Indian Maritime University

(A Central University, Govt of India)

End Semester Examinations – December 2023

Programme Name: B Tech (ME)

Semester: VII

Subject Code: UG11T3702

Subject Name: Advanced Marine Control Engineering and Automation

Date: 06.12.2023	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

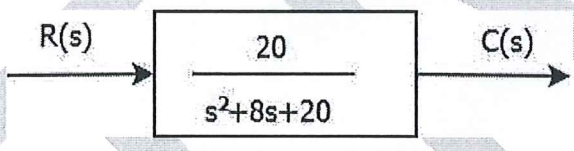
General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in the respective section.

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each-Choose the correct answer as applicable.

1. The natural response shown below is:



a) Over damped with $\zeta = 0.894$ and $\omega_n = 20\ rad/sec$
b) Under damped with $\zeta = 1.894$ and $\omega_n = 4.472\ rad/sec$
c) Over damped with $\zeta = 1.894$ and $\omega_n = 20\ rad/sec$
d) Under damped with $\zeta = 0.894$ and $\omega_n = 4.472\ rad/sec$

2. The overall transfer function of two blocks in parallel are:
a) Sum of individual gain
b) Product of individual gain
c) Difference of individual gain
d) Division of individual gain

3. Root Locus always starts from:
a) The open loop poles and terminate at the open loop zeros
b) The open loop zeros and terminate at the open loop poles
c) The close loop poles and terminate at the open loop zeros
d) The close loop poles and terminate at the close loop zeros

4. Which of the following measures of error constants of the system?
   a) Relative stability
   b) Transient state response
   c) Steady state response
   d) Steady state as well as transient response

5. In the formation of Routh array for a polynomial, when all the elements in one row of the Routh's tabulation are zero then this condition indicates:
   i. one pair of real roots with opposite sign in s-plane
   ii. one pair of conjugate roots on the imaginary axis in s-plane
   iii. conjugate roots forming a quadrate in s-plane

   Which of the statements given below is/are correct?

   a) i only
   b) ii only
   c) i, ii and iii
   d) iii only

6. State space analysis is applicable even if the initial conditions are _____

   a) Zero

   b) Non-zero

   c) Equal

   d) Not equal

7. Which one is not an input to the auto pilot system?
   a) Main engine RPM.
   b) Ship's speed.
   c) Rate of turn.
   d) Turn radius.

8. Which one is not a requirement for a steering gear system?
   a) Steering gear for U.M.S. operation must be of the type such that the steering gear control can be regained by manual isolation in not more than 45 s after the loss of one power actuating system.
   b) There should be two separate steering gear pumps, which can independently help to steer the vessel, and one of them must have its power supply through the emergency switchboard
   c) Means for indicating that the motors of electric and electrohydraulic steering gear are running shall be installed on the navigation bridge and at a suitable main machinery control position.

d) The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative.

9. In a system zero initial condition means that:
   a) The system is at rest and no energy is stored in any of its components
   b) The system is working with zero stored energy
   c) The system is working with zero reference signal
   d) Laplace transform is not possible

10. What is the set of all values of z for which X(z) attains a finite value?

   a) Radius of convergence
   b) Radius of divergence
   c) Feasible solution
   d) None of the mentioned

Section B

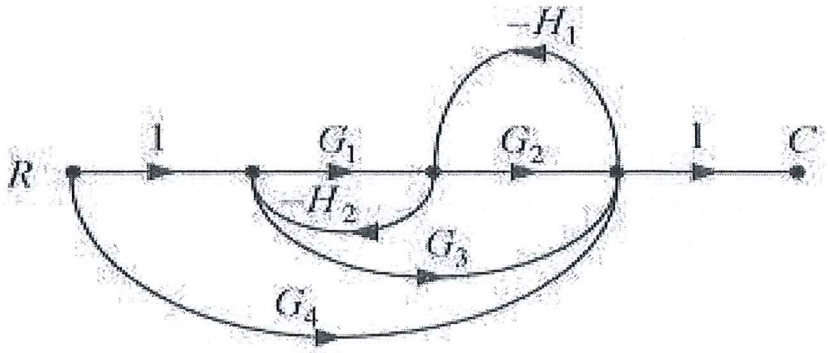
Five Questions of 02 Marks each

11. For a unity feedback system $G(s)=\frac{30(s+1)}{s(s+3)(s+6)}$. Determine static error coefficients.
12. What is the angle and magnitude criterion, a point should satisfy to conclude that it is on the Root Locus?
13. Explain Phase Margin and Gain Margin.
14. Write a brief note on Two step on-off control.
15. What is controllability and observability?

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

16. Find the overall gain of the system whose signal flow graph is shown in figure. (10 Marks)



17. The state diagram of a system is shown below. A system is described by the state variable equations $\dot{X} = AX + Bu;\ y = CX + Du$. What will be the state transition matrix e^{At} of the system shown in the figure? (10 Marks)

18. a) Explain various physical nonlinear performances in the control system. (5 Marks)

b) Find the response of the system $s(n+2)-3s(n+1)+2s(n)=\delta(n)$, when all the initial conditions are zero. (5 Marks)

19. a) Derive the expression of Time Response for second order system considering Underdamped performance: $0<\xi<1$ with unit step input. (6 Marks)

b) The open loop transfer function of a unity feedback system is given by,

$$G(s) = \frac{K}{s(1+sT)}$$

where K and T are positive constants. By what factor should 'K' be multiplied so that the peak overshoot of unit step response of the system will reduce from 75% to 25%. (4 Marks)

20. For the given control system,

$$G(s)H(s) = \frac{10}{s(s+1)(s+10)}$$

, determine the stability of the system by plotting Bode plot. Calculate PM and GM. (10 Marks)

21. a) Draw the Root locus for the system with

$$G(s)H(s) = \frac{K}{s(s+1)(s+2)}$$

(5 marks)

b) For a unity feedback system, process transfer function is given by

$$G(s) = \frac{1}{s\,(s+1)(s+4)}$$

The controller is of PID mode. Calculate the optimal values of controller parameters based on ultimate cycle method of tuning as per table given below: (5 marks)

Type of controller	KP	Ti	Td
P	0.5Kcr	∞	0
PI	0.45Kcr	$\frac{1}{1.2}$Pcr	0
PID	0.6Kcr	0.5Pcr	0.125Pcr

22. Sketch and explain central cooling LT fresh water temperature control system. (10 marks)