NITDGP/B.TECH/Reg/Odd/2023-24

# NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

## Odd Semester Mid-Term Examination, 2023-24

**Course Code:EEO540** Full Marks: 25

**Course Name:Measurement and Instrumentation** Time: 90 Minutes

Question Paper No.: NITDGP/EEO540/ Date of Exam: 15-09-2023

**Instructions:** Question No. 1 is compulsory and attempt any two questions from Q2 to Q4

Materials to be supplied: NIL

| Q. No. | Question | Marks | Mapped CO |
|---|---|---|---|
| | **Group A (Compulsory)** | | |
| 1 | (a) Describe an AC bridge which can be used for the measurement of resistance and inductance if high Q coils. Derive the condition for balance and draw the phasor diagram under conditions of balance. What are the advantages and disadvantages of this bridge?<br>(b) A balanced bridge has the following components connected between its five nodes A, B, C, D and E and arranged as<br>(i) Between A and B: 1000 Ω resistance, (ii) between B and C: 1000 Ω resistance, (iii) between C and D: an unknown inductor, (iv) between D and A: 218 Ω resistance, (v) between A and E: 469 Ω resistance, (vi) between E and B: 10 μF capacitance. (vii) between E and C: a detector, (viii) between B and D: a power supply.<br>Obtain the values of resistance and inductance of the unknown inductor. Derive the formula used. | 13 [(3+3+2)+5] | CO1, CO2, CO3 |
| | **Group B (Any Two)** | | |
| 2 | (a) Describe the various operating forces needed for proper operation of an analog indicating instruments.<br>(b)The inductance of a moving iron instrument is given by an expression $L = (20 + 10\theta - 3\theta^2)$ μH. Where θ is the deflection in radian from the zero position. Determine the deflection of ammeter for a current of 10A, if the spring constant is $8 \times 10^6$ N-m/radian. | 6 [3+3] | CO1, CO2, CO3 |
| 3 | (a) With the help of a neat sketch, describe the construction and working principle of permanent magnet moving iron instruments. What are its advantages and limitations?<br>(b) A moving coil meter has a resistance of 5 Ω and gives a full-scale deflection with 10 mA. Show how it can be used to measure current up to 10 A. | 6 [3+3] | CO1, CO2, CO3 |
| 4 | (a) Describe how Schering bridge can be used for measurement of an unknown capacitance and its loss angle. Derive the conditions of balance and draw the phasor diagram of the bridge circuit under conditions of balance.<br>(b) An ac bridge with terminals A, B, C, D (consecutively marked) has in arm AB a pure resistance; arm BC a resistance of 800 Ω in parallel with a capacitor of 0.5 μF; arm CD a resistance of 400 Ω in series with a capacitor of 1.0 μF and arm DA a resistance of 1000 Ω. Obtain the value of the frequency for which the bridge can be balanced by first deriving the balance equations connecting the branch impedances and also calculate the value of the resistance in arm AB to produce balance. | 6 [3+3] | CO1, CO2, CO3 |

Course Outcomes

- CO1: Given specifications of different measuring instruments for measurement of particular parameter of some known electrical system, compare and judge to find the most suitable one.
- CO2: Given application of electrical engineering for measurement of particular parameter along with specified range and accuracy, choose most suitable measuring instrument with the understanding of individual working principles, also judge to fit the given application.
- CO3: For some specific parameter to be measured, along with the given range, resolution, accuracy and output format, choose suitable sensor, design associated signal conditioning and analog/digital processing circuit to meet the desired specification.
- CO4: Given parameters to identify the location of fault.

