M.E. ELECTRICAL ENGINEERING FIRST YEAR SECOND SEMESTER - 2017
MECHATRONICS

Time : Three hours   Full Marks : 100

*Answer any **Five** questions.*

Answer all parts of a question in the sequential order.

1. a) What is kinematics? Explain the "direct kinematics problem" and "inverse kinematics problem" of a robot arm.

b) Define the terms "mechanisms" and "machines". What are their roles in mechatronics?

c) Explain the various kinematic pairs with suitable sketches.

[5+5+10=20]

2. a) What is homogeneous coordinate system?

b) How are the link parameters of a serial-link robot manipulator specified in terms of Denavit-Hartenberg convention? How will the representation differ in the Modified Denavit-Hartenberg convention? Explain with suitable example.

c) Derive the basic rotation matrices.

[2+6+12=20]

3. a) Explain, with two examples, the "internal state sensors" and "external state sensors" in mechatronic applications.

b) What are the different factors that should be considered for the selection of appropriate sensors during the mechatronic design?

c) Write a brief note on the application of various motion sensors in mechatronic applications.

[4+6+10=20]

4. Explain the various aspects of signal conditioning process during the computer interfacing circuit design for a mechatronic system. State the assumptions, if any.

[20]

[P.T.O.]

5. a) Explain, highlighting their advantages and disadvantages, the centralized and decentralized control schemes in serial link manipulators.

b) Explain the basic architecture of the hybrid position/force control scheme of a robot manipulator.

[15+5=20]

6. Explain the basic approach of trajectory planning of industrial manipulator for "pick and place" operation in a cluttered environment.

[20]

7. a) Explain the significance of interaction control of robot manipulators in industrial environment.

b) Write a note on the basic mechanism of impedance control of serial manipulator interacting with a compliant environment.

[5+15=20]

8. Explain the basic design steps that should be adopted during the design of a robot manipulator for metal sheet welding applications. State the assumptions, if any.

[20]

9. Write a brief note on **any four** from the following:

a) Transmission mechanisms in mechatronic applications.

b) Universal joint.

c) Forward and Inverse Dynamics.

d) Four-bar linkage.

e) Force sensors.

f) Robust control of robotic systems.

[5x4=20]