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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

FIFTH SEMESTER B.Tech. (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2017
SUBJECT: LINEAR AND DIGITAL CONTROL SYSTEMS (ECE - 3101)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- Centimeter and semilog graph sheets will be supplied

1A. The closed loop transfer function of a system is $\frac{C(s)}{R(s)} = \frac{100}{s^6 + 3s^5 + 8s^4 + 18s^3 + 20s^2 + 24s + 16}$. Determine the number of poles on right hand side, left hand side and on the jω axis. Comment on the stability of the system.

1B. Explain the time domain specifications of a second order system with suitable sketches.

1C. A negative unity feedback system has open-loop transfer function $G(s) = \frac{4}{s(s+4)}$. The nature of the step response is --------

a) Underdamped b) Over damped c) critically damped d) oscillatory.

(5+3+2)

2A. Obtain the differential equation governing the motion of the mechanical system and write the state equations for a mechanical system shown in figure (2A).

2B. Derive the expression for resonant frequency and magnitude of a second order system.

2C. A unity feedback system has forward- path transfer function $G(s) = \frac{25}{s(s+6)}$. The resonant peak of the closed loop frequency response is ------- a) 1.012 b) 1.122 c) 1.032 d) 1.042.

(5+3+2)

3A. A closed loop sampled data system whose open lop transfer function $\frac{5}{s(s+2)}$ is sampled at the error signal with sampling period of 0.4 sec. Find the characteristic polynomial in the z-domain and ascertain its stability through Bilinear transformation.

3B. For a lag-lead controller obtain the expression for the transfer function.

3C. The transfer function Y(s)/X(s) for a system with a signal flow graph as shown in figure (3C) is ----

a) $\frac{s+2}{s(s+1)}$ b) $\frac{s+2}{s-1}$ c) $\frac{s+2}{s(s-1)}$ d) $\frac{s+2}{s+1}$

(5+3+2)

4A. If $A = \begin{bmatrix} -2 & 0 \\ 0 & -3 \end{bmatrix}$, find state transition matrix using e^{At} (power series method). Verify the result by Laplace transform method and also find the inverse state transition matrix.

4B. Discuss why transportation lag is important in control systems. How it is modelled mathematically?

4C. The pulse transfer function for a process with zero order hold is given by $GH(z) = \dfrac{Z^{-2}(0.6 + 0.5Z^{-1})}{4 - 3Z^{-1}}$. Write the difference equation for implementing DDC using Kalman's method.

(5+3+2)

5A. The open loop transfer function of the uncompensated system is $G(s) = \dfrac{K}{s(s+2)}$. Design a suitable phase lag compensator for the system so that the static velocity error constant is 20 $\sec^{-1}$ and phase margin is at least 55^0.

5B. Derive an expression for a controller D(z) that will achieve dead beat control of a process of transfer function G(s).

5C. State and prove the properties of state transition matrix.

(5+3+2)

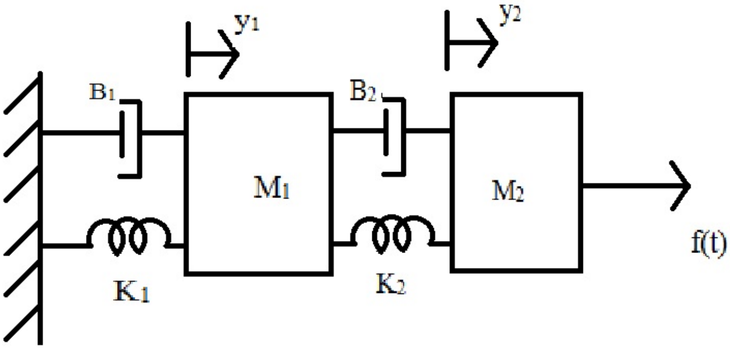

Figure (2A)

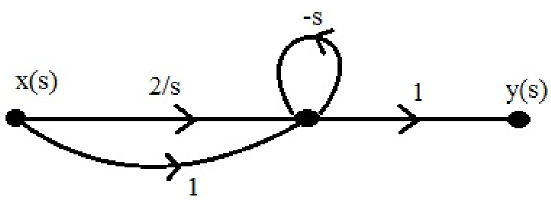

Figure (3C)