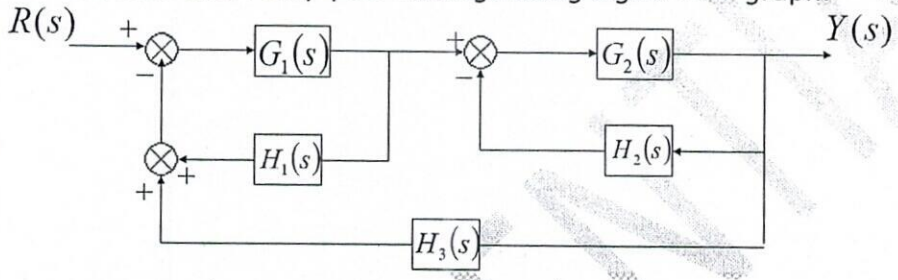
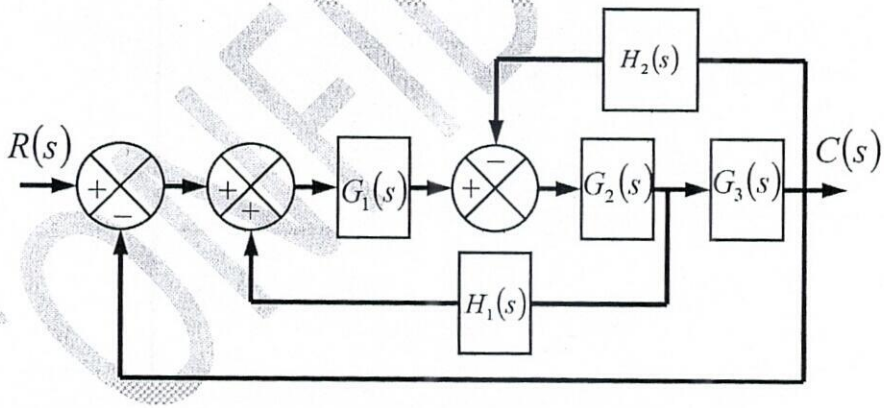
# NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

## Odd Semester Mid-Term Examination, 2023-24

**Course Code: EEO541** Full Marks: 25

**Course Name:** FUNDAMENTALS OF CONTROL SYSTEMS Time: 90 Minutes

Instructions: Answer Any **five** (5) questions.

| Question No. | Body of the Question | Marks | Mapped CO |
|---|---|---|---|
| 1 | Mention two significant advantages of negative feedback control systems and theoretically justify your statements. | 5 | CO1, CO2 |
| 2 | Derive the transfer function, Y(s)/R(s), for the block diagram shown below and verify your findings using signal flow graph.   **Figure 1** | 5 | CO2 |
| 3 | Derive the C(s)/R(s) transfer function for the block diagram shown below.   **Figure 2** | 5 | CO2 |
| 4 | Evaluate the closed-loop transfer function of a unity feedback (negative) control system (second order) which has a unit step response with percentage overshoot of 20% and settling time of 4 sec. Formulate the forward path transfer function of the closed loop system. How does the proportional gain of the forward path transfer function effect the damping ratio of the closed loop system? | 5 | CO2, CO3 |

Course Outcomes

CO1: To get the knowledge of basic objectives of control system design

CO2: To derive input-output relationship of systems based on their mathematical modeling governed by basic laws of physics

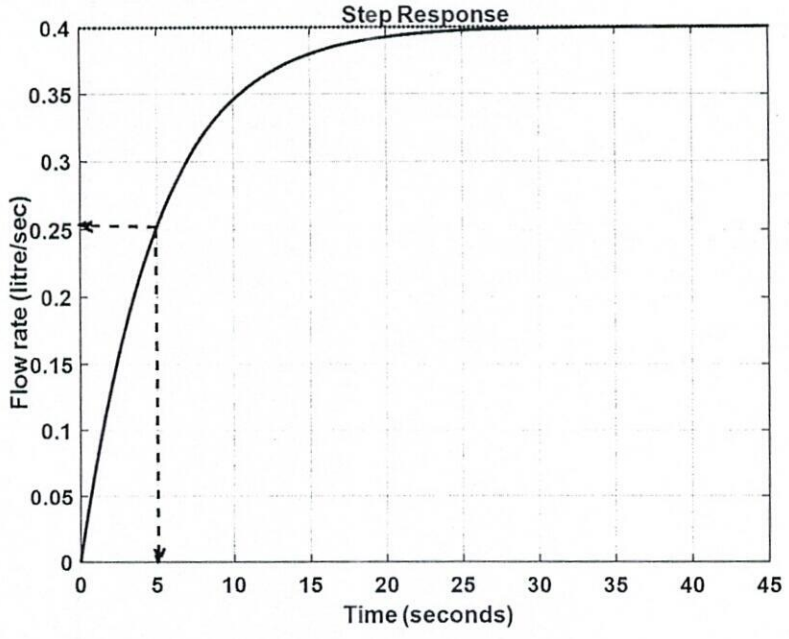
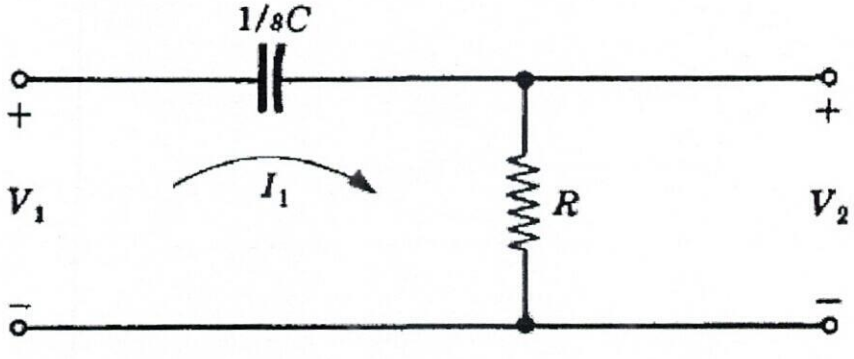
CO3: To justify stability of systems based on their transfer functions, time domain and frequency domain specifications

