understand** the concept of shear force and bending moment and apply it to find shear force diagram and bending moment diagram for any loading condition on simply supported beam and cantilever beam. 4. **Understand** the concept of slope and deflection and apply it to find for any loading condition on simply supported beam and cantilever beam by maculays double integration method 5. **Understand** the concept of pure bending and shear and apply it to find bending stress and shear stress diagram of I and T section of beam. 6. **Understand** the concept of column theory and strain energy and apply it for loading condition.

Course Contents

Unit-I	**Simple Stress and Strain**	**(06 Hrs)**

Load, Direct or normal stress, Direct strain, Sign convention for direct stress and strain, Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E, G and K, Allowable working stress -factor of safety, Thermal stresses in plain and composite members.

Unit-II	**Principal Stresses, Theories of Failure**	**(06 Hrs)**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses, and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses.

Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory.

Unit-III	**Shear Force and Bending Moment Diagram; Slope and Deflection**	**(06 Hrs)**

Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B. M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contra flexure. Introduction, Simple bending theory, Neutral axis, Section modulus, slope and deflection for S.S.B. and C.B., Double integration method (Macaulay's method) for S.S.B. and C.B.		
Unit-IV	**Bending and Shear Stress in Beam**	**(06 Hrs)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (I and T) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance and section modulus. **Shear stresses:** Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses.		
Unit-V	**Torsion**	**(06 Hrs)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Strain energy in torsion, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load, combined torsion and bending loads.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends only, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden and impact), Strain energy due to self-weight.		

List of Assignments

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Simple stress and strain.
2. Principal stresses and strain.
3. Shear force and Bending moment diagram and slope and deflection
4. Stresses in beams, thick and thin cylinder
5. Torsion
6. Euler's column and strain energy method

List of Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Stresses in simple bar, Elastic modulus and two-dimensional stress systems.
2. Normal, tangential and resultant stresses on any oblique plane inclined to normal plane by analytical and graphical method.
3. Shaft diameter and factor of safety by using theories of failure.
4. Shear and bending moments on cantilever and simply supported beam and draw SFD and BMD.
5. Slope and deflection at any section between beams by using Macaulay's method.
6. Stresses in beam and draw shear stress diagram and bending stress diagram.
7. Shaft diameter and stresses when shaft subjected to torsion, bending combined torsional and bending, combined torsional and axial loads.
8. Euler's column theory and strain energy.

Textbooks

1. A textbook of strength of material by R.K.Bansal

Reference Books

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication
2. J. E. Shigley, Mechanical Engineering Design, McGraw Hill

3. R. Subramanian strength of Material
4. S Ramamrutham, Strength of Material
5. R.K Rajput, Strength of materials

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare demonstration model of cantilever beam for the study of deflection in it.
2. To prepare demonstration model of simply supported beam for the study of deflection in it.
3. To prepare demonstration model of fixed beam for the study of deflection in it.
4. To prepare demonstration model of Overhang beam for the study of deflection in it.
5. To prepare the chart on relation between E, G, K with derivation.
6. To prepare demonstration model for studying strain energy with consideration of various conditions like impact load, sudden load, gradual load.
7. To prepare the chart on various concepts used in Principal Stresses& planes.
8. To prepare the chart on concept use in Mohr's Circle method using graphically & analytically.
9. To prepare the chart on Rules and guidelines use for drawing SFD & BMD.
10. To prepare the chart on finding bending stress for I cross-sections.
11. To prepare the chart on finding bending stress for T cross-sections.
12. To prepare the chart on finding bending stress for C cross-sections.
13. To prepare the chart on concepts used in solid &hollow shafts.
14. To prepare the chart and demonstration model of Euler's formula for buckling load.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	DIGITAL ELECTRONICS (ES1108305)		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	Electronics Engineering Systems
Course Objective	1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems 2. To familiarize with the design of various combinational digital circuits using logic gates 3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits 4. To explain the various semiconductor memories and related technology 5. To introduce the electronic circuits involved in the making of logic gates 6. To introduce memory operation is PLA
Course Outcomes:-	The students should be able to- 1. Use digital electronics in the present contemporary world. 2. Design various combinational digital circuits using logic gates. 3. Do the analysis and design procedures for synchronous and asynchronous sequential circuits. 4. Use the semiconductor memories and related technology. 5. Use electronic circuits involved in the design of logic gates. 6. To understand characteristics of PLDs, Semiconductor memories and their applications

Course Contents

Unit 1	**Digital Fundamentals**	**(06 Hrs)**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization		
Unit 2	**Combinational Circuit Design**	**(06 Hrs)**
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.		
Unit 3	**Synchronous Sequential Circuits**	**(06 Hrs)**
Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.		
Unit 4	**Asynchronous Sequential Circuits**	**(06 Hrs)**
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.		
Unit 5	**Digital Integrated Circuits**	**(06 Hrs)**
Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS		

Unit 6	PLDs & Semiconductor Memories: Programmable logic devices	(06 Hrs)
Study of PROM, PAL, FPGA,PLAs. Designing combinational circuits using PLDs. **Semiconductor memories** **C**lassification and characteristics of memory, different types of RAMs, ROMs and their applications, Double Data Rate RAMs.		

List of Experiments-

Term work shall consist of **Minimum Eight** Experiments.

1. Implementation of Boolean functions using logic gates
2. Design of Half, Full Adder and subtractor using gates and IC's
3. Code conversion (Binary to Gray and Gray to Binary) using digital IC's
4. Design and implement Boolean expression using Multiplexer / Demultiplexer.
5. Design and implement 2-bit comparator
6. Design and implement 3-bit comparator
7. Design and implement BCD adder (4 bit)
8. Design and implement 3-bit ripple counter
9. Design and implement 3 bit synchronous up/down counter
10. Design and implement left shift / right shift register

Text Books/ Reference Books

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.
2. R.P. Jain , Modern Digital Electronics

REFERENCE BOOKS

1. Charles H.Roth. "Fundamentals of Logic Design", 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.Arivazhagan"Digital Electronics", Ist Edition, Vikas Publishing House pvt Ltd, 2012.
4. Anil K.Maini "Digital Electronics", Wiley, 2014.
5. A.Anand Kumar "Fundamentals of Digital Circuits", 4th Edition, PHI Learning Private Limited, 2016.
6. Soumitra Kumar Mandal " Digital Electronics", McGraw Hill Education Private Limited, 2016.

Assignments:

At least ONE assignment on each unit

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Survey report of basic gates ICs 7432, 4011, 4050, 4070,4071,40106
2. Implement combinational logic Circuit of given Boolean Equation.
3. Implement Half Adderand Half Subtractor.
4. Implement Full Adder using two Half Adders
5. Build4-bit parallel Adder / Subtractor using IC.
6. Build Code Converters: Binary to Gray
7. Build Code Converters: Excess 3 to Binary)
8. Implement Two Bit Magnitude Comparator using IC 7485
9. Implement given combinational logic using MUX

10. Implement 7 segment decoder driver using IC 7447.
11. Build a Decade counterand Up-Down Counter.
12. Build a Shift Registers: SISO and SIPO
13. Implement the Johnson Counter and Ring Counter.
14. Survey Report on Static I/O and transfer Characteristic of TTL and CMOS.
15. Implement given Boolean Function using PLA.

(Function and Equation will be given by Subject Teacher)

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

MATLAB PROGRAMMING

Designation of Course	**MATLAB Programing (SE1112306)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Practical: - 02 Hours/ Week	Term Work	25 Marks	**1**
	Practical	25 Marks	
	Total	**50 Marks**	**1**

Course Prerequisites: -	Student should have knowledge of 1. Basic Mathematics
Course Objectives: -	Student should be able to 1. Develop techniques for problem solving using a programming language.
Course Outcomes: -	Student should be able to 1. Understand basics of MATLAB and apply that knowledge to write simple programs. 2. Understand the concept of arrays and functions and be able apply them in writing programs/solving problems. 3. Understand the concept of 2D graphics and be able apply them in developing 2D plots 4. Understand the concept of 3D graphics and be able apply them in developing 3D plots 5. Apply MATLAB knowledge to solve algebraic problems 6. Understand the concepts of GUI and apply them in creation of forms and objects

Course Contents

Unit I	**Introduction to MATLAB**	**(04 Hrs.)**
MATLAB Introduction; Platform & Features; Advantages & Disadvantages; MATLAB Commands; MATLAB Environment; Working with Variables & Arrays Workspace, Variables, & Functions; MATLAB Data Types; Control Statements; if...end statement; if-else... end statement; MATLAB switch; Loops: for loop; while loop; break and continue		
Unit II	**Arrays and Functions**	**(04 Hrs.)**
Matrices & Arrays; Multi-Dimensional Arrays; MATLAB Compatible Array; MATLAB Sparse Matrices; MATLAB M-Files; MATLAB Functions; Anonymous Function		
Unit III	**Graphics I: 2D plots**	**(04 Hrs.)**
fplot(); Semilogx(); Semilogy(); loglog(); Polar Plots(); fill(); Bar(); errorbar(); barh(); plotyy(); area(); Pie(); hist();		
Unit IV	**Graphics II: 3D plots**	**(04 Hrs.)**
plot3(); fill3(); contour3(); surf(); surfc(); mesh(); meshz(); waterfall(); stem3(); ribbon();.		
Unit V	**Algebra in MATLAB**	**(04 Hrs.)**
Gauss & Gauss-Jordan Elimination; Eigenvalues & Eigenvectors; Symbolic Mathematics, Polynomials and Interpolation		
Unit VI	**GUI in MATLAB**	**(04 Hrs.)**
Components, Containers, Callback		

Term Work

Term work shall consist of programs and assignments based on syllabus.

1. Introduction to MATLAB commands
2. Introduction to MATLAB programming
3. Use of Arrays in command prompt and programming
4. Use of functions in command prompt and programming
5. Generation of 2D graphs
6. Generation of 3D graphs
7. Solving algebraic problems using MATLAB
8. Creation of GUI forms and objects

Reference Books

1. “Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers”, Rudra Pratap, Oxford University Press

Textbooks

1. “MATLAB and its Applications in Engineering”, Barbara Johnston, Prentice Hall of India, New Delhi.
2. " MATLAB: An Introduction with Applications ", Amos Gilet, Wiley Publication
3. " MATLAB Programming for Engineers ", Stephen Chapman, Cengage Learning India Pvt. Ltd.
4. " Fundamental Concepts of MATLAB Programming: From Learning the Basics to Solving a Problem with MATLAB (English Edition) ", Dr.Brijesh Bakariya, Dr.Kulwinder Singh Parmar, BPB Publications

Designation of Course	Massive open online courses (MOOC) AE1112307		
Teaching Scheme: ---	**Examination Scheme**		**Credits Allotted**
		--	--
	Total	--	**02**

The students shall be encouraged to complete two MOOCs during their B. Tech. Robotics and Automation Engineering. Students shall register to MOOCs which are offered by any one the following agencies:

(i) SWAYAM: www.swayam.gov.in
(ii) NPTEL: www.onlinecourse.nptel.ac.in
(iii) Course Era: www.coursera.org
(iv) edX online learning: www.edx.org
(v) MIT Open Course ware: www.ocw.mit.edu
(vi) Udemy: www.udemy.com
(vii) IIT Bombay Spoken Tutorial: www.spoken-tutorial.org
(viii) Artificial Intelligence - C DAC Pune: https://futureskillsprime.in/
(ix) AR- VR - CDAC Pune: https://futureskillsprime.in/ https://tinyurl.com/jx93jwft

Student shall take a prior approval from the department before registering for a given MOOCs. Students shall complete MOOCs during their tenure of a given B. Tech. programme. Students shall submit a passing certificate of MOOCs to obtain two credits per MOOC. The credits obtained for MOOC will be reflected in the mark sheet of Semester VIII.

