# GURU NANAK INSTITUTE OF TECHNOLOGY

**An Autonomous Institute under MAKAUT**

**2020-2021**

## CONTROL ENGINEERING(Backlog)

## EI 503

**TIME ALLOTTED: 3 Hours** **FULL MARKS: 70**

***The figures in the margin indicate full marks.***

***Candidates are required to give their answers in their own words as far as practicable.***

**GROUP – A**

**(Multiple Choice Type Questions)**

Answer any ***ten*** from the following, choosing the correct alternative of each question: **10×1=10**

| | | | Marks | CO No |
|---|---|---|---|---|
| 1. | (i) | For relative stability of the system which of the following is sufficient?<br>a) Gain margin<br>b) Phase margin<br>c) Both (a) and (b)<br>d) None of these | 1 | CO4 |
| | (ii) | In Nyquist criterion roots of the characteristic equation are given by<br>a) Zeros of open loop transfer function<br>b) Zeros of closed loop transfer function<br>c) Poles of closed loop transfer function<br>d) Poles of open loop transfer function | 1 | CO3 |
| | (iii) | Cut off frequency is the frequency at which magnitude of closed loop frequency response is<br>a) 1 db below its zero frequency<br>b) 2 db below its zero frequency<br>c) 3 db below its zero frequency<br>d) 4 db below its zero frequency | 1 | CO3 |
| | (iv) | Steady state error is always zero in response to the displacement input for<br>a) Type 0 system<br>b) Type 1 system<br>c) Type 2 system<br>d) Type (N > 1) system for N= 0, 1, 2….N | 1 | CO2 |
| | (v) | Electrical resistance is analogous to<br>a) Inertia<br>b) Dampers<br>c) Spring<br>d) Fluid capacity | 1 | CO1 |
| | (vi) | Transfer function of a system can used to study its<br>a) Steady state behavior<br>b) Transient behavior<br>c) Both (a) and (b)<br>d) d) None of these | 1 | CO1 |

| | | | |
|---|---|---|---|
| (vii) | An open loop system<br>a) Output control the input signal<br>b) Output has no control over input signal<br>c) Some other variable control the input signal<br>d) Neither output nor any other variable has any effect on input | 1 | CO1 |
| (viii) | A system Gain Margin is -12 dB, the system is<br>a) Stable<br>b) unstable<br>c) marginally stable<br>d) none of the above | 1 | CO3 |
| (ix) | If a Nyquist plot of G (jω) H (jω) for a closed loop system passes through (-2, j0) point in GH plane, what would be the value of gain margin of the system in dB?<br>a) 0 dB<br>b) 2.0201 dB<br>c) 4 dB<br>d) 6.0205 dB | 1 | CO3 |
| (x) | Polar plots for+ve and –ve frequencies<br>a) Are always symmetrical<br>b) Can never be symmetrical<br>c) May be symmetrical<br>d) None of these | 1 | CO3 |
| (xi) | By adding a pole at s = 0, Nyquist plot of the system will<br>a) Shift 90° clockwise<br>b) Shift 90° anticlockwise<br>c) Shift 180°<br>d) Not change at all | 1 | CO3 |
| (xii) | A complex-conjugate pair of poles on the jw axis will produce a<br>a) High oscillatory mode of transient response<br>b) Steady state mode of response<br>c) Sinusoidal mode of response<br>d) None of these | 1 | CO1,CO 2 |

## GROUP – B
## (Short Answer Type Questions)

Answer any ***three*** from the following: **3×5=15**

| | | | Marks | CO No |
|---|---|---|---|---|
| 2. | (a) | Draw the transient response characteristics graph of second order underdamped initially relaxed system. | 2 | CO2 |
| | (b) | Define the following:-<br>Delay Time<br>Rise Time<br>Peak Time<br>Maximum Peak<br>Settling Time<br>Steady State error | 3 | CO2 |
| 3. | (a) | Calculate the steady state error of the close loop system of | 3 | CO1,CO |

