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Periyanaickenpalayam, Coimbatore – 641020

DEPARTMENT OF ROBOTICS AND AUTOMATION

QUESTION BANK

II YEAR

SEMESTER – 04

ACADEMIC YEAR: 2025 – 2026

INDEX

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HEAD OF THE DEPARTMENT

ACOE **PRINCIPAL** **CHAIRMAN**

24ESBS401

ENVIRONMENTAL SCIENCE AND SUSTAINABILITY

UNIT I

ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY

Environment**:** Definition, scope and importance of the environment.
Ecosystem**:** Definition, structure and function of an ecosystem (Forest ecosystem and River ecosystem) – producers, consumers and decomposers - Ecological succession.
Biodiversity**:** Introduction, Definition and Types – values of biodiversity – threats to biodiversity-habitat loss and poaching of wildlife, case study of man-wildlife conflicts – conservation of biodiversity.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is an ecosystem and what are the components of ecosystem?	CO1	RE	2
2.	What are biotic and abiotic components of an ecosystem?	CO1	RE	2
3.	What do you mean natural resources? Give examples.	CO1	RE	2
4.	What are food chains and food webs and give their significance?	CO1	RE	2
5.	Define Ecological succession.	CO1	RE	2
6.	Differentiate between endangered and endemic species.	CO1	UN	2
7.	Define primary succession and secondary succession	CO1	RE	2
8.	Define key stone species with a suitable example.	CO1	RE	2
9.	List out the effect of habitat loss on biodiversity.	CO1	RE	2
10.	What are the major causes of man-wildlife conflict?	CO1	RE	2
	PART B			
1.	Define ecosystem. What are the classification of ecosystem and explain in detail?	CO1	AP	16
2.	Discuss in detail about the threats faced by Indian biodiversity.	CO1	AP	16
3.	Name and briefly describe two how spots of biodiversity that extent in India.	CO1	AN	16
4.	Write about In-situ and Ex-situ conservation of biodiversity.	CO1	AP	16
5.	Explain in detail about the endangered and endemic species of India.	CO1	AN	16
6.	Define Ecological succession. Classify the types of succession and explain in detail.	CO1	AP	16

UNIT II

ENVIRONMENTAL POLLUTION AND WASTE MANAGEMENT

Pollution - definition –causes, effects and control measures of (a) air pollution (b) water pollution- Solid and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS)

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Differentiate between primary and secondary air pollutants.	CO2	UN	2
2.	Define photochemical smog.	CO2	RE	2
3.	What are point and non -point sources of water pollution?	CO2	RE	2
4.	Define e-waste management.	CO2	RE	2
5.	Name any four environmental protection acts in India.	CO2	RE	2
6.	Define hazardous waste management.	CO2	RE	2
7.	What are the effects of noise pollution?	CO2	RE	2
8.	Write any two causes and sources of soil pollution.	CO2	UN	2
9.	List out sources of toxic pollutants in water?	CO2	RE	2
10.	Define OHASMS.	CO2	RE	2
	PART B			
1.	Define air pollution .What are the sources of air pollution? Explain the approach to control air pollution.	CO2	AP	16
2.	Demonstrate with a flow sheet and explain the steps involved in Solid waste management.	CO2	AN	16
3.	What is OHASMS? Explain it with any one case study	CO2	AP	16
4.	Write a detailed note on solid, hazardous, and e-waste management.	CO2	AP	16
5.	Explain the causes, effects and control measures of water pollution.	CO2	AP	16
6.	Give a comparative account of urban and industrial wastes in terms of their sources, characteristics and management and disposal methods.	CO2	AN	16

UNIT III

NATURAL RESOURCES

Forest resources-use and over-exploitation, deforestation, Water resources- use and over utilization of surface and ground water, drought, Dams benefits and problems, Food resources-changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, role of an individual in conservation of natural resources

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define sustainable forestry	CO3	RE	2
2.	Mention any two causes of over-exploitation of forests	CO3	RE	2
3.	What are the effects of dams on tribal communities?	CO3	UN	2
4.	What is water logging?	CO3	RE	2
5.	Define overgrazing.	CO3	RE	2
6.	What is meant by soil erosion?	CO3	RE	2
7.	What is desertification?	CO3	RE	2
8.	Write any two adverse effects caused by overgrazing.	CO3	UN	2
9.	What are the types of agriculture?	CO3	RE	2
10.	What are the preventive measures for protecting natural resources?	CO3	UN	2
	PART B			
1.	Explain in detail the role of an individual in the conservation of natural resources.	CO3	AP	16
2.	Describe the major causes of deforestation. Discuss its consequences and suggest measures to overcome it.	CO3	AN	16
3.	Write a brief note on the environmental impacts of modern agriculture with reference to: (i) Fertilizers (ii) Pesticides	CO3	AP	16

4.	Elaborate the changes caused by modern agriculture and overgrazing.	CO3	AN	16
5.	Explain in detail about the over-utilization of surface water and groundwater.	CO3	AP	16
6.	Discuss the various factors influencing soil degradation.	CO3	AN	16

UNIT IV

SUSTAINABILITY AND MANAGEMENT

Development, GDP, Sustainability- concept, needs and challenges-millennium development - indicators and intervention areas -Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is GDP?	CO4	RE	2
2.	List out any four millennium development goals.	CO4	UN	2
3.	Define carbon credit.	CO4	RE	2
4.	What are the sources of carbon foot print?	CO4	RE	2
5.	Define environmental management.	CO4	RE	2
6.	Mention any five important needs of sustainability.	CO4	UN	2
7.	Enlist the advantages of carbon credits.	CO4	RE	2
8.	Mention some effects of climate change.	CO4	UN	2
9.	Write any 4 millennium development goals.	CO4	RE	2
10.	Define Sustainability.	CO4	RE	2

PART B

1.	Write brief notes on (i) Millennium Development Goals (ii) Sustainability protocols.	CO4	AP	16
2.	What is environmental management? Explain the various steps of environmental management.	CO4	AP	16
3.	Analyse the of concept, goal and aim of sustainable development.	CO4	AN	16
4.	What are the causes, effects and possible solutions of climate change? What is carbon credit? Explain the types and merits.	CO4	AP	16
5.	Explain the sources, causes and remedy measures of carbon foot print.	CO4	AN	16
6.	Analyze the sustainable development indicators.	CO4	AN	16

UNIT V

SUSTAINABILITY PRACTICES

Sustainable targets and goals (STG), Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Sustainable transports, Sustainable urbanization- Socio-economical and technological change.

Q.No	Question	CO	BTL	Marks

PART A

1.	What is zero waste and R concept?	CO5	RE	2
2.	Define circular economy.	CO5	RE	2
3.	What are the key elements of ISO14000?	CO5	RE	2
4.	Mention the objectives of EIA.	CO5	UN	2
5.	What is green engineering?	CO5	RE	2
6.	What is meant by energy cycles?	CO5	RE	2

7.	What is sustainable urbanization?	CO5	RE	2
8.	Define carbon sequestration.	CO5	RE	2
9.	How do you calculate energy efficiency?	CO5	UN	2
10.	What are the harmful effects of carbon emission?	CO5	RE	2

PART B

1.	Explain the various steps to achieve zero waste? Mention advantages and disadvantages of zero waste. Determine the concept and advantages of R concept.	CO5	AN	16
2.	What are green materials? Explain important green building materials. (8) What is sustainable transport? Discuss the key elements of sustainable transport.(8)	CO5	AP	16
3.	What is sustainable urbanization? Explain the rules to develop sustainable urban.	CO5	AN	16
4.	Write notes on socio-economical change on sustainable urbanization.	CO5	AP	16
5.	Explain methods of achieving energy efficiency.	CO5	AP	16
6.	Explain the various steps to achieve zero waste? Mention advantages and disadvantages of zero waste.	CO5	AP	16

