

**GANPAT UNIVERSITY**  
**B.TECH SEM. VI- MECHATRONICS ENGINEERING**  
**REGULAR EXAMINATION NOV/DEC - 2011**  
**MC-702 ROBOTICS**

Time: 3 Hours

Total Marks: 70

**Instructions:**

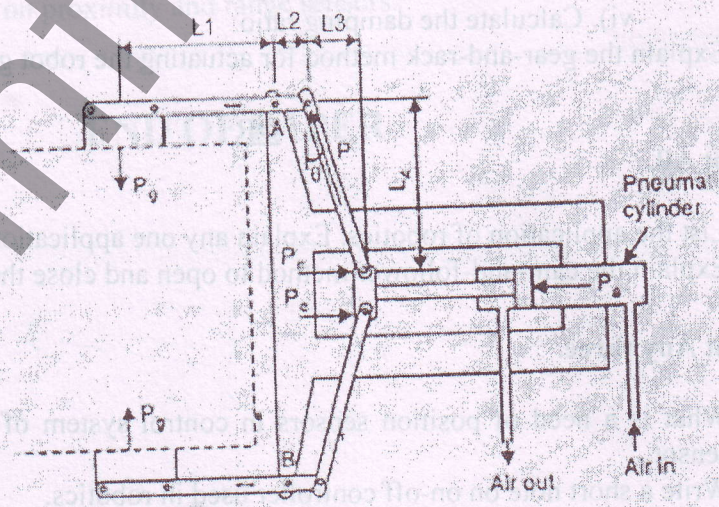
- 1). All questions are **compulsory**.
- 2). Figures to the **right** indicate full marks.
- 3). Answers to the two sections must be written in **separate** answer books.
- 4). Assume all necessary data.

**Section - I**

**Que:-1 Attempt All.**

[12]

- (A) Define rise time, maximum overshoot, accuracy and compliance.
- (B) Explain the various motions associated with the robot with neat sketches.
- (C) The mechanical gripper uses friction to grasp a part weighting 25N. The co-efficient of friction between the part and the gripper pad shown in fig. is 0.3. The gripper is accelerating down with a acceleration =  $9.81 \text{ m/s}^2$ . The diameter of the piston is of pneumatic cylinder is 65mm. Assume a factor of safety = 1.5 and assume the lengths  $L_1 = 60\text{mm}$ ,  $L_2 = 40\text{mm}$ ,  $L_3 = 15\text{mm}$  and  $L_4 = 45\text{mm}$ . Calculating the following
  - i). The gripper force to retain the part
  - ii). Actuation force required to achieve this gripper force



**OR**

Que:-1 Attempt All.

- (A) Explain the difference between the Cartesian configuration and cylindrical configuration of a robot.
- (B) A DA hydraulic cylinder is used to actuate one of the linear arm joint of a Cartesian robot. The diameter of the piston is 15 cm and the diameter of the rod is 6 cm. A pump supplies hydraulic oil at a rate of 30 cm<sup>3</sup>/sec with a pressure of 40 N/cm<sup>2</sup>. Determine
- The force that can be supplied by the piston in the forward and the reverse strokes
  - The maximum velocity with which rod can operate in forward and reverse directions
- (C) Explain different modes of a robot language operating system

Que:-2 Attempt All.

- (A) A certain robot manipulator has a mechanical joint described by the differential equation specifying the position of the output link as a function of time [06]

$$\frac{3.26 d^2 y}{dt^2} + \frac{17.5 dy}{dt} + 44.2 y = X$$

Where y gives the output response and X is the function describing the force applied.

- Write the characteristic equation
  - What are the roots of the characteristic equation?
  - Determine the type of response.
  - Write the transfer function.
  - Write the natural frequency and the resonant frequency.
  - Calculate the damping ratio.
- (B) Explain the gear-and-rack method for actuating the robot gripper. [05]

OR

Que:-2 Attempt All.

- (A) List the application of robotics. Explain any one application with neat sketch. [06]
- (B) Explain the cam-and-follower method to open and close the gripper. [05]

Que:-3 Attempt Any three.

- (A) What is a need of position sensors in control system of a robot? Explain any one sensor.
- (B) Write a short note on on-off controller used in robotics.
- (C) Discuss the leadthrough programming method for a robot.
- (D) What is spatial resolution of a robot? [12]

- (B) For a given equivalent matrix R, show that equivalent angle of rotation  $\theta$  about the k-axis and direction of axis k are given by [04]

$$\theta = \cos^{-1} \left[ \frac{(r_{11} + r_{22} + r_{33}) - 1}{2} \right] \quad \begin{bmatrix} k_x \\ k_y \\ k_z \end{bmatrix} = \frac{1}{2 \sin \theta} \begin{bmatrix} r_{32} - r_{23} \\ r_{13} - r_{31} \\ r_{21} - r_{12} \end{bmatrix}$$

Where,  $R = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix}$

Que:-5 Attempt All.

- (A) Explain construction & working of vidicon tube camera. [05]  
(B) Write a short note on force sensing wrist. [06]

OR

Que:-5 Attempt All.

- (A) Write down desirable features of sensors. [05]  
(B) Draw block diagram of machine vision system and explain each block in detail. [06]

Que:-6 Attempt Any three. [12]

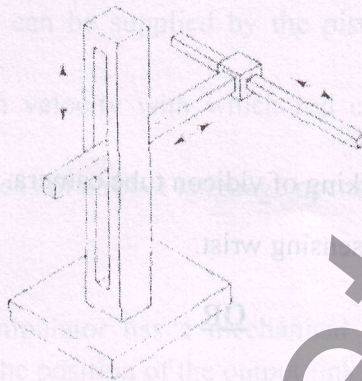
- (A) Define all DH parameters with figure.  
(B) Explain how to find vector representing a point in space when frame is rotated and translated frame with respect to initial frame.  
(C) Derive rotational transformation matrices for rotation about x and y axis.  
(D) Write a short note on proximity and range sensors.

**END OF PAPER**

**Section - II**

Que:-4 Attempt All.

- (A) Draw frame assignment and obtain DH parameter for each joint link. Also find the forward kinematics model for following configuration. [08]



- (B) The homogeneous transformation matrices between frames {i}-{j} and {i}-{k} are [04]

$${}^jT_i = \begin{bmatrix} 0.866 & -0.500 & 0 & 11 \\ 0.500 & 0.866 & 0 & -1 \\ 0 & 0 & 1 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad {}^kT_i = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.866 & -0.500 & 10 \\ 0 & 0.500 & 0.866 & -20 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Determine  ${}^jT_k$ .

**OR**

Que:-4 Attempt All.

- (A) Find DH parameters for robotics arm shown and find direct kinematic model. [08]

