

Student Exam No: \_\_\_\_\_

**GANPAT UNIVERSITY**  
**B.TECH SEM. VII - MECHATRONICS ENGINEERING**  
**REGULAR EXAMINATION NOV/DEC - 2012**  
**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.**

- (A) Define spatial resolution, payload and compliance of a robot. [03]
- (B) Explain degree of freedoms associated with a robot wrist with a neat sketch. [04]
- (C) A jointed arm robot of configuration VVR is to move all three axes so that the first joint is rotated through  $50^\circ$ , the second joint is rotated through  $90^\circ$ , and the third joint is rotated through  $25^\circ$ . Maximum speed of any of these joint is  $10^\circ/\text{sec}$ . Ignore effects of acceleration and deceleration. [04]
- (a) Determine the time required to move each joint if slew motion is used
- (b) Determine the time required to move the arm to the desired position and the rotational velocity of each joint, if joint-interpolation motion is used

**OR**

**Que:-1 Attempt All.**

- (A) Explain the working principle of a potentiometer [03]
- (B) Write a short note on the SCARA robot. [04]
- (C) Explain the speed or response and the stability of a robot. [04]

**Que:-2 Attempt All.**

- (A) (a) One of the links of a robot has a telescopic arm with a stroke of 1500 mm. The control memory of the robot has 10-bit storage capacity for this axis. Determine the control resolution for the same. [04]
- (b) Explain the difference between the playback robot with point-to-point control and playback robot with continuous path control.



- (B) A vacuum gripper will be used to lift flat plates of 18-8 SS. Each piece of steel is  $\frac{1}{4}$  in. thick and measures 2.5 by 3.5 ft. The gripper will utilize two suction cups separated by 1.5 ft. for stability. Each suction cup is round and has a diameter of 4.0 in. The negative pressure required to lift the SS plate is to be determined. A safety factor of 1.5 is used. SS has a density of  $0.28 \text{ lb/in.}^3$ . [04]
- (C) Explain the different parts mating operations which can be performed by a robot. [04]

OR

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 [05]

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

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

- i). Write the characteristic equation
  - ii). What are the roots of the characteristic equation?
  - iii). Determine the type of response.
  - iv). Write the transfer function.
  - v). Write the natural frequency.
- (B) Explain the permanent magnet actuation method to open and close the gripper. [05]
- (C) What are the three laws of robotics? [02]

Que:-3 Attempt Any three. [12]

- (A) Explain the following commands of the robot VAL II programming language.
- |            |             |
|------------|-------------|
| (i) MOVE   | (iii) APPRO |
| (ii) MOVES | (iv) DEPART |
- (B) Write a short note on the remote center compliance (RCC) device.
- (C) How does the robotics coincide most closely with programmable automation?
- (D) Explain the different components of a hydraulic system used in a robot.

### Section - II

Que:-4 Attempt All.

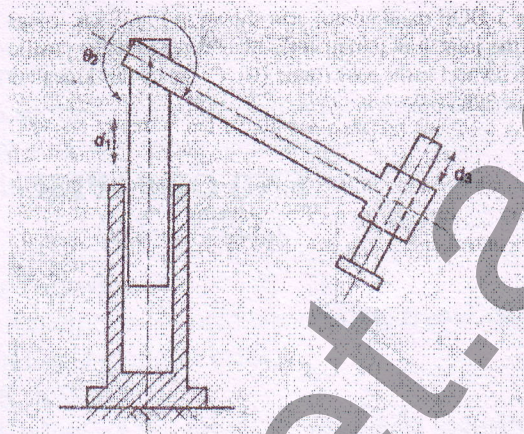
- (A) Find out the forward and the inverse kinematics of the final position of the end effector of a 3 DOF Cartesian robot arm. [08]
- (B) A vector  $P = 5i - 32j + 7k$  is first rotated by  $60^\circ$  about x-axis, then by  $90^\circ$  about z-axis. [04]  
Finally, it is translated by  $-3i + 4j - 6k$ . Determine the new position of vector P.



OR

Que:-4 Attempt All.

- (A) For the 3 -DOF robotics manipulator arm shown in the below figure, assign frames to each of the link and determine the joints -link parameters and, therefore, obtain the direct kinematic model. [08]



- (B) What is Mapping? Discuss that the second frame is translated with respect to the first frame. [04]

Que:-5 Attempt All.

- (A) Write a short note on the sampling and the quantization. [06]  
(B) Write down different desirable features of sensors in robotics. [05]

OR

Que:-5 Attempt All.

- (A) What is segmentation? Describe the edge detection technique of the segmentation. [06]  
(B) What are the uses of sensors in robotics? [05]

Que:-6 Attempt Any three. [12]

- (A) Derive matrix formula for inverting homogeneous transformation matrix without taking its inverse.  
(B) Write a short note on the composite transformation.  
(C) Explain construction & working of the vidicon tube camera.



(D) The homogeneous transformation matrices between frames  $\{i\}$ - $\{j\}$  and  $\{i\}$ - $\{k\}$  are

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

Determine  ${}^jT_k$

END OF PAPER

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