EE-2023

EE24Btech11022 - Eshan Sharma

1) Which of the following statement(s) is/are true?
   a) If an LTI system is causal, it is stable.
   b) A discrete time LTI system is causal if and only if its response to a step input $u[n]$ is 0 for $n < 0$.
   c) If a discrete time LTI system has an impulse response $h[n]$ of finite duration, the system is stable.
   d) If the impulse response $0 < |h[n]| < 1$ for all n, then the LTI system is stable.

2) The bus admittance (Y_{bus}) matrix of a 3-bus power system is given below.

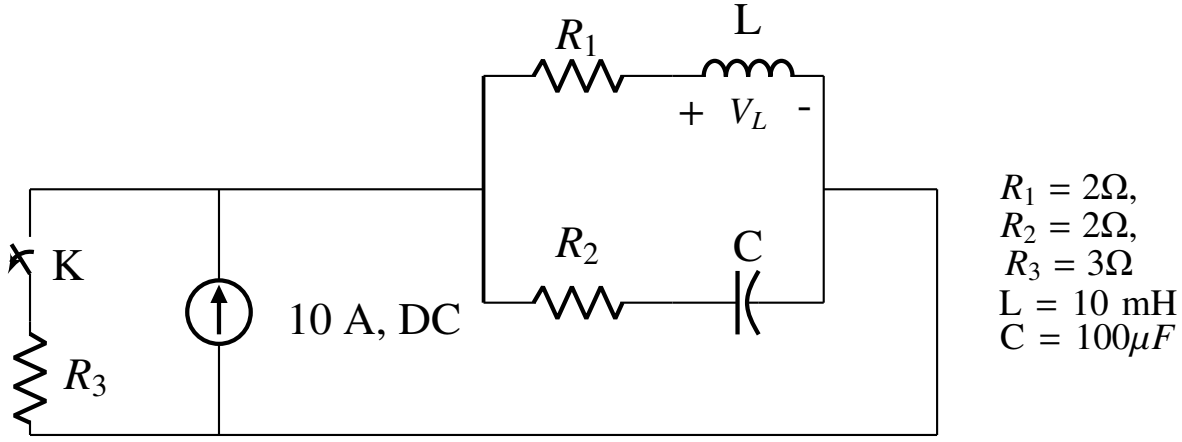
$$Y_{\text{bus}} = \begin{bmatrix} -j15 & j10 & j5 \\ j10 & -j13.5 & j4 \\ j5 & j4 & -j8 \end{bmatrix}$$

   Considering that there is no shunt inductor connected to any of the buses, which of the following can NOT be true?
   a) Line charging capacitor of finite value is present in all three lines
   b) Line charging capacitor of finite value is present in line 2-3 only
   c) Line charging capacitor of finite value is present in line 2-3 only and shunt capacitor of finite value is present in bus 1 only
   d) Line charging capacitor of finite value is present in line 2-3 only and shunt capacitor of finite value is present in bus 3 only

3) The value of parameters of the circuit shown in the figure are:

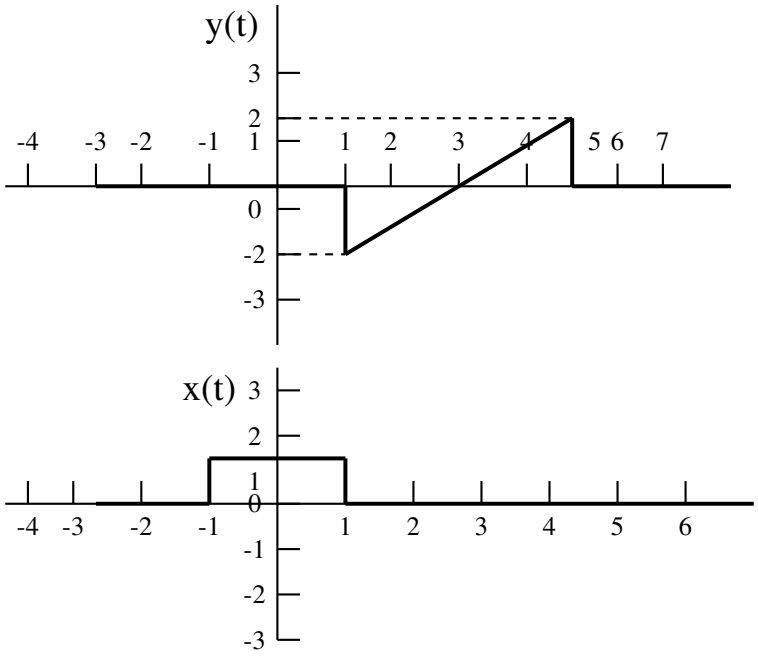
$$R_1 = 2\,\Omega, \quad R_2 = 2\,\Omega, \quad R_3 = 3\,\Omega, \quad L = 10\,\text{mH}, \quad C = 100\,\mu\text{F}$$

   For time $t < 0$, the circuit is at steady state with the switch 'K' in closed condition. If the switch is opened at $t = 0$, the value of the voltage across the inductor (V_L) at $t = 0^+$ in Volts is _____ (Round off to 1 decimal place).

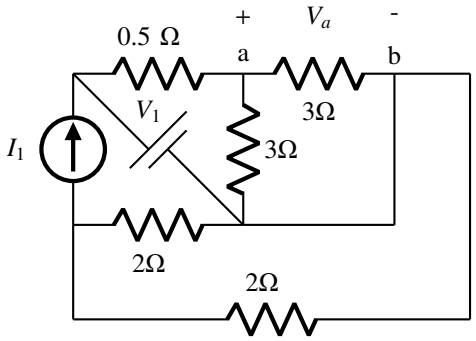


4) A separately excited DC motor rated 400 V, 15 A, 1500 RPM drives a constant torque load at rated speed operating from 400 V DC supply drawing rated current. The armature resistance is 1.2 Ω. If the supply voltage drops by 10% with field current unaltered, then the resultant speed of the motor in RPM is _____ (Round off to the nearest integer).

5) For the signals $x(t)$ and $y(t)$ shown in the figure, $z(t) = x(t) * y(t)$ is maximum at $t = T_1$. Then T_1 in seconds is _____ (Round off to the nearest integer).



6) For the circuit shown in the figure, $V_1 = 8$ V, DC and $I_1 = 8$ A, DC. The voltage V_{ab} in Volts is _____ (Round off to 1 decimal place).



$V_1 = 8V, DC$
$I_1 = 8A, DC$

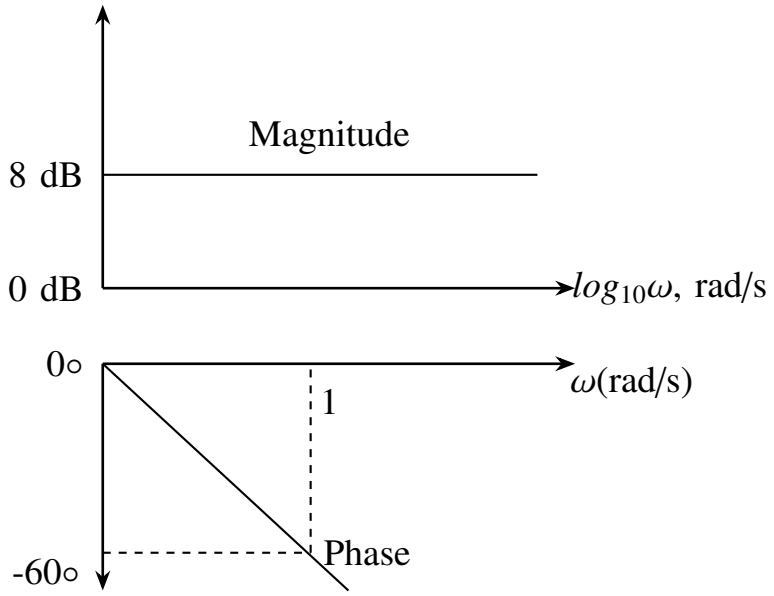
7) A 50 Hz, 275 kV line of length 400 km has the following parameters:
Resistance, $R = 0.035\,\Omega$/km;
Inductance, $L = 1$ mH/km;
Capacitance, $C = 0.01\,\mu$F/km;
The line is represented by the nominal-π model. With the magnitudes of the sending end and the receiving end voltages of the line (denoted by V_S and V_R, respectively) maintained at 275 kV, the phase angle difference (θ) between V_S and V_R required for maximum possible active power to be delivered to the receiving end, in degrees is _____ (Round off to 2 decimal places).

