PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

MIDTERM EXAMINATION

Winter Semester: 2021 - 22

Course Code: MEC 3065

Course Name: Introduction to Robotics and Automation

Program & Sem: B. Tech (MEC) & II

Date: 14/MAY/2022

Time: 01:30 PM to 03:00 PM

Max Marks: 50

Weightage: 25%

Instructions:
  (i) *Read the all questions carefully and answer accordingly.*

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries THREE marks.   **(5Qx 3M= 15M)**

1 Define a Robotic Manipulator.   (C.O.No.1) [Knowledge level]
2 Define End-effector of a Robot.   (C.O.No.1) [Knowledge level]
3 Differentiate between Prismatic Joint & Sliding joint.   (C.O.No.1) [Knowledge level]
4 Define DOF. Also write down DOF of a SCARA robot.   (C.O.No.1) [Knowledge level]
5 Brief any four applications of a Robotics System.   (C.O.No.1) [Knowledge level]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks.   **(2Qx10=20M)**

6 Shashwat has written a program on Python that solves the forward kinematics problem for a robot manipulator with two links connected in series with two revolute joints. The motion of this robot is constrained in a plane. He has sent the program to his favourite teacher to check its correctness. Unfortunately, the teacher doesn't know Python programming. So the teacher decides to check the program's output using the following data. The length of the first link is 10 mm, the length of the second link is 7 mm, the angle of the first joint is 15 degrees and the angle of the second joint is 45 degrees. If the program is correct, what should the coordinates of the end effector of the robot be?

(C.O.No.1) [Comprehension level]

7 A prelude to solving the forward kinematics of a robot manipulator involves the determination of its degrees of freedom. MechaTron, Inc., has developed a robotic arm which is serial link manipulator operating in a plane. The robot has one fixed link, and three moving links with two revolt joints and one prismatic joint. Determine the degrees of freedom of this robot

(C.O.No.2) [Comprehension level]

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries FIFTEEN mark.   **(1Qx15M=15M)**

8 The transformation of the coordinates of an object from the end effector of a robot manipulator to its base is critical to the design of autonomous control systems. Sensors on a robot determine the coordinates of an object with respect to the frame A on its end effector to be (2,-5,7). It is known that the frame A is rotated by 30 degrees about the X- axis of the frame U at the base of the robot. The frame A is also translated by 3 units along the X-axis of the frame U. Determine the coordinates of the object with respect to the frame U.   (C.O.No.2) [Application level]

Roll No | | | | | | | | | | | |

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM EXAMINATION

Winter Semester: 2021 - 22

Course Code: MEC 3065

Course Name: Introduction to Robotics and Automation

Program & Sem: B. Tech (MEC) & II

Date: 29/JUNE/2022

Time: 01:00PM to 04:00PM

Max Marks: 100

Weightage: 50%

Instructions:

(i)   Read the all questions carefully and answer accordingly.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries SIX marks.   (5Qx 6M= 30M)

Q.1 Explain control resolution, and accuracy attributes regarding a robot.

(C.O.No.1) [Knowledge level]

Q.2 Briefly explain the components required to make a robot.   (C.O.No.2) [Knowledge level]

Q.3 Compile a list of sensors that might be used in robotics systems. For Each Sensor, Give an application.   (C.O.No.4) [Knowledge level]

Q.4 What do you think of future of robots?   (C.O.No.4) [Knowledge level]

Q.5 Using the D-H notation for frame assignment, is it possible to have a link with zero link length whereas the physical link on the manipulator will have a finite link length?

(C.O.No.3) [Knowledge level]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks.   (3Qx10M=30M)

Q.6 It is decide to determine the values to which the angle θ_1 and θ_2 must be set in order to achieve a certain point in the space. The length of the links L_1 =12 unit and L_2 =10 unit. The point which the robot must achieve is define by the coordinate x = 6 unit and y =12 unit. Find the solution using Inverse Kinematics.

(C.O.No.1) [Comprehension level]

Q.7 A single cubic trajectory given by q(t) = $40+t^2$- $6t^3$ is used for a period of 3 seconds. Determine starting goal position, Velocity, and accelerations of the end-effector.

Q.8 Define Manipulator. Also briefly explain the classification of End Effector.

