KUMARAGURU
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B.E DEGREE EXAMINATIONS: MAY 2017

(Regulation 2014)

Sixth Semester

MECHATRONICS ENGINEERING

U14MCT603**:** Robotics Engineering

COURSE OUTCOMES

CO1: Define robotic terminologies and apply the concept of degrees of freedom for a particular robotic configuration.

CO2: Select an appropriate gripper for a given application and also estimate the force components acting on a gripper.

CO3: Develop homogeneous transformation matrices to solve kinematic problems.

CO4: Effectively apply DH notations for direct kinematic problems.

CO5: Calculate the angle of motion at joints for a given end position of a robot.

CO6: Explain various motion planning algorithms.

CO7: Apply Lagrangian and Newton-Euler methods to analyze dynamic characteristics of a RR and RP type planar robots

CO8: Describe various control strategies used in robot control.

CO9: Explain various programming techniques used in industrial robots.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1.   CO9 [K_2]

List I	**List II**
A. Raspberry Pi	i. PBasic
B. Ardunio	ii. RAPID
C. Parallax	iii. C & C++ Functions
D. ABB	iv. Python

	A	B	C	D
a)	ii	iii	iv	i
b)	iii	iv	ii	i
c)	iv	iii	i	ii
d)	iii	i	ii	iv

2. Relation between spatial resolution, control resolution and mechanical inaccuracies is   CO8 [K$_2$]

   a) spatial resolution = control resolution + mechanical inaccuracies
   b) spatial resolution = control resolution - mechanical inaccuracies
   c) spatial resolution = control resolution x mechanical inaccuracies
   d) spatial resolution = control resolution -r mechanical inaccuracies

3. Which of the following statements are correct for industrial robots?   CO4 [K$_2$]

   1. An industrial robot is a general purpose programmable machine which possess certain anthropomorphic or human like characteristics
   2. It can be programmed to move its arm through sequence of motion in order to perform some useful task
   3. It is possible to obtain the position of end effector using link and joint parameters
   4. The industrial robot can perform any task without any human orders.
   5. The first industrial robot used in general motors' is a gantry type robot.

   a) 1,2,3
   b) 2,4,5
   c) 3,4,5
   d) 1,2,3,4

4. Jacobian relates the velocities of joints to the velocities of ………………..   CO7 [K$_2$]

   a) Tool point
   b) Manipulator
   c) Joint
   d) Links

5. Assertion (A):The suction cups of vacuum gripper is made up of hard materials   CO2 [K$_3$]

   Reason (R): The Manipulator can handle soft and flat materials

   a) Both A and R are Individually true and R is the correct explanation of A
   b) Both A and R are Individually true but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

6. Newton – Euler formulation is used to analyze the ……behavior of the manipulator   CO7 [K$_2$]

   a) Static
   b) Dynamic
   c) Kinematic
   d) Kinetic

7. Arrange the following component of robot joint control system in an ascending order   CO8 [K$_2$]

   1. Joint Controller
   2. Mechanical Transmission
   3. Motor Drive
   4. Actuator
   5. Position Sensor

   a) 1-4-2-3-5
   b) 1-3-4-5-2
   c) 2-4-3-1-5
   d) 4-2-1-3-5

8. Which of the following is not the functionality of robot?   CO1 [K$_2$]

   a) Reprogramability   b) Multifunctionality

   c) Responsibility   d) Efficient Performance

9. Assertion (A): Homogeneous transformation matrix contain unit matrix with 4x4 dimensions   CO3 [K$_3$]

   Reason (R): Manipulator transformation can be pure rotation, Pure translation and combination of both.

   a) Both A and R are Individually true and R is the correct explanation of A   b) Both A and R are Individually true but R is not the correct explanation of A

   c) A is true but R is false   d) A is false but R is true

10. The Robot designed with cylindrical coordinate systems has   CO1 [K$_2$]

   a) Three linear movements   b) Three rotational movements

   c) Two linear and one rotational movement   d) Two rotational and one linear movement

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11.	Differentiate between Bug algorithm and Tangent Bug Algorithm.	CO6	[K$_2$]
12.	Sketch the teach pendant of the ABB industrial robot.	CO9	[K$_2$]
13.	State the importance of inertia in determining torque of the robot joint motor	CO8	[K$_2$]
14.	What do you meant by Newton Euler equation?	CO7	[K$_2$]
15.	Give some examples of tool as robot end effector	CO2	[K$_L$]
16.	Differentiate forward and inverse kinematics of a robot.	CO5	[K$_2$]
17.	Name the factors to be considered while purchasing an industrial robot?	CO1	[K$_2$]
18.	State degeneracy and dexterity of a robot.	CO3	[K$_2$]
19.	Outline the importance of DH link parameters.	CO4	[K$_2$]
20.	Name the different ways to represent pose ξ of a robot?	CO1	[K$_2$]

## Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. Select a suitable gripper for handling flat type materials and explain with a neat sketch.   CO2 [K$_3$]

22. Explain different types of robots based on configuration and applications.   CO1 [K$_2$]

23. The figure shows a 2-DOF planar elbow-arm. The link and joint parameters are a1 = 2, a2 = 4, θ1 = 45°, θ2 = 90°. Obtain the transformation matrices and find the solution for forward kinematics problem.

CO4   [K₃]
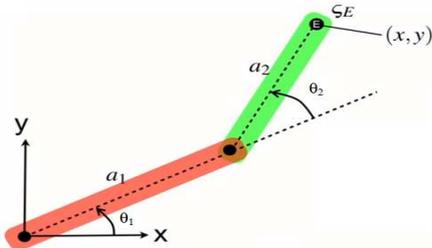
24. A point P (7, 3, 2) T, attached to a frame (n,o,a), and is subjected to the transformations described next.Find the coordinates of the point relative to the reference frame at the conclusion of transformations.

CO3   [K₃]

     1. A rotation of 90 degree about the z-axis.
     2. Followed by a translation of (4,-3,7),
     3. Followed by a rotation of 90 degree about the y axis.

25. Compare the functions of Online and Off line Programming Method with a neat sketch

CO9   [K₂]

26. Discuss the working of Bug and Voronoi Graph motion planning algorithms in detail.

CO6   [K₂]

27. Using the Lagrangian method, derive the equation of motion for the 2 DOF robot arm. The center of mass for each link is at the center of the link. The moments of Inertia are I1 and I2.

CO7   [K₃]

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