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24RAPC402

FLUID POWER SYSTEMS AND INDUSTRIAL AUTOMATION

UNIT I

FLUID POWER SYSTEM GENERATION AND ACTUATORS

Need For Automation, Classification of Drives - Hydraulic, Pneumatic and Electric – Comparison – ISO Symbols for their Elements, Selection Criteria. Generating Elements- Hydraulic Pumps and Motor Gears, Vane, Piston Pumps – Motors - Selection and Specification - Drive Characteristics – Utilizing Elements - Linear Actuator – Types, Mounting Details, Cushioning – Power Packs – Accumulators.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define automation and state any two needs for automation in manufacturing.	1	RE	2
2.	Outline the major classifications of industrial drives.	1	UN	2
3.	What is meant by a hydraulic drive system?	1	RE	2
4.	Summarize the advantages of pneumatic drives.	1	UN	2
5.	Mention two differences between hydraulic and electric drives.	1	UN	2
6.	What are ISO symbols? State their importance in fluid power circuits.	1	RE	2
7.	Define hydraulic pump.	1	RE	2
8.	What is an accumulator?	1	RE	2
9.	What is meant by cushioning in a hydraulic cylinder?	1	RE	2
10	What is a hydraulic power pack?	1	RE	2
	PART B			
1.	Explain the need for automation and classify industrial drives. Compare hydraulic, pneumatic and electric drives.	1	UN	16
2.	Explain ISO symbols applied to hydraulic and pneumatic system elements with neat sketches.	1	AP	16
3.	Identify the different hydraulic pumps and motors and describe their types and working principles.	1	AP	16
4.	Explain the selection and specification of hydraulic pumps and motors. Also discuss drive characteristics.	1	AP	16
5.	Explain linear actuators utilized in hydraulic systems. Describe their types, mounting arrangements and cushioning methods.	1	AP	16
6.	With a neat diagram, construct the hydraulic power packs and accumulators and describe their functions and applications.	1	AP	16

UNIT II

CONTROL AND REGULATING ELEMENTS

Control and Regulating Elements — Direction, Flow and Pressure Control Valves -Methods of Actuation, Types, Sizing of Ports. Spool Valves - Operating Characteristics -Electro Hydraulic Servo Valves - Types - Characteristics and Performance.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define control and regulating elements in a hydraulic system.	2	RE	2
2.	What is a directional control valve (DCV)?	2	RE	2
3.	Outline the different functions of a flow control valve.	2	UN	2
4.	What is a pressure control valve? Mention one example.	2	RE	2
5.	List any two methods of actuation used for control valves.	2	RE	2
6.	What is meant by port sizing in control valves?	2	RE	2
7.	Define spool valve.	2	RE	2
8.	Mention any two operating characteristics of spool valves.	2	RE	2
9.	What is an electro-hydraulic servo valve?	2	RE	2
10	Summarize the applications of electro-hydraulic servo valves.	2	UN	2
	PART B			
1.	Explain directional, flow and pressure control valves used in hydraulic systems.	2	UN	16
2.	Identify the different methods of actuation and explain the importance of the sizing of ports.	2	AP	16
3.	Construct a spool valve with neat sketch and discuss its operating characteristics.	2	AP	16
4.	Describe electro-hydraulic servo valves and explain their types.	2	UN	16
5.	Inspect the characteristics and performance parameters of electro-hydraulic servo valves.	2	AN	16
6.	Analyze the selection criteria for control and regulating elements in high-precision hydraulic systems.	2	AN	16

UNIT III

CIRCUIT DESIGN FOR HYDRAULIC AND PNEUMATICS

Typical Design Methods – Sequencing Circuits Design - Combinational Logic Circuit Design - Cascade Method – Electrical Control of Pneumatic and Hydraulic Circuits - Use of Relays, Timers, Counters and PLC in pneumatics and hydraulics

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is meant by sequencing in pneumatic or hydraulic circuits?	3	RE	2
2.	Define sequencing circuit design.	3	RE	2
3.	What is a combinational logic circuit?	3	RE	2
4.	Outline the logic elements used in pneumatic logic circuits.	3	UN	2
5.	What is the cascade method in circuit design?	3	RE	2
6.	Define Karnaugh–Veitch (KV) map.	3	RE	2
7.	What is electrical control of pneumatic systems?	3	RE	2
8.	Summarize the functions of a relay in electro-pneumatic circuits.	3	UN	2
9.	Interpret the role of a timer in pneumatic or hydraulic circuits?	3	UN	2
10.	What is a PLC? State one advantage of using PLCs in fluid power systems.	3	RE	2
	PART B			
1.	Explain typical design methods used in pneumatic and hydraulic circuit design.	3	UN	16
2.	Construct a sequencing circuit design with an example.	3	AP	16
3.	Develop a combinational logic circuit design used in pneumatic systems.	3	AP	16
4.	Design and explain the fluid power circuit for a drilling machine to perform the following functions: (i) Clamping the workpiece, (ii) Drilling the workpiece, and (iii) Unclamping the workpiece.	3	CR	16
5.	Design an electro pneumatic circuit using cascade method for the following sequence A+ B+ C+ B- A- C-, Where A, B and C stands for cylinders, (+) indicates extension and (-) indicates retraction of cylinders.	3	CR	16
6.	Analyze the role of relays, timers, and counters in the electrical control of pneumatic and hydraulic systems.	3	AN	16

UNIT IV PROGRAMMABLE LOGIC CONTROLLER

Industrial Automation - Programmable Logic Controller - Functions of PLCs - Features of PLC - Selection of PLC - Architecture – IEC61131-3 programming standard and types - Basics of PLC Programming – Ladder Logic Diagrams – Communication in PLC – Programming Timers and Counters – Data Handling - PLC modules – Advanced motion controlled Multi Axis PLC

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define industrial automation.	4	RE	2
2.	What is a Programmable Logic Controller (PLC)?	4	RE	2
3.	Outline the functions of a PLC.	4	UN	2
4.	Summarize the features of PLCs.	4	UN	2
5.	What is meant by PLC selection?	4	RE	2
6.	Show the basic components of PLC architecture.	4	UN	2
7.	What is IEC 61131-3 standard?	4	RE	2
8.	List any two programming languages defined in IEC 61131-3.	4	RE	2
9.	What is ladder logic diagram (LLD)?	4	RE	2
10.	Define PLC communication.	4	RE	2
	PART B			
1.	Explain the architecture and features of a PLC in industrial automation.	4	UN	16
2.	Explain the basics of PLC programming using ladder logic diagrams.	4	UN	16
3.	How PLC communication, timer and counter programming, and data handling techniques are applied in industrial automation.	4	AP	16
4.	Design a ladder logic program that could be used to operate the simplified task of the automatic drilling of workpieces. The drill motor and the pump for the air pressure for the pneumatic valves has to be started to the required depth. Then the drill has to be retracted and the workpiece unclamped.	4	CR	16
5.	Design the program for a pneumatic system for control by a PLC to give the cylinder sequence A+, B+, B-, A- and which will give a LED display indicating, in the presence of a fault such as a sticking cylinder at which point in the cycle the fault occurred. Explain the action of all elements in the system	4	CR	16