CO4: To develop concepts on root pattern with variable gains and comment on the stability

CO5: To determine the stability of closed-loop system based on open loop frequency response

CO6: To be able to design controllers so as to meet design specifications both in time as well as frequency domain

CO7: To be able to realize the controller both in software simulation through MATLAB coding as well as in real-time environment.

| | | | |
|---|---|---|---|
| 5 | Estimate the transfer function for angular position of a valve to flow rate of a viscous chemical fluid in a chemical plant from the unit step response as given by Figure 3. Analytically justify your answer.<br>  <br><br>**Figure 3** | 5 | CO2, CO3 |
| 6 | Develop the block diagram and signal flow graph for the circuit given by Figure 4 and derive the transfer function for V2(s)/V1(s)<br>  <br><br>**Figure 4** | 5 | CO1 |

# NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

## Odd Semester Mid-Term Examination, 2023-24

**Course Code:** EEO743 Full Marks: 25

**Course Name:** FLIGHT CONTROL SYSTEMS Time: 90 Minutes

Instructions: Answer **Question No 1** and any **three (3)** from the rest.

| Question No. | Body of the Question | Marks | Mapped CO |
|---|---|---|---|
| 1 | (a) Which reference frame is used for autonomous navigation of an aircraft?<br>(b) What do you understand by the term "trimming of aircraft"?<br>(c) What is the justification of designing the wing tip of an aircraft tilted in upward direction?<br>(d) How the drag is compensated for an aircraft?<br>(e) What do you interpret by the terms "statically stability" and "dynamic stability" of an aircraft?<br>(f) What is the significance of dihedral angle?<br>(g) What is the justification of sudden drop of lift at stall angle of attack (AoA)? | 1x7 | CO1,<br>CO3<br>CO1<br>CO1<br>CO3<br>CO3<br>CO1 |
| 2 | Draw the Pitching Moment Coefficient ($C_{M\text{-}CG}$) vs Angle of Attack (AoA) plot for a positively cambered aerofoil and interpret it with proper explanation. Is it possible to fly a tailless aircraft with positively cambered aerofoil? How would you redesign the aircraft in that situation? | 6 | CO3 |
| 3 | Derive the force and moment equation of aircraft (point mass object) with respect to inertial reference frame. What is the justification of representing 6DOF equation of motion with respect to body fixed axes? | 6 | CO1 |
| 4 | For an aerofoil the aerodynamic center is ahead of the center of gravity. The distance between the aerodynamic center and the CG is ***0.35c*** where ***c*** is the chord length. If the aircraft is trimmed at a lift coefficient ($C_L$) of 0.42, find the moment coefficient at aerodynamic center ($C_{M\text{-}AC}$) if no pitching moment is experienced at CG. | 6 | CO3 |
| 5 | Estimate the location of the aerodynamic center during the design of an aircraft for its neutral static stability. | 6 | CO3 |
| 6 | Explain 6 DOF motion of an Aircraft with proper illustration. What are the forces acting on an aircraft during wings level steady flight? Express the aerodynamic forces and moments in terms of the dynamic pressure. | 6 | CO1, |

Course Outcomes

**CO1:** To develop the concept of the aerodynamics, 6 degrees of freedom motion of aircraft and understanding the role of control surface.

**CO2:** To understand the longitudinal and lateral dynamics of aircrafts and to identify different modes along with the scope of their improvements by designing control law.

**CO3:** To develop the concept of Static and Dynamic Stability of Aircrafts.

**CO4:** To develop insight on margin criterion, the closed loop response specifications and their relation with the stability and flying qualities of the aircrafts.

**CO5:** To design control law based on Classical Control Theory for Longitudinal and Lateral/directional dynamics to meet the desired margin and flying qualities criteria

**CO6:** To design control law based on Classical Control Theory for Longitudinal and Lateral/directional dynamics to meet the desired margin and flying qualities criteria