Register Number: ………….

B.E DEGREE EXAMINATIONS: MAY 2015

(Regulation 2013)

Fourth Semester

U13MAT403: MODELING AND ANALYSIS OF ENGINEERING SYSTEMS

(Common to AERO & AUTO)

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1.   A system model is
   a) A mathematical representation of its components
   b) A simplified system retaining main components
   c) A mathematical representation of component behavior and their interaction
   d) An analytical tool to solve the system content

2.   An abstract representation of a physical system behavior is derived using……………..

3.   The mathematical model for describing the dynamic behavior of a lumped parameter system is given by
   a) Set of algebraic equations
   b) A set of ordinary differential equations
   c) Partial differential equations
   d) A set of logical relationships

4.   The order of a system with a mathematical model given by third order differential equation is…………

5.   A system giving steady – state output y_1 in response to an input x_1 and output y_2 in response to input x_2 is said to be a linear system only if
   a) $y_1/x_1=y_2/x_2$
   b) $y_1y_2=x_1x_2$
   c) $x_2>x_1$ implies $y_2>y_1$
   d) Provides output of $(a_1y_1+a_2y_2)$ for an input $(a_1x_1+a_2x_2)$

6.   The number of arbitrary constants that will appear in the free response from a dynamic system model in the form of first order differential equations is equal to……………..

7. The phase angle for a sinusoidal transfer function with derivative factor is

   a) 0 degree   b) -45 degree

   c) 90 degree   d) -90 degree

8. Fourier transform is used to find the _____ response of a dynamic system.

9. A linear system having a transfer function with information on the number and location of all its poles and zeros is said to be a stable system only if

   a) All the poles lie to the left of the imaginary axis
   b) The number of zeros is less than the number of poles

   c) All the poles and zeros lie on the real axis
   d) There are no poles on the imaginary axis

10. The band with (in rad /sec) of a first order system with a time constant of 0.2 seconds is_____.

PART B (10 x 2 = 20 Marks)
(Not more than 40 words)

11. What is the electrical analogue for a first order mass – damper system? Give the connecting equation.

12. Will a first order system's transient response have an overshoot? Justify.

13. For what values of damping ratio, does a second order system exhibit an oscillatory response? Justify.

14. Draw a simple translational mechanical system with mass-spring-damper to represent the dynamics of a moving car.

15. Differentiate between Fourier transform and Laplace transform in the analysis of dynamic systems.

16. An electrical circuit with a sinusoidal voltage source connected to it was found to have the voltage measured across one circuit component as periodic, but non – sinusoidal (as observed on an oscilloscope). What is your inference about the circuit components?

17. The Bode plots corresponding to most physical systems have the magnitude going down with increasing frequency, particularly at high frequencies. Which characteristics of the physical system is responsible for this?

18. What is a resonant frequency? How is it related to the time domain model of a second order system?

19. Define transfer function.

20. For a linear system having transfer function H(s), how do you relate the input x(t) and output y(t) in the time domain?

PART C (5 x 14 = 70 Marks)
(Not more than 400 words)

Q.No. 21 is Compulsory

21.   Determine the governing equations and transfer function $X_3(s)/F(S)$ for the system shown below:

22. a) (i)   Define unit impulse function, unit step function and unit ramp function.   (7) Bring out the interrelationships amongst them.

           (ii)   What is impulse response of a linear system? How is this useful in predicting (7) the dynamic behavior of the system with arbitrary inputs?

(OR)

      b) (i)   What is a system characteristic equation? How the roots of this equation (7) determine the system dynamic behavior?

           (ii)   Given the value of time constant in a first order system, what inferences you (7) can quickly make about the system dynamic behavior?

23. a) (i)   How do we express an arbitrary periodic function x(t) with a fundamental (8) period T_0 in terms of exponential Fourier Series?
Derive the relationships used for evaluating the coefficient values in the above series.

           (ii)   What is Fourier spectrum and what information about a signal can be obtain by (6) looking at this spectrum?

(OR)

      b) (i)   What is the condition to be satisfied by x(t) in order that its Fourier Transform (4) exists?

(ii) Show that the Fourier Transform X(ω) of a real valued even function x(t) is also (10) real and even. In other words, that

Re{X (ω)}=Re{X(-ω)} and I$_m${X (ω)}=0.

24. a) (i) A first order system with unity gain and a time constant τ is subjected to (10) external input in the form of an unit step signal. How do you evaluate the system response following this input? Derive the relationships involved and sketch the response.

What will be the response if the input given to the system from t=0 is a ramp signal. i.e. input x(t)=k.t, for t>0?

(ii) How is this time constant expressed for a mass – damper system, and an L-R (4) circuit?

(OR)

b) Obtain the response of a II order under damped system when the input is a unit step input.

25. a) Sketch the Bode plot for the following transfer function and obtain the gain margin and phase margin $G(s) = \dfrac{20}{s(1+3s)(1+4s)}$

(OR)

b) Derive the expressions for resonant peak, resonant frequency and bandwidth for a second order dynamic system.

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