6.	Analyze PLC modules and discuss advanced motion-controlled multi-axis PLC systems.	4	AN	16

UNIT V

DATA COMMUNICATION AND SUPERVISORY CONTROL SYSTEMS

Industrial Data Communications -– Modbus – HART – DeviceNet – Profibus – Fieldbus – RS232- RS485- Modbus/ Modbus TCP/IP - mechatrolink – CAN – Ether CAT - Introduction to Supervisory Control Systems – SCADA - Distributed Control System (DCS) – Safety Systems human machine interfaces - Total Integrated Automation (TIA) – Industry 4.0.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define industrial data communication.	5	RE	2
2.	What is Modbus protocol?	5	RE	2
3.	Outline the purpose of HART communication	5	UN	2
4.	What is meant by Fieldbus?	5	RE	2
5.	Differentiate between RS-232 and RS-485.	5	UN	2
6.	What is CAN protocol?	5	RE	2
7.	Define EtherCAT.	5	RE	2
8.	What is SCADA system?	5	RE	2
9.	What is Distributed Control System (DCS)?	5	RE	2
10.	What is Industry 4.0?	5	RE	2

PART B

1.	Explain Modbus protocol and discuss its variants including Modbus TCP/IP.	5	UN	16
2.	How the communication systems such as HART, DeviceNet, Profibus and Fieldbus are applied in industrial automation.	5	AP	16
3.	Analze serial and industrial network communication standards used in automation systems.	5	AN	16
4.	Explain supervisory control systems and discuss SCADA architecture with applications.	5	UN	16
5.	Compare SCADA and DCS. Explain safety systems and human–machine interfaces (HMI).	5	AN	16
6.	Analzye the implementation of Total Integrated Automation (TIA). Discuss the role of industrial communication systems in Industry 4.0.	5	AN	16

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24RAPC403
SENSORS AND INSTRUMENTATION

UNIT I
INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	State the fundamental concept of measurement in instrumentation systems.	1	RE	2
2.	Identify the major categories of errors encountered in measurements.	1	RE	2
3.	Indicate the purpose of performing error analysis in measurement systems.	1	RE	2
4.	Specify any two static characteristics associated with transducers.	1	RE	2
5.	Point out two dynamic characteristics relevant to sensor performance.	1	RE	2
6.	Highlight the key performance measures used for evaluating sensors.	1	RE	2
7.	Indicate the criteria commonly used for the classification of sensors.	1	RE	2
8.	Mention any two techniques adopted for sensor calibration.	1	RE	2
9.	State the significance of calibration in ensuring sensor accuracy.	1	RE	2
10.	State the significance of calibration in ensuring sensor accuracy.	1	RE	2
	PART B			
1.	Explain the basic concepts of measurement and classify measurement errors with suitable illustrations.	1	UN	16
2.	Describe the static and dynamic characteristics of transducers used in measurement systems.	1	UN	16
3.	Demonstrate the application of error analysis techniques to improve measurement accuracy.	1	AP	16
4.	Apply appropriate calibration methods to ensure reliable sensor performance.	1	AP	16
5.	Analyze the performance measures of sensors and their impact on measurement reliability.	1	AN	16
6.	Examine various sensor output signal types and analyze their suitability for different applications.	1	AN	16

UNIT II

MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).				
Q.No	**Question**	**CO**	**BTL**	**Marks**
	PART A			
1.	Indicate the primary functions of motion sensors in measurement systems.	2	RE	2
2.	State the operating principle underlying potentiometric sensors.	2	RE	2
3.	Specify the functional role of resolvers in angular position sensing.	2	RE	2
4.	Indicate the purpose of encoders in motion measurement applications.	2	RE	2
5.	Highlight two advantages of optical sensing techniques	2	RE	2
6.	State the application of LVDT in displacement measurement.	2	RE	2
7.	Identify the significance of accelerometers in motion sensing.	2	RE	2
8.	Indicate the role of GPS in position and navigation systems.	2	RE	2
9.	Mention two commonly used ultrasonic ranging methods.	2	RE	2
10.	Specify one practical application of laser range sensors (LIDAR).	2	RE	2
	PART B			
1.	Discuss the working principles of potentiometers, resolvers, and encoders used in motion sensing.	2	UN	16
2.	Explain the operation of inductive and capacitive sensors with reference to proximity detection.	2	UN	16
3.	Illustrate the application of LVDT, RVDT, synchro, and microsyn in industrial measurement systems.	2	AP	16

4.	Apply range sensing techniques using ultrasonic, RF beacon, and laser-based sensors.	2	AP	16
5.	Compare and analyze optical, magnetic, and inductive sensors for motion and proximity measurement.	2	AN	16
6.	Evaluate GPS- and Bluetooth-based ranging systems with respect to accuracy and limitations.	2	AN	16

UNIT III

FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	State the basic operating principle of strain gages.	3	RE	2
2.	Indicate the functional purpose of a load cell.	3	RE	2
3.	Identify the major categories of magnetic sensors.	3	RE	2
4.	State the phenomenon governing Hall effect sensors.	3	RE	2
5.	Highlight one advantage of magneto-resistive sensors.	3	RE	2
6.	Indicate the role of current sensors in electrical systems.	3	RE	2
7.	Specify the application areas of heading sensors.	3	RE	2
8.	Indicate the function of compass sensors in navigation.	3	RE	2
9.	State the purpose of gyroscopes in orientation measurement.	3	RE	2
10.	Identify one application of inclinometers.	3	RE	2

PART B				
1.	Explain the construction and working of strain gages and load cells used for force measurement.	3	UN	16
2.	Describe the principles and requirements of magnetic sensors used in industrial applications.	3	UN	16
3.	Demonstrate the use of Hall effect and magneto-resistive sensors in current measurement systems.	3	AP	16
4.	Apply heading sensor principles to orientation and navigation applications.	3	AP	16
5.	Analyze the performance characteristics of magnetic sensors in dynamic environments.	3	AN	16
6.	Assess the suitability of compass, gyroscope, and inclinometer sensors for navigation systems.	3	AN	16

UNIT IV
OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photoconductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors – Smart Sensors – Film sensor, MEMS & Nano Sensors, LASER sensors.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	State the principle governing the operation of photoconductive sensors.	4	RE	2
2.	Indicate the energy conversion mechanism in photovoltaic sensors.	4	RE	2
3.	Specify the sensing role of light dependent resistors (LDR).	4	RE	2
4.	Highlight the advantages of fiber optic sensors in measurement systems.	4	RE	2
5.	Identify the sensing element used in diaphragm-based pressure sensors.	4	RE	2
6.	State the function of piezoelectric materials in pressure sensing.	4	RE	2
7.	Indicate the application areas of tactile sensors.	4	RE	2
8.	Specify the role of IC-based temperature sensors.	4	RE	2
9.	State the operating principle of thermocouples.	4	RE	2
10.	Identify one application area of MEMS-based sensors.	4	RE	2
	PART B			
1.	Explain the working principles of optical sensors used for light detection and measurement.	4	UN	16
2.	Describe pressure and temperature sensing techniques employed in industrial instrumentation.	4	UN	16
3.	Illustrate the application of fiber optic and piezoelectric sensors in measurement systems.	4	AP	16
4.	Apply temperature sensing methods using thermistors, RTDs, and thermocouples.	4	AP	16

5.	Analyze the effectiveness of acoustic sensors in flow and level measurement.	4	AN	16
6.	Examine the role of smart sensors, MEMS, nano, and laser sensors in advanced sensing applications.	4	AN	16

UNIT V

SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEMS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multichannel data acquisition – Data logging – applications – Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Indicate the necessity of amplification in signal conditioning circuits.	5	RE	2
2.	State the purpose of filtering in sensor signal processing.	5	RE	2
3.	Specify the function of sample and hold circuits.	5	RE	2
4.	Indicate the role of data acquisition systems in instrumentation.	5	RE	2
5.	State the concept of single-channel data acquisition.	5	RE	2
6.	Specify the objective of multi-channel data acquisition systems.	5	RE	2
7.	Highlight the importance of data logging in monitoring applications.	5	RE	2
8.	Indicate the application of DAQ systems in automobiles.	5	RE	2
9.	Specify the use of data acquisition in aerospace systems.	5	RE	2
10.	Identify the role of DAQ systems in environmental monitoring.	5	RE	2
	PART B			
1.	Explain the need for signal conditioning in sensor-based measurement systems.	5	UN	16

