KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year 1st Term Examination, 2014

ME 4083

(Robotics)

Time: 3 Hours | Total Marks: 210

N.B.: i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) Define 'Robot'. What can robots do? Classify robots with example of each. 07

1(b) Briefly explain the history of Robotics. 10

1(c) Describe the application areas of modern Robots. 10

1(d) Compare Robot with human labor and explain why Robot is preferred. 08

2(a) What are the basic components of a Robot? What are the specific points need to be considered for Manipulator design? 12

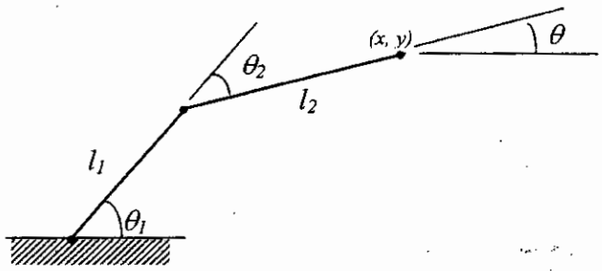
2(b) Mention different types of sensors that are used in robot. What is the working principle of range finders for robot? 13

2(c) What are the characteristics of actuator systems? What type of actuator is used to grip an object by robot? 10

3(a) What is forward kinematics and inverse kinematics? 06

3(b) By considering universal coordinate system, draw a 3 link manipulator with different link lengths. Now rotates the joints about $\hat{z}$ axis by different joint angles. Select the link lengths and joint angles as you like and find the Denavit-Hartenberg parameters. Finally compute the orientation and position of the end-effector with respect to base. 17

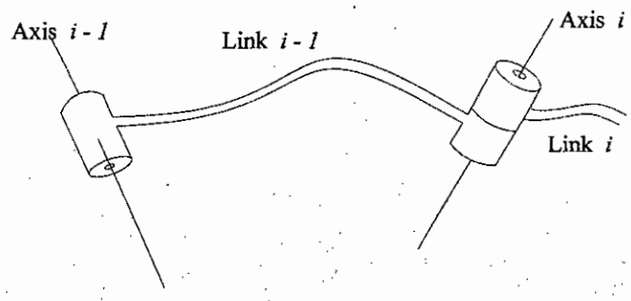
3(c) Find two joint angles from 2–DOF planner manipulator using given end-effector position. 12



4(a) Explain mappings involving translated frames, rotated frames and general frames with necessary figures and equations. 12

4(b) Consider frame {A} as universal coordinate system. Frame {B} is rotated relative to frame {A} about $\hat{Z}$ by 60 degrees, translated 15 units in $\hat{X}_A$, and translated 7 units in $\hat{Y}_A$. Draw the both frames and find ${}^{A}P$, where ${}^{B}P = [4\ \ 9\ \ 0]^{T}$. 08

4(c) Derive the homogeneous transformation matrix from {i – 1} to {i} frames by using Denavit–Hartenberg parameters. 15



SECTION-B

5(a) What is 'path' and 'trajectory'? Make a comparison between joint and Cartesian space. 10

5(b) Mention the procedure of trajectory planning in joint space. 12

5(c) List some methods of planning in joint spaces. Explain cubic polynomial method to calculate a_0, a_1, a_2 and a_3 from four constraints. 13

6(a) What is the purpose of robot control? Explain feed forward and feed back control for robotic systems. 12

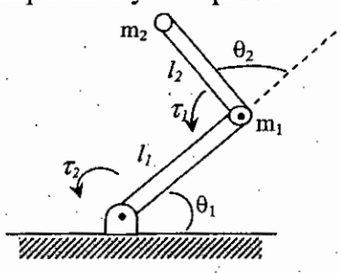
6(b) Derive the control law for force control of a mass-spring system. 15

6(c) What are the purposes of force sensing for manipulator? 08

7(a) What is Jacobian? Explain Singularity, and mention the relationship between Jacobian and Singularity. 08

7(b) What is dynamic modeling? What are the outward and inward iterations of iterative Newton–Euler Dynamic Formulation? 07

7(c) Calculate the joint torques of a 2–DOF planner manipulator as shown in figure. Take the necessary assumptions if you required. 20



8(a) Mention the different methods of robot programming? What are the requirements of a robot programming language? 15

8(b) Design a Robot manipulator with available sensors and actuators which trajectory planning method is suitable for your purpose and how you will control your robot. Explain with necessary sketch. 20

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