8) In the following differential equation, the numerically obtained value of $y(t)$, at $t = 1$, is _____ (Round off to 2 decimal places).

$$\frac{dy}{dt} = \frac{e^{-\alpha t}}{2 + \alpha t}, \quad \alpha = 0.01 \text{ and } y(0) = 0$$

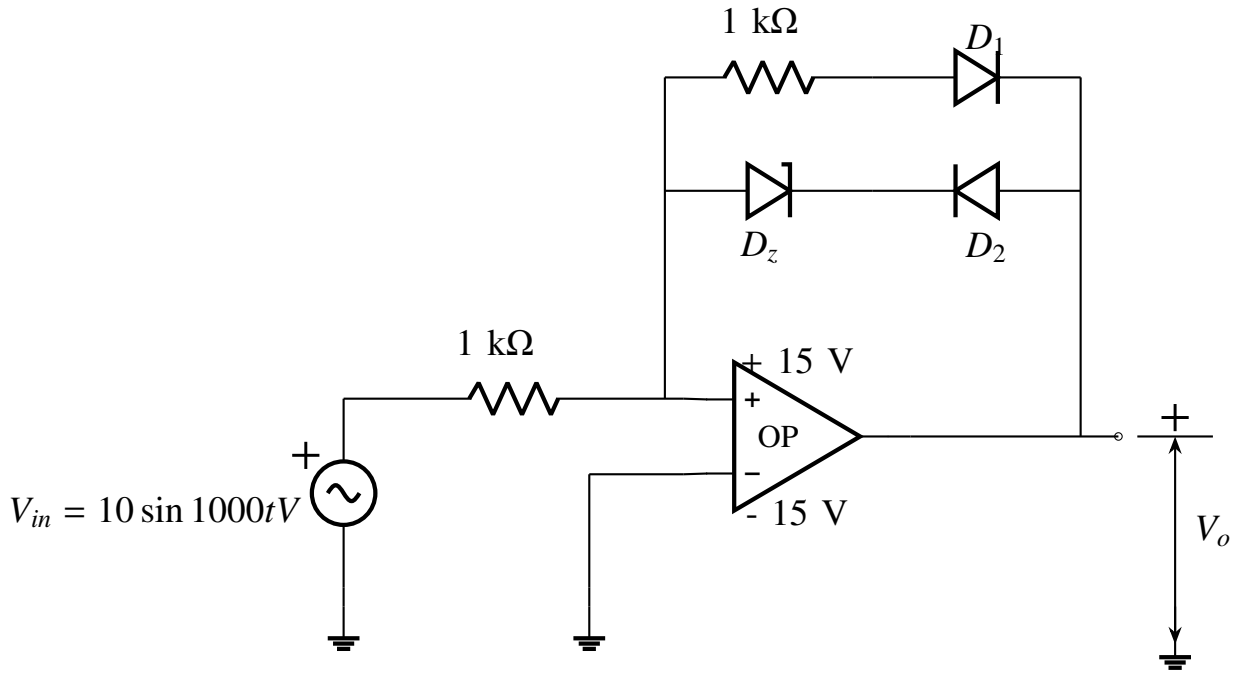
9) Three points in the x-y plane are $(-1, 0.8)$, $(0, 2.2)$ and $(1, 2.8)$. The value of the slope of the best fit straight line in the least square sense is _____ (Round off to 2 decimal places).