Bharati Vidyapeeth (Deemed to be University), Pune Value-Added Course Curriculum

Course Title:	**Application of Robotics in Health Sciences**
Course Code:	**VA1112308**
Faculty:	Engineering & Technology
College:	B V D U C O E Pune
Department:	Robotics & Automation Engineering
Institution:	**Bharati Vidyapeeth (Deemed to be University), Pune**

Table of Contents

A. Course Identification

1.Credit/Hours:	01								
2.Coursetype(Please mark with X)									
a.	University		College		Department	X	Others		
b.	Required		Elective	X					
3.Level/year at which this course is offered:	U G								
4.Pre-requisitesforthis course(if any): knowledge of Manufacturing processes									
5.Co-requisitesforthiscourse(if any): 2 Hrs/week									
6.Coursedurationin weeks:	**12 weeks**								

7. Mode of Instruction(mark all that apply)

#	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	24	100
2	**Blended**		
3	**E-learning**		
4	**Distance learning**		
5	**Other (Laboratory, Clinic, Community)**		

8. Learning Hours (mark all that apply)

#	Activity	Hours
1	**Lecture, Small-group, Workshop**	24 HRS
2	**Laboratory/ Studio**	
3	**Self-study(including preparing for assessment)**	
4	**Others** (specify)	
	Total	24 Hrs

B. Course Goals and Learning Outcomes

1.Course Description
This course provides students with knowledge on healthcare robotics including surgical, assistive, and rehabilitation robots, plus essential skills in ethics, design, IP and market considerations. Specific topics include medical imaging-guided surgery; minimally-invasive surgery through miniaturization, novel actuation and sensing; robotic surgery at tissue and cell levels; autonomous robotic systems to assist with daily living activities; multi-modal robot interfaces; robotics-based rehabilitation technologies; upper limb rehabilitation robots; wearable exoskeletons and sensors; implanted neural interfaces. Students are provided with state-of-the-art advances in healthcare robotics. Robotics has emerged as a pivotal force shaping global industries. Rapid advancements in technologies such as rapid prototyping, cloud computing, the Internet of Things, and Artificial Intelligence have propelled the widespread integration of robots across various sectors, including healthcare, automotive, and space exploration.
2.Course Goals
1. Learn about the state-of-the-art of robotics and the opportunities 2. Understand the principles of design and functioning of robots 3. Understand implementation strategies for robotic sensing 4. Understand the introduction to embedded computing and control 5. Understand the introduction to embedded hardware platforms – Arduino and Raspberry Pi.
6. To enable understanding the design and control concepts of medical robots 7. To comprehend on the application of robotics in the field of healthcare

2. Course Learning Outcomes (CLOs)

CLOs *(Add or delete rows as needed.)*		Aligned Course Goal
1	**Cognitive domain*:**	
1.1	Participants will acquire knowledge in the cognitive domain by **understanding** ability to understand different types of Robotic Systems	
1.2	Ability to apply the concepts of robotics for surgery	
1.3	Understand about standards and ethics associated with robotics and AI	
1.4		
2	**Skills domain**:**	
2.1	Ability to analyse the positioning and orientation of medical robots	
2.2	Ability to design the kinematics model for a specified robotic system	
3	**Affective domain***:**	
3.1	In the affective domain, participants will demonstrate the significance of safety, telemetry and hospital information system in biomedical Instrumentation.	
3.2		
3.3		

* *Cognitive: All levels of Bloom's taxonomy (Choose as applicable to the course.)*

** *Skills: Psychomotor, Communication, IT, Numeric (Choose as applicable to the course.)*

*** *Affective: Asepsis, Respect for autonomy, Respect for the living and the dead, Ethics, Empathy, Professionalism, Legal awareness, Interpersonal behavior, Leadership, Working in teams, Self-assessment, Life-long learning, Sense of responsibility, etc. (Choose as applicable to the course.)*

C. Course Content

#	List of Topics *(Add or delete rows as needed.)*	Contact Hours

1	**Fundamentals of Robotics and Automation:** Introduction to robotics in industry and society, historical perspectives; Classification of robots and overview of current research in robotics, applications of AI/ML; Robotics market, current challenges, and opportunities; System-level architecture of robots – levels of autonomy; Fundamental concepts of robots – components, joints, coordinate systems, workspace; Kinematics and kinetics of robots; Dynamics of a robot – trajectory and path.	08
2	**Robotics Sensors and Actuators:** Sensors in robot –Introduction, Classification, Internal and external sensors, Touch sensors, Tactile sensor, Proximity and range sensors, Robotic vision sensor, Light sensors, Pressure sensors. Position sensors &Velocity sensors, acceleration sensors, sound sensors, Proximity sensors & Force or Torque sensors. Role and characteristics of robotic actuators; Electrical motors – servos, stepper motors, and drive mechanisms; Pneumatic and hydraulic actuators; Soft robotic actuators; shape memory actuators, and emerging paradigms; Biomimetic actuators, artificial muscle technology and wearable actuators; Role of 3D printing and mechanical testing in robotic fabrication	08
3	**Medical robots and its application:** Robots for navigation – Movement replication – Robots for imaging Rehabilitation and prosthetics – Describing spatial positioned orientation – Standardizing kinematic analysis – Computing joint angles – Quaternions – Robot kinematics -Three-joint robot – Six-joint robot. The learning curve of robot – Assisted laparoscopic surgery – Haptic feedback in robotic heart surgery – Robotic applications in neurosurgery – Miniature robotic guidance for spine surgery.	08
	Total	24

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes *(Add or delete rows as needed.)*	Teaching Strategies	Assessment Methods
1	**Cognitive domain:**		
1.1	U**nderstanding** ability to understand different types of Robotic Systems	Instructions, Demonstrations on software	Unit Test
1.2	Ability to apply the concepts of robotics for sensors, actuators etc.	Instructions, Demonstrations on software	Assignment
1.3			
1.4			
2	**Skills domain:**		
2.1	Ability to design the kinematics model for a specified robotic system	Practical on Software Tool	Experiment
2.2	To create the robot joint trajectories by using Robo Analyser.	Practical on Software Tool	Experiment
2.3			
2.4			
3	**Affective domain:**		
3.1	To demonstrate the significance of safety, telemetry and hospital information system in biomedical Instrumentation.	Instructions, Demonstrations	Unit Test

3.2			
3.3			

2. Assessment Tasks for Students

#	Assessment task* *(Add or delete rows as needed.)*	Week Due	Percentage of Total Assessment Score
1	Written test on Unit I	8 WEEK	33%
2	Assignment on Unit II	8 WEEK	33%
3	Written test on Unit III	8 WEEK	33%
4			

*: *Written test, or al test, Oral presentation, Project, Essay, Assignment, Practical/Clinical exercise, etc.*

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff or individual student consultations and academic advice:
miansari@bvucoep.edu.in , 2hrs /week

F. Learning Resources and Facilities

(If new expenditure is required, prior sanction of the University must be obtained.)

1. Learning Resources

Required Textbooks	1. Achim Schweikard and Floris Ernst, Medical Robotics, Springer, 2015.
	2. VanjaBozovic, Medical Robotics, Springer, 2008. 3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, John Wiley & Sons, 2005. 4. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta. 5. "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012. 6. Craig. J. J. "Introduction to Robotics- mechanics and control", Addison-Wesley, 1999.
Essential References Materials	1. S.R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education., 2009. 2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning. 2009. 3. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987. 4. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing Company Ltd., 1995. 5. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008. 6. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987. 7. Ray Asfahl. C., "Robots and Manufacturing Automation", John Wiley & Sons Inc.,1985

Electronic Materials	NA	NA
Other Learning Materials	Robo Analyzer Software	NA

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Classrooms, laboratories, demonstration rooms
Technology Resources (AV, data show, Smart Board, software, etc.)	Smart Board
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	Robo Analyzer Software Laboratories

G. Course Quality Evaluation

Evaluation Areas/Issues*	Evaluators**	Evaluation Methods***
Effectiveness of teaching	Faculty colleagues	Peer teaching observation
Effectiveness of assessment	Other faculty in the department External advisors	Internal review of blue print External review of blue print
Verifying standards of student achievement	Other faculty in the department	Internal moderation
Extent of achievement of course learning outcomes	Course Coordinator	Benchmarking
Course as a whole	Students	Students Course Evaluation Survey
Performance assessment of faculty members	Head of Department	Performance appraisal form

*: *Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.*

**: *Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)*

*** *Direct, Indirect*

H. Course Approval Data

Board of Studies (Mechanical, Robotics & Automation)Ref. No., Date	Mechanical
Faculty of Engineering & Technology Ref. No., Date	
Academic Council Ref. No., Date	

Designation of Course	**Instrumentation for Robotics and Automation (MJ1112401)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- -- Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week			--
	Total	**100 Marks**	**03**

Course Prerequisite:-	1. Knowledge of basic control strategies, Knowledge of working of basic controllers
Course Objective:-	To provide Knowledge about 1. Classification by coordinate system and control system 2. Acquire Knowledge on Different types of Power Sources and Sensors 3. Classification of Manipulators, Actuators and Grippers 4. Acquire Knowledge of kinematics and Applications of different Robots
Course Outcomes:-	On completion of the course, students will be able to 1. Acquire knowledge on different types of Power Sources (actuators) and Sensors, 2. Select suitable sensor for different robotic application 3. Classification of Manipulators, Actuators and Grippers Acquire knowledge on different applications of various types of robots. 4. Understand Robot Vision System 5. Develop Interfacing of robot controller 6. Understand Robot Operating System

Course Content

Unit I	**Basic Concepts & Power Sources**	**(06 Hrs.)**
Fundamentals: Robot Components, An overview of Robotics power sources, Types of robot power sources, comparison of different robot power sources, Interfacing and communication module between power sources and robot.		
Unit II	**Smart Sensors**	**(06 Hrs.)**
Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Lidar 2D- 3D Lidar Sensor, Self-calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.		
Unit III	**Design of Robotics Manipulators and Grippers**	**(06 Hrs.)**
Introduction: Robot manipulator , Classification, Design Procedure of Mechanical Grippers, Gripper force Analysis and Gripper Design, Design of Vacuum Grippers, Active and passive Grippers. Selection criteria for Robotics Grippers		
Unit IV	**Robotics Vision Techniques**	**(06 Hrs.)**
Robot Vision devices: Camera, CCD, Image acquisition, Illumination Techniques, Imaging Geometry, Some Basic Relationships between Pixels, Segmentation, Description, Segmentation and Description of 3-D Structures, Recognition, Interpretation. Advanced vision technique. Algorithm to capture dynamics System		
Unit V	**Robotic controllers and accessories**	**(06 Hrs.)**

Microprocessors and Microcontrollers based robotic controllers, Peripheral Interfacing with microcontrollers and its programming in C, Arduino platform as robotic controller, Sensors & Actuators, Gripper's interfacing with robotic controller, Industrial Robot Controller, Selection criteria for selection of controller		
Unit VI	**Robot Operating Systems**	**(06 Hrs.)**
Introduction –The ROS Equation, Role and responsibilities of ROS, History, Distributions & difference from other meta-operating systems. Version of ROS, ROS framework: Operating system and its various releases.		

