

Time: 3 Hrs

Marks: 80

N.B.: (1) Question No. 1 is **Compulsory**.

(2) Attempt any **three** questions out of the remaining **five**.

(3) Each question carries 20 marks and sub-question carry equal marks.

(4) Assume suitable data if required

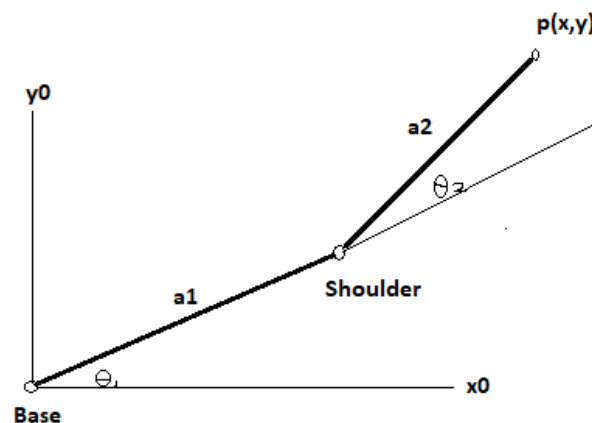
**Q.1**

**(20)**

- What are the essential components of a robotic system? State the main functions of each of the components. **5**
- Define kinematic parameters. Explain them with neat sketches. **5**
- Discuss control problems for the manipulator. **5**
- Explain briefly the following terms i) Dextrous Workspace, ii) reachable Workspace, iii) Sensor Noise, iv) Sensor Aliasing. **5**

**Q.2**

- Consider the two axes planer articulate robot as shown in figure Compute by trigonometry. Coordinate position  $p(x,y)$  of the end P of the arm in terms of  $a_1, a_2, \theta_1, \theta_2$ . **10**



- Derive equation of motion of planer 2R manipulator using Lagrangian Formulation. **10**

**Q.3**

- State and explain different challenges in mobile robot localization. **10**
- A frame  $\{B\}$  is described as initially coincident with  $\{A\}$ . We then rotate  $\{B\}$  about the vector  ${}^A\hat{K} = [0.707 \ 0.707 \ 0.0]^T$  (passing through the point  ${}^AP = [1.0 \ 2.0 \ 3.0]$ ) by an amount  $\Theta = 30$  degrees. Give the frame description of  $\{B\}$  **10**

**Q.4**

- Write Short note on concept of Collision Avoidance **5**
- Write short note on applications of Humanoids. **5**
- Discuss different Linear control Schemes for robotic manipulator. **10**

- Q.5** a) In a Stanford Arm Manipulator 6 DOF robot, the second joint is to move from an initial position of 20 degrees to final position of 68 degrees in 4 seconds. Assume that the joint starts and finishes at zero velocity and find cubic polynomial that satisfies this motion. Calculate the position, velocity and acceleration of this joint at intervals of 1 second and show their plots against time. **10**
- b) Explain Bug 1 and Bug 2 Algorithm. **10**
- Q.6** Solve **any Two** **(20)**
- a) Differentiate between Joint space technique and Cartesian space Technique for robotic Manipulator Trajectory. **10**
- b) Write Short note on applications of robots for military applications. **10**
- c) Explain Denavit Hartenberg Algorithm in detail. **10**

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