KUMARAGURU college of technology
character is life

Register Number:……..…

M.TECH DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Second Semester

DEFENCE TECHNOLOGY

P18DTE0010: Robotics (MSS, MCC)

COURSE OUTCOMES

CO1: Clearly understand basic concepts of robotics with emphasis on basics of manipulators, sensors and actuators.

CO2: Able to do coordinate transformation and kinematics for Robotic system

CO3: Understand and analyses trajectory planning and control techniques.

CO4: Exposed to software and tools for robot programming and path following basics.

CO5: Able to perceive robot applications and design of robots applicable for future industrial needs.

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Degrees of freedom for a rigid object in $\mathbb{R}^2$ space. CO1 [K_2]

   a) 2 b) 3

   c) 4 d) 6

2. Which one of the following is not the property of SE (3)? Assume $T_1, T_2, T_3 \in SE(3)$ CO1 [K_2]

   a) $T_1(T_2T_3) = (T_1T_2)T_3$ b) $T_1T_2 \in SE(3)$

   c) $T_1{T_2}^{-1} = {T_1}^{-1}T_2$ d) Both (a) and (c)

3. Which of the following Euler's rotation sequence is incorrect? CO2 [K_1]

   a) XYX b) XZY

   c) XZZ d) ZYZ

4. Matching type item with multiple choice code CO2 [K_1]

List I	List II
A. The processor belongs to	i. Fixed Sequence Robot
B. Systems uses motors and gears	ii. Karel Capek
C. Repeats the recorded motions	iii. Control System
D. First introduced the word "robot"	iv. Propulsion system

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

5. What is the key difference between Machine Learning (ML) and Deep Learning (DL) with respect to hardware dependencies CO3 [K1]

a) ML suitable for small / medium data set while DL works well with large data set
b) ML takes few minutes to hours while DL takes up to weeks.
c) ML works on low-end machine while DL requires a high-end machine with GPU
d) None of the above

6. What is the slope of the first-order system low-pass filter? CO3 [K1]

a) -3 dB/decade
b) -20dB/decade
c) Insufficient data
d) None of the above

7. Assertion (A): Data science uses techniques and theories drawn from many fields within the context of Mathematics, Statistics, Computer science, Information science, Domain knowledge. CO4 [K1]

Reason (R): Data Science is a concept to unify statistics, data analysis, informatics & their related methods for understanding and analyzing actual phenomena with data.

a) Both A and R are correct and R is the correct explanation of A.
b) A is not correct but R is correct.
c) Both A and R are correct but R is NOT the correct explanation of A.
d) A is correct but R is NOT correct.

8. Which of the following statement is NOT true for PID control? CO4 [K1]

a) Increase Kp increases overshoot
b) Increase Kp reduces rise time
c) Kd adds value only on rate of change of error
d) PID control not applicable for discrete system

9. A type of Robot Locomotion: A. Wheel, B. Leg C. Tracked deslip CO5 [K2]

a) Only A
b) All A, B and C
c) Only A and B
d) Only B and C

10. The reason for AI booming nowadays CO5 [K2]

a) Advanced Hardware and Large Data
b) State of art advanced Algorithms
c) Both A & B
d) None of the above

PART B (10 x 2 = 20 Marks)

11.	Explain Rigid Body Transformation and its properties.	CO1	[K_2]
12.	Define configuration space	CO1	[K_2]
13.	List the different types of links and joints	CO2	[K_2]
14.	Differentiate between planar and spatial mechanisms	CO2	[K_2]
15.	What are the properties of the 3D Rotation matrix?	CO3	[K_2]
16.	Differentiate between Newtonian Mechanics and Analytical Mechanics.	CO3	[K_2]
17.	What is an end – effector? Give at least two types of it.	CO4	[K_2]
18.	What is AI? Why do we implement AI in the robots?	CO4	[K_2]
19.	Name three characteristics capabilities that define a robot.	CO5	[K_2]
20.	Write the rise-time and peak-time expression for a second-order system with step input	CO5	[K_2]

PART C (6 x 5 = 30 Marks)

21.	With a neat sketch, derive forward kinematics for a 3R planar manipulator.	**5**	CO1	[K_3]
22.	Write short notes on Euler-Lagrangian formulation.	**5**	CO2	[K_3]
23.	Describe the terms: Spatial resolution, Accuracy and Repeatability of robot.	**5**	CO3	[K_2]
24.	What are industrial robots? Explain the various types of Industrial robots?	**5**	CO4	[K_2]
25.	Explain various types of sensors used in the robotics	**5**	CO5	[K_2]
26.	a. What is the advantage of using MPC over PID control? In other words, when you prefer MPC control over PID control? b. Draw a block diagram for a position control system. What are the bandwidth constraints for each of the outer loop?	**5**	CO5	[K_3]

Answer any FOUR Questions
PART D (4 x 10 = 40 Marks)

27. With a neat sketch, derive inverse kinematic equations for a 2R planar manipulator. **10** CO1 [K3]

28. Assume R (given below), c_i and s_i be the 3D rotation matrix for Euler's ZYZ convention, cos θ_i , and sin θ_i , respectively. The singularity happens when $c_2 = \pm 1$. **10** CO2 [K4]

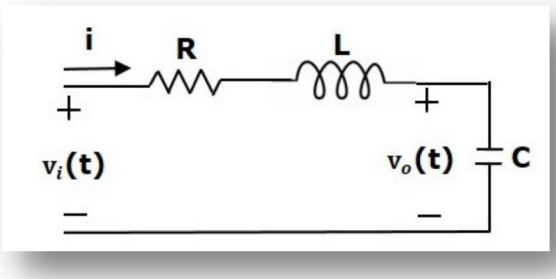
$$R = \begin{bmatrix} c_1c_2c_3 - s_1s_3 & -c_1c_2s_3 - s_1c_3 & c_1s_2 \\ s_1c_2c_3 + c_1s_3 & -s_1c_2s_3 + c_1c_3 & s_1s_2 \\ -s_2c_3 & s_2s_3 & c_2 \end{bmatrix}$$

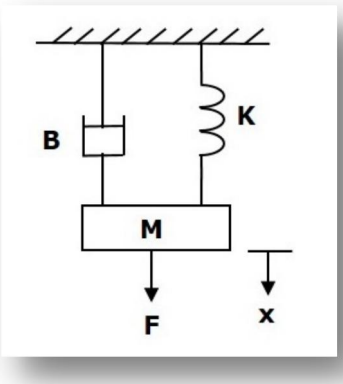
Find θ_1, θ_2, and θ_3.

29. What are the basic components of a robotic system? State the main function of each of the component. **10** CO3 [K3]

30. Write at least 2 application examples each for robots in Industrial, Medical, Space, Defense and Agriculture domains. **10** CO4 [K4]

31. **10** CO5 [K4]





Derive transfer function of the above electrical system and mechanical system. Compare the electrical parameters with the translational mechanical system.

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