(C.O.No.4) [Comprehension level]

Part C [Problem Solving Questions]

Answer both the Questions. Each question carries TWENTY marks. (2Qx20M=40M)

Q.9 Two joints of a SCARA manipulator are to move by 15^0 and 30^0 in 1 seconds and 2 seconds, respectively. Assuming the trajectory to be cubic for both the joints, determine the coefficients a_{ij} for the two cubic polynomials:

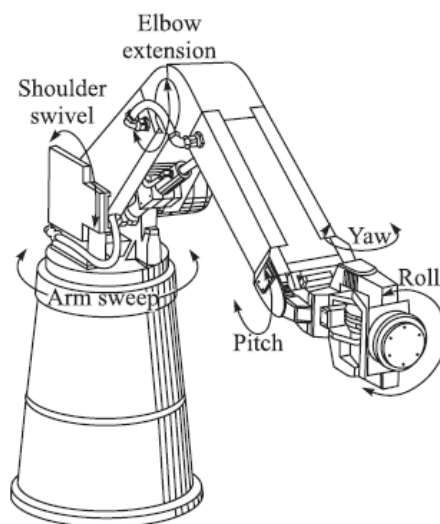$$\theta_1 (t) = a_{10} + a_{11}t + a_{12}t^2 + a_{13}t^3$$
$$\theta_2 (t) = a_{20} + a_{21}t + a_{22}t^2 + a_{23}t^3$$

Will the trajectories for the two joints be different if the joints are considered at some location other than 0^0 at the start point ? (C.O.No.3) [Application level]
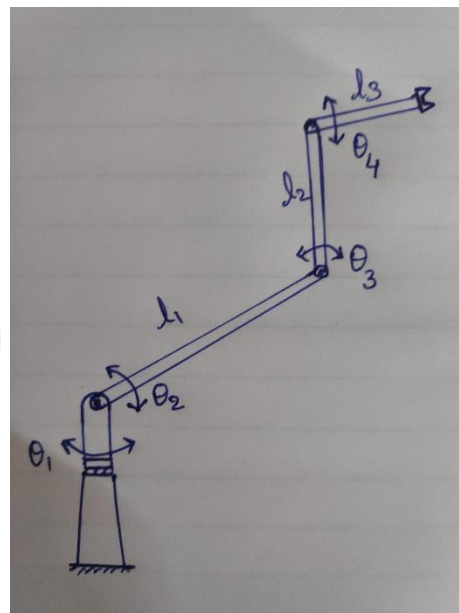
Q.10 Determine the D-H Parameter Table for following Robot. You can replicate Cincinnati Milacron robot with right line diagram. (C.O.No.3) [Application level]

(a) Cincinnati Milacron (T3)
[Courtesy: Koivo (1989)]

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM EXAMINATION

Winter Semester: 2021 - 22

Course Code: MEC 3065

Course Name: Introduction to Robotics and Automation

Program & Sem: B. Tech (MEC) & IV

Date: 29/JUNE0/2022

Time: 01:00PM to 04:00PM

Max Marks: 100

Weightage: 50%

Instructions:

(i)   *Read the all questions carefully and answer accordingly.*

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries SIX marks.   **(5Qx 6M= 30M)**

Q.1 Explain control resolution and accuracy attributes regarding a robot.

(C.O.No.1) [Knowledge level]

Q.2 What is Manipulator. Briefly explain classification of Manipulator. (C.O.No.2) [Knowledge level]

Q.3 Compile a list of sensors that might be used in robotics systems. For Each Sensor, Give an application.   (C.O.No.4) [Knowledge level]

Q.4 What do you think of future of robots?   (C.O.No.4) [Knowledge level]

Q.5 Using the D-H notation for frame assignment, is it possible to have a link with zero link length whereas the physical link on the manipulator will have a finite link length?

(C.O.No.3) [Knowledge level]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks.   **(3Qx10M=30M)**

Q.6 What are the physical characteristics required for determining a work volume. Also give work volume for all types of configuration robot with neat sketch diagram.

(C.O.No.1) [Comprehension level]

Q.7 A single cubic trajectory given by q(t) = $50+t^2- 6t^3$ is used for a period of 3 seconds. Determine starting goal position, Velocity, and accelerations of the end-effector.

