GATE - 2007 - EE

EE1030 : Matrix Theory
Indian Institute of Technology Hyderabad

Satyanarayana Gajjarapu
AI24BTECH11009

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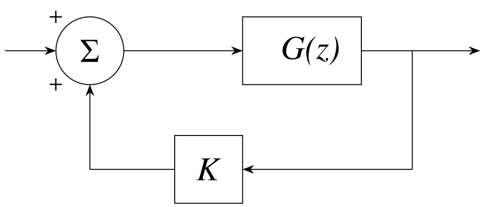
1) The system $\frac{900}{s(s+1)(s+9)}$ is to be compensated such that its gain-crossover frequency becomes same as its uncompensated phase-crossover frequency and provides a 45° phase margin. To achieve this, one may use
   a) a lag compensator that provides an attenuation of 20 dB and a phase lag of 45° at the frequency of $3\sqrt{3}$ rad/s
   b) a lead compensator that provides an amplification of 20 dB and a phase lead of 45° at the frequency of 3 rad/s
   c) a lag-lead compensator that provides an amplification of 20 dB and a phase lag of 45° at the frequency of $\sqrt{3}$ rad/s
   d) a lag-lead compensator that provides an attenuation of 20 dB and a phase lead of 45° at the frequency of 3 rad/s

2) Consider the discrete-time system shown in the figure where the impulse response of $G(z)$ is $g(0) = 0,\ g(1) = g(2) = 1,\ g(3) = g(4) = \cdots = 0$.



This system is stable for range of values of K
   a) $\left[-1, \frac{1}{2}\right]$
   b) $[-1, 1]$
   c) $\left[-\frac{1}{2}, 1\right]$
   d) $\left[-\frac{1}{2}, 2\right]$

3) A signal $x(t)$ is given by

$$x(t) = \begin{cases} 1, -\frac{T}{4} <\leq \frac{3T}{4} \\ -1, \frac{3T}{4} < t \leq \frac{7T}{4} \\ -x(t+T) \end{cases}$$

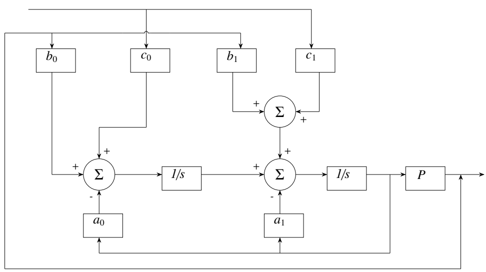
Which among the following gives the fundamental Fourier term of $x(t)$?

a) $\frac{4}{\pi}\cos\left(\frac{\pi t}{T} - \frac{\pi}{4}\right)$
b) $\frac{\pi}{4}\cos\left(\frac{\pi t}{2T} + \frac{\pi}{4}\right)$
c) $\frac{4}{\pi}\sin\left(\frac{\pi t}{T} - \frac{\pi}{4}\right)$
d) $\frac{\pi}{4}\sin\left(\frac{\pi t}{2T} + \frac{\pi}{4}\right)$

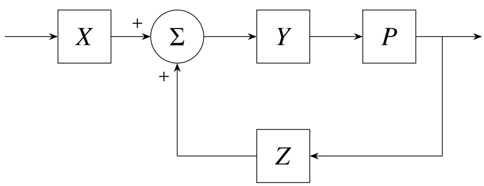
4) If the loop gain K of a negative feedback system having a loop transfer function $\frac{K(s+3)}{(s+8)^2}$ is to be adjusted to induce a sustained oscillation then

a) The frequency of this oscillation must be $\frac{4}{\sqrt{3}}$ rad/s
b) The frequency of this oscillation must be 4 rad/s
c) The frequency of this oscillation must be 4 or $\frac{4}{\sqrt{3}}$ rad/s
d) such a K does not exist

5) The system shown in figure below



can be reduced to the form



with

a) $X = c_0 s + c_1$, $Y = \frac{1}{(s^2+a_0 s+a_1)}$, $Z = b_0 s + b_1$
b) $X = 1$, $Y = \frac{(c_0 s+c_1)}{(s^2+a_0 s+a_1)}$, $Z = b_0 s + b_1$
c) $X = c_1 s + c_0$, $Y = \frac{(b_1 s+b_0)}{(s^2+a_1 s+a_1)}$, $Z = 1$

d) $X = c_1 s + c_0$, $Y = \frac{1}{(s^2+a_1 s+a_1)}$, $Z = b_1 s + b_0$

6) The value of $\oint\limits_C \frac{dz}{(1+z^2)}$ where C is the contour $\left|z - \frac{i}{2}\right| = 1$ is