Project Based Learning

1. Develop a robotics model by using rechargeable power sources
2. Develop a robotic model consisting of different electrical actuator
3. Develop a robotic model consisting of different hydraulic and pneumatic actuator
4. Develop a robot working on speech sensor
5. Develop a robot for inspection /surveillance application
6. Develop robot model using RoS
7. Develop a robot working on tactile sensor
8. Develop a robot working on vision sensor

Text Book

1. Mikell. P, Weiss. G. M, Nage. l R. N and Odraj .N.G, ‖Industrial Robotics", McGraw Hill Singapore, 1996.
2. Ghosh, ‖Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998. R18 B.Tech.
3. Industrial Automation and Robotics, A. K. Gupta and S. K. Arora, University Science Press
4. Robotics and Industrial Automation, R. K. Rajput, S. Chand, New Delhi
5. Automation and Robotics, Khushdeep Goyal, Deepak Bhandari, S. K. Kataria& sons
2. Robotics and Controls, R. K. Mittal & I. J. Nagarath, Tata McGraw Hill
3. 7.Magnetic Gripper for Unstructured Robotic Workspace by Lambart Academic Publication

Reference Book: -

1. Deb. S.R, ‖Robotics technology and flexible Automation", John Wiley, USA 1992.
2. Asfahl. C.R, ―Robots and manufacturing Automation", John Wiley, USA 1992.
3. Klafter. R. D, Chimielewski. T. A, Negin. M, ―Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi, 1994.

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Designation of Course	POWER ELECTRONICS AND DRIVES (ES1107402)		
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: -- Hours / Week	Internal Assessment	40 Marks	
Tutorial------ Hour/Week			--
	Total	**100 Marks**	**03**

Course Prerequisites:-	Construction, Working Principle & Application of AC and DC motors Introductions to Electronic Components SCR , Diodes etc
Course Outcomes:-	1. Explain the basics of the power electronic components and dynamics related to electrical drives and also basics of Power electronic devices. 2. Illustrate the basic knowledge of Power control rectification. 3. Illustrate the operation of solid state control using Inverters and choppers. 4. Explain the various DC motor Drives with applications. 5. Illustrate the various Induction motor drives in various applications. 6. Compare the various speed control methods to control speed of various motors.

Course Contents

Unit 1	**Introduction:**	**(06 Hrs.)**
Principle, construction, characteristic and ratings of SCR, DIAC, TRIAC, UJT. Series connection of SCR, Parallel connection of SCR, UJT as a relaxation oscillator, Snubber circuit, Transistor analogy of SCR, Comparison of SCR and TRIAC. Over voltage and over current protection circuit for SCR.		
Unit 2	**Power Control Rectification:**	**(06 rs.)**
Phase control of SCR, Different phase controlling circuits: R, RC, UJT (Pedestal and Ramp), Transformer circuit, Different methods of turn off of SCR, Single-phase and three-phase half wave and full wave rectifier using SCR-With resistive load, With inductive load, With flywheel diode.		
Unit 3	**Inverters & Choppers**	**(06 rs.)**
Basic principle of inverter, Series inverter, Parallel inverter, Single phase voltage source inverter, Three phase bridge inverter, Applications, UPS. Principle of chopper operation, Control strategies-Constant frequency system & Variable frequency system. Types of chopper circuits- First quadrant or type A chopper, Second quadrant or type B chopper, Two quadrant type A chopper (type C chopper), Two quadrant type B chopper (type D chopper), Four quadrant chopper (type E chopper)		
Unit 4	**DC Drives**	**(06 Hrs.)**
Single phase and 3 phase converter drives. Four quadrant Chopper drives, closed loop control of DC motor, Permanent magnet DC motor drives, DC Servo drives, applications.		
Unit 5	**Induction Motor Drives**	**(06 Hrs.)**
3 phase induction motor control, stator voltage control/rotor voltage control, voltage and frequency control, current control, closed loop control of 3-phase induction motor. variable frequency drives, induction motor servo drives, applications.		
Unit 6	**Speed Control of Motors:**	**(06 Hrs.)**
Introduction, Electrical braking methods including, Rheostatic braking, plugging and DC dynamic braking of Electrical drives. Speed control of motors using SCR for- D.C. shunt motor and series motor, Single phase and three phase induction motor, Slip ring induction motor, Brush less DC motor		

Text Books:

1. Bimal K Bose, Modern power electronics and AC drives, Pearson education asia
2. G. K. Dubey, Fundamentals of Electrical Drives CRC press 2002
3. Vedam Subrahmanyam Electric Drives: Concepts &Appl Tata McGraw-Hill
4. Power electronics convertors, applications and design, Ned Mohan, Tore M Undeland, William P Robbins, Wiley India Pvt. Ltd., 2009

5 E. Acha, Miller & Others, Power Electronic Control in Electrical Systems (Newnes, Oxford publication) – first Edition
6 M. H. Rashid Power Electronics, Prentice Hall of India Pvt. Ltd. New Delhi, (3rd Edition)
7. R Krishnan, Electric motor drives, modeling, analysis and control, PHI learning Pvt. ltd. 2001
8. S.K. Pillai, A first course in electrical drives, Newage international publishers. 2010

Reference Books and Papers:

1. E. H. Watanube, R.M. Stephen and Maurico Ardes "New Concepts of instantaneous active and reactive powers in Electrical systems with Generic loads" (IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703.
2. L. Benchaita, S. Sadaate and A. Salemnia – "A comparison of voltage source and current source shunt Active filter by simulation and Experimentation" (IEEE Transaction on Power Systems, Vol 14, No.2, May 99, PP 642-647.
3. H. Akagi, E.H. Watanabe and M. Aredes "Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press, New York.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Review paper on applications of Power electronic switches with and without Snubber
2. Modeling and system simulation of basic electrical circuits using MATLAB-SIMULINK/SCILAB
3. Modeling and System simulation of basic power electronic circuits using MATLAB-SIMULINK/SCILAB
4. Development of AC Source with Single Diode fed Resistive and Resistive-Inductive Load
5. Development of AC source with Single SCR fed Resistive and Resistive-Inductive Load
6. Modeling and System Simulation of SCR based full converter with different types of load using MATLAB-Simulink/SCILAB
7. Development of prototype of Full converter fed resistive load
8. Development of prototype of Full Converter fed Resistive-Inductive Load at different firing angles
9. Development of prototype of Full converter fed DC motor load at different firing angles
10. Circuit Simulation of Voltage Source Inverter and study of spectrum analysis with and without filter using MATLAB/SCILAB
11. Development of prototype of Single phase square wave inverter
12. Development of prototype of Three phase sine PWM inverter
13. Design of PI controller using OP-AMP
14. PCB design and fabrication of DC power supply using any PCB design software (open source-KiCAD/students version)

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	AUTOMATIC CONTROL SYSTEMS (MJ1112403)		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Orak	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites: -	1. Mathematics & Science 2. Basic Electrical Engineering. 3. Sensors and Measurement System.
Course Objectives: -	1. Familiarization with Control System Principles and Applications of Control System. 2. Calculate and Estimate the Stability Measures, Time Response Measures from the Analysis of Mathematical Models of Some Simple Engineering Systems. 3. Develop Data Acquisition System using Controllers and apply it for Industrial Automation Application.
Course Outcomes: -	The students should be able to 1. Understand the basic concepts of automatic control systems 2. Obtain an overall transfer function of control system by using block diagram algebra methods 3. Determine the time and frequency response of control systems 4. Determine the (absolute) stability of a closed-loop control system using Routh-Hurwitz's stability criterion. 5. Apply fundamentals of PID controllers and use it in industrial automation 6. Select and use control system components for industrial automation.

Course Contents

Unit-I	**Introduction to Automatic Control systems**	**(06 Hrs.)**
Introduction to Control system, Classification of Control Systems ,Open Loop system, Closed Loop system, Conversion of an Open Loop system to a Closed Loop system, , the design process. Transfer Function, Properties of Transfer Function, Transfer Function of Basic Devices; Mathematical Modelling of Mechanical and Electrical Systems. Mechatronics System & Its Examples, Mechatronics System Components.		
Unit-II	**Block Diagram Representation**	**(06 Hrs.)**
Block Diagram Definitions, Generating a Block Diagram from a Physical System, Canonical Form, Rules for Block Diagram Reduction, Reduction of Block Diagram, Reducing to Unity Feedback Systems, Examples on Block Diagram Reduction.		
Unit-III	**Stability Analysis**	**(06Hrs.)**
Concept of Poles & Zeros of a Transfer Function, Stable system, Unstable System, Marginally Stable System, Time Response of Poles, Hurwitz Stability Criterion, Routh Stability Criterion, Routh Criterion Special Cases, Relative Stability, Application of Routh's Criterion.		
Unit-IV	**Time Response and Frequency Response Analysis**	**(06 Hrs.)**
Time response of control system, standard test signal, Time Response, Analysis of First and Second order system, Time Domain specifications. Step response of second order system. Steady-state errors, static error constants, steady state, analysis of different type of Systems using step. Ramp and parabolic inputs, Frequency Response Specification, Co-relation between Time and Frequency Domain		
Unit-V	**Control Actions**	**(06 Hrs.)**
Introduction to Controllers, Control System Parameters, Controller Modes, Control Actions, Types of		

Controllers-ON-OFF Controller, Proportional Controller (P-Controller), Proportional + Integral Controller(P-I Controller), Proportional + Derivative Controller (P-D Controller), Proportional +Integral+ Derivative Controller (P-I-D Controller), Effect of Proportional, Integral, and derivative control on the Time Response of the System, Distributed control system.