(C.O.No.3) [Application level]

Q.8 Define actuators. Also explain general features of hydraulic, pneumatic and electric

actuators.

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries TWENTY marks. **(2Qx20M=40M)**

Q.9 Two joints of a SCARA manipulator are to move by 45^0 and 60^0 in 2 seconds and 3 seconds, respectively. Assuming the trajectory to be cubic for both the joints, determine the coefficients a_{ij} for the two cubic polynomials:

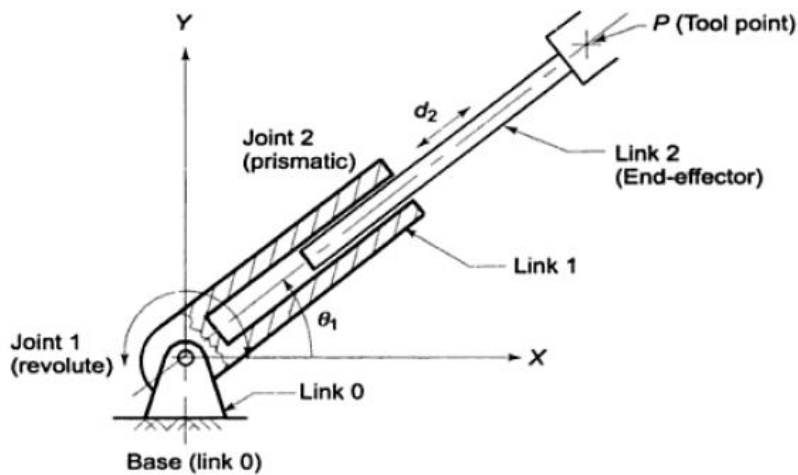$$\theta_1\ (t) = a_{10} + a_{11}t + a_{12}t^2 + a_{13}t^3$$
$$\theta_2\ (t) = a_{20} + a_{21}t + a_{22}t^2 + a_{23}t^3$$

Will the trajectories for the two joints be different if the joints are considered at some location other than 0^0 at the start point ? (C.O.No.3) [Application level]

Q.10 Determine the D-H Parameter Table for following Robot. (C.O.No.3) [Application level]

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM EXAMINATION

Winter Semester: 2021 - 22

Course Code: MEC 3065

Course Name: Introduction to Robotics and Automation

Program & Sem: B. Tech (MEC) & IV

Date: 7th July 2022

Time: 09.30 AM to 12.30 PM

Max Marks: 100

Weightage: 50%

Instructions:

(i)   Read the all questions carefully and answer accordingly.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries SIX marks.   (5Qx 6M= 30M)

Q.1 Explain Accuracy and repeatability attributes regarding a robot.

(C.O.No.1) [Knowledge level]

Q.2 Briefly explain the components required to make a robot.   (C.O.No.2) [Knowledge level]

Q.3 Compile a list of sensors that might be used in robotics systems. For Each Sensor, Give an application.   (C.O.No.4) [Knowledge level]

Q.4 What do you think of future of robots?   (C.O.No.4) [Knowledge level]

Q.5 Using the D-H notation for frame assignment, is it possible to have a link with zero link length whereas the physical link on the manipulator will have a finite link length?

(C.O.No.3) [Knowledge level]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks.   (3Qx10M=30M)

Q.6 It is decide to determine the values to which the angle θ_1 and θ_2 must be set in order to achieve a certain point in the space. The length of the links L_1 =12 unit and L_2 =10 unit. The point which the robot must achieve is define by the coordinate x = 6 unit and y =12 unit. Find the solution using Inverse Kinematics.

(C.O.No.1) [Comprehension level]

Q.7 A single cubic trajectory given by q(t) = $40+t^2- 6t^3$ is used for a period of 3 seconds. Determine starting goal position, Velocity, and accelerations of the end-effector.

Q.8 Define Manipulator. Also briefly explain the classification of End Effector.