a) $2\pi i$
b) π
c) $\tan^{-1} z$
d) $\pi i \tan^{-1} z$

7) A single-phase voltage source inverter is controlled in a single pulse-width modulated mode with a pulse width of 150° in each half cycle. Total harmonic distortion is defined as

$$\text{THD} = \frac{\sqrt{V_{rms}^2 - V_1^2}}{V_1} \times 100,$$

where V_1 is the rms value of the fundamental component of the output voltage. The THD of output ac voltage waveform is

a) 65.65%
b) 48.42%
c) 31.83%
d) 30.49%

8) A voltage source inverter is used to control the speed of a three-phase, 50 Hz, squirrel cage induction motor. Its slip for rated torque is 4%. The flux is maintained at rated value. If the stator resistance and rotational losses are neglected, then the frequency of the impressed voltage to obtain twice the rated torque at starting should be

a) 10 Hz
b) 5 Hz
c) 4 Hz
d) 2 Hz

9) A three-phase, 440 V, 50 Hz ac mains fed thyristor bridge is feeding a 440 V dc, 15 kW, 1500 rpm separately excited dc motor with a ripple free continuous current in the dc link under all operating conditions. Neglecting the losses, the power factor of the ac mains at half the rated speed, is

a) 0.354
b) 0.372
c) 0.90
d) 0.955

10) A single-phase, 230 V, 50 Hz ac mains fed step down transformer (4 : 1) is supplying power to a half-wave uncontrolled ac-dc converter used for charging a battery (12 V dc) with the series current limiting resistor being 19.04 Ω. The charging current is

a) 2.43 A
b) 1.65 A
c) 1.22 A
d) 1.0 A

11) A three-phase synchronous motor connected to ac mains is running at full load and unity power factor. If its shaft load is reduced by half, with field current held constant, its new power factor will be
a) unity
b) leading
c) lagging
d) dependent on machine parameters

12) A 100 kVA, 415 V (line), star-connected synchronous machine generates rated open circuit voltage of 415 V at a field current of 15 A. The short circuit armature current at a field current of 10 A is equal to the rated armature current. The per unit saturated synchronous reactance is
a) 1.731
b) 1.5
c) 0.666
d) 0.577

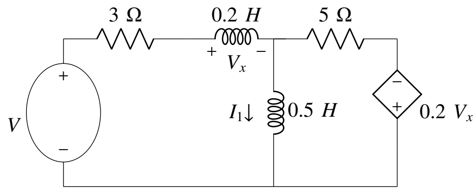
13) A three-phase, three-stack, variable reluctance step motor has 20 poles on each rotor and stator stack. The step angle of this step motor is
a) 3°
b) 6°
c) 9°
d) 18°

14) A single-phase 50 kVA, 250V/500V two winding transformer has an efficiency of 95% at full load, unity power factor. If it is reconfigured as a 500V/750V autotransformer, its efficiency at its new rated load at unity power factor will be
a) 95.752%
b) 97.851%
c) 98.276%
d) 99.241%

15) A 230 V (Phase), 50 Hz, three-phase, 4-wire system has a phase sequence ABC. A unity power-factor load of 4 kW is connected between phase A and neutral N. It is desired to achieve zero neutral current through the use of a pure inductor and a pure capacitor in the other two phases. The value of inductor and capacitor is
a) 72.95 mH in phase C and 139.02 μF in phase B
b) 72.95 mH in phase B and 139.02 μF in phase C

c) 42.12 mH in phase C and 240.79 μF in phase B
d) 42.12 mH in phase B and 240.79 μF in phase C

16) The state equation for the current I_1 shown in the network below in terms of the voltage V_x and the independent source V, is given by



a) $\frac{dI_1}{dt} = -1.4V_x - 3.75I_1 + \frac{5}{4}V$
b) $\frac{dI_1}{dt} = 1.4V_x - 3.75I_1 - \frac{5}{4}V$
c) $\frac{dI_1}{dt} = -1.4V_x + 3.75I_1 + \frac{5}{4}V$
d) $\frac{dI_1}{dt} = -1.4V_x + 3.75I_1 - \frac{5}{4}V$

17) If $u(t)$, $r(t)$ denote the unit step and unit ramp functions respectively and $u(t) * r(t)$ their convolution, then the function $u(t+1) * r(t-2)$ is given by
a) $\left(\frac{1}{2}\right)(t-1)(t-2)$
b) $\left(\frac{1}{2}\right)(t-1)(t-2)$
c) $\left(\frac{1}{2}\right)(t-1)^2\, u(t-1)$
d) none of the above