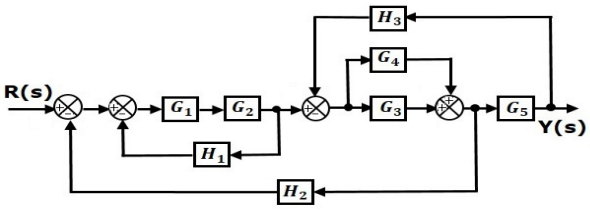
transfer function 2

$G(s) = 1 / S(S+3)$

and H(s) = 1 with the I/P signal

$2 + 5t + 9t^2/2$

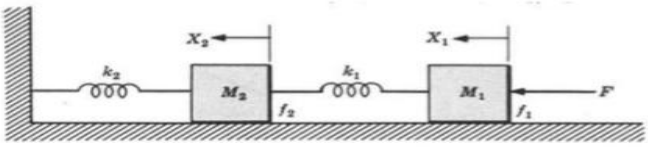
| | | | | |
|---|---|---|---|---|
| | (b) | What do you mean by proportional Error Coefficient & Acceleration Error coefficient? | 2 | CO2 |
| 4. | (a) | Draw the Signal Flow graph of the following Block diagram. | 4 | CO1,CO 2 |




| | | | | |
|---|---|---|---|---|
| | (b) | What is Close Loop Transfer Function? | 1 | CO1 |
| 5. | (a) | Sketch the Polar plots of the transfer function given below. Where K=20. | 3 | CO4 |

$$G(s)H(s) = \frac{K}{s(s+1)(s+5)}$$

| | | | | |
|---|---|---|---|---|
| | (b) | Determine the gain Cross over frequency. | 2 | CO4 |
| 6. | (a) | Draw the electrical equivalent circuit of the following mechancal system using Force-Current analogy? | 4 | CO1,CO 2 |



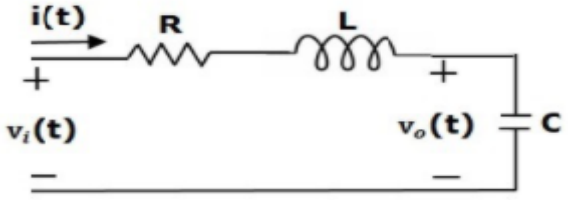

| | | | | |
|---|---|---|---|---|
| | (b) | What is force Voltage Analogy? | 1 | CO1 |

## GROUP – C
## (Long Answer Type Questions)

Answer any ***three*** from the following: **3×15=45**

| | | | Marks | CO No |
|---|---|---|---|---|
| 7. | (a) | Sketch Nyquist plot for following transfer function. G(S)= 2 / [S(S+ 2)(S +3)] | 10 | CO1 |
| | (b) | Find the GM and PM. | 4 | CO4 |
| | (c) | Comment on the stability of the system. | 1 | CO4 |
| 8. | (a) | Define Root Locus. | 2 | CO1 |
| | (b) | Consider a feedback system having characteristics equation | 10 | CO2 |

G(s) = K / [ s(s + 1) (s2 + 2s + 2) ]

| | | | | |
|---|---|---|---|---|
| | | Find the root locus of the system. | | |
| | (c) | Explain the Relative stability measurement using Root Locus Technique. | 3 | CO1 |
| 9. | (a) | Explain Nyquist stability criteria. | 5 | CO3 |
| | (b) | Using Bode Plot find whether the closed-loop system will be stable for the open-loop transfer function and Calculate its gain margin. G(s) = 14 / [ s(s + 1) (s + 2) ] | 10 | CO2 |
| 10. | (a) | Write definitions of state and state variables. Derive expression of transfer function of the system which is represented in the following standard state space form: $\dot{X} = AX + BU$ ; Y = CX +DU | 5 | CO4 |
| | (b) | Derive the State Space Model from Differential Equation of the following system.   | 8 | CO3 |
| | (c) | Define controllability and Observability. | 2 | CO4 |
| 11. | | Answer **any three** of the following | | |
| | (a) | Relative Stability and Absolute Stability of the Control System | 5 | CO3 |
| | (b) | Lag Compensator | 5 | CO4 |
| | (c) | Polar Plot | 5 | CO3 |
| | (d) | Gain margin & phase margin | 5 | CO2 |
| | (e) | Time response of Second Order System for step response | 5 | CO2 |