(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 199854 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. VIII) THEORY EXAMINATION 2013-14

AUTOMATION AND ROBOTICS

Time : 3 Hours *Total Marks : 100*

Note :– Attempt all questions.

1. Answer any **two** parts of the following : **(10×2=20)**

(a) (i) Give a classification of industrial robots based on arm geometry configurations and control systems. Your answer should be supported by neat sketches.

(ii) Discuss the advantages and disadvantages of the following robot configurations :

(a) Rectangular co-ordinate type

(b) Spherical co-ordinate type

List their areas of applications.

(b) (i) Sketch and explain the working of the following types of grippers :

– Angular type

– Vacuum type.

(ii) A Carton weighing 10 kg is held in a gripper using friction against two opposing fingers. Coefficient of friction = 0.25. Weight of the Carton is directed parallel to finger surfaces. Determine the required gripping force. Assume a g-factor of 2.0.

(c) Discuss the factors to be considered while selecting the drive systems for robots. Compare the relative advantages and disadvantages of the following robot drives :

(i) Electric motor

(ii) Pneumatic system

(iii) Hydraulic motor.

Recommend suitable drives for the following :

– Pick and Place robot (light loads)

– Robot for loading and unloading heavy work-pieces and assembly Robot.

2. Answer any **two** parts of the following : **(10×2=20)**

(a) Explain in brief the following :

– Kinematics of Manipulators

– Forward Kinematics

– Inverse Kinematics.

A point "u" is rotated by 90° about z-axis to yield point v. This point (v) is rotated by 90° about y-axis to obtain point "w" and finally the point w is translated by –5, 3, 8 along x, y, z axis respectively to obtain the point "x_1".

What is the co-ordinate of x_1 ? Given that $u = \begin{bmatrix} 7 \\ 3 \\ 2 \end{bmatrix} = u$.

(b) Fig. 1 shows a 2-link planer arm. Given that AB = 10 mm, BC = 20 mm, AD = 26.98 mm and CD = 12.6 mm compute the value of θ_2. If AZ = 15.00 mm and AD = 30 mm, what is the value of θ_1 and θ_2 ?

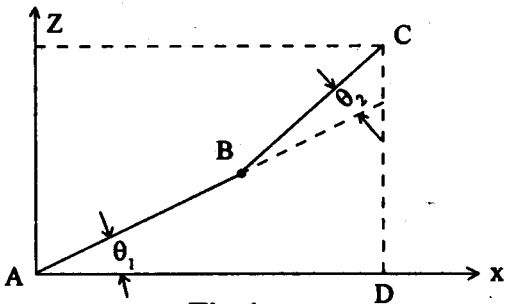

Fig. 1

(c) A single link robot with rotary joint is motionless at θ= 15°. It is desired to move the joint in a smooth manner to θ = 75° in 3 secs. Find the coefficients of a cubic which accomplishes this motion and brings the arm to rest at the goal. Plot the velocity and acceleration profile of the arm.

3. Answer any **two** parts of the following : **(10×2=20)**

(a) Discuss the working principles and important characteristics of the following types of controls :

– Proportional control

– Integral control

– Derivative control

– PID control

– On-Off control

Describe their relative merits and demerits and mention their applications.

(b) A mechanical device used in a forge press operation follows the following equation of motion :

$$16.3\frac{d^2y}{dt^2} + 87.5\frac{dy}{dt} + 221y = F$$

F = Forcing function, y = response

Examine, if the system response be oscillatory ? Determine the roots of the characteristic equation and damped natural frequency.

(c) (i) Discuss the difference between feed-back control and adaptive control. Differentiate between ACO and ACC types of adaptive control.

(ii) Describe the following in an adaptive control system :

– Identification function

– Decision function

– Modification function.

With the help of a neat sketch explain the help of a neat sketch explain how the three functions are incorporated in an adaptive control system.

4. Answer any **two** parts of the following : **(10×2=20)**

(a) With the help of suitable illustration, explain the following :

– Collision free motion planning

– Robot programming synthesis

– Assembly sequence planning.

(b) A robot is required to drill 16 holes on a 20 × 20 mm grid as shown in Fig. 2. Write a robot operation program for the above in VAL II. Assume speed = 20% of the normal speed.

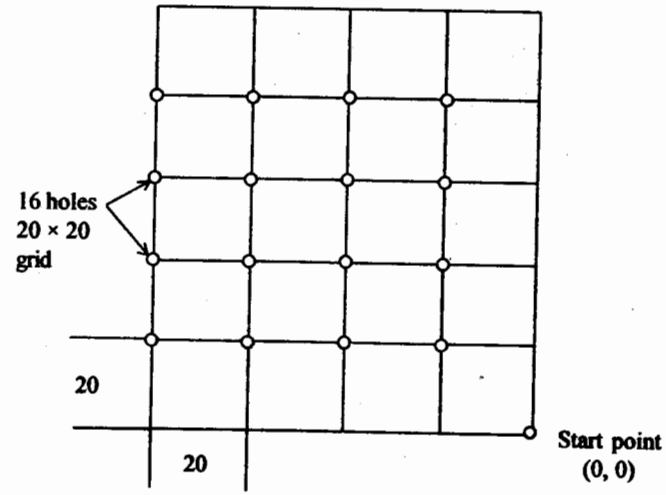

Fig. 2

(c) Discuss the major disadvantages of language based programming. How can task level processing can solve these ? Discuss. Use a suitable illustration to support your answer.

5. Answer any **two** parts of the following : **(10×2=20)**

(a) Give a list of factors that should be considered while evaluating a robot for welding capabilities. Give suitable explanations in support of your answer.

(b) Describe the important characteristics of robot grippers for robotic assembly operations. Give a list of design rules for designing a part for robotic assembly.

(c) (i) Table below gives the operation times for a sequential activity related to loading and unloading a press. Compute the cycle time and the number of units produced per 8 hrs. shift for (i) one hand gripper (ii) two hand gripper.

Activity	**Time (Secs.)**
Machine operation time	25.0
Unload the unit with a robot	1.2
Robot moves to finished part conveyor	1.7
Release the unit	0.2

Activity	**Time (Secs.)**
Move the arm to input conveyor	2.6
Pick a unit	0.3
Move to machine	1.9
Load the machine	2.1

(ii) Discuss the general characteristics of industrial work situations that tend to promote the substitution of robots for human labour.