Unit-VI	**Control System Components**	**(06 Hrs.)**

Data Acquisition: Elements of a Data Acquisition and Control System, Overview of the Input/Output Process, Analog to Digital (A/D) Conversion, Digital to Analog (D/A) Conversion, Data Acquisition Case Studies. Variable Frequency Drive, Servomotor.

Relays: Construction, working, specifications/selection criteria and applications of electromechanical relay, Reed relay, hermetically sealed relay, Solid state relays.

Contactors: Construction, working, specifications and applications of contactors. Comparison between relay& contactor.

Term Work:

Term work shall consist record of minimum 8 experiments from the following;

1. Analysis of following control system parameters using software like MATLAB/SIMULINK
    a. Plot the pole-zero configuration in s-plane for the given transfer function
    b. Stability analysis of given control system using Routh-Hurwitz's criterion
    c. Determine the transfer function for given closed loop system in block diagram representation.
    d. Plot unit step response of given transfer function and find peak overshoot, peak time, rise time and delay time.
2. To study the basic Open and Closed Loop Control system
3. To study the Water Level Control System Using Industrial PLC
4. Determination of step & impulse response for a first order unity feedback system
5. Study of P, P+I, P+D, P+I+D control actions using any Trainer Kit / Simulation Software.
6. Study of A/D and D/A Converters.
7. Study the functions and applications of variable frequency drive (VFD).
8. Study the functions and applications of AC servomotor.
9. Study of various switches, Relays and Contactors.
10. Study of Data Acquisition System and Interfacing of sensors with computer using DAQ Cards
11. Study of Distributed control system.

Text Books/Reference Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall of India, 3rd edition, 1998
2. I.J. Nagarath and M. Gopal, Control Systems Engineering , New Age International (P) Ltd.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997.
4. Stainslaw H. Zak, Systems and Control , Oxford Press, 2003.
5. M. Gopal Modern Control System Theory, New Age International Publishers, 2nd edition, 1996.
6. W. Bolton, "Mechatronics", Pearson Education.
7. Ramchandran K. P., Vijyaraghavan G. K., Balasundaram M. S., "Mechatronics: Integrated Mechanical Electronic Systems", John Wiley & Sons, 2008.
8. Kumar D. S., "Mechanical Measurement & Control", Metropolitan Book Co. Pvt. Ltd. New Delhi, 2007
9. Singh M. D. and Joshi J. G., "Mechatronics", 3rd Edition, Prentice Hall, New Delhi, 2009.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Prepare a simple circuit for Open Loop Control systems for any Engineering application
2. Prepare a simple circuit for Closed Loop Control systems for any Engineering application
3. Prepare a simple working model which depicts an application of Mechatronics System
4. Generate a Block Diagram Algebra for any Mechanical System using Block Diagram Algebra rules.
5. Prepare Mathematical Model of any simple Mechanical Systems using MATLAB
6. Prepare a MATLAB Code to find the Time Response of Control system.
7. Solve the any Control system Characteristics equation for Stability Analysis using MATLAB
8. Prepare a simple control industrial application using Proportional Controller using any simulation software
9. Prepare a simple model which depicts the application of PID Controller using any simulation software
10. Prepare a circuit which depicts the operation of Analog to Digital Converter
11. Prepare a circuit which depicts the operation of Digital to Analog Converter
12. Identify Mechatronics Systems from Day-to-Day Applications and mention all the system components used
13. Prepare a simple circuit which depicts application of different Switches
14. Prepare a simple circuit which depicts application of different Relays
15. Prepare a simple circuit which depicts application of different Contactors
16. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for temperature sensors
17. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for Load Cell
18. Prepare a Model to control water level in Tank

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Manufacturing Technology-I (MJ1112404)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term work	25 Marks	01
	Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites:	The student should have basic knowledge of 1. Mechanical engineering system 2. Engineering materials
Course Objectives:	The student should be able to- 1. To acquire knowledge of Foundry Technology. 2. To acquire knowledge of hot and cold working processes. 3. To acquire the knowledge of lathe, drilling, milling, and sheet metal operations.
Course Outcomes:	The students should be able to– 1. **Understand** the pattern and mold making. 2. **Understand** the various casting processes and **apply** the best casting process for a specific product. 3. **Understand** the hot working and cold working processes and **apply** them in Manufacturing. 4. **Understand** various sheet metal operations and **apply** them to create the job. 5. **Understand** different operations on lathe machine and **apply** them to create the job. 6. **Understand** different operations on drilling, milling machines and **apply** them to create the job.

Course Contents

Unit 1	**Pattern and Mould Making**	**(06 Hrs.)**
Introduction to casting, Foundry Layout, Foundry departments and sections, Pattern and pattern making, Design and allowances for patterns, Colour codes for patterns, Storage of patterns. Moulding sand and core sands, Sand control test, Core and core making –Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making-Moulding Methods, Moulding processes, Design of Gating System.		
Unit 2	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment's, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. **Die Casting Practice:** Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits and limitations.		
Unit 3	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle rolling, forging - drops, press, upset. Rolling, forging-extrusion,drawing, spinning, Angle of Contact of rolling, effect of hot working. **Cold Working Processes**: Cold rolling, swaging, forges extrusion- forward backward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high energy rate forming, Stresses in wire drawing operations.		
Unit 4	**Introduction to Sheet Metal Working**	**(06 Hrs.)**

Introduction to machines in sheet metal Industry: shearing machine, bending machine, circular profile cutting machines. Rivets and its different parts, Punching, blanking, shearing, bending, and piercing. Punch & Die tolerance and clearance. Introduction to Dies: Simple Dies, Compound Dies, Progressive Dies. Types of presses.

Unit 5	**Theory of Metal Cutting**	**(06 Hrs.)**

Introduction of Lathe, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool Wear and Tool Life, Mechanics of Metal cutting- Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.

Unit 6	**Drilling, Milling and Grinding Machines**	**(06 Hrs.)**

Drilling Machines: Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process.

Milling Machines: Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing, Introduction to grinding Machines.

List of Experiments: (Any Eight)

1. Moulding and core sand testing (Clay content test, moisture content test etc.).
2. Strength of Green sand mould and greens sand core.
3. Mold Making Practice.
4. Job on drilling, reaming, tapping.
5. Casting of component by using green sand molding / Die casting.
6. Individual job on center Lathe.
7. Study of dividing indexing mechanism on milling machine.
8. Gear cutting job on Milling Machine.
9. Study and demonstration of Grinding Machines.
10. Job on sheet metal working.

Assignments:

1. Assignment on Pattern and Mould Making.
2. Assignment on Sand Casting and Die Casting Practice.
3. Assignment on Hot Working processes and Cold Working Processes.
4. Assignment on Turning, boring related process.
5. Assignment on Drilling Machines.
6. Assignment on Milling Machines.
7. Assignment on Rivets and its different parts.
8. Assignment on Punch & Die tolerance and clearance.

Text Books:

1. O. P. Khanna, A text book of Foundry Technology, Dhanpat Rai and Sons
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. G. R. Nagpal, Tool Engineering and Design, Khanna Publishers
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Hajra Chaudhari, Workshop Technology, Vol.-II
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabuscontents:

1. Working model of all types of patterns.
2. Different types of gates in casting process.
3. Different types of runner's layout.
4. Design and working model of gating system for any simple mechanical component.
5. 2D model for detailed sand-casting process.
6. 2D model for detailed die casting process.
7. Selection criteria, detail specifications, brands available in market and cost comparison of pressure and gravity die casting machine.
8. Selection criteria, detail specifications, brands available in market and cost comparison of shell moulding.
9. Selection criteria, detail specifications, brands available in market and cost comparison of centrifugal casting.
10. Selection criteria, detail specifications, brands available in market and cost comparison of rolling machines.
11. Selection criteria, detail specifications, brands available in market and cost comparison of wire drawing.
12. Selection criteria, detail specifications, brands available in market and cost comparison of forging machine.
13. Design and working model of simple die.
14. Design and working model of compound die.
15. Design and working model of combination die.
16. Design and working model of progressive die.
17. Selection criteria, detail specifications, brands available in market and cost comparison of lathe machine.
18. Selection criteria, detail specifications, brands available in market and cost comparison of drilling machine.
19. Selection criteria, detail specifications, brands available in market and cost comparison of milling machine.
20. Selection criteria, detail specifications, brands available in market and cost comparison of CNC machine.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Design and Analysis of Machine Component (MJ1112405)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	03
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
Tutorial :- 01 Hours/Week	Term Work	25 Marks	01
	Oral	25 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Computer Aided Graphics 2. Strength of Machine Elements
Course Objectives: -	1. To study basic concepts of machine design. 2. To design and analyze different machine elements. 3. To design machine component for finite and infinite life under fluctuating load.
Course Outcomes: -	1. **Understand** the basic concept of machine design and **evaluate** dimensions of machine components. 2. **Understand** the fundamental concepts of designing shaft, key and coupling and **evaluate** the forces and its dimensions. 3. **Understand** the concept of power screws and mechanical spring and **apply** it for designing various applications. 4. **Understand** the basic concept of fluctuating loads and **analyze** design of components under fluctuating loads. 5. **Understand** the concept of fasteners and threaded joints; and **analyze** it for different loading conditions. 6. **Understand** the design concepts of welded & riveted joint and analyze it under different loading conditions.

Course Contents

Unit-I	**Introduction to Design and Design against Static Load**	**(06 Hrs)**
Introduction to Design: Basic procedure of machine design and machine element, Design consideration for casting, forging & machined parts, hot & cold worked parts and welded assembly, Introduction to design for manufacture & assembly, Aesthetic and Ergonomic considerations in design, concurrent engineering. **Design against Static Load:** Modes of failure, Factor of safety, Service factor, stress strain relationship, shear stress & strain, stress due to bending moment, Eccentric axial loading. Design of simple machine parts - Cotter joint, Knuckle joint		
Unit –II	**Shafts, Keys and Coupling**	**(06 Hrs)**
Shaft: Shaft design on strength basis, Torsional rigidity basis and ASME code, Design of hollow shaft on strength basis and Torsional rigidity basis. **Keys:** Types of keys, Design of square, flat, kennedy key and splines. **Couplings:** Design of rigid and flexible couplings.		
Unit-III	**Power Screws and Mechanical Spring**	**(06 Hrs)**
Power Screws, Forms of Threads, Multiple Threaded Screws, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Square Threaded Screw, Efficiency of Self-locking Screw, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency, Coefficient of Friction, Design of Screw and Nut, Design of Screw Jack		

Mechanical Spring: Types of Springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Concentric Springs, Helical Torsion Springs, Surge in Spring, Multi-Leaf Spring, Nipping of Leaf Springs, Shot Peening.		
Unit-IV	**Design for Fluctuating Loads**	**(06 Hrs)**
Stress concentration factor and its reduction, Stress concentration factor for various machine parts, Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Cumulative Damage in Fatigue, Design for finite and infinite life, Soderberg, Goodman, Modified Goodman& Gerber criteria.		
Unit-V	**Threaded Joints**	**(06 Hrs)**
Basic Types of Screw Fastening, Cap Screws & Setscrews, Bolt of Uniform Strength, Locking Devices, Terminology of Screw Threads, ISO Metric Screw Threads, Bolt under tension, Eccentrically Loaded Bolted Joints in Shear, Eccentric Load Perpendicular to Axis of Bolt, Eccentric Load on Base plate, Torque Requirement for Bolt Tightening, Dimensions of Fasteners, Design of Turnbuckle.		
Unit-VI	**Welded and Riveted Joints**	**(06 Hrs)**
Welded Joints- Welding Processes, Strength of Butt, Parallel Fillet Welds and Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welded Joint Subjected to Bending Moment and Torsional Moment **Riveted Joints**- Types of Rivet Heads and riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Eccentrically Loaded Riveted Joint		

Term work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Design of Cotter Joint.
2. Design of Knuckle Joint.
3. Design of Square, Flat, Kennedy key and Splines.
4. Design of Rigid and Flexible Couplings.
5. Design of Screw Jack.
6. Design of Helical Springs, Helical Torsion Springs and Multi-Leaf Spring.
7. Design of Turnbuckle
8. Eccentrically loaded Welded and Rivetted Joint

Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engineering examinations.

