Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / M. TECH (ME) / SEM-2 / MMT-203 / 2011

2011

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.

Question No. **1** in **Group A** is compulsory.

Answer any *five* questions from **Group B** and **Group C**, taking at
least *two* from each Group.

GROUP – A

[Compulsory]

1. a) What is robot ? What are the basic components of a
robotic system ? State the main function of each of the
components.

    b) What is work envelope of a robot ? Sketch two views to
indicate the work envelope of a

        i) Cartesian robot

        ii) Cylindrical robot

        iii) Polar robot

        iv) Anthropomorphic robot.   (1 + 2 + 3) + (2 + 2)

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GROUP – B

2. a) Explain basic control system. Deduce the mathematical model for the 2nd order spring mass system.

   b) Explain undamped, underdamped, critically damped and over damped system from the characteristics equation.

   c) A mechanical joint design for a certain robot manipulator has the following differential equation which describes the position of the output link as a function of time :

   $$\frac{3 \cdot 26 \, d^2 y}{dt^2} + \frac{17 \cdot 5 \, dy}{dt} - 44 \cdot 2y = x$$

   where x equal to the forcing function and y represents the positions response of the joint.

   i) Write the characteristic equation for the differential equation above.

   ii) Determine the roots of the characteristic equation.

   iii) Best on the roots of the characteristic equation will the response be undamped, underdamped, critically damped or overdamped ? 4 + 4 + 4

3. a) What are the functions of the sensors ? What are the different types of sensors ? Classify them with example.

   b) What are meant by Range sensor and proximity sensor ?

   c) What is template matching ? Describe briefly the method. 5 + 3 + 4
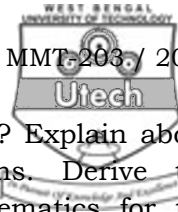
4. a) What is robot manipulator kinematics ? Explain about Forward and Reverse Transformations. Derive the equation for forward and reverse kinematics for the 3D configuration.

   b) What is robot vision ? What are the types of vision sensor used to take the image of an object ?

   c) What are the functions of vision processor ? What are the steps necessary in the image processing ?   4 + 4 + 4

5. a) What are lead through method and textual robot language method of robot programming ? Differentiate between these two.

   b) What are the different generations of robot language ? Explain robot language structure with diagram.

   c) A weldment is to be made. The weld trajectory is a continuous path arc welding along the paths $X_2 - X_3$ with triangular weaving, $X_3 - X_1$ with straight weld, $X_4 - X_5$ with circular interpolation, $X_6 - X_7$ with straight weld, $X_7 {}^- X_8 {}^- X_9$ with circular arc, $X_9 {}^- X_{10}$ with straight line weld and $X_{10} {}^- X_{11}$ with five point weaving. The weld torch begins its movement from home position X_1 and departs to location X_{12}. Cater filling is done at the end of trapezoidal weaving. Write the VAL program for suitable arc welding.   4 + 4 + 4

GROUP – C

6. a) Why are SCARA robots preferred for assembly operations ? Compare and contrast revolute robots and SCARA robots from the viewpoint of assembly operations.

   b) What are the important characteristics to be added to the existing commercial robots to improve them for using in the factory of future ? Suggest a good robot system plan.

   c) What is teleported robot ? How can it be used for maintenance of a reactor plant ?   4 + 4 + 4
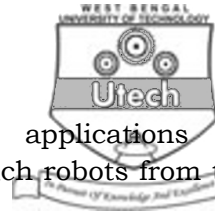
7. a) What are the possible robot applications in manufacturing industry ? Classify such robots from the view point of drives and control.

   b) What is robotic welding ? Describe briefly the operations involved in robotic spot welding. What are the advantages of robotic welding over manual welding ?

   c) How robotic technology can help undersea welding. Explain. $5 + 4 + 3$

8. a) It is desired to have the first joint of a six-axis robot to move from the initial, $\theta_i = 15°$, to final positions, $\theta_f = 75°$ using a cubit polynomial

   i) determine the trajectory

   ii) calculate joint angle at 2 sec

   iii) comment on its end point velocities and acceleration.

   b) What is Trajectory planning of robot arm manipulator ? What are the different Trajectory planning techniques there ? Explain and derive any one methods of trajectory planning.

   c) What is point to point planning and what is continuous path generation ? Explain with example. What is collision free path planning ? $4 + 4 + 4$

9. a) Define inverse and forward dynamics of a robot manipulator.

   b) Derive the Euler-Lagrange (EL) equations of motions for a Revolute-Prismatic (RP) joined manipulator.

   c) Find at least three commercial softwares which are capable of performing dynamics of a robot manipulator.

   d) What are the apparent advantages and disadvantages of the Euler-Lagrange and Newton-Euler formulations.

   $3 + 4 + 2 + 3$

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