MECHATRONICS, ROBOTICS & CONTROL
(MEC3103)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which of the following is NOT an element of a mechatronic system?
(a) Sensor (b) Actuator
(c) Mechanical system (d) Fertiliser

(ii) Which of the following is a type of gripper?
(a) Hydraulic (b) Magnetic
(c) Pneumatic (d) All of the above

(iii) Which of these robots has all its axes linear?
(a) Cylindrical (b) Cartesian
(c) Polar (d) SCARA

(iv) Pneumatic actuators work using:
(a) Water (b) Air (c) Oil (d) Gasoline

(v) Which of the following is used for precise angular positioning?
(a) Servo motor (b) Hydraulic cylinder
(c) Pneumatic cylinder (d) Induction motor

(vi) Stepper motors are controlled by:
(a) Voltage (b) Frequency (c) Pulses (d) Current

(vii) Which of these is an absolute encoder?
(a) Provides unique digital code for each position
(b) Gives pulses only
(c) Cannot measure displacement
(d) Works on temperature change

(viii) Which of the following is a temperature sensor?
(a) LVDT (b) RTD (c) Strain gauge (d) Encoder

(ix) Transfer function is the ratio of
(a) reference signal to output signal (b) output to reference signal
(c) all of the above (d) none of the above

(x) How many DH (Denavit-Hartenberg) parameters are associated with a link of a manipulator?
(a) 2 (b) 3 (c) 4 (d) 6

Fill in the blanks with the correct word

(xi) The number of independent motions of a robot is called _____.

(xii) The ability of a robot to return to the same point repeatedly is called _____.

(xiii) The speed of an AC motor can be controlled using a _____.

(xiv) Determination of specific joint angles of a manipulator to reach a desired position and orientation for its end-effector is called _____.

(xv) The process of calculating the position and orientation of the end-effector of a robotic manipulator, given the specific angles or positions of its joints is called _____.

Group - B

2. (a) Describe the role of sensors, controllers, and actuators in a mechatronic system. *[(CO1)(Understand/LOCQ)]*

(b) Compare conventional mechanical systems with mechatronic systems. *[(CO1)(Analyse/IOCQ)]*

6 + 6 = 12

3. (a) Compare soft grippers and hard grippers. *[(CO2)(Analyse/IOCQ)]*

(b) Compare spherical and cylindrical robots with diagrams and examples. *[(CO2)(Analyse/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) Show with neat sketches one mechanism that transforms:
I. Rotary to rotary motion
II. Rotary to reciprocating motion
III. Rotary to translational motion. *[(CO3)(Apply/IOCQ)]*

(b) Explain, with the help of a pneumatic circuit diagram, the operation of a double-acting cylinder for forward and reverse motion using a lever-operated directional control valve. *[(CO3)(Apply/IOCQ)]*

6 + 6 = 12

5. (a) Explain the functioning of a double-acting pneumatic cylinder with a suitable diagram. *[(CO3)(Apply/IOCQ)]*

(b) Discuss about the shape memory alloy. *[(CO3)(Understand/LOCQ)]*

6 + 6 = 12

Group - D

6. (a) Write the advantages, limitations, and applications of an inductive proximity sensor. *[(CO4)(Analyse/IOCQ)]*

(b) Write the advantages, limitations, and applications of an infrared sensor. *[(CO4)(Analyse/IOCQ)]*

6 + 6 = 12

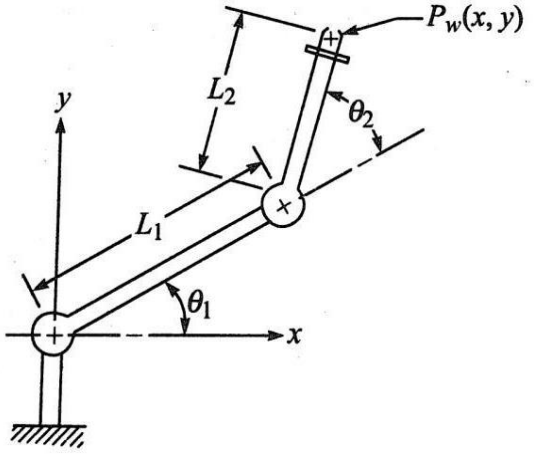
7. (a) Explain the working principle of an LVDT with a suitable diagram. *[(CO4)(Remember/LOCQ)]*

(b) Explain the image processing steps in robot vision. *[(CO4)(Apply/IOCQ)]*

6 + 6 = 12

Group - E

8. (a) It is desired to determine the values to which the angles θ_1 and θ_2 must be set in order to achieve a certain point in space for the manipulator shown in fig. 1. The length of joint 1, L_1 =10 cm, the length of joint 2, L_2 = 8 cm. The point P_w which the robot must achieve is defined by the coordinates x = 10.73 cm and y = 12.73 cm.

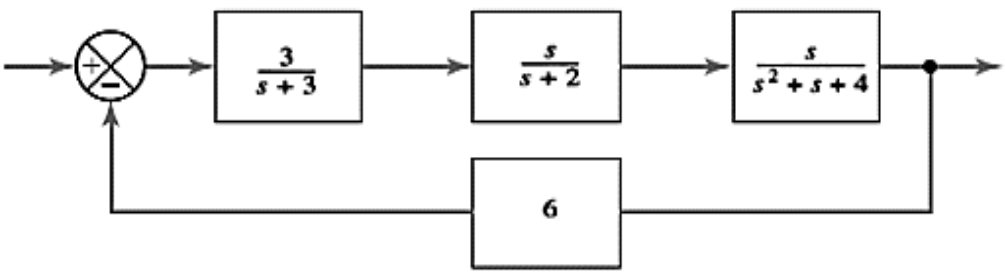


[(CO5)(Evaluate/HOCQ)]

(b) Determine a composite rotation matrix for the following sequence of rotations
(i) Rotation of angle α about X-axis,
(ii) Rotation of angle β about Y-axis and
(iii) Rotation of angle γ about Z-axis. *[(CO5)(Evaluate/HOCQ)]*

6 + 6 = 12

9. (a) Determine the transfer function for the following system shown in following figure.



[(CO6)(Apply/IOCQ)]

(b) Consider three frames {A}, {B} & {C}. Frame {B} is rotated relative to frame {A} about z-axis by 30^0 and translated 10 units in positive x-axis and 5 units in positive y-axis. Frame {C} is rotated relative to frame {B} about x-axis by 45^0 and translated 15 units in positive x-axis and 10 units in positive z-axis. Find the transformation matrix (${}^A_C T$), that describes frame {C} relative to frame {A}, then find the position of point "P" relative to frame {A} if ${}^C P = [6\ 5\ 7]^T$. *[(CO5)(Evaluate/HOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	18.75	62.5	18.75