Total No. of Questions: 6 *Total No. of Printed Pages:2*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
ME3EL03 Robotics Engineering

Programme: B.Tech. Branch/Specialisation: ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Robot is derived from Czech word- **1**
(a) Rabota (b) Robota (c) Rebota (d) Ribota

ii. Drives are also known as- **1**
(a) Actuators (b) Controller (c) Sensors (d) Manipulator

iii. Rotation matrix is **1**
(a) 3*2 (b) 3*1 (c) 4*4 (d) 3*3

iv. RPY stands for- **1**
(a) Rotate, Prismatic, Yaw (b) Roll, Pitch, Yaw
(c) Roll, Prismatic, Yaw (d) None of these

v. Newton-Euler approach is a _____. **1**
(a) Vectorial approach (b) Scalar approach
(c) Energy based approach (d) Mass based approach

vi. Generalised coordinate system defines _____ of a mechanical system. **1**
(a) Position (b) Orientation
(c) Position and orientation (d) None of these

vii. Grippers are used to_____. **1**
(a) Hold the objects (b) Sense the objects
(c) Move the objects (d) Both (a) and (c)

viii. ____ sensors are used to identify objects for pick and place purpose. **1**
(a) Range detectors (b) Infrared sensors
(c) Vision sensors (d) Photo-metric sensors

ix. Interlock is/are- **1**
(a) Wait (b) Signal (c) Delay (d) All of these

x. Circular programming is more readily programmed using a ____. **1**
(a) Lead through programming
(b) Teach pendant
(c) Textual programming
(d) None of these

Q.2 i. Define the term “work volume”. **3**

ii. Explain the Cartesian robot with neat sketch and write any two applications. **7**

OR iii. Briefly describe the four basic arm configurations that are used in robotic manipulator, with neat sketch. **7**

Q.3 i. Define degree of freedom. **3**

ii. Explain forward and inverse kinematics analysis with advantages. **7**

OR iii. Explain D-H representation algorithm. **7**

Q.4 i. What do you mean by Jacobian? **3**

ii. Explain Euler-Lagrange formulation. **7**

OR iii. Derive the inertia tensor of a rectangular box. **7**

Q.5 i. Define the gripper and end effector. **4**

ii. Explain the types of end effector with suitable examples. **6**

OR iii. What do you mean by position sensors? Explain any one of them with neat sketch. **6**

Q.6 i. What do you mean by programming? **4**

ii. Explain the teach pendant programming method. **6**

OR iii. Write short note on wait, signal and delay command. **6**

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Scheme of Marking

MEDI-CAPS UNIVERSITY Knowledge is Power	Faculty of Engineering End Sem Examination Dec-2023 Robotics Engineering (T) - ME3EL03 (T)
	Programme: B.Tech. | Branch/Specialisation:

Note: The Paper Setter should provide the answer wise splitting of the marks in the scheme below.

Q.1	i)	(b) Robota	1
	ii)	(a) Actuators	1
	iii)	(d) 3*3	1
	iv)	(b) Roll Pitch Yaw	1
	v)	(a) Vectorial approach	1
	vi)	(c) Position and orientation	1
	vii)	(d) Both (A) & (C)	1
	viii)	(c) Vision sensors	1
	ix)	(d) All of the above	1
	x)	(c) Textual programming	1
Q.2	i.	Define the term "work volume" Definition 2, diagram 1	3
	ii.	Explain the Cartesian robot neat sketch write any two applications.	2.5 2.5 2
OR	iii.	Briefly describe the four basic arm configurations that are used in robotic manipulator, with neat sketch.	4 3
Q.3	i.	Define Degree of freedom?	3
	ii.	Explain forward and inverse kinematics analysis with advantages	2.5 2.5 2
OR	iii.	Explain D-H representation Algorithm. Four parameters 3 Explanation - 4 Frame Assignment process - 3	7
Q.4	i.	What do you mean by Jacobian?	3
	ii.	Explain Euler-Lagrange formulation.	7
OR	iii.	Derive the inertia tensor of a rectangular box.	7
Q.5	i.	Define the gripper and End effector.	2 2
	ii.	Explain the types of end effector with suitable examples.	4 2
OR	iii.	What do you mean by position sensors and explain any one of them with neat sketch?	1 3 2
Q.6	i.	What do you mean by programming?	4
	ii.	Explain the teach pendant programming method.	6
	iii.	Write short note on wait, Signal and Delay command.	 2 2 2

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marks

Q4(ii)

$L = T - U$ — (1)

$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = \phi_i \quad \text{for } i = 1, 2, \ldots n$ — (1)

Kinetic energy:

$T_i = \frac{1}{2} m_i \dot{c}_i^T \dot{c}_i + \frac{1}{2} \omega_i^T I_i \omega_i$ — (1)

$T = \frac{1}{2} \dot{\theta}^T I \dot{\theta}$ — (1)

Potential energy:

$U = -\sum_{i=1}^{n} m_i c_i^T g$ — (1)

$L = T - U = \sum_{i=1}^{n} \left[\frac{1}{2} \dot{\theta}^T I \dot{\theta} + m_i c_i^T g\right]$ — (1)

$I\ddot{\theta} + h + \gamma = \tau$ — (1)

Q4(iii) $I_{xx} = \int_0^h \int_0^d \int_0^w (y^2 + z^2)\rho \, dx \, dy \, dz$

$= \int_0^h \int_0^d (y^2 + z^2) w \rho \, dy \, dz = \int_0^h \left(\frac{d^3}{3} + z^2 d\right) w \rho \, dz$

$I_{xx} = \left(\frac{hd^3 w}{3} + \frac{h^3 dw}{3}\right)\rho = \boxed{\frac{M}{3}(d^2 + h^2)}$ — (1)

Similarly —

$I_{yy} = M/3 (w^2 + h^2)$; & $I_{zz} = \frac{M}{3}(d^2 + w^2)$ — (2) — (3)

$I_{xy} = -\int_0^h \int_0^d \int_0^w xy\rho \, dx \, dy \, dz = -\int_0^h \int_0^d y\rho \, dy \, dz$

$= -\int_0^h \frac{w^2 d^2}{4} \rho \, dz = -M/4 \, wd$ — (4)

Similarly $I_{xz} = -M/4 \, hw$ — (5) ; $I_{yz} = -\frac{M}{4} hd$ — (6)

$$I = \begin{bmatrix} \frac{M}{3}(d^2/h^2) & (-M/4)wd & -\frac{M}{4}hw \\ -\frac{M}{4}wd & \frac{M}{3}(w^2/h^2) & -\frac{M}{4}hd \\ -\frac{M}{4}hw & -\frac{M}{4}hd & M/3(d^2/w^2) \end{bmatrix}$$ — (7)

(1) Mark

I_{xx}, I_{yy}, I_{zz}, I_{xy}, I_{xz}, I_{yz} — (1) Mark each