(C.O.No.4) [Comprehension level]

Part C [Problem Solving Questions]

Answer both the Questions. Each question carries TWENTY marks. **(2Qx20M=40M)**
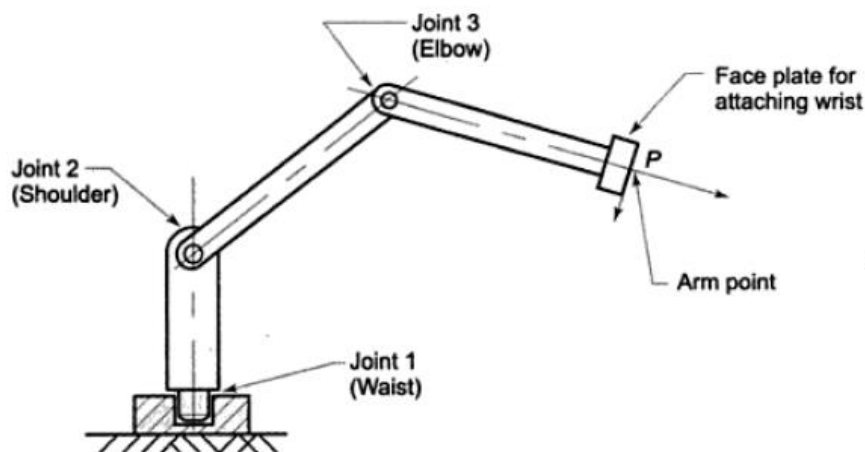
Q.9 Two joints of a SCARA manipulator are to move by 15^0 and 30^0 in 1 seconds and 2 seconds, respectively. Assuming the trajectory to be cubic for both the joints, determine the coefficients a_{ij} for the two cubic polynomials:

$$\theta_1 (t) = a_{10} + a_{11}t + a_{12}t^2 + a_{13}t^3$$

$$\theta_2 (t) = a_{20} + a_{21}t + a_{22}t^2 + a_{23}t^3$$

Will the trajectories for the two joints be different if the joints are considered at some location other than 0^0 at the start point ? (C.O.No.3) [Application level]

Q.10 Determine the D-H Parameter Table for following Robot with coordinate frame assignment for the following TRR robot. (C.O.No.3) [Application level]

End of the Paper

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

MIDTERM EXAMINATION

Winter Semester: 2021 - 22

Course Code: MEC 3065

Course Name: Introduction to Robotics and Automation

Program & Sem: B. Tech (MEC) & II

Date: 14/MAY/2022

Time: 01:30 PM to 03:00 PM

Max Marks: 50

Weightage: 25%

Instructions:

(i)   Read the all questions carefully and answer accordingly.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries THREE marks.   **(5Qx 3M= 15M)**

1 Define a Robotic Manipulator.   (C.O.No.1) [Knowledge level]
2 Define End-effector of a Robot.   (C.O.No.1) [Knowledge level]
3 Differentiate between Prismatic Joint & Sliding joint.   (C.O.No.1) [Knowledge level]
4 Define DOF. Also write down DOF of a SCARA robot.   (C.O.No.1) [Knowledge level]
5 Brief any four applications of a Robotics System.   (C.O.No.1) [Knowledge level]

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks.   **(2Qx10=20M)**

6 Shashwat has written a program on Python that solves the forward kinematics problem for a robot manipulator with two links connected in series with two revolute joints. The motion of this robot is constrained in a plane. He has sent the program to his favourite teacher to check its correctness. Unfortunately, the teacher doesn't know Python programming. So the teacher decides to check the program's output using the following data. The length of the first link is 10 mm, the length of the second link is 7 mm, the angle of the first joint is 15 degrees and the angle of the second joint is 45 degrees. If the program is correct, what should the coordinates of the end effector of the robot be?

(C.O.No.1) [Comprehension level]

7 A prelude to solving the forward kinematics of a robot manipulator involves the determination of its degrees of freedom. MechaTron, Inc., has developed a robotic arm which is serial link manipulator operating in a plane. The robot has one fixed link, and three moving links with two revolt joints and one prismatic joint. Determine the degrees of freedom of this robot

(C.O.No.2) [Comprehension level]

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries FIFTEEN mark. (1Qx15M=15M)

8 The transformation of the coordinates of an object from the end effector of a robot manipulator to its base is critical to the design of autonomous control systems. Sensors on a robot determine the coordinates of an object with respect to the frame A on its end effector to be (2,-5,7). It is known that the frame A is rotated by 30 degrees about the X- axis of the frame U at the base of the robot. The frame A is also translated by 3 units along the X-axis of the frame U. Determine the coordinates of the object with respect to the frame U. (C.O.No.2) [Application level]