1. Design against Static loading
2. Design of shafts, keys and couplings
3. Design of Power screw
4. Mechanical springs
5. Fluctuating load
6. Design of threaded joints
7. Design of welded joints
8. Design of Riveted joints.

Note: Design data book should be used extensively.

Textbooks

1. V. B. Bhandari, “Design of Machine Elements”, Tata McGraw Hill Publication Co. Ltd.
2. R. S. Khurmi And J.K. Gupta “Machine Design”, S Chand Publication.
3. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., “Design of Machine Elements”, Prentice Hall International.

Reference Books

1. Black P.H. and O. Eugene Adams, "Machine Design", McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, "Machine Components Design", West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, "Theory and Problems of Machine Design", Schaum's Outline Series.
4. Sharma C. S. and Purohit Kamlesh, "Design of Machine Elements", PHI LearingPvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., "Machine Design", S.K Kataria and Sons
6. Gope P. C., "Machine Design: Fundamentals and Applications", PHI LearingPvt. Ltd.
7. "Design Data- P. S. G." College of Technology, Coimbatore.
8. V. B. Bhandari, "Design Data Book", Tata McGraw Hill Publication Co. Ltd.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys, coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
3. To develop a demonstration models of different types of couplings.
4. To develop a demonstration models of different types of keys.
5. To observe the system where transmission of power takes place through power Screws. (e.g. Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.) Get the required information regarding effort, clamping force, etc., and selecting suitable materials design screw, nut and different simple components in assembly. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
6. To develop demonstration models of different types of springs.
7. To develop demonstration models of different types of threaded joints.
8. To develop demonstration models of different types of fasteners.
9. To develop demonstration models of different types of welded joints.
10. To develop demonstration models of different types of riveted joints.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	**Python Programming (SE1112406)**		
Course Code			
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**25 Marks**	**01**

Course Prerequisites:-	Basics of C and C^{++} Programming
Course Objectives:-	The students should be able to 1. Readily use the Python programming language 2. Apply various data types and control structure. 3. Understand and begin to implement code
Course Outcomes:-	Upon completion of the course, students will be able to 1. **Understand** how to install and run python and create. 2. **Understand** flow control. 3. **Understand** complex datatypes. 4. **Understand** and **Apply** functions. 5. **Understand** various modules. 6. **Understand** and **Apply** NumPy module.

Course Contents

Unit-I	**Python introduction**	**(04 Hrs.)**
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import.		
Unit-II	**Python Flow Control**	**(04 Hrs.)**
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import.		
Unit-III	**Datatypes**	**(04 Hrs.)**
Numbers, Type Conversion and Mathematics, List, Tuple, Strings, Sets, Dictionary.		
Unit-IV	**Python Functions**	**(04 Hrs.)**
Function Arguments, Recursion, Anonymous/Lambda Function, Global, Local and Nonlocal variables, Global Keyword.		
Unit-V	**Python Modules**	**(04 Hrs.)**
Modules in Python, import modules in Python, import statement, Import with renaming, from import statement, Import all names, Python Module Search Path.		
Unit-VI	**NumPy Module**	**(04 Hrs.)**
Python Matrix, Add Two Matrices, Transpose a Matrix, Multiply two matrices		

Term Work

1. Basic Exercise for Beginners
   Practice and quickly learn Python's necessary skills by solving simple questions and problems. Topics: Variables, Operators, Loops, String, Numbers, List
2. Python Loop Exercise

This Python loop exercise aims to help developers to practice branching and Looping techniques in Python.

Topics: If-else statements, loop, and while loop.

3. Python Functions Exercise

   Practice how to create a function, nested functions, and use the function arguments effectively in Python by solving different questions.

   Topics: Function's arguments, built-in functions.
4. Python String Exercise

   Solve Python String exercise to learn and practice String operations and manipulations.
5. Python Data Structure Exercise

   Practice widely used Python types such as List, Set, Dictionary, and Tuple operations in Python
6. Python List Exercise

   This Python list exercise aims to help Python developers to learn and practice list operations.
7. Python Dictionary Exercise

   This Python dictionary exercise aims to help Python developers to learn and practice dictionary operations.
8. Python Tuple Exercise

   This exercise aims to help Python developers to learn and practice tuple operations.

Text Books

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher,
2. Timothy A. Budd, "Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt.Ltd., 2016.

Reference Books

1. Python Programming using problem solving Approach by ReemaThareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Data Structures and Algorithms in Python by Michael T Goodrich and RoberttoThamassia, Micheal S Goldwasser, Wiley Publisher(2016)
3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February2009)

Supplementary Resources:

1. http://www.w3schools.com
2. http://docs.python.org
3. http://www.tutorialspoint.com
4. http://www.learnpython.org

Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune

B. Tech. Sem. IV: Robotics and Automation Engineering
SUBJECT: - Indian Knowledge System (AC1113407)

TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 02	End Semester Examination: --	Credits: 02
Practical: 00	Internal Assessment: 100 Marks	
Tutorial: 00		
		Total Credit: 02

Course Objectives:

1.	To sensitize the students about Indian culture and civilization including its Knowledge System and Tradition.
2.	To help student to understand the knowledge, art and creative practices, skills, and values in ancient Indian system
3.	To help to study the enriched scientific Indian heritage.
4.	To introduce the contribution from Ancient Indian system & tradition to modern science & Technology

Course Outcomes: After learning this course students will be able to understand

1	Concepts of Indian Knowledge System
2	India's contribution in Philosophy and Literature
3	India's involvement in Mathematics and Astronomy
4	India's role in Medicine and Yoga
5	India's influence in Sahitya
6	Concepts of Indian Shastra

UNIT – I	**Introduction to Indian Knowledge System**	**(04 Hours)**
	Definition, Concept and Scope of IKS, IKS based approaches on Knowledge Paradigm, IKS in ancient India and in modern India	
UNIT – II	Philosophy and Literature	**(04 Hours)**
	Contributions by Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna and Panini in Philosophy and Literature	
UNIT - III	Mathematics and Astronomy	**(04 Hours)**
	Contribution of Aryabhatta, Mahaviracharya, Bodhayan,	

	Bhashkaracharya, Varahamihira and Brahmgupta in Mathematics and Astrononmy	
UNIT -IV	Medicine and Yoga	**(04 Hours)**
	Major contributions of Charak, Susruta, Maharishi Patanjali and Dhanwantri in Medicine and Yoga	
UNIT -V	Sahitya	**(04 Hours)**
	Introduction to Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma and Meditation)	
UNIT -VI	Shastra	**(04 Hours)**
	Introduction to Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet	

Reference Books

1.Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru

2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay, 1995.

3. The Cultural Heritage of India. Vol.I. Kolkata:Ramakrishna Mission Publication, 1972.

4. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.

5. Dr. R. C. Majumdar, H. C. Raychaudhuri and Kalikinkar Datta: An Advanced History of India (Second Edition) published by Macmillan & Co., Limited, London, 1953.

6. Rao, N. 1970. The Four Values in Indian Philosophy and Culture. Mysore: University of Mysore.

7. Avari, B. 2016. India: The Ancient Past: A History of the Indian Subcontinent from c. *7000* BCE to CE 1200. London: Routledge.

8. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan,

9. Histrory of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishan Mission Institute of Culture, Kolkata (2014).

10. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).

12. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).

13. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).

14.Kapoor, Kapil, Avadesh Kr. Singh (eds.) *Indian Knowledge Systems* (Two Vols), IIAS, Shimla, 2005

Designation of Course	**Social Activities (EC1112408)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - - Hours/ Week	End Semester Examination	-- Marks	02
Practical: -- Hours/Week	Internal Assessment	-- Marks	
	Term Work and Oral	-- Marks	-
	Total	**-- Marks**	**02**

Course Contents

Students should participate in at least **TWO** activities from the list below

1. Volunteer work
2. Community clean-up events
3. Fundraising for charitable organizations
4. Hosting awareness campaigns
5. Participating in marches or protests for social justice
6. Organizing food or clothing drives for those in need
7. Advocacy for environmental conservation
8. Peer support groups for mental health or addiction recovery
9. Organizing blood drives or bone marrow registry events
10. Visiting nursing homes or shelters to spend time with residents or animals
11. Participating in cultural exchange programs
12. Supporting initiatives for gender equality and women's rights
13. Creating art installations or performances that address social issues
14. Participating in political activism and lobbying for policy change.
15. Participating in NSS Social Activities.

**Social Activities are not limited to those listed above*

B. Tech. (Robotics and Automation)

Minor Degree Course: Robotics

Sr. No	Subject Code	Subject	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr /Or	Tut	Total
1.		Sem- III Fundamentals of Robotics	3	2	0	60	40	25	-	25	125	3	1	-	4
2.		Sem- IV Instrumentation for Robotics and Automation	3	2	0	60	40	25	-	25	125	3	1	-	4
3.		Sem- V Robotics Simulation	3	2	0	60	40	25	-	25	125	3	1	-	4
4.		Sem- VI Industrial Robotics and Drone Technology	3	2	0	60	40	25	-	25	125	3	1	-	4
5.		Sem- VII **Project- I**	-	4	-	-	-	50	-	50	100	-	4	-	4
		Total	**12**	**12**	**0**	**240**	**160**	**150**	**0**	**150**	**700**	**12**	**8**	**0**	**20**

Designation of Course	**Fundamentals of Robotics**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hour/ Week	End Semester Examination	60 Marks	03
Practical: -02 hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	The student should have 1. Basic knowledge of higher secondary Physics 2. Basic knowledge of Mathematics
Course Objective: -	The student should acquire the knowledge of 1. The concepts of Robotic system, its components and Configurations. 2. Robot Grippers, Drive systems and Robotics sensors. 3. Application of robots in various fields.
Course Outcomes: -	The student should be able to 1. **Understand** the basic components and configurations of robots. 2. **Understand** different types of grippers and **apply** them based on applications. 3. **Understand** the robot drive systems. 4. **Understand** the fundamentals of sensors and **apply** them based on application. 5. **Understand** the robot control systems. 6. **Understand** the applications of robots in various fields.