2.	Describe the architecture of data acquisition systems with functional blocks.	5	UN	16
3.	Illustrate the design of amplification and filtering circuits for sensor signals.	5	AP	16
4.	Apply data acquisition techniques for real-time industrial monitoring applications.	5	AP	16
5.	Analyze single-channel and multi-channel data acquisition systems for performance and scalability.	5	AN	16
6.	Evaluate data logging systems used in automotive, aerospace, and manufacturing applications.	5	AN	16

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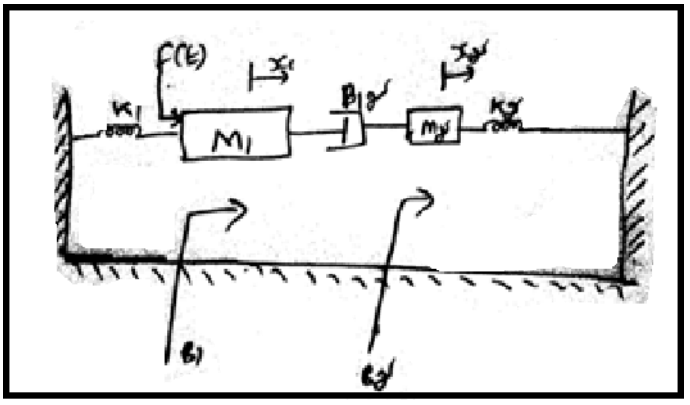
24ECPC404

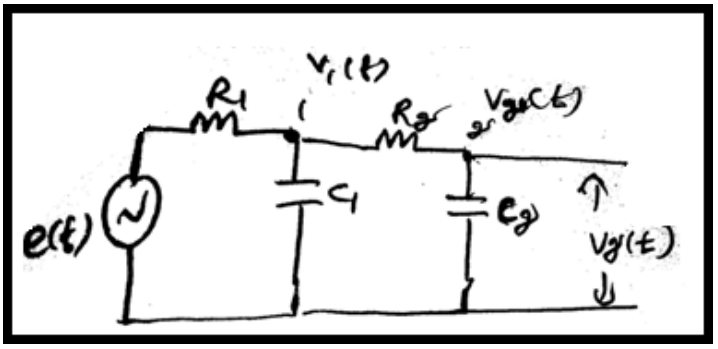
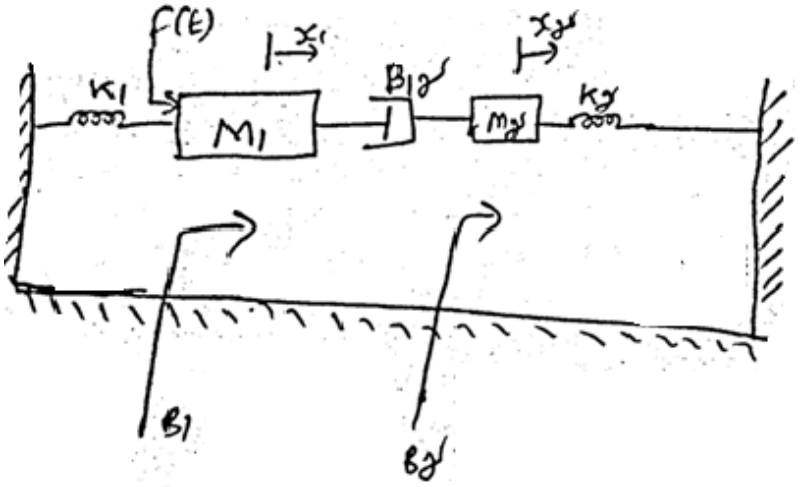
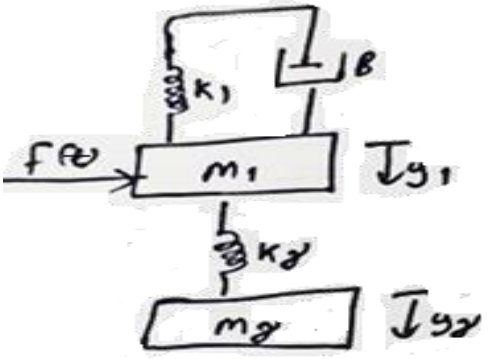
CONTROL SYSTEMS ENGINEERING

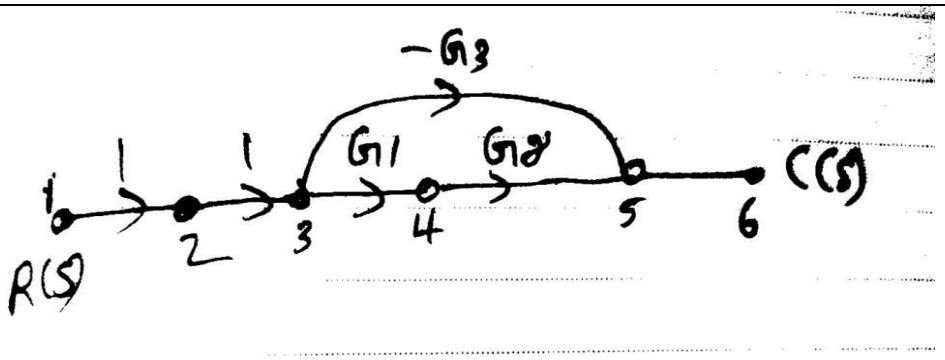
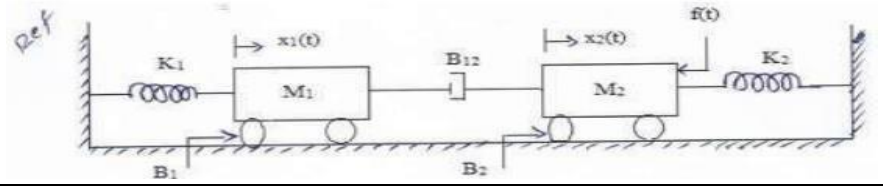
UNIT I

SYSTEMS COMPONENTS AND THEIR REPRESENTATION

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory, Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define system.	1	RE	2
2	What is Control System?	1	UN	2
3.	What are the types of control system?	1	UN	2
4.	What is open loop and control loop systems?	1	UN	2
5.	What are the advantages and disadvantages of open loop control System?	1	UN	2
6.	What are the advantages and disadvantages of closed-loop control System?	1	RE	2
7.	Distinguish between open loop and closed loop system	1	UN	2
8.	What is the feedback in the control system?	1	UN	2
9	What are the basic components of an automatic control system?	1	RE	2
10	Why is negative feedback invariably preferred in a closed loop system?	1	RE	2
	PART B			
1.	For the mechanical system shown in Fig, determine the transfer functions $\frac{X1(s)}{F(s)}$ & $\frac{X2(s)}{F(s)}$ 	1	AN	16

