Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

Online End Semester Examination, May 2021

Programme Name: B.Tech/ Electrical **Semester: IV**
Course Name : Control System **Time: 03 hrs.**
Course Code : ECEG2031 **Max. Marks: 100**
Nos. of page(s) : 5

SECTION A

1. Each Question will carry 5 Marks
2. Instruction: Complete the statement / Select the correct answer(s).
Graph paper is required in one question.

S. No.	Question	CO
Q.1	**A. The characteristic equation of a system is** $s^4 + \mathbf{2}s^3 + 2s^2 + \mathbf{3s} + \mathbf{6} = \mathbf{0}$. **The number of roots on right hand side of the s plane are:** a) 4 b) 2 c) 3 d) 6 **B. If** $A = \begin{bmatrix} -0.5 & 0 \\ 0 & -2 \end{bmatrix}, \boldsymbol{B} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ then a) System is controllable b) System is uncontrollable c) System is undefined d) None of these **C. A control system has** $\boldsymbol{G(S)H(S)} = \frac{\boldsymbol{K(S+1)}}{\boldsymbol{S(S+3)(S+4)}}$ **root locus o the system can lie on the real axis**: (a) between s = -1 and s = - 3 (b) between s = 0 and s = - 4 (c) between s = -4 and s =- 4 (d) towards left of s = -4	CO3

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<tr>
<td>Q 2</td>
<td>Consider a system described by $\dot{x} = \begin{bmatrix} 0 & 1 \\ 7 & -4 \end{bmatrix} x + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u$ and $y = [1 \quad 3]x$

1. Find the transfer function using the matrix algebra:
(a) $\frac{7s+27}{s^2+4s-7}$

(b) $\frac{7s+27}{s^2+4s+7}$

(c) $\frac{7s+21}{s^2+4s-7}$

(d) $\frac{7s+21}{s^2+4s+7}$

2. Comment on the system's stability. Is this system stable?

(a) Yes (B) No</td>
<td>CO4</td>
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<td>Q 3</td>
<td>Define the forward paths and loops in a signal flow graph.
For the graph shown below in Fig:1 Write the number of forward path and loop gains.

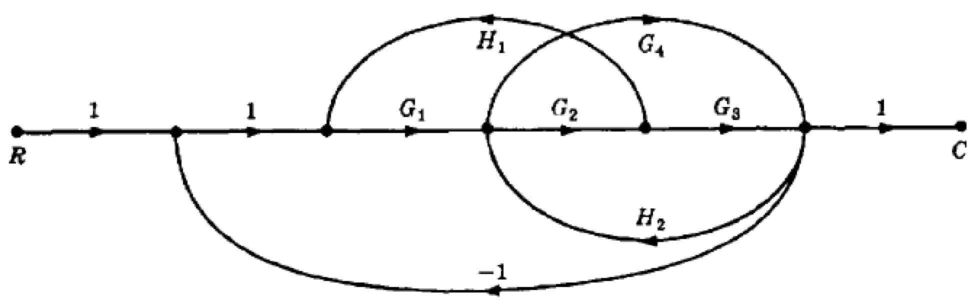

Fig:1</td>
<td>CO2</td>
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<td>Q 4</td>
<td>State true or false for the followings:

a) Marginally stable system has some real roots with real parts equal to zero, but none with positive real parts. T/F
b) The bode plat is not a plot relation of log w with magnitude in decibel and phase angle. T/F
c) Gain margin is a measure of relative stability of a system. T/F
d) Laplace transform of an impulse function is one. T/F
e) In frequency domain analysis both amplitude and phase varies with frequency change. T/F</td>
<td>CO3</td>
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Q 5	**1. The capacitance, in force-current analogy, is analogous to** (a) momentum (b) velocity (c) displacement (d) mass **2. In force-voltage analogy, velocity is analogous to** (a) current (b) charge (c) inductance (d) capacitance **3. The system given** $G(s)=\frac{1}{s^2+0.14s+1}$ **by is** a) Underdamped b) overdamped c) critically damped. d) Undamped. **4. The steady state error for a type two system subjected to unit ram input is** (a) 2 (b) 1 (c) 0 (d) infinity **5. The characteristic equation of a system is** $s^2+2s+8=0$**. The damping ration will be.** (a) <1 b) <1 (c) =1 (d) none	**CO1**
Q 6	Define the following time domain specifications of the second order system. 1. Delay time 2. Rise time 3. Peak time 4. Maximum overshoot 5. Settling time	CO2
SECTION B **1. Each question will carry 10 marks** **2. Instruction: Write short / brief notes**		
Q 7	The overall transfer function of a unity feedback control system is given by $G(s) = \frac{10}{s^2+6s+10}$ Find (a) K_p, K_v and K_a (b) A closed loop system when subjected to a unit step input has an expression for the time response given by $c(t) = 0.5 + 2.25\,e^{-4t} – 3.75\,e^{-15t}$ Determine the overall transfer function of the system.	CO3
Q 8	A. Derive the transfer function representation from the generalized state space model. B. Define the state transition matrix and list down the properties	CO5

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<td>Q 9</td>
<td>Define the following with respect to bode plot: Draw diagrams in support of your answer.
1. Phase Margin
2. Gain Margin
3. Phase Cross over frequency
4. Gain Cross over frequency</td>
<td>CO2</td>
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<td>Q 10</td>
<td>What do you understand by root locus? Describe the rules for construction of root locus plot. The forward path transfer function of a unity feedback system is given by $G(s) = \frac{K}{S(S+4)(S+5)}$. Sketch the root locus as K varies from zero to infinity.</td>
<td>CO4</td>
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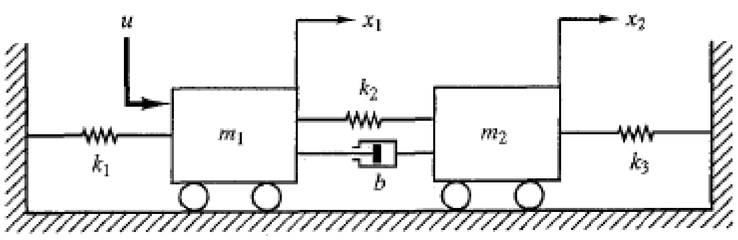
<td>Q 11</td>
<td>Derive transfer function $X_1(s)/U(s)$. For the same system obtain the electrical analogous system using force- voltage and force-current analogy.


Fig: 2</td>
<td>CO1</td>
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<td colspan="3">Section C
1. Each Question carries 20 Marks.
2. Instruction: Write long answer.</td>
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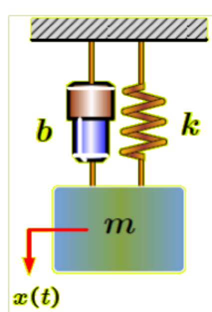
<td>Q 12</td>
<td>For the following system shown in Figure 3 below kept in zero gravity derive the transfer function if m=100g, b=0.4 N/ms, k=4N/m and find out damping ratio and natural frequency of the system.


Fig:3</td>
<td>CO4</td>
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	Describe the PID controller in details with relative advantages and disadvantages of individual three term controls. Design the closed loop control using PID controller for the transfer function obtained in above steps. Assume the values of constants associated with design.. ***OR*** The open loop transfer function of a unity feedback control system is given by $$G(s) = \frac{K}{s(1+0.5s)(1+0.2s)}$$ It is desired that (i) For a unit step input the steady state error of the output position be less than 0.125 degrees/(degree/second) (ii) P.M. $\geq 40^0$. Design a suitable compensation network.	