Course Contents

Unit-I	**Introduction to Robotics**	**(06 Hrs.)**
History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Robot Joints, Robot Anatomy, Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Basic Configuration of Robots.		
Unit-II	**Robot Grippers**	**(06 Hrs.)**
Introduction to End effectors. Consideration in selection of gripper, Types of grippers, Mechanical Grippers, Hooks and Scoops, Magnetic Grippers, Vacuum Grippers, Expandable Bladder Type Grippers, Adhesive Grippers. Specifications of robot. Industrial Robots in Manufacturing trial robots specifications. Selection based on the Application.		
Unit-III	**Robotics Drives Systems**	**(06 Hrs.)**
Introduction, Functions of drive systems, Hydraulic actuators- Linear Hydraulic actuators and Rotary Hydraulic actuators. Pneumatic Actuators- Linear Pneumatic actuators and Rotary Pneumatic actuators. Electric Actuators-D.C. Motor, Reversible A.C. Motors, Brushless D.C. Motors, D.C. Servomotors, A.C. Servomotors, Stepper Motors.		
Unit-IV	**Fundamentals of Industrial Fluid Power Systems**	**(06 Hrs.)**
Components of fluid power system, advantages and limitations. Difference between electrical, pneumatic and fluid power systems. Seals, sealing materials. Types of pipes, hoses, material. ISO symbols for hydraulic and pneumatic Components		
Unit-V	**Robot Path Planning**	**(06 Hrs.)**
Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for Robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations,Control architecture- position, path velocity, and force control systems.		
Unit-VI	**Applications of Robots**	**(06 Hrs.)**

Robots in continuous arc welding, Spot welding, Spray painting, assembly operation,cleaning, and robot for under water applications. material handling, Robotics and Automation for Industry 4.0, Applications in unmanned systems, defense, medical, biomedical, industries, Co-bot etc.

Term work:

Term work shall consist of any six experiments from the following list:

1. To study an introduction to basic components of Robot.
2. To study an introduction to Robot configuration
3. To introduce different types of robotics and demonstrate them to identify different parts and components.
4. To study and demonstrations of various robotics sensors.
5. To study and demonstrations of Hydraulic actuators.
6. To study and demonstrations of Pneumatic actuators.
7. To study and demonstrations of Electric actuators.
8. Two Case Studies of Applications in Industry
    a. Introduction and general considerations in robot applications.
    b. Case study I: Robot application for Welding.
    c. Case study II: Robot application for Spray painting.
9. Mini project is based on above syllabus.

Assignment

Assignments questions based on following topic

1. Classification, configuration and characteristics of robot.
2. Robot grippers and their types.
3. Drive systems used in Robots.
4. Sensors used in Robots.
5. Robot control systems.
6. Applications of Robots.

Text Books

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta,
2. “Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.
3. Craig. J. J. “Introduction to Robotics- mechanics and control”, Addison- Wesley, 1999.

Reference Books

1. S.R. Deb, “Robotics Technology and flexible automation”, Tata McGraw-Hill Education., 2009.
2. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning. 2009.
3. Francis N. Nagy, Andras Siegler, "Engineering foundation of Robotics", Prentice Hall Inc., 1987.
4. P.A. Janaki Raman, "Robotics and Image Processing an Introduction", Tata McGraw Hill Publishing Company Ltd., 1995.
5. Carl D. Crane and Joseph Duffy, "Kinematic Analysis of Robot manipulators", Cambridge University press, 2008.
6. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 1987
7. Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. 2D models of basic components of robotic system.
2. 2D models of different configuration of robots and its application.
3. Working model and application of mechanical gripper.
4. Working model and application of magnetic l gripper.
5. Working model and application of adhesive gripper.
6. Working model and application of expandable ladder gripper.
7. Working model of robotic drive system using pipe and syringe.

a. Linear actuator b. Rotary actuator.

8. Selection of electric actuators with respect to its specification and application.

9. Detail description and working model of touch sensor.
10. Detail description and working model of tactile sensor.
11. Detail description and working model of proximity sensor.
12. Detail description and working model of pressure sensor.
13. Detail description and working model of sound sensor.
14. Detail description and working model of temperature sensor.
15. Detail description and working model of torque sensor.
16. Detail description and working model of accelerometer.

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Instrumentation for Robotics and Automation**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of Mathematics, Physics, basics of robotics 2. Knowledge of Basic Electrical and Electronics
Course Objectives: -	1. Understand the importance of instrumentation in robotics and automation systems. 2. Identify and apply various sensor technologies for measuring physical parameters. 3. Analyze and interpret sensor data using appropriate signal processing techniques. 4. Design and implement data acquisition systems for robotics and automation applications. 5. Develop an understanding of emerging trends and advancements in instrumentation for robotics and automation. 6. To make the students acquainted with the conceptual as well as practical knowledge of the PLC programming & latest technologies being used to achieve PLC Industrial Automation.
Course Outcomes: -	The students should be able to– 1. Understand & apply fundamentals of instrumentation to robotics and automation 2. Understand concepts of sensors and apply it for robotics applications 3. Understand concepts of PLC and Develop ladder diagram for industrial applications. 4. Understand concepts related to control systems and Control actions 5. Understand concepts related to totally integrated automation and identify such systems 6. Understand the concept of SCADA System and able to develop its applications in the field of robotics

Course Contents

Unit I	**Fundamentals of Sensors and Transducers**	**(06 Hrs.)**
Different types of sensors and their working principles (e.g., piezoelectric, capacitive, inductive, optical, etc.). Sensor characteristics such as accuracy, precision, resolution, sensitivity, and dynamic range. Signal conditioning techniques for amplifying, filtering and converting sensor signals, Principles of analog-to-digital conversion (ADC) and digital-to-analog conversion (DAC), Different types of DAQ systems and their specifications, Interfacing sensors with DAQ systems		
Unit II	**Robotics Sensors**	**(06 Hrs.)**
Position and Motion Sensors: encoders, potentiometers, accelerometers, gyroscopes, LiDAR, vision systems. Force and Torque Sensors: Touch Sensor, strain gauges, piezoelectric sensors, force-torque sensors. Environmental Sensors: temperature, pressure, humidity, proximity, flow sensors, velocity, light. Other Sensors: chemical sensors, acoustic sensors, tactile sensors, Robotic vision sensor		
Unit III	**Programmable Logic Controller (PLC)**	**(06 Hrs.)**

Introduction to PLCs, Basic Structure of a PLC, Principles of Operation, PLC Programming Languages, Ladder diagram, Latching and internal relays, Timers and Counters, Selection of a PLCs, Application of PLCs. Broad classes of industrial automation and their comparative study, Automation Principles and Strategies, USA Principle, Ten Strategies for Automation and production systems, Automation Migration Strategy		
Unit IV	**Automatic Control Systems and Control Actions**	**(06 Hrs.)**
Introduction to control systems: Mechatronics system & its examples, mechatronics system components. Open loop and closed loop system, effects of feedback and basic characteristic of feedback control systems, classification of control systems. **Introduction to Controllers:** Control System Parameters, Controller Modes, Control Actions, Types of Controllers-ON-OFF Controller, Proportional Controller (P-Controller), Proportional + Integral Controller (P-I Controller), Proportional + Derivative Controller (P-D Controller), Proportional + Integral + Derivative Controller (P-I-D Controller)		
Unit V	**Totally Integrated Automation (TIA)**	**(06 Hrs.)**
Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure. Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI		
Unit VI	**Supervisory Control and Data Acquisition (SCADA)**	**(06 Hrs.)**
Overview Developer and runtime packages, architecture, Tools, Tag, Internal & External graphics, Alarm logging, Tag logging, structured tags, Trends, history, Report generation, SCADA applications, DCS Architecture, Case studies of Machine automation, Process automation, Comparison between SCADA and DCS		

Term Work

(Term work shall consists of minimum 8 experiments from following)

1. Study of P, P+I, P+D, P+I+D control actions using any trainer kit / simulation software.
2. To study working of servomotor and its applications in industrial automation.
3. To study working of variable frequency drive and its applications in industrial automation.
4. Study of Analog to Digital Convertor (ADC)
5. Study of Digital to Analog Convertor (DAC)
6. Study of Data Acquisition System (DAS)
7. Study of PLC, SCADA and development of ladder logic for various industrial applications.
8. Study of distributed control systems and its applications.
9. Study of various types of sensors used in robotic systems.

Project Based Learning

1. Develop a robotics model by using rechargeable power sources
2. Develop a robotic model consisting of different electrical actuator
3. Develop a robotic model consisting of different hydraulic and pneumatic actuator
4. Develop a robot working on speech sensor
5. Develop a robot for inspection /surveillance application
6. Develop robot model using RoS
7. Develop a robot working on tactile sensor
8. Develop a robot working on vision sensor

Reference Books

1. Automation, Production Systems and Computer Integrated Manufacturing

M.P.Groover, Pearson Education.5th edition, 2009.
2. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.Stuart A Boyer: SCADA supervisory control and data acquisition, International Society of Automation, 2010
3. N. S. Nise, "Control Systems Engineering," Wiley, 2011.
4. S. B. T.-L. De Silva, "Sensors for Mechatronics," Elsevier, 2007.
5. J. Craig, "Introduction to Robotics: Mechanics and Control," Pearson Education, 2005.

Textbooks

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
2. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill Book Company.
4. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
5. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill Book Company.