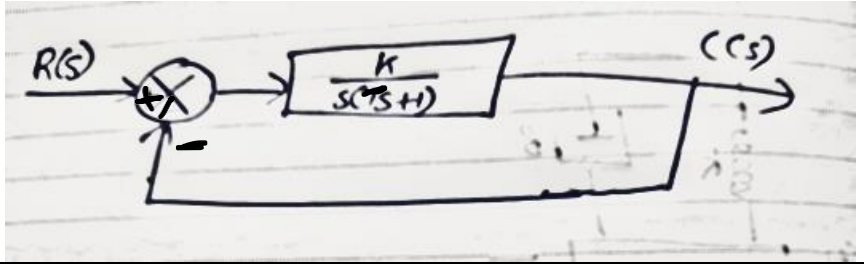
2.	Obtain the transfer function for the the electrical system shown 	1	AN	16
3.	Using block diagram reduction technique find closed loop transfer function of the system whose block diagram is shown 	1	AN	16
4	For the mechanical translational system, find the transfer function for the figure given below 	1	AP	16
5	Find the overall transfer function of the system whose signal flow graph is shown.	1	AP	16

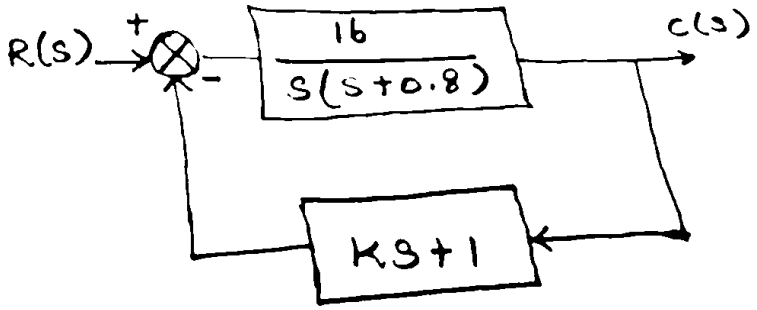
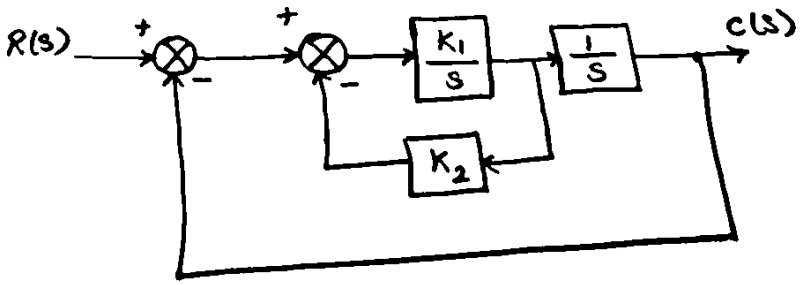
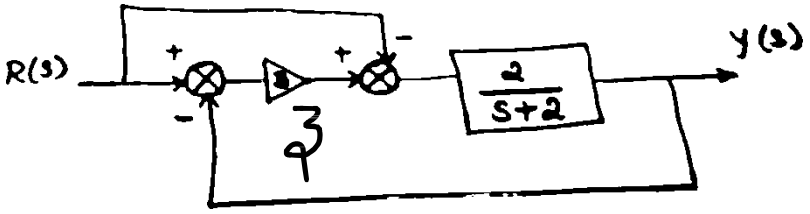
				
6	For the mechanical system shown in Fig, determine the transfer functions $\frac{X1(s)}{F(s)}$ & $\frac{X2(s)}{F(s)}$ 	1	AP	16

UNIT II

TIME RESPONSE ANALYSIS

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system-type number-PID control-Analytical design for PD, PI, PID control systems

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is time response?	2	RE	2
2.	List the time domain specifications.	2	RE	2
3.	What is transient and steady state response?	2	RE	2
4.	Define delay time.	2	RE	2
5.	Define rise time.	2	RE	2
6.	Define Peak time	2	RE	2
7.	Define Peak overshoot	2	RE	2
8.	What are the types of test signals?	2	RE	2
9	What is the type number of a system?	2	RE	2
10	What is the order of a system?	2	RE	2
PART B				
1	A system has the following transfer function $\frac{C(s)}{R(s)} = \frac{20}{s+10}$ Determine its unit step response with zero initial conditions.	2	AP	16
2	The System shown in figure subjected to a unit step input . Determine the values of K and T, where the damped frequency ω_d *is* 1.05 rad/sec and damping ratio $\sum = 0.4$. 	2	AP	16

3	A Positional control System with velocity feedback is shown in fig. what is the response c(t) to the unit step input. Given that z=0.5. Also calculate rise time , peak time, maximum overshoot and settling time. 	2	AP	16
4	Determine the values of k1 and k2 respectively of the closed loop system in figure such that the maximum overshoot for unit step input is 25% and peak time is 2 sec. 	2	AP	16
5	A Unity feedback system has G(s) = $\frac{40(s+2)}{s(s+1)(s+4)}$ Determine (i) Type of the system (ii) All error coefficients (iii) Error for ramp input.	2	UN	16
6	When subject to a unit step input, the closed loop control system shown in figure will have a steady state error of 	2	UN	16

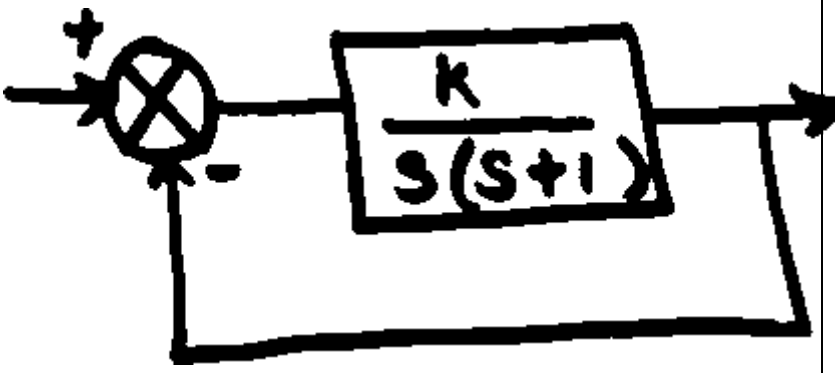
UNIT III

FREQUENCY RESPONSE AND SYSTEM ANALYSIS

.

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot-Polar Plot-Design of compensators using Bode plots-Cascade lead, lag and lag-lead compensation

Q.No	Question	CO	BTL	Marks
1.	What is frequency response?	3	RE	2
2	What are frequency domain specifications?	3	RE	2
3.	List out the frequency response plot.	3	RE	2
4.	What is minimum phase system?	3	RE	2
5.	What is non minimum phase transfer function?	3	UN	2
6.	What is bode plot?	3	UN	2
7.	What are the main advantages of Bode plot?	3	RE	2
8.	Define corner frequency.	3	RE	2
9	Define Bandwidth .	3	UN	2
10	What is resonant frequency?	3	RE	2
	PART B			
1.	Given G(s) = $\frac{K\, e^{-0.23}}{S(s+2)(s+3)}$ · Find k so that the system is stable with (a) gain mergin=2 db (b) phase margin =45^0.	3	AP	16
2.	Consider a unity feedback open loop transfer function G(s)=$\frac{100}{S(1+0.13)(1+0.2s)}$. Draw the Bode plot and find the phase and gain cross over frequencies, phase and gain margin and stability of the system	3	AP	16
3.	The open loop transfer function of a unity feedback system is given by G(s) = $\frac{(1+0.2s)(1+0.253)}{s^3(1+0.0053)(1+0.0013)}$. Sketch the polar plot and	3	AP	16