10) The magnitude and phase plots of an LTI system are shown in the figure. The transfer function of the system is



a) $2.51e^{-0.032s}$
b) $\frac{e^{-2.514s}}{s+1}$
c) $1.04e^{-2.514s}$
d) $2.51e^{-1.047s}$

11) Consider the OP AMP based circuit shown in the figure. Ignore the conduction drops of diodes D_1 and D_2. All the components are ideal, and the breakdown voltage of the Zener is 5 V. Which of the following statements is true?



a) The maximum and minimum values of the output voltage V_O are +15 V and −10 V, respectively.
b) The maximum and minimum values of the output voltage V_O are +5 V and −15 V, respectively.
c) The maximum and minimum values of the output voltage V_O are +10 V and −5 V, respectively.
d) The maximum and minimum values of the output voltage V_O are +5 V and −10 V, respectively.

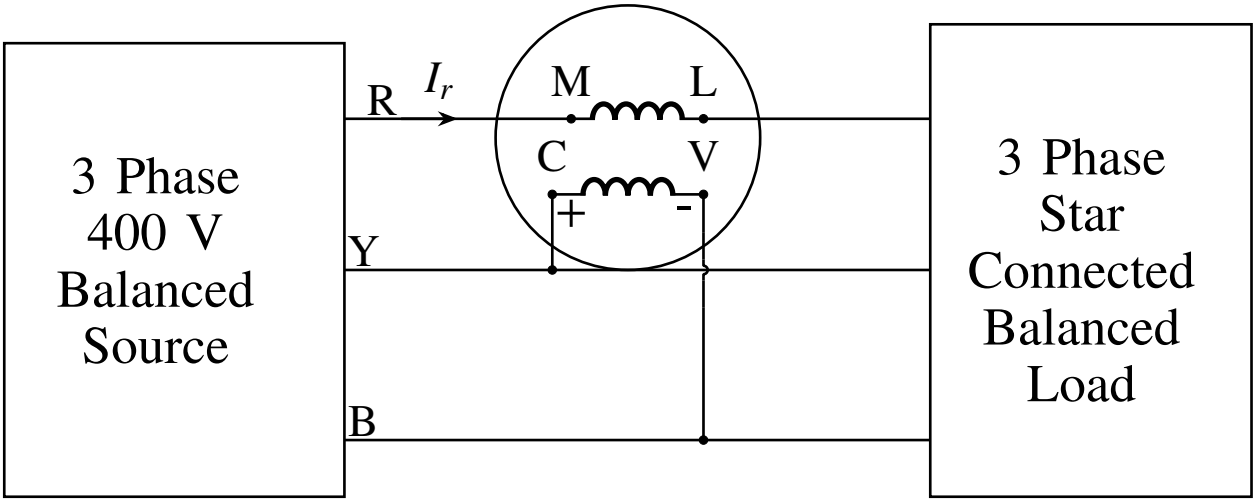
12) Consider a lead compensator of the form

$$K(s) = \frac{1 + \frac{s}{a}}{1 + \frac{s}{\beta a}}, \quad \beta > 1,\ a > 0$$

The frequency at which this compensator produces maximum phase lead is 4 rad/s. At this frequency, the gain amplification provided by the controller, assuming asymptotic Bode-magnitude plot of $K(s)$, is 6 dB. The values of a and β, respectively, are

a) 1, 16
b) 2, 4
c) 3, 5
d) 2.66, 2.25

13) A 3-phase, star-connected, balanced load is supplied from a 3-phase, 400 V (rms), balanced voltage source with phase sequence R-Y-B, as shown in the figure. If the wattmeter reading is -400 W and the line current is $I_R = 2$ A (rms), then the power factor of the load per phase is



a) Unity
b) 0.5 leading
c) 0.866 leading
d) 0.707 lagging