GANPAT UNIVERSITY

B.Tech. Sem. VIIth Mechatronics

External Examination December 2013

2MC702 **Robotics**

Time: 3 Hrs **Marks: 70**

Instructions:

(i) All questions are compulsory.
(ii) Answers to two sections must be written in separate answer books.
(iii) Assume suitable data if required but state them clearly in your answer-books.
(iv) Figure to the right indicates full marks.

SECTION – I

Q1 Answer the following Questions. **12**

(a) State and explain various aspects that justify the needs of Robots in industries.

(b) Define Robot as per Robotics Industries Association. Discuss the differences between polar arm and articulated arm configurations.

(c) Define & Explain different robot capabilities.

OR

Q1 Answer the following Questions. **12**

(a) What are the costs involved in the calculation of payback period for investment made on robot?

(b) Write short note on robot application in space application.

(c) How many degrees of freedom can a wrist have? What is the purpose of these degrees of freedom?

Q2 Answer the following Questions. **12**

(a) Give design consideration for Mechanical Gripper.

(b) Explain importance of duel gripper over single gripper in machine loading /unloading application.

(c) Figure 1. show mechanism of mechanical gripper calculate the gripper force Fa for Fg = 30 N.

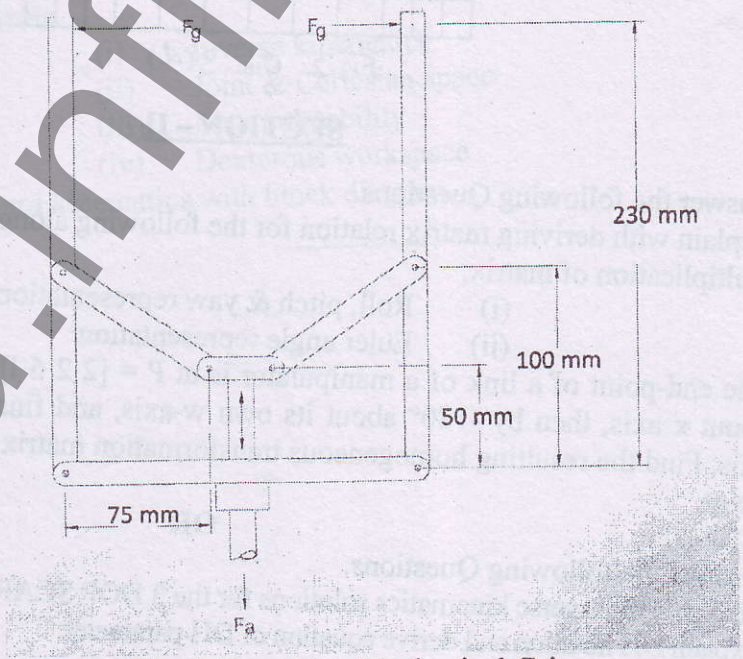

Fig. 1 Que. 2 (c) Mechanical Gripper

OR

Q2 Answer the following Questions. 12

(a) Describes different path control, normally used for robots with examples.

(b) A vacuum gripper is to be designed to handle flat platen glass in an automobile windshield plant. Each plate weights 18 kgs. A single suction cup will be used, and the diameter of the suction cup is 125mm. determine the negative pressure required to list each plate. Use a safety factor of 2 in calculation.

(c) Explain Edge-detection algorithm for Binary Images.

Q3 Write answers on following **(Any three)** 11

(a) The second joint of a SCARA manipulator is required to move from $\theta_2 = 30^0$ to 150^0 in 5 seconds. Find the cubic polynomial to generate the smooth trajectory for the joint. What is the maximum velocity and acceleration for this trajectory?

(b) List and describe different types of motion which can be imported to robot manipulator for traveling from one point to another.

(c) Explain Architecture of a computer-based intelligent robotic manipulator.

(d) Compute the area, centroid, aspect ratio and orientation of the binary image shown in Fig.2

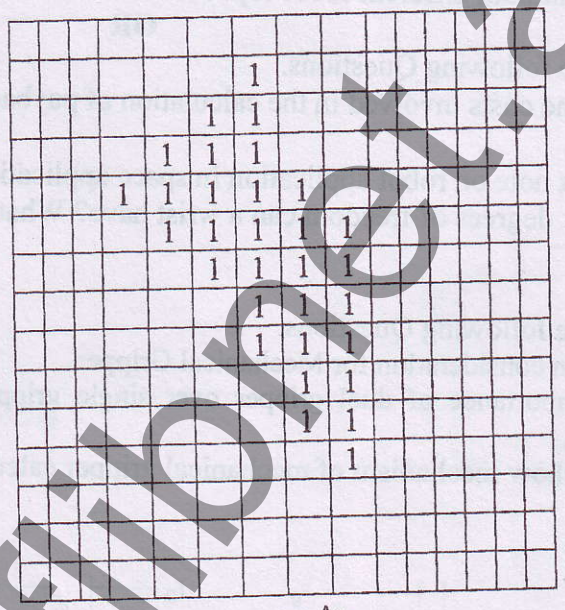

Fig.2 Que. 3(d)

SECTION – II

Q4 Answer the following Questions.