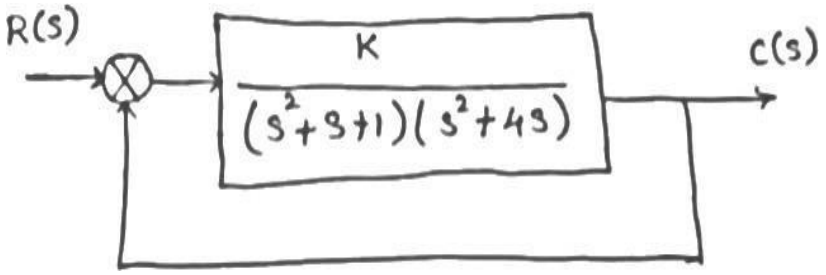
	determine the phase margin.			
4	Consider the unity feedback system whose open loop transfer function is G(S)=$\frac{K}{S(s+3)(s+6)}$. Design a lag-lead compensator to meet the following specifications. (i) velocity error constant K_r=80, (ii) Phase margin $\gamma \geq 35^0$.	3	AP	16
5	Design a phase lead compensator for the system shown in fig. to satisfy the following specifications (i) The Phase margin of the system $\geq 45^0$. (ii) steady state error for a unit ramp input $\leq \frac{1}{15}$ (iii) The gain cross over frequency of the system must be less than 7.5 rad/sec. 	3	AP	16
6	A Unity feedback system has an open loop transfer function G(s)=$\frac{K}{S(1+2S)}$.Design a suitable lag compensator so that phase margin is 40^0 and the steady state error for ramp input is less than or equal to 0.2.	3	AN	16

UNIT IV

CONCEPTS OF STABILITY ANALYSIS

Concept of stability-Bounded Input Bounded Output stability-Routh stability criterion-Relative stability Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define BIBO stability.	4	RE	
2	What is characteristic equation?	4	RE	2
3.	List out the some of the finite word length effects in digital filters.	4	RE	2
4.	What is Nyquist stability criterion?	4	RE	2
5.	What is the necessary and sufficient condition for stability?	4	RE	2
6.	What is limitedly stable system?	4	RE	2
7.	What is routh stability criterion?	4	RE	2
8.	In routh array what conclusion you can make when there is a row of all zeros?	4	RE	2
9	State the rule for obtaining the breakaway point in the root locus?	4	RE	2
10	How is the angle condition used in root locus?	4	RE	2
	PART B			
1.	Use the Routh stability criterion to determine the location of roots on the s-plane and hence the stability for the system represented by the characteristic equation $S^5+4s^4+8s^3+8s^2+7s+4=0$.	4	AN	16
2.	Sketch the root locus of the system whose open loop transfer function is $G(s)=\frac{K}{s(s+2)(s+4)}$.	4	AN	16
3.	Determine the range of K for stability of Unity feedback system using routh stability criterion whose transfer function is $\frac{C(s)}{R(s)} = \frac{K}{S(s+7)(s+11)}$	4	AN	16
4	A Unity feedback control system has an open loop transfer function $G(s)= \frac{K}{s(s^2+4s+13)}$.Sketch the root locus.	4	AN	16

5	Sketch the Nyquist plot the following openloop transfer function by G(s)H(s)=$\frac{k(1+s)^2}{s^3}$. Determine the range of K for Stability	4	AN	16
6	Consider the closed loop system in fig, determine the range of K of which the system is stable 	4	AN	16

UNIT V

CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability

S.No	Question	CO	BTL	Marks
	PART A			
1.	List the advantages of state space analysis.	5	UN	2
2	What are the drawbacks in transfer function model analysis?	5	UN	2
3.	Define state and state variable.	5	RE	2
4.	What is a state vector?	5	RE	2
5.	Write the state model of n^{th} order of the system.	5	RE	2
6.	Define state space.	5	RE	2
7.	What is an input and output space?	5	RE	2
8.	What is state diagram?	5	RE	2
9	List the basic elements used to construct the state diagram.	5	RE	2
10	What are the advantages of state space modeling using physical variables?	5	UN	2
	PART B			
1.	An LTI system given by the following sate variable description: $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, y = [1 \quad 0]x$ Determine whether the system is controllable or not.	5	AN	16
2.	Construct a state model for a system characterized by the differential equation $\frac{\quad}{dt} + b \frac{\quad}{dt} + 11\frac{dy}{dt}$ +by+u=0	5	AP	16

3.	The Transfer function of a control system is given by G(s)=$\frac{s+2}{s^3+9s^2+26s+24}$. Check for controllability.	5	AN	16
4	Determine the canonical state model of the system the transfer function $\frac{y(s)}{u(s)} = \frac{10(s+4)}{S(S+1)(s+3)}$	5	AP	16
5	Obtain the state model of the system whose transfer function is given as $\frac{y(s)}{u(s)} = \frac{10(s+4)}{s^3+4s^2+2s+1}$	5	AP	16
6	A system is represented by the state equation $\dot{X}$=AX+BU, y=cx where A=$\begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & -10 \end{bmatrix}$,B=$\begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix}$,C=[1 0 0]. Determine the transfer function.	5	AP	16

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24RAPC405

DESIGN OF ROBOT ELEMENTS

UNIT I

FUNDAMENTALS OF MECHANICAL DESIGN

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Considerations - Standards and Codes - Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

Q.No	Question	CO	BT	M
	PART A			
1.	Define machine design. What is the main objective of engineering design?	CO1	RE	2
2.	What are design considerations? Name any two design considerations used in machine design.	CO1	RE	2
3.	Infer the phases of design in engineering.	CO1	UN	2
4.	What are standards and codes in design? Give two examples.	CO1	RE	2
5.	Compare between static load and dynamic load with examples.	CO1	UN	2
6.	Outline the modes of failure in machine elements.	CO1	UN	2
7.	Define factor ofsafety (FoS) and its significance in mechanical design.	CO1	RE	2
8.	Explain stress concentration and its effect on mechanical components.	CO1	UN	2
9.	Define fatigue failure and explain its causes.	CO1	RE	2
10.	Explain the Soderberg and Goodman criteria for fatigue failure.	CO1	UN	2
	PART B			
1.	Explain design against static and dynamic load.	CO1	UN	16
2.	Classify the failure theories and specify which are suitable for ductile and brittle materials.	CO1	AN	16
3.	Develop the phases of design in engineering.	CO1	AP	16
4.	Develop methods to reduce stress concentration.	CO1	AP	16
5.	Examine how do stress concentration factors affect fatigue failure?	CO1	AN	16
6.	Explain Soderberg and Goodman criteria.	CO1	UN	16

UNIT II

DESIGN OF LINKS, JOINTS AND FLEXIBLE DRIVES

Loads and Forces on Links and Joints - Design of solid and hollow shafts - Rigid and flexible couplings -Threaded fasteners - rolling contact bearings– Links Design: Path and Motion Synthesis – Cognate Linkages – Design of Spherical Joints. Flexible drive systems - types of flexible drives – design of V-Belt drives, design of chain drives.

Q.No	Question	CO	BT	M
	PART A			
1.	Define links and joints.	CO2	RE	2
2.	What is meant by path synthesis in link design?	CO2	RE	2
3.	Explain the difference between solid and hollow shafts in terms of strength and weight.	CO2	UN	2
4.	Compare between rigid and flexible couplings with examples.	CO2	UN	2
5.	Define cognate linkages and their significance in motion synthesis.	CO2	RE	2
6.	Explain the term stress concentration in threaded fasteners.	CO2	UN	2
7.	Classify the factors affecting the fatigue life of a shaft.	CO2	UN	2
8.	What is a spherical joint? Give an example of its application.	CO2	RE	2
9.	What is a cognate linkage? State its application.	CO2	RE	2
10.	Classify any two types of flexible drive systems.	CO2	UN	2
	PART B			
1.	Identify the forces acting on links and joints in a mechanical system with an example.	CO2	AP	16
2.	Compare the design aspects of solid and hollow shafts and derive an expression for the strength of a hollow shaft.	CO2	AN	16
3.	Outline their applications. Discuss are the different types of rigid and flexible couplings?	CO2	UN	16
4.	Identify the design considerations for selecting threaded fasteners in mechanical assemblies.	CO2	AP	16
5.	Summarize the concept of cognate linkages and their application in machine design.	CO2	UN	16
6.	Analyze the different types of flexible drives.	CO2	AN	16

UNIT III

FUNDAMENTALS OF COMPUTER GRAPHICS

Product cycle- Design process - Computer Aided Design – Computer graphics – coordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle- drawing algorithms) - Clipping- viewing transformation. Fundamentals of solid modelling, Different solid representation schemes, Half-spaces, Boundary representation (Brep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modelling, Perspective, Parallel projection, Hidden line removal algorithms.

