

Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech(MTI)/SEM-1/MTI-109/2009-10

2009

ROBOTICS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any *seven* questions. $7 \times 10 = 70$

1. a) State the third law of robotics. 2
b) Name the components of a robot. 2
c) Describe the function of control unit of robot controller. 3
d) Distinguish between internal sensors and external sensors. 3
2. a) "The dextrons workspace of a robot is subset of the reachable workspace." Justify the statement. 3
b) Explain why articulated robots are less expensive for applications needing smaller workspace. 3
c) Explain briefly how motion of a robot is programmed using teaching arm or pendant. 4
3. a) Explain why a factor of safety is included in determining recommended load capacity of a robot. 3
b) A robot with one degree of freedom has one sliding joint with a full range of 1.0 m. The robot's control memory has 12-bit storage capacity. Determine the control resolution for the axis. 4
c) Explain the working principle of a cam actuated gripper with a neat sketch. 3



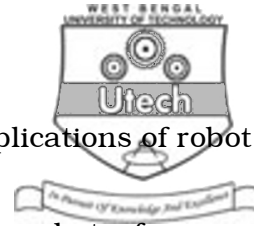
4. a) What type of gripper is used to handle fabrics ? Explain the working principle. 3
- b) What type of tool is mounted on the wrist of an industrial robot to rout workpiece edges, remove flash from plastic parts and to do rough snagging of castings.3
- c) A part weighing 8 pounds is to be held by a gripper using friction against two opposing fingers. The coefficient of friction between the fingers and the part surface is estimated to be 0.3. The orientation of the gripper will be such that the weight of the part will be applied in a direction parallel to the contacting finger surfaces. A fast cycle is anticipated so that the g factor to be used in force calculation should be 3.0. Compute the required gripper force for the specification given. 4
5. a) Explain why reduction gears are used for electric motors. 3
- b) Describe the main parts of a hydraulic actuation system with a neat sketch. 7
6. a) Explain the working principle of an incremental encoder with a neat sketch. 4
- b) Differentiate between touch sensor and tactile sensor. 3
- c) Name three proximity sensors. 3
7. a) Explain the working principle of vidicon camera with a neat sketch. 5
- b) Name the different techniques for image processing and analysis. 2
- c) Name six basic features and measures for object identification for two-dimensional objects. 3
8. a) Define robot programming. 2
- b) Write a small program using the following VAL commands : OPEN, MOVE, CLOSE, DEPART. 4
- c) Explain the basic elements and functions of robot language. 4



9. An SCARA robot of four degrees of freedom is shown in figure. Derive the complete set of forward kinematics equation by performing the following steps :

- | | |
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| a) Establish appropriate Denavit-Hartenberg (D-H) coordinate frames. | 2 |
| b) Construct a table of link parameters. | 2 |
| c) Form A matrices — A_1, A_2, A_3, A_4 . | 4 |
| d) Compute transformation matrix T_4 . | 2 |

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10. a) Name the main areas of industrial applications of robot. 2
- b) Write the main requirements of the robots for spray coating application. 4
- c) In a particular robot project the total investment cost is estimated to be Rs. 50,00,000. The total operating costs (labour, maintenance and other annual expenses) are expected to be Rs. 10,00,000 per year and the anticipated revenues from the robot installation are Rs. 32,50,000 annually. It is expected that the robot project will have a service life of 5 years. Determine the payback period that is expected of the investment. 4

