Q. No. EEE 612/ 71

B.TECH/EVEN
REG/(22-23)

Even Semester Mid-term Examination, 2022-23

MODERN CONTROL SYSTEM

EEE 612

Full Marks : 25 *Time* : 90 Minutes

The figures in the margin indicate full marks

Answer any *five* questions.

Question No.	Body of the Question	Marks	Mapped CO
1.	Obtain a state space mathematical model for the electrical system shown in Figure Ql. Consider the voltage and current sources as two inputs, and the voltage across the resistance of $1\,\mathrm{k\Omega}$ as the output.	5	CO1, CO2

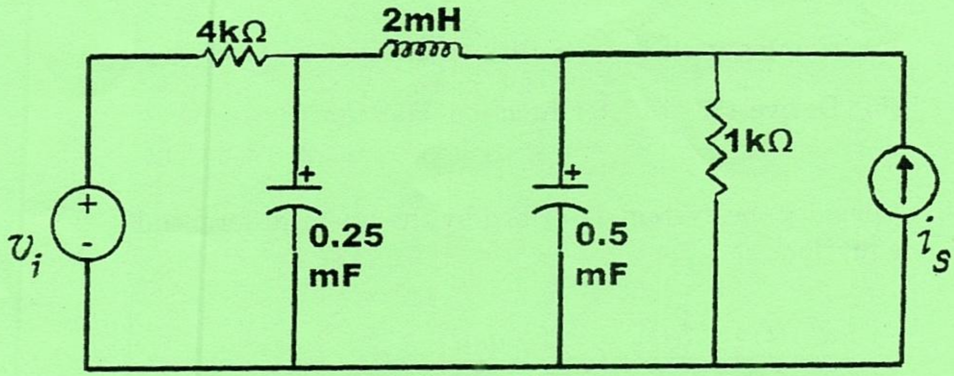

Figure Q1

Question No.	Body of the Question	Marks	Mapped CO
2.	Derive a state space mathematical model for a system represented by the block diagram shown in Figure Q2.	5	CO1, CO2

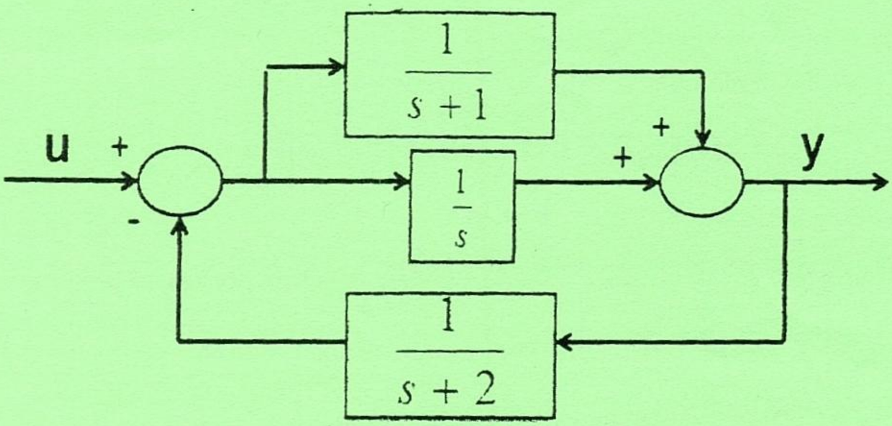

Figure Q2

3. Consider a LTI system described by $\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x +$

$\begin{bmatrix} 1 \\ 0 \end{bmatrix} u$; $y = [1 \;\; 0]x.$

(a) Comment on the stability of the system,

(b) Derive the transfer function $Y(s)/U(s)$.

2+3 = 5 CO2

4. Consider the system described by the linear differential equation

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = \frac{du(t)}{dt} + u(t),$$

(a) Assuming initial conditions to be zero find out the transfer function $Y(s)/U(s)$ of the system,

(b) Consider the input u(t) to be unit step and find the output response $y(t)$. 2+3 = 5 CO2

5. Consider an autonomous system with state space model $\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} x$. Using the Caley - Hamilton technique, find the state transition matrix. 5 CO2

6. Consider the system $\dot{x} = \begin{bmatrix} 0 & -3 \\ 1 & -4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$.

