TIME- 3 Hours **Total Marks: 80**

N.B. 1) Question **No. 1 is compulsory**.
2) Attempt **any Three questions** from the remaining five questions.
3) Assume any suitable data if necessary with justification.
4) Figures to the right indicate full marks.
5) Use of design data book is permitted.
6) Draw neat sketches to support your answer wherever necessary.

Q. 1 Attempt (Any Four) **20**

a) Anatomy of Robotic manipulator.
b) Applications of Robotics.
c) Kinematics of Robot manipulator
e) Differentiate between trajectory and path.
f) Work space and dexterous work space

Q. 2 a) Explain D-H parameters with a neat sketch. **08**
b) Derive a Direct kinematic model of a 3-DOF articulated Robotic manipulator (R-R-R) with a neat sketch. Assume constant parameters of the configuration. **12**

Q. 3 a) Explain the basic arm configurations of 3-DOF manipulators and derive work space characteristics of each configuration with a neat sketch. **12**
b) Types of mechanical grippers used in Robotic arm, **08**

Q. 4 a) Derive the trajectory plan for an articulated joint to execute $\theta_i = 30^o$ to150^o using cubic polynomial scheme in 10 seconds. **10**
b) Explain in detail position, Velocity and acceleration sensors used in Robotics **10**

Q. 5 a) Explain in detail data acquisition and digitisation of a machine vision system. **8**
b) Explain the following vision algorithms: **12**
a. Segmentation
b. Edge detection

Q. 6 Write short notes on the any of the four in the following: **20**
a. State space search method
b. Robotic cell design and control
c. Control scheme for robotics
d. Actuators used in Robotics
e. Robot drive system.