Unit Test:

Unit Test 1	Unit I, II, III
Unit Test 2	Unit IV, V, VI

ROBOTIC SIMULATION

Designation of Course	**Robotic Simulation**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisite:-	1. Engineering mathematics, Differential Equation, 2. Modelling and design of Mechanism, Mechanical system
Course Objective:-	To provide Knowledge about 1. Different types of Modelling strategies 2. Kinematic and Dynamic Model of Robot 3. Different types of simulation software
Course Outcomes:-	On completion of the course, students will be able to 1. To Define Different type of Modelling strategies 2. To Develop Kinematic Mathematical Model for robot by using different modelling technique 3. To Develop Dynamic Model for Robot 4. To Understand Simulation Model 5. To Simulate Model by different simulation software 6. To Develop Path Planning for Robot

Course Content

Unit I	**Introduction to Modelling and Simulation**	**(06 Hrs.)**
Definition and concepts of simulation and modelling, steps in a simulation study, Advantages, Disadvantages and Applications areas of simulation, Basic principles of simulation-based modeling, Model based problem solving, Types of Model along with examples, Modelling of different configuration of robots.		
Unit II	**Kinematic Modelling and Simulation of Robot**	**(06 Hrs.)**
Introduction, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Classical and Modified D-H Parameter, Matrix Manipulation Examples of D-H parameters and link transforms, Direct and inverse kinematics model – Numerical, Simulation of Kinematic model by suitable software		
Unit III	**Dynamic Modeling of Robot**	**(06 Hrs.)**
Robot dynamics – Rigid body dynamics, Newton-Euler formation, Lagrange-Euler, formation, generalized D'Alembert equations of motion		
Unit IV	**System Simulation**	**(06 Hrs.)**
Basics of simulation, Steps in simulation, Discrete event system simulation, Decision making with simulation. Techniques of simulation, Monte-Carlo simulation methods and their applications in inventory and queuing problems (single server queuing system) – problem organization and logic.		
Unit V	**Simulation Software**	**(06 Hrs.)**

Classification of simulation software, Description of a general-purpose simulation package, interfacing with other software, summary of results. Examples with ROBO DK, ROBO Analyzer, MATLAB SiMULINK/ AWESIM / ARENA/LAB VIEW/SIEMENS NX		
Unit VI	**Motion planning and control**	**(06 Hrs.)**
Joint and Cartesian space trajectory planning and generation, Steps in trajectory planning, Trajectory planning for cubic polynomial, quadratic polynomial, Simulation study for path planning and notion of robotic arm.		

Term work-

1. Build and Simulate Cartesian Configuration type of Robot for any application
2. Build and Simulate Cylindrical Configuration type of Robot for any application
3. Build and Simulate Spherical Configuration type of Robot for any application
4. Build and Simulate SCARA Configuration type of Robot for any application
5. Build and Simulate Kinematic joints in 2 link manipulators
6. Build and Simulate Kinematic joints in 3 link manipulators
7. Build and Simulate Robot Manipulator for Assembly operation in Smart Factory "
8. Industrial Visit to any automation industry using Robot Simulation Software

Text Book

1. Shannon, R. E., "System Simulation: the Art and Science", Prentice Hall Inc. 1990
2. Averill M Law, "Simulation Modeling and Analysis", Fourth Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2010.
3. Fishman, G.S., "Monte Carlo: Concepts, Algorithms and Applications", Chapman & Hall, New York, 2006

Reference Book

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition.Academic press, 2000
2. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co.
3. Ogata K , "Modern control Engineering" 3 rd edition. Prentice hall of India 2001
4. Jang J.S.R. sun C.T and MizutaniE,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prenticehall of India, 2002

Unit Test

Unit Test I	Unit I,II,III
Unit Test II	Unit IV,V,VI

Designation of Course	**Industrial Robotics and Drone Technology**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	04

Course Prerequisites: -	The students should have knowledge of 1. Robotics Simulation software 2. Robotic Control Systems 3. Artificial Intelligence in Robotics.
Course Objectives: -	To impart knowledge on 4. The applications and current trend in field and service robot (FSR 5. To recognize and describe the role of Mobile Robots & Drone Technology (MRDT) in past, present, and future society. 6. To comprehend and explain various components of MRDT. 7. To comprehend and explain the basics of flight and flight control systems. 8. To understand and describe basics of underwater robots.
Course Outcomes: -	The students should be able to– 1. Describe the applications and current trend in field and service robot. 2. Identify and differentiate various types of industrial robots 3. Understand the challenges in developing autonomous mobile Robots. 4. Ability to design UAV drone system. 5. Identify avionics hardware of drones 6. Determine the payloads and able to fly the drone

Course Contents

Unit I	**Field and Service Robot**	**(06 Hrs.)**
History of service robotics, Present status, future trends, Need for service robots, application examples and specifications of service and field Robots. Ariel robots, Collision avoidance, Robots for agriculture, mining, exploration, underwater, Civilian and military applications, Nuclear applications, Space applications.		
Unit II	**Industrial Robot**	**(06 Hrs.)**
Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot cantered cell.		
Unit III	**Introduction to mobile robots**	**(06 Hrs.)**
Introduction to Mobile robots, Locomotion, Classification -Legged, hopping, Wheeled, Aerial, Key issues in locomotion, Degree of mobility and steerability, robot maneuverability, kinematic modelling of Mobile robot, Wheel kinematic constraints Motion control, Kinematic models of simple car and legged robots.		
Unit IV	**Introduction and Design of UAV Drone Systems**	**(06 Hrs.)**
Introduction to Unmanned Aircraft Systems, History of UAV drones, classification of drones, System Composition, Applications. Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards and Regulatory Aspects-India Specific, Design for Stealth.		
Unit V	**Avionics Hardware of Drones**	**(06 Hrs.)**
Autopilot, AGL-pressure sensors-servos-accelerometer - gyros-actuators - power supply-processor, integration, installation, configuration.		

Unit VI	Payloads, Controls, Navigation and Testing	(06 Hrs.)
Payloads, Telemetry, Tracking, controls-PID feedback, radio control frequency range, modems, memory system, simulation, ground test-analysis-trouble shooting. Waypoints navigation, ground control software, System Ground Testing, System In-flight Testing		

List of Experiments (Any 8)

1. Design for service robot.
2. Experiment on robot kinematics.
3. Probabilistic Map based Localization-Monte carlo localization
4. Global & Local path planning in robotics.
5. Assignment on Metrical maps - Grid maps - Sector maps – Hybrid Maps.
6. Case study on Human activity recognition using vision, touch, sound etc.
7. Use of PUDU Bot mobile robot for office work.
8. Identify different types of ports and connectors.
9. Study and sketch various frame structure viz. quadcopter frame (plus shape, cross shape and H-shape), hexacopter frame (hexa+ and hexa S).
10. Practices on various drone assembly materials.

ProjectBasedLearning

1. Develop a Model for field robot application
2. Develop a Model for service robot application
3. Develop a Model for assembly line robot application
4. Develop a Model for inspection robot application
5. Develop a Model for UAV robot application
6. Develop a Model for robot drone application
7. Develop a Model for fire prevention robot application
8. Develop a Model for AR VR environments robot drone application

Text books

1. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011.
2. Sebastian Thrun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.
3. Karsten Berns, Ewald Von Puttkamer, “Autonomous L and Vehicles Steps towards Service Robots”, Vieweg Teubner Springer, 2009.
4. Bruno Siciliano, Oussama Khatib, Springer Hand book of Robotics, Springer, 2008.
5. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0-470-05819-0
6. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing, 2016. 978-0789755988
7. Beard & McLain, Small Unmanned Aircraft: Theory and Practice. Princeton University Press 2012. 978-0691149219
8. Cares & Dickmann, Operations Research for Unmanned Systems. Wiley, 2016. 978-1-118- 91894-4

Reference Books

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots‖, Bradford Company Scituate, USA, 2004
2. Riadh Siaer, „The future of Humanoid Robots- Research and applications‟, Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.

4. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
6. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
7. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998.
8. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

B. Tech. (Robotics and Automation)
Minor Degree Courses: Industry 5.O

Sr. No	Subject Code	Subject	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr /Or	Tut	Total
1.		Sem.- III Fundamentals of Manufacturing Systems	3	2	0	60	40	25	-	25	125	3	1	-	4
2.		Sem.- IV Smart Manufacturing and Management Systems	3	2	0	60	40	25	-	25	125	3	1	-	4
3.		Sem.- V Industry 4.O and IOT	3	2	0	60	40	25	-	25	125	3	1	-	4
4.		Sem.- VI Industry 5.O and its Applications	3	2	0	60	40	25	-	25	125	3	1	-	4
5.		Sem.- VII **Project- I**	-	4	-	-	-	50	-	50	100	-	4	-	4
		Total	**12**	**12**	**0**	**240**	**160**	**150**	**0**	**150**	**700**	**12**	**8**	**0**	**20**

Designation of Course	Fundamentals of Manufacturing Systems		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: -03 Hours/Week	End Semester Examination	60 Marks	03
Term Work :-2 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	The student should have basic knowledge of 1. Knowledge of basic concept of Physics and chemistry 2. Basic knowledge of Engineering materials and its properties 3. Basic knowledge of engineering company
Course Objectives: -	The student should acquire the knowledge of 1. To acquire the knowledge of Material science and power metallurgy. 2. To acquire the knowledge of lathe, drilling, milling, and abrasive machining. 3. To acquire the knowledge of CNC Technology
Course Outcomes: -	The students should be able to– 1. **Understand** basics of casting manufacturing processes its characteristics **2.** . **Understand** different operations of Lathe, Drilling and Milling machine and **apply** them to create the job 3. **Understand** the concept of powder metallurgy and apply in manufacturing of components 4. **Understand** the **v**arious rolling processes and **apply** the best rolling process for a specific product. 5. **Understand** various grinding machines and plastic moulding machines and **apply** them for create the shape. 6. **Understand** the **v**arious CNC Programming and **apply** them for manufacturing of components.

Course Contents

Unit-I	**Study of Casting Processes**	**(06Hrs.)**
Introduction to casting, Pattern and pattern making, Core and core making-–Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making- Moulding Methods. Sand Casting, Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits and limitations		
Unit II	**Machining Processes**	**(06Hrs.)**
Lathe Machines: Introduction, function, types, construction, accessories, operations. **Drilling Machines:** Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. **Milling Machines:** Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing.		

Unit-III	**Introduction to Powder Metallurgy and Welding technology**	**(06 Hrs.)**
Introduction to Powder Metallurgy, Advantages and limitations of powder metallurgy, Production of metals powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces, Introduction to welding and welding processes,		
Unit-IV	**Introduction to Rolling Forging and Extrusion**	**(06 Hrs.)**
Rolling processes , Types of rolling ,its applications , close die forging and open die forging its applications, extrusion and other forming processes		
Unit-V	**Abrasive Machining Processes, Plastics & Plastic Moulding**	**(06 Hrs.)**
Abrasive Machining Processes: Abrasive machining, abrasives -types, size and geometry, Grinding, grinding wheels,. Types of grinding machines, **Plastics & Plastic Moulding:** Moulding characteristics of plastic, Moulding process- compression, transfer and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, moulding parameters, moulding machines, extruders.		
Unit-VI	**CNC Technology**	**(06 Hrs.)**
Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning Centre, machining Centre, , CNC controllers. CNC Programming: Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation,		

Project Base Learning

Student can do following small working models as PBL

1. Anyone casting the component from non ferrous alloys and do the different types of machining on it.
2. Take raw materials and do the different machining operations to produce finish product.
3. Prepare green compact from metallic powder and do sintering on to produce component from powder metallurgy technique
4. Prepare plastic mounding component from raw materials
5. Prepare the CNC programing for any component by use of G code and M code .

