Total No. of Questions : 10]

SEAT No. :

P4001

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M.E. (Mechanical) (Design Engg. & Automotive Engg.)

MATHEMATICAL MODELING AND ANALYSIS

(2008 Pattern)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates :

1) ***Questions 1 and 6 are compulsory. Additionally, solve any two questions from the remaining questions in section - I and any two questions from the remaining questions in section - II.***
2) ***Answers to each sections should be written in separate answer books.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data wherever necessary but mention it clearly.***
5) ***Use of scientific calculator is allowed.***

SECTION - I

Q1) a) Linearize the function $f(x) = 5\cos x$ about $x = \pi/2$. **[7]**

b) Linearize the differential equation $d^2\theta/dt^2 = -(g/L)\sin\theta$ about $\theta = 0$, where g and L are constants. **[7]**

c) What is a signal flow graph, explain. **[4]**

Q2) Explain the following : **[16]**

a) Continuous-time system.

b) Discrete-time system.

c) Time-varying system.

d) Time-invariant system.

Q3) Write the governing equations for a fluid system (assuming incompressible flow) in differential form and explain the various terms in them. **[16]**

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Q4) Draw linear graphs for the systems shown in Figure 1. **[16]**

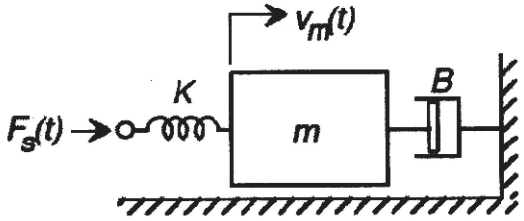

Figure 1a

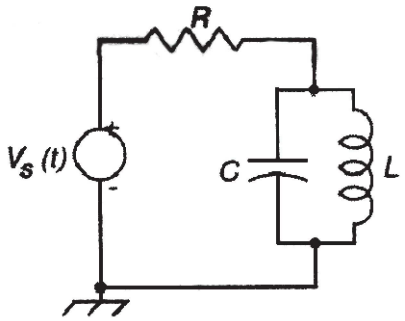

Figure 1b

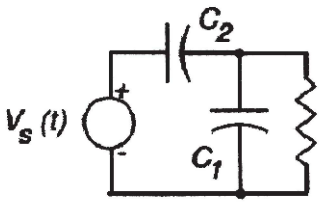

Figure 1c

Q5) Given two continuous time signals x(t) and g(t) as **[16]**

$$x(t)=\begin{cases}0, & t<0\\ t/3, & 0\le t\le 3\\ 0, & t>3\end{cases} \qquad g(t)=\begin{cases}0, & t<-1\\ 1, & -1\le t\le 1\\ 0, & t>1\end{cases}$$

compute the convolute integrals.

SECTION - II

Q6) a) Discretize the Laplace equation $\partial^2 u/\partial x^2+\partial^2 u/\partial y^2=0$ using finite difference method. **[12]**

b) Explain the following terms with respect to the finite difference method. **[6]**

i) Truncation error

ii) Convergence

Q7) The heat equation that determines the one-dimensional temperature distribution T(x, t) on a plane x = constant at time t in a block of metal with heat conduction properties characterized by the constant α(*i.e., thermal diffusivity*) is given by **[16]**

$$\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$$

Write the Laplace Transform solution of this equation, considering the metal slab to be semi-infinite. Consider the situation where for $t < 0$ all of the metal in the slab is at the temperature T = 0 and then, at time t = 0, the plane face of the slab at x = 0 is suddenly brought up to and maintained at the constant temperature $T = T_0$. The problem is to find the temperature inside the slab on any plane x = constant at any time $t > 0$, knowing that physically the temperature must remain finite for all $x > 0$ and $t > 0$.

Q8) a) Determine the Fourier transform of a periodic function. **[12]**

$$f(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$$

b) Explain the term modulation. **[4]**

Q9) Determine z transforms of the following signals : **[16]**

a) x(m) = 1 for m = 0 and x(m) = 0 for $m \neq 0$.

b) x(m) = 1 for m = k and x(m) = 0 for $m \neq k$.

c) $x(m) = \alpha^m$ for $m \geq 0$ and x(m) = 0 for $m < 0$.

Q10) Explain the following simulation methods : **[16]**

a) Digital,

b) Analogue,

c) Analytic, and

d) Monte-Carlo

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SEAT No. :

P4002

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M.E. (Mechanical) (Design Engineering)

ADVANCED STRESS ANALYSIS

(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates :

1) ***Answer any three questions from each section.***
2) ***Answers to the two sections should be written in separate answer books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Show that the Airy stress function $\Phi = 2x_1^4 + 12x_1^2 x_2^2 - 6 x_2^4$ satisfies the bi-harmonic equation $\nabla^4 = 0$ and determine the stress components assuming plain strain. **[8]**

b) What is the significance of compatibility conditions? Derive compatibility equation by using polar-co-ordinate system. **[8]**

Q2) a) A thin walled box section of dimensions '2a × a × t' is to be compared with a solid section of diameter 'a' as shown in fig.1. Find the thickness 't' so that the two sections have **[10]**

i) The same maximum stress for the same torque.

ii) The same stiffness.

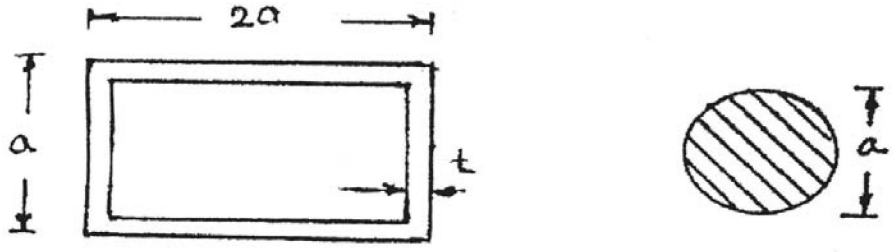

Fig.1

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