(a) Explain with deriving matrix relation for the following along with importance of order of multiplication of matrix. 6

(i) Roll, pitch & yaw representation

(ii) Euler angle representation

(b) The end-point of a link of a manipulator is at P = [2 2 6 l]T. The link is rotated by 90° about x axis, then by -180° about its own w-axis, and finally by -90° about its own v-axis. Find the resulting homogeneous transformation matrix and the final location of end-point. 6

OR

Q4 Answer the following Questions.

(a) Find general Inverse kinematics solutions for the 3 DOF SCARA Robotics Arm. 8

(b) Explain DH notation and derive equation of DH parameter. 4

OR

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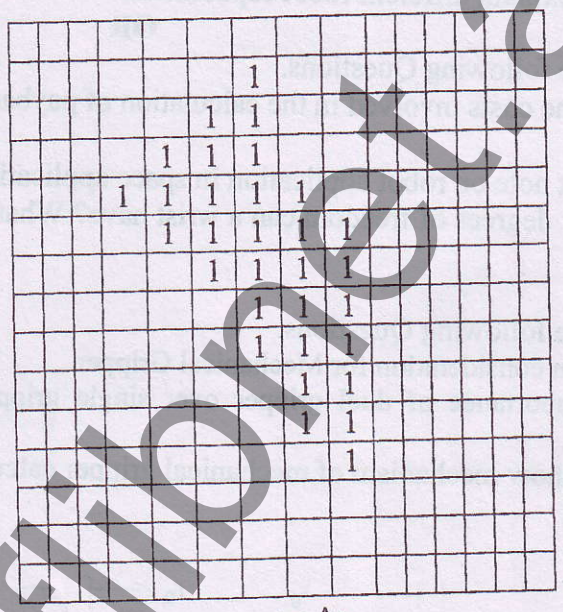

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Q5 Answer the following Questions.

(a) A vector P = 3i - 2j + 5k is first rotated by 90° about x-axis, then by 90° about z-axis. Finally, it is translated by -3i + 2j - 5k. Determine the new position of vector P. 4

(b) For the 3-DOF manipulator arm shown in figure 3, assign frames and obtain the joint-link parameter. Also, determine the position of the tool tip with respect to the base frame{0}. 7

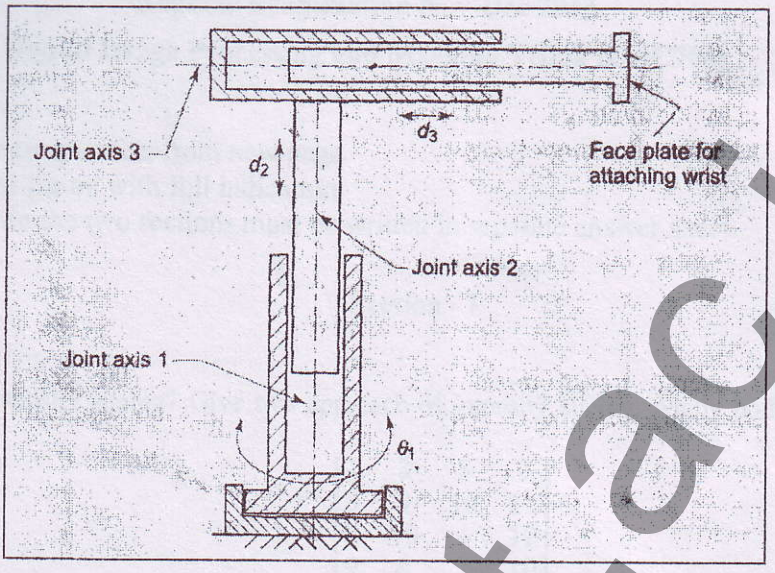

Fig. 3 Ques 5(b)

OR

Q5 Answer the following Questions.

(a) State and explain laws of robotics. 3

(b) Find out the final position of end effectors of Articulated arm forward and inverse kinematics. 8

Q6 Write answers on following **(Any three)** 12

(a) Define types of joints, its degree of freedom, symbols and explain how different combination of joints & order of joints made different shape of work volume.

(b) What is Mapping? Discuss second frame translated with respect to first frame.

(c) Explain the terms

(i) Inverse kinematics
(ii) Joint & Cartesian space
(iii) Manipulatability
(iv) Dexterous workspace

(d) Explain forward kinematics with block diagram.