List of Practical's:

1. Demonstration and Practical on casting processes
2. Demonstration and Practical on welding processes
3. Demonstration and Practical casting processes
4. Study on lathe and other machining processes
5. Demonstration and Practical on milling and drilling
6. Demonstration and Practical on grinding operations
7. Demonstration and Practical on plastic molding.

Text Books

1. "Material Science and Engineering", R K Rajput S K Kataria and Sons Publication, Delhi.
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers
4. P.Radhakrishnan,V.Raju, CAD/CAM/CIM, New Edge international Publishers.

Reference Books

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited

3. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
4. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
5. HMT Handbook, Production Technology, TMH
6. "Material Science and Physical Metallurgy",Dr.V.DKodgere, Everest Publication, Pune.
7. "Physical Metallurgy", S H Avner , McGraw Hill Publication.
8. "Material science and metallurgy", O P Khanna, Khanna Publication, Delhi.

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Smart Manufacturing System And Management		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: -03 Hours/Week	End Semester Examination	100 Marks	03
Term Work :-2 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	The student should have basic knowledge of 4. Knowledge of basic concept of Physics and chemistry 5. Basic knowledge of manufacturing processes 6. Basic knowledge of engineering materials
Course Objectives: -	The student should acquire the knowledge of 4. To acquire the knowledge of smart manufacturing processes . 5. To acquire the knowledge of 3D printing and robotics application in manufacturing . 6. To acquire the knowledge of management and industrial engineering
Course Outcomes: -	The students should be able to– 7. **Understand** basics of 3D printing and its characteristics **8.** . **Understand** different operations on industrial automations and **apply** them to create the job 9. **Understand** the concept of CAD?CAM and apply in manufacturing of components 10. **Understand** the **v**arious flexible manufacturing processes and **apply** the best process for a specific product. 5. **Understand** different project management knowledge areas and apply them in manufacturing industries 6. **Understand** the project planning and scheduling tools and techniques and apply them for manufacturing of components.

Course Contents

Unit-I	**Study of advanced manufacturing processes**	**(06 Hrs.)**
Introduction to micro machining, non-traditional machining, ultrasonic and electron beam machining, 3D printing technology, different types of additive manufacturing , Applications, Merits and limitations.		
Unit II	**Industrial Automations**	**(06 Hrs.)**
Introduction to Industrial Automation: Definition and scope of industrial automation. Evolution of automation in industries. Sensors and Actuators: Types of sensors and Actuators and their applications. Programmable Logic Controllers (PLCs): Robotics in Industrial Automation: Introduction to industrial robots. Robot kinematics and dynamics. Robot programming methods (teach pendant, offline programming, etc.). Applications of robots in manufacturing and automation.		
Unit-III	**Introduction to CAD/CAM CAE**	**(06Hrs.)**
Overview of the product development lifecycle, Introduction to CAD/CAM/CAE: Overview of CAD, CAM, and CAE systems. Features of CAD/CAM/CAE in manufacturing. Evolution and latest trends in CAD/CAM/CAE. Basic concepts of computer graphics and geometric modeling, Fundamentals of computer-controlled machining and its integration, Overview of finite element analysis (FEA) and Applications of CAE in design optimization and validation.		
Unit-IV	**Introduction to flexible manufacturing**	**(06 Hrs.)**
Introduction to Flexible Manufacturing Systems, Challenges of traditional manufacturing in a dynamic market, FMS architecture: workstations, material handling systems, Computer control		

systems: supervisory control, part programming, and data management, Principles and applications of GT, Production planning concepts: capacity planning, material requirements planning (MRP), and Just-in-Time (JIT) in FMS.		
Unit-V	**Project management**	**(06 Hrs.)**
Project management associations, Project management Process, Project Lifecycle, Feasibility Studies, Steps in Risk Management, Project cost estimating methods, Resource allocation		
Unit-VI	**Project planning**	**(06 Hrs.)**
Project planning process, Work breakdown structure, Network diagrams, Critical path method, Project execution and control, Project management information systems (PMIS), Ensuring integrity and professionalism, balancing stakeholder's interest		

Project Base Learning

Student can do following small working models as PBL

6. Anyone the component from ferrous alloys and do the different types of Micro machining on it.
7. Take raw materials and do the different handling operations with robot to produce finish product.
8. Prepare CAD model and from any industrial product.
9. Prepare , part programming, and data management for any one industrial component

List of Practical's:

8. Demonstration and Practical on 3 D printing and additive manufacturing
9. Demonstration and Practical on use of robot in manufacturing
10. Draw 2-D sketching with geometrical and dimensional constraints using any commercially used solid modeling software.
11. Draw 3d solid modelling of the parts of a machine using any commercially used solid modeling software
12. Case study on project life cycle.
13. Creating Gantt chart and allocation of resources in project management software
14. Case study on project scheduling
15. Case study on project risk management.

Text Books

5. Project Management Institute, " A Guide to the Project Management Body of Knowledge (PMBOK Guide)": 5the Revised edition (1 January 2013)
6. Harold Kerzner, " Project Managemnt: A SystemsApproach to Planning, Scheduling, and controlling paperback": Wiley: tength edition (20 November 2012)
7. P. C. Sharma, Production Engineering, S. Chand Publications
8. R. K. Jain, Production Technology, Khanna Publishers
9. P.Radhakrishnan,V.Raju, CAD/CAM/CIM, New Edge international Publishers.

Reference Books

9. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
10. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
11. . Erik Larson, Clifford Gray: "Project Management: Rhe Managerial Process": McGraw Hill Education: Sixth edition (1 July 2014)
12. . Pannerselvam R: "Project Management": Prentice Hall India Learning private Limited: Ist edition (2009)

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Rules regarding ATKT, Continuous Assessment and award of Class

(I) Theory

(A) Theory Examination

Theory examination consists of: (i) End semester examination (ESE), and (ii) Internal assessment (IA).

(i) ESE is of 60 marks for theory courses.

(ii) IA is of 40 marks. Out of 40 marks, 20 marks will be for Unit Tests and 20 marks will be for Project Based Learning for a given course. Two Unit Tests, each of 20 marks, will be conducted. Average of marks obtained in these two unit tests will be considered as UT marks. Roll numbers allotted to the students shall be the examination numbers for the conduction of unit tests.

(B) Standard of Passing

(i) There is a separate passing of 40% of 60 marks, i.e. 24 marks, for ESE for a given course.

(ii) There is a separate passing of 40% of 40 marks, i.e. 16, for IA for a given course.

(iii) A student who fails at ESE in a given course has to reappear only at ESE as a backlog student and clear the head of passing. Similarly, a student who fails at IA in a given course has to reappear only at IA as a backlog student and clear the head of passing

(II) Practical

(A) Practical Examination

Practical examination consists of: (i) Term work, and (ii) Practical/Oral examination for a given course based on term work.

(i) Term work (TW): TW marks are as mentioned in the curriculum structure.

(ii) Practical/Oral (PR/OR): PR/OR marks are as mentioned in the curriculum structure.

(B) Conduction of practical/oral examination

(i) A student will be permitted to appear for practical/oral examination only if he/she submits term work of a given course.

(ii) Practical/oral examination shall be conducted in the presence of internal and external examiners appointed by university.

(B) Standard of Passing

(i) A student shall pass both heads TW and PR/OR separately with minimum 40% of total marks of respective head.

(III) MOOC and Social Activity Course

(i) If a student completes one MOOC during a programme, he/ she will earn additional TWO credits, subjected to submission of the certificate of completion of the respective course. It is mandatory for a student to complete atleast two MOOC to obtain degree in a given discipline. Students shall register to MOOCs which are offered by any one the following agencies:

(a) SWAYAM : www.swayam.gov.in

(b) NPTEL : www.onlinecourse.nptel.ac.in

(c) Course Era : www.coursera.org

(d) edX online learning : www.edx.org

(e) MIT Open Course ware : www.ocw.mit.edu

(f) Udemy : www.udemy.com

(g) Spoken tutorial : www.spoken-tutorial.org

(ii) If a student completes social activity, he/she will earn additional TWO credits, subjected to submission of the certificate of completion of the respective course/ activity from the relevant authorities. It is mandatory for a student to complete atleast one social activities to obtain degree in a given discipline.

(iv) The additional credits for MOOC and Social Activity will be given only after verification of the authentic document by the Head of the Department and a separate mark-sheet will be submitted by the Head of the Department along with the course examiner

(IV) A. T. K. T

(i) A student who is granted term for B. Tech. Semester-I, III, V, VII will be allowed to keep term for his/her B. Tech. Semester-II, IV, VI, VIII examination, respectively even if he/she appears and fails or does not appear at B. Tech. Semester-I,III, V, VII examination respectively.

(ii) A student shall be allowed to keep term for the B. Tech. Semester-III course if he/she has a backlog of any number of Heads of passing at B. Tech. Semester-I & II taken together.

(iii) A student shall be allowed to keep term for the B. Tech. Semester-V of respective course if he/she has no backlog of B. Tech. Semester-I & II and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-III & IV taken together.

(iv) A student shall be allowed to keep term for the B. Tech. Semester- VII of respective course if he/she has no backlog of B. Tech. Semester-I, II, III, IV and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-V & VI taken together.

(V) Minor Programme

(i) A students shall receive a MINOR degree when he/she acquire additional 20 credits in a given specialization defined by respective UG programme.

(ii) The MINOR DEGREE programme is OPTIONAL. The interested students may opt MINOR programme.

(iii) A student must complete the MINOR program prior to graduation.

(VI) Grade Point, Grade Letter and Equivalent Marks

The student must obtain a minimum Grade Point of 5.0 (40% marks) in ESE and also in combined ESE + IA. A student who fails in ESE of a course has to reappear only to ESE as a backlog student and clear that head of passing.

Award of the Class for the Degree considering CGPA: A student who has completed the minimum credits specified for the programme shall be declared to be passed in the programme. The CGPA will be computed

every year of all the courses of that year. The grade will be awarded according to the CGPA of every year.

Range of CGPA	**Final Grade**	**Performance Descriptor**	**Equivalent range of Marks (%)**
9.50 ≤ CGPA ≤10.00	O	Outstanding	80 ≤ Marks ≤ 100
9.00 ≤ CGPA ≤ 9.49	A+	Excellent	70 < Marks <80
8.00 ≤ CGPA ≤ 8.99	A	Very Good	60 < Marks < 70
7.00 ≤ CGPA ≤ 7.99	B+	Good	55 < Marks < 60
6.00 ≤ CGPA ≤ 6.99	B	Average	50 < Marks < 55
5.00 ≤ CGPA ≤ 5.99	C	Satisfactory	40 ≤ Marks < 50
CGPA below 5.00	F	Fail	Marks Below 40