(3 Hours) **Total Marks: 80**

N.B: (1) Question No. 1 is compulsory.
(2) Attempt any three from the remaining questions.
(3) Figures to the right indicate full marks.
(4) Each question is of 20 Marks.

Q1. Answer ANY FOUR.

a) Summarize the principles and strategies of Automation. **05**
b) Discuss the selections criteria of robot grippers. **05**
c) Compare process industry and discrete manufacturing industry. **05**
d) Describe briefly joint and link parameters of a robotic arm. **05**
e) Discuss the need of modelling and simulation for manufacturing plant automation. **05**

Q 2. Answer the following.

a) Explain applications of automation in production systems. **10**
b) Explain the use of optical encoder as position sensor in robotic application. **10**

Q 3. Answer the following.

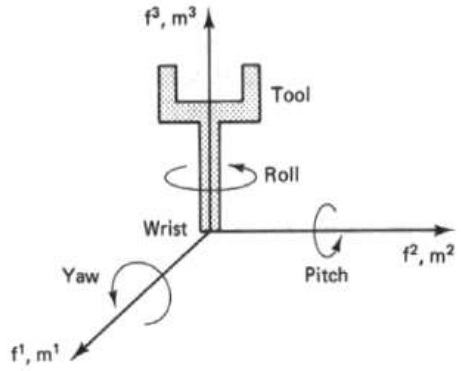
a) Illustrate WAIT, SIGNAL, and DELAY commands used in robot programming with help of program. **10**
b) Describe the use of modern tools in manufacturing plant automation. **10**

Q 4. Answer the following.

a) Classify robots on the basis of type of drive, type of control, and work envelope. **10**
b) Discuss the features of various programming languages of robot. **10**

Q 5. Answer the following.

a) Discuss the Denavit-Hartenberg algorithm for solving direct kinematic problem of a robot. **10**
b) Let $F = \{f^1, f^2, f^3\}$ and $M = \{m^1, m^2, m^3\}$ be fixed and moving orthonormal coordinate frames in R^3 space. For the tool shown in figure, derive the yaw, pitch, roll transformation matrix assuming the origins of the two frames and axes are coinciding in the beginning. **10**



Q 6. Attempt the following.

a) Illustrate the working of Magnetic gripper and Vacuum gripper. State advantages and limitations. **10**
b) Describe the velocities and static forces in robotic manipulator. **10**