Q.No	Question	CO	BT	M
	PART A			
1.	Define the product cycle in engineering design.	CO3	RE	2
2.	What are the main phases of the design process?	CO3	RE	2
3.	Explain Computer-Aided Design (CAD) and its advantages.	CO3	UN	2
4.	Explain homogeneous coordinate system. Why is it used?	CO3	UN	2
5.	What are graphic primitives? Give examples.	CO3	RE	2
6.	Explain clipping in computer graphics.	CO3	UN	2
7.	What is the difference between window-to-viewport transformation and viewing transformation?	CO3	RE	2
8.	Summarize the basic 2D transformations.	CO3	UN	2
9.	Define solid modelling. Mention any two solid representation schemes.	CO3	RE	2
10.	Outline hidden line removal. Name any one hidden line removal algorithm.	CO3	UN	2
	PART B			
1.	Classify various clipping algorithms used in computer graphics.	CO3	UN	16
2.	Compare 2D and 3D transformations with examples.	CO3	AN	16
3.	Organize homogeneous coordinates, and how do they help in geometric transformations?	CO3	AP	16
4.	Develop viewport transformation? Explain with a diagram.	CO3	UN	16
5.	Explain solid modelling. Discuss different solid representation schemes such as Half-spaces, Boundary Representation (B-Rep), Constructive Solid Geometry (CSG), and Sweep representation.	CO3	AP	16
6.	Analyze projection techniques used in computer graphics. Compare perspective and parallel projections and explain any one hidden line removal algorithm in detail.	CO3	AN	16

UNIT IV

ANATOMY AND POSITIONING SYSTEM OF ROBOT

Introduction to Industrial robotics – Manipulator configuration (examples with product specification): two link planar, Cartesian, Cylindrical, Polar, Articulated, SCARA, Delta and Stewart platform – CAD modelling of manipulator configuration (students by own) – Analysis of Positioning Systems (Actuator + Gear reduction unit): open-loop study with stepper motor, Closed-loop study with servo motor – Precision in Positioning system: control resolution, accuracy and repeatability– Harmonic drives in robotic manipulators.

Q.No	Question	CO	BT	M
	PART A			
1.	Outline industrial robot as per the Robotics Institute of America (RIA).	CO4	UN	2
2.	What is a robot manipulator? State its main functions.	CO4	RE	2
3.	Explain manipulator configuration. Give any two examples.	CO4	UN	2
4.	List any two applications of SCARA robots.	CO4	RE	2
5.	What is a Delta robot? State one advantage of Delta robots.	CO4	RE	2
6.	Explain open-loop control system. Give one example used in robotics.	CO4	UN	2
7.	Explain closed-loop control system. Name the actuator commonly used.	CO4	UN	2
8.	Define control resolution in a robotic positioning system.	CO4	RE	2
9.	Compare between accuracy and repeatability in robots.	CO4	UN	2
10.	What is a harmonic drive? Mention one advantage of using harmonic drives in robots.	CO4	RE	2
	PART B			
1.	Build different manipulator configurations with neat sketches and suitable applications: two-link planar, Cartesian, Cylindrical, Polar, Articulated, SCARA, Delta, and Stewart platform.	CO4	AP	16
2.	Explain the CAD modelling procedure of a robotic manipulator configuration. Explain the modelling steps and constraints involved.	CO4	UN	16
3.	Analyze the positioning systems using an open-loop control system. Discuss the working of a stepper motor with gear reduction unit.	CO4	AN	16
4.	Develop the closed-loop positioning systems used in robotics. Describe the working of a servo motor with feedback mechanism and gear reduction unit.	CO4	AP	16
5.	Survey the precision in robotic positioning systems. Explain control resolution, accuracy, and repeatability with suitable examples.	CO4	AN	16
6.	Explain harmonic drives used in robotic manipulators. Describe their construction, working principle, advantages, and applications.	CO4	UN	16

UNIT V

DESIGN OF GRIPPERS

Grippers – Types of Grippers Mechanisms – Gripping Methods – Gripping Force analysis – Gripper Design – Two-Finger Gripper – Three-Finger Gripper – Magnetic Gripper Design – Vacuum Gripper Design – Hooks – Scoops – Spools – Miscellaneous Grippers.

Q.No	Question	CO	BT	M
	PART A			
1.	Explain gripper and its role in automation.	CO5	UN	2
2.	What are the main types of grippers used in robotic systems?	CO5	RE	2
3.	List two advantages of mechanical grippers over vacuum grippers.	CO5	RE	2
4.	Explain vacuum grippers and their applications.	CO5	UN	2
5.	Explain the function of hooks and scoops in material handling.	CO5	UN	2
6.	What are spool-based grippers used for?	CO5	RE	2
7.	List two miscellaneous types of grippers and their applications.	CO5	RE	2
8.	Outline magnetic gripper work.	CO5	UN	2
9.	Explain hooks and scoops. State one application of each.	CO5	UN	2
10.	Define gripping force. Why is it important in gripper design?	CO5	RE	2
	PART B			
1.	Develop the different types of gripping mechanisms with examples.	CO5	AP	16
2.	Compare vacuum grippers and magnetic grippers in terms of design and application.	CO5	AN	16
3.	Explain the working of a magnetic gripper and provide a case study where it is used in an industrial application	CO5	UN	16
4.	Illustrate the design considerations and applications of hooks, scoops, and spools in material handling systems.	CO5	UN	16
5.	Develop the construction and working of a three-finger gripper. Compare it with a two-finger gripper.	CO5	AP	16
6.	Analyze special-purpose grippers such as hooks, scoops, spools, and miscellaneous grippers with suitable applications	CO5	AN	16

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24RAPC401

ROBOT KINEMATICS

UNIT I

OVERVIEW OF ROBOTICS

Introduction to Robotics - History - Definitions - Law of Robotics – Terminologies - Classifications Overview – Links & Joints - Degrees of Freedoms - Coordinate Systems - Work Volume - Precision, Repeatability & Accuracy - Position and Orientation of Objects - Roll, Pitch and Yaw Angles - Joint Configuration of Five Types of Serial Manipulators - Wrist Configuration - End effector and its types - Selection and Application of Serial Manipulators.