(a) Apply a Similarity transformation $x(t) = Mz(t)$ to obtain the system matrix in the diagonal form,

(b) Express the state model in terms of the states $z(t)$. 3 + 2 CO2

7. (a) Enumerate any three properties of state transition matrix.

(b) Justify the statement that "Poles of a system are same as Eigenvalues of system dynamic matrix".

3 + 2=5 CO1, CO2

COURSE OUTCOMES

CO1: To understand the states for physical systems

CO2: To analyse LTI continuous systems with state variable representation

CO3: To understand the advantages of state variable feedback control

CO4: To understand optimal control

CO5: To learn the concept of optimal filtering and state estimation as an essential part of control system design

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NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester Mid-term Examination, 2022-23

Course Code: EEE 616 Full Marks: 25

Course Name: Soft-Computing Theory and Applications Time: 90 Mins

Question Paper No.: NITDGP/EEE 616/1

Instructions: Answer all the questions.
All usual notations/symbols are used.

Question No.	Body of the Question	Marks	Mapped CO
1	(a) In the first iteration, how will you obtain gbest solution for PSO technique? Explain with code/pseudo code.	2	CO3
	(b) What will be the velocity in the first iteration of PSO technique? Justify your answer.	1	CO3
	(c) Write complete flowchart for the PSO technique.	2	CO3
	(d) What is the significance of 'inertia weight factor (w)'? Let, the maximum number of iteration ($\max\_iteration$) is 100. $w_{max} = 0.9\ and\ w_{min} = 0.5$. Derive exponential adaptive inertia weight factor (*EAIWF*) in such a way that w exponentially varies with the iteration from w_{max} to w_{min}.	1 3	CO3 CO3
2	(a) In a multi-objective problem, there are two objective functions – (i) efficiency of the machine ($f^{efficiency}$) and (ii) cost of the machine (f^{cost}). $f^{efficiency}$ is required to maximize. On the contrary, f^{cost} should be minimized. Convert this problem into a single objective function as a minimization problem. Show all steps with clarifications.	2	CO2
	(b) What do you mean by global optima and local optima? Explain with suitable examples.	2+2	CO1
	(c) How can you avoid the local optima in case of PSO technique?	2	CO3
	(d) if a problem can be solved by both hard and soft-computing techniques, which computational technique among the two types of techniques will you prefer? Justify your answer.	1	CO1
3	(a) The Ackley function is given below: $$f(x) = -a\exp\left(-b\sqrt{\frac{1}{d}\sum_{i=1}^{d} x_i^2}\right) - \exp\left(\frac{1}{d}\sum_{i=1}^{d}\cos(cx_i)\right) + a + \exp(1)$$ Where $a = 20, b = 0.2, c = 2\pi$. Let the population ($pop$)=100 and dimension ($d$)=5; Write code / pseudo code to find the fitness value for each population. Keep all fitness values of all population in the array.	5	CO2
	(b) Compare GA and PSO.	2	CO2

Course Outcomes:

CO1: For the given linear and non-linear problems under practical limitations, compare classical analytical method and soft computing technique.

CO2: For a given single objective problem (SOP), apply binary coded genetic algorithm (BCGA) and real coded genetic algorithm (RCGA) with different types of crossover, mutation and also understand the impact of different parent selection strategies.

CO3: For a given non-linear or non-derivative problem, tune the control parameters of adaptive particle swarm optimization (APSO) for efficiently controlling the global exploration and local exploitation.

CO4: For a given multi-objective problem, explain the significance of Difference vector in Differential Evolutionary (DE) technique and also implement the differential evolutionary (DE) technique.

CO5: For a given problem, logically clarify the impact of hidden layers in artificial neuron network (ANN) and also stepwise explicate the back-propagation algorithm of ANN.

CO6: For a given problem, describe fuzzy knowledge base controller (FKBC) showing information and computational flow with membership function, rule base and defuzzification.