Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Examination December 2021 (2019 scheme)

Course Code: ECT 307

Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

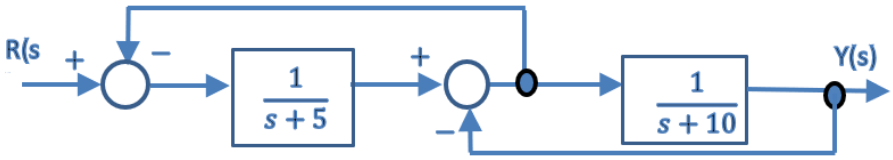
(Answer all questions; each question carries 3 marks) Marks

1	Compare open loop and closed loop control systems. Give one example to both.	3
2	What is the criterion on the roots of the characteristic equation for the stability? How is it connected to the BIBO stability?	3
3	Draw the signal flow graph for the following set of algebraic equations: $x_1 = ax_0 + bx_1 + cx_2$ $x_2 = dx_1 + ex_3$	3
4	State the angle and magnitude criteria that roots of the characteristic equation must be satisfied.	3
5	In a system represented by the state vector differential equation, let **A** is the coefficient matrix of the state variable vector. Then, if $\mathbf{A} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$, find the characteristic roots of the system.	3
6	Draw the response of an underdamped second order system with complex poles on the left half of s-plane showing the rise time, peak overshoot, and settling time.	3
7	Distinguish between Order of a system and Type of a system.	3
8	Draw the s-plane contour used for mapping, for stability analysis, to the plane of open-loop transfer function. $G(s)H(s) = \frac{1}{s(s+1)}$ Explain the choice of the contour	3
9	Write and explain the transfer function for a first order phase lag compensator. State the function of a phase lag compensator in a control system.	3
10	Give two advantages for using state variable representation of systems.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

11 a) 7

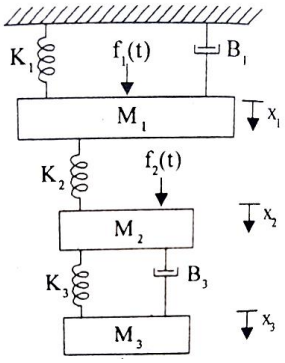


Find the transfer function of the system shown by the block diagram using direct block diagram reduction rules.

b) Draw the signal flow graph for the system in question 11 (a) and obtain the gain using the Mason's Formula. 7

12 a) Draw the schematic of a second order spring-mass-damper (SMD) system and obtain its transfer function. Draw the Force current and force voltage analogy circuits of the SMD system. 7

b) Find the differential equation governing the mechanical system shown in fig. Draw the corresponding Force-Voltage analogous circuit 7



Module -2

13 a) Define position, velocity and acceleration error constants for a unity feedback control system. 7

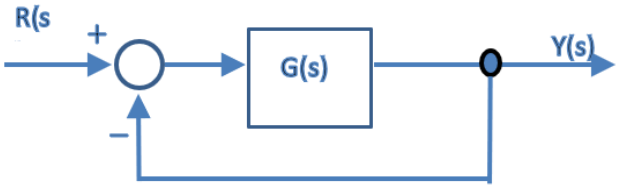
b) For the second order system with complex poles on the left half of s-plane, derive the expression for rise time, settling time, and steady state error parameters. 7

14 a) Find the response of a system with transfer function 7

$T(s) = \frac{1}{(s+1)(s(+3)}$ when subjected to unit step input.

b) For the system in the block diagram, 7

$$G(s) = \frac{10}{s^2 + 14s + 50}$$



Find the steady state error values for unit step and unit ramp inputs.

Module -3

15 a) A system has characteristic equation, $s^3 + 3s^2 + (K+1)s + 4 = 0$. Find the range of *K* for the stable system. 7

b) For a system having open loop transfer function, 7

$$G(s)H(s) = \frac{K}{(s+1)(s+3)(s+6)}$$

Plot the root locus stating the steps.

16 a) Explain the effect of adding a pole to a second order system. 7

b) Write the general transfer functions of P, PI and PID controllers. Explain their role in a control system design. 7

Module -4

17 Using the Nyquist contour, analyse the following system to obtain the limit of *K* for the stability. The system has the open-loop transfer function 14

$$G(s)H(s) = \frac{K}{s(\tau_1 s+1)(\tau_2 s+1)}$$

Find the expression for gain margin of the system. Determine phase margin of the system from the graph plotted.

18 a) State Cauchy's argument principle with the conditions to be applied on the contour of mapping. State the Nyquist criterion of stability on the open loop transfer function of a control system. 7

b) Draw the bode plots of the system with open loop transfer function. 7

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

Explain how the plot can be used for analysing the stability of the system.

Module -5

19 a) Let 7

$$T(s) = \frac{1}{s^2 + 20s + 100}$$

is the transfer function of a system. Draw its signal flow graph in phase variable form. Also represent the system in the state variable form.

b) Find the state transition matrix of a system represented by two state variables and having state coefficient matrix, $\mathbf{A} = \begin{bmatrix} 0 & 6 \\ -1 & -5 \end{bmatrix}$. 7

20 a) A single-input single-output system has the matrix equations 7

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = [10 \quad 0]\mathbf{x}$$

Determine the transfer function using the signal flow model.

b) A system characterised by the transfer function 7

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3 + 6s^2 + 11s + 6}$$

Find the state and output equation in matrix form and also test the controllability and observability of the system

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