Q.No	Questions	CO	BTL	Marks
	PART A			
1.	Define Robot.	CO1	RE	2
2.	Define SCARA	CO1	UN	2
3.	Define payload	CO1	UN	2
4.	Define laws of robotics	CO1	UN	2
5.	What are the different classifications of robots?	CO1	RE	2
6.	Define link	CO1	RE	2
7.	Define joint	CO1	RE	2
8.	Define Roll, Pitch and Yaw.	CO1	RE	2
9.	Define degrees of freedom.	CO1	UN	2
10.	What are the applications of serial manipulators?	CO1	UN	2
	PART B			
1.	Explain the different types of joints and explain the law of robotics.	CO1	RE	16
2.	Classify the different types of robot configurations with neat sketch.	CO1	UN	16
3.	Derive an expression for rotation of fixed frame with moving frame using the fixed angle rotation and Euler angles rotation with neat sketch.	CO1	AN	16
4.	List the generalized form of representing the position and orientation of objects also explain different types of series manipulators.	CO1	UN	16
5.	Explain the types of end effectors with neat sketch.	CO1	RE	16
6.	Explain in detail about the selection and application of serial manipulators.	CO1	UN	16

UNIT II

FORWARD KINEMATICS - GEOMETRICAL AND ALGEBRAIC APPROACH

Need for forward and Inverse Kinematic equations – Parameters in Design and Control – Methods of forward and inverse kinematics – Geometrical and Algebraic Approach in Forward Kinematics solution, 1 DOF – 2 DOF Planar Robot (2P and 2R); 3 DOF 2 RP Spatial Robot.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define forward kinematics.	CO2	RE	2
2.	What do you understand by the term spatial robot?	CO2	UN	2
3.	List the methods used for inverse kinematics.	CO2	UN	2
4.	Define inverse kinematics.	CO2	UN	2
5.	Determine the translated vector for the given vector v = 25i + 10j +20k, perform a translation by a distance of 6 units in X direction, 5 units in Y direction and 0 units in Z direction.	CO2	AP	2
6.	Define Spatial robot.	CO2	RE	2
7.	Define Planar robot	CO2	RE	2
8.	Define geometric approach	CO2	RE	2
9.	Define algebraic approach.	CO2	UN	2
10.	What is a 2R planar robot?	CO2	RE	2
	PART B			
1.	Explain the geometrical and algebraic approach in forward kinematics solution.	CO2	RE	16
2.	Explain 1 DOF and 2 DOF planar robot (2P and 2R) with neat sketch.	CO2	UN	16
3.	Derive forward and inverse kinematics equations of manipulator for a particular position. Briefly explain methods of forward and inverse kinematics.	CO2	AN	16
4.	Derive the Inverse Kinematic Equations of a 2 DOF Planar Revolute Robot.	CO2	AN	16
5.	Determine the position of a body point P in the local coordinate, if it is moved to $G_{rp} = [1,3,4]^T$ after global rotation. 1) A rotation of 45 deg about X-axis, 45 deg about Y-axis and 45 deg about Z-axis. 2) A rotation of 30 deg about X-axis, 30 deg about Y-axis and 30 deg about Z-axis.	CO2	AN	16
6.	Explain 3 DOF spatial robot (2RP) with neat sketch.	CO2	RE	16

UNIT III

FORWARD KINEMATIC MODELING – DENAVIT-HARTEBERG (DH) APPROACH

Unit Circle Trigonometry - Translation Matrix - Rotation matrix, Euler Angles - Quaternion Fundamental - Dot and Cross Products - Frames and Joint Coordinates - Homogeneous Transformation - D-H and Modified D-H Convention and Procedures – Forward kinematics Solution using D-H Convention: 3 DOF wrist, RR Planar, 3 DOF RRP, Cartesian, Cylindrical, Spherical, SCARA and Articulated 3 DOF robots.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What is meant by Euler angle?	CO2	RE	2
2.	Define Quaternion fundamental.	CO2	UN	2
3.	What is D-H convention?	CO2	RE	2
4.	Define SCARA.	CO2	RE	2
5.	Define unit circle trigonometry.	CO2	UN	2
6.	Define translation matrix.	CO2	RE	2
7.	Define rotation matrix.	CO2	RE	2
8.	Explain about the dot and cross product.	CO2	UN	2
9.	Define frame and joint coordinates.	CO2	RE	2
10.	Define homogeneous transformation.	CO2	UN	2
	PART B			
1.	Discuss the structure of the following matrix used in robotics position and orientation. (i) Homogenous transformation matrix. (ii) Rotational matrix. (iii) Dot and cross product matrix.	CO2	RE	16
2.	Find the forward kinematics using D-H parameter, relative transformation, total transformation and inverse kinematic equations for 3 degrees of freedom manipulator with P / -P / -P.	CO2	AP	16
3.	Explain the forward kinematics using D-H parameter, relative transformation, total transformation and inverse kinematic equations for 3 degrees of freedom manipulator with P / -R / R.		AP	
4.	Explain the forward kinematics using DH and inverse kinematics equations for 2 DOF manipulator with RP Planar configuration.	CO2	AN	16
5.	Enumerate different types of 3 DOF robots using D-H convention.	CO2	AP	16
6.	Derive the forward kinematic link for Cartesian, cylindrical, spherical, SCARA and articulated 3DOF robots.	CO2	AP	16

UNIT IV

INVERSE KINEMATICS MODELING

Introduction to inverse kinematics -Issues in inverse kinematics - Inverse kinematics of 2 DOF Planar robot - 2 and 3DOF planar and Spatial robot - Tool configuration - Inverse kinematics of 3-axis robot and 6-axis Robot - Inverse kinematics Computation- Closed loop solution - Degeneracy and Dexterity.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	What are the different methods to solve inverse kinematic problems?	CO2	RE	2
2.	Define closed loop solution.	CO2	UN	2
3.	What are the issues in inverse kinematics?	CO2	UN	2
4.	Define inverse kinematics.	CO2	UN	2
5.	Difference between planar and spatial robot.	CO2	RE	2
6.	Define inverse kinematic computation.	CO2	UN	2
7.	Define inverse kinematics of 3-axis robot.	CO2	RE	2
8.	What are the inputs and outputs of Forward Kinematics?	CO2	UN	2
9.	Write the position equations of a 1 DOF planar revolute robot.	CO2	AP	2
10.	Write the position equations of a 3 DOF spatial RP robot.	CO2	AP	2
	PART B			
1.	1. Write a short notes on the following: (i) Issues in inverse kinematics (ii) Inverse kinematic computation	CO2	RE	16
2.	Explain briefly inverse kinematics of Planar robot both 2DOF.	CO2	UN	16
3.	Explain briefly inverse kinematics of spatial robot both 2DOF and 3DOF.	CO2	UN	16
4.	Sketch and explain inverse kinematics of 6-axis robot.	CO2	AN	16
5.	Explain briefly about closed loop solution.	CO2	RE	16
6.	With neat sketch, discuss about inverse kinematics of a 3 DOF Planar robot.	CO2	UN	16

UNIT V

KINEMATIC MODELING OF DIFFERENTIAL DRIVE ROBOT

Degree of Mobility, Steerability and Maneuverability- Mobile Robot kinematics - Kinematic model and constraints – Representation of robot position – Kinematic models of differential wheel drive - Fixed wheel and steered wheel - Mobile manipulators and its applications – swarm robots.

Q.No	Question	CO	BTL	Marks
	PART A			
1.	Define swarm robots.	CO5	RE	2
2.	What is degree of mobility in robotics?	CO5	UN	2
3.	Define mobile manipulator.	CO5	UN	2
4.	Define mobile robot workspace.	CO5	UN	2
5.	Define steerability.	CO5	RE	2
6.	Define maneuverability.	CO5	UN	2
7.	What is the difference between fixed wheel and steered wheel?	CO5	RE	2
8.	Define mobile manipulators.	CO5	UN	2
9.	What are the applications of mobile manipulators?	CO5	UN	2
10.	Explain representation of the robot position.	CO5	UN	2
	PART B			
1.	Write a short notes on the following: (i) Steerability and Maneuverability (ii) Kinematic model and constraints	CO5	RE	16
2.	Discuss about the representation of robot position.	CO5	UN	16
3.	Present a survey on differential drive robot used in industrial application for loading, assemble and unloading.	CO5	AN	16
4.	Discuss about the kinematics models and constraints of mobile robot workspace.	CO5	UN	16
5.	Draw a suitable sketch and explain industrial application of robot in non-manufacturing field.	CO5	RE	16
6.	Explain mobile manipulators and its applications.	CO5	UN	16

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