Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S,FE) (FT/WP), (S3 PT) Examination May 2025 (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 The impulse response of a system is given by $g(t) = e^{-t}(1 - \cos 2t)$. Determine the transfer function of the system. 3

2 Draw the signal flow graph based on the following expressions and find the overall transmittance relating x_5 and x_1 3

$x_2 = a\,x_1 + c\,x_3$;

$x_3 = bx_2 + ex_4$;

$x_4 = d\,x_3$;

$x_5 = f\,x_4$ where x_1 is the input node and x_5 is the output node.

3 What are test inputs? Explain with examples 3

4 Derive an expression for maximum overshoot of a second order system subjected to step input. 3

5 List any three effects of a derivative controller 3

6 What are the two Criteria that any point on a root locus should satisfy? 3

7 Obtain the transfer function of a simple phase lead network 3

8 Explain phase margin and gain margin using suitable expression. 3

9 Give any two advantages of state variable approach 3

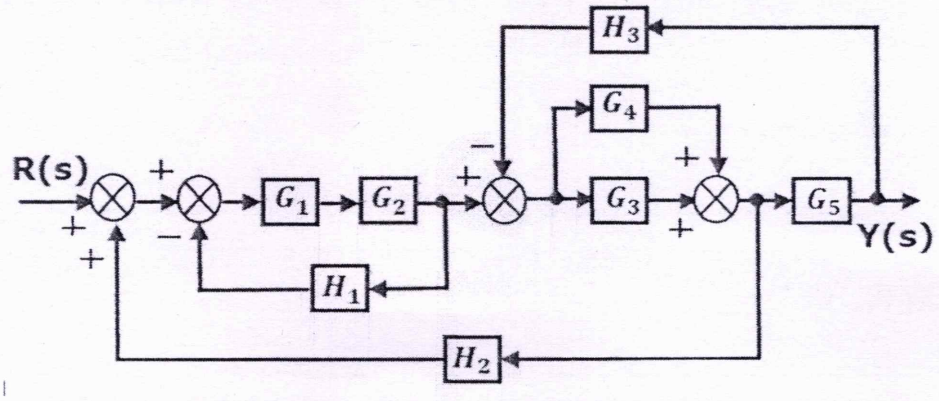
10 Define the terms controllability and observability of a system 3

PART B

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

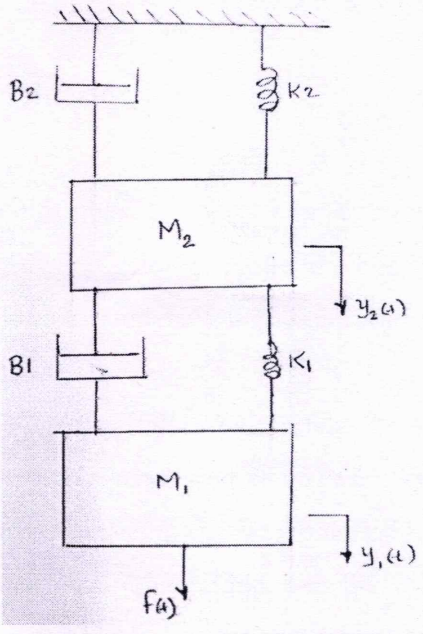
Module -1

11 Use Block reduction technique to reduce the block diagram to its canonical form and thereby find the overall transfer function. Verify the transfer function using Mason's gain formula. 14



12 a) Explain any 3 real time examples of a control system 6

b) For the mechanical system shown in the figure determine the transfer function $\frac{Y_1(S)}{F(S)}$. 8



Module -2

13 a) The forward path gain of a unity feedback control system is given by G(s) = $\frac{144}{s(s+12)}$. Find the natural frequency, frequency of damped oscillation, maximum overshoot, peak time, rise time and settling time (with 2% tolerance) for unit step response. 6

b) Derive an output expression for a second order system subjected to unit step signal to explain underdamped and critically damped output condition. Also sketch the response for each case. 8

14 a) Prove that resonance frequency of a typical second order system is a function of damping ratio ζ. Thereby show that resonance frequency occurs only when the value of ζ is less than 0.707. 8

b) A second order system has a damping ratio of 0.5 and a settling time of 1 s. Find resonant frequency, peak resonance, cut-off frequency and bandwidth. 6

Module -3

15 Sketch the locus of closed loop poles of a unity feedback control system whose open loop transfer function is given by G(s) H(s) = $\frac{K}{(s+1)(s+3)(s+5)(s+7)}$. From the sketch find the limit of K for which the system is stable and also find the frequency at which system exhibits sustained oscillation. 14

16 a) The open loop transfer function of a unity feedback system is given by G(s) = $\frac{8}{s^2+2ks+k+3.}$. Find the value of k for which the system response is oscillatory assuming k to be a positive number. Also find the range of K for which the system is absolutely stable. 6

b) Compare P PI PID controllers 8

Module -4

17 For unity feedback system the open loop transfer function is given by G(s) = $\frac{0.25(1+0.5s)}{s(1+2s)(1+4s)}$. Draw the asymptotic Bode plot and determine: 14

i) The gain crossover frequency

ii) Phase margin

iii) Phase crossover frequency

iv) Gain margin

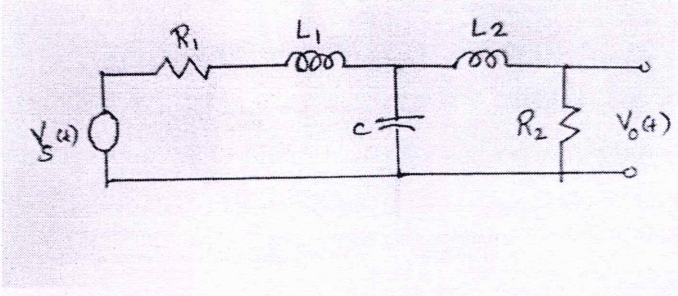
Assess the stability of the system.

18 a) Using Nyquist criterion investigate the closed loop stability of the system whose open loop transfer function is given by G(s)H(s)= $\frac{K(s+1)}{(s+0.5)(s-2)}$. Consider K to be 1.25 and 2.25 and compare the stability for each case. 8

b) What are steps involved in the design procedure of phase lag compensator using Bode plots ? 6

Module -5

19 a) Obtain the state model of the network shown in physical variable form. 6



b) The transfer function of a dynamic system is $\frac{Y(S)}{R(S)} = \frac{3s^2+s+2}{s^3+7s^2+14s+8}$. Find the state model of the system in canonical form. 8

20 a) A system matrix for a LTI system is $A = \begin{bmatrix} 0 & 2 \\ -3 & -5 \end{bmatrix}$. Determine the state transition matrix φ (t) and thereby prove that φ (0) = I 7

b) A dynamic system is represented by the state equation 7

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

Check whether the system is completely controllable.

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