

# 2017-EE

EE24BTECH11020 - Ellanti Rohith

- 1) Consider the differential equation

$$(t^2 - 81) \frac{dy}{dt} + 5ty = \sin(t) \quad \text{with } y(1) = 2\pi.$$

There exists a unique solution for this differential equation when  $t$  belongs to the interval

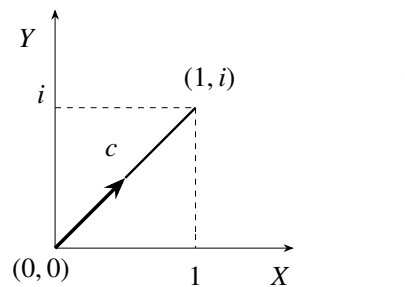
[GATE 2017]

- |                |               |
|----------------|---------------|
| a) $(-2, 2)$   | c) $(-10, 2)$ |
| b) $(-10, 10)$ | d) $(0, 10)$  |

- 2) Consider the line integral

$$I = \int_C (x^2 + iy) dz,$$

where  $z = x + iy$ . The line  $C$  is shown in the figure below.

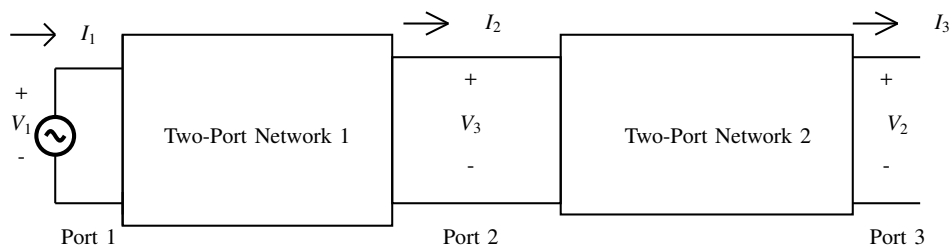


The value of  $I$  is

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- |                   |                   |
|-------------------|-------------------|
| a) $\frac{1}{2}i$ | c) $\frac{3}{4}i$ |
| b) $\frac{2}{3}i$ | d) $\frac{4}{5}i$ |

- 3) Two passive two-port networks are connected in cascade as shown in the figure. A voltage source is connected at port 1.



Given

$$V_1 = A_1 V_2 + B_1 I_2$$

$$I_1 = C_1 V_2 + D_1 I_2$$

$$V_2 = A_2 V_3 + B_2 I_3$$

$$I_2 = C_2 V_3 + D_2 I_3$$

where  $A_1, B_1, C_1, D_1, A_2, B_2, C_2$  and  $D_2$  are the generalized circuit constants. If the Thevenin equivalent circuit at port 3 consists of a voltage source  $V_T$  and an impedance  $Z_T$ , connected in series, then

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$$\text{a) } V_T = \frac{V_1}{A_1 + A_2}, \quad Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2}$$

$$\text{c) } V_T = \frac{V_1}{A_1 + A_2}, \quad Z_T = \frac{A_1 A_2 + B_1 C_2}{A_1 A_2 + B_1 D_2}$$

$$\text{b) } V_T = \frac{V_1}{A_1 A_2 + B_1 C_2}, \quad Z_T = \frac{A_1 B_2 + B_1 D_2}{A_1 A_2 + B_1 C_2}$$

$$\text{d) } V_T = \frac{V_1}{A_1 A_2 + B_1 C_2}, \quad Z_T = \frac{A_1 A_2 + B_1 C_2}{A_1 A_2 + B_1 C_2}$$

- 4) Let a causal LTI system be characterized by the following differential equation, with initial rest condition

$$\frac{d^2 y}{dt^2} + 7 \frac{dy}{dt} + 10y(t) = 4x(t) + 5 \frac{dx(t)}{dt}$$

where  $x(t)$  and  $y(t)$  are the input and output respectively. The impulse response of the system is  $u(t)$  is the unit step function

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$$\text{a) } 2e^{-2t}u(t) - 7e^{-5t}u(t)$$

$$\text{c) } 7e^{-2t}u(t) - 2e^{-5t}u(t)$$

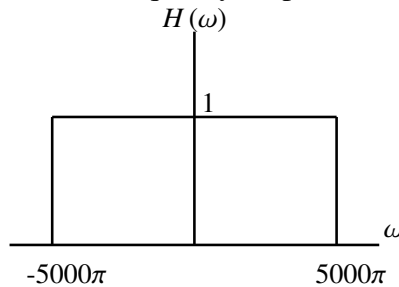
$$\text{b) } -2e^{-2t}u(t) + 7e^{-5t}u(t)$$

$$\text{d) } -7e^{-2t}u(t) + 2e^{-5t}u(t)$$

- 5) Let the signal

$$x(t) = \sum_{k=-\infty}^{+\infty} (-1)^k \delta\left(t - \frac{k}{2000}\right)$$

be passed through an LTI system with frequency response  $H(\omega)$ , as given in the figure below.



The Fourier series representation of the output is given as

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$$\text{a) } 4000 + 4000 \cos(2000\pi t) + 4000 \cos(4000\pi t)$$

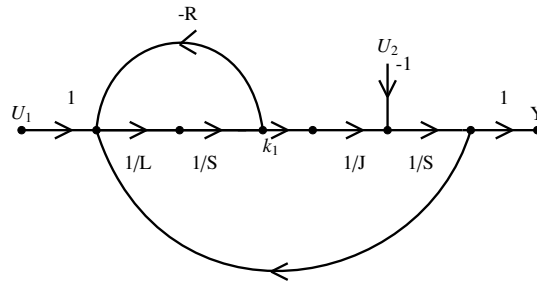
$$\text{b) } 2000 + 2000 \cos(2000\pi t) + 2000 \cos(4000\pi t)$$

$$\text{c) } 2000 \cos(2000\pi t)$$

$$\text{d) } 4000 \cos(2000\pi t)$$

- 6) In the system whose signal flow graph is shown in the figure,  $U_1(s)$  and  $U_2(s)$  are inputs. The transfer function  $\frac{Y(s)}{U_1(s)}$  is

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a)  $\frac{k_1}{JLs^2 + JRs + k_1k_2}$

b)  $\frac{k_1}{JLs^2 - JRs - k_1k_2}$

c)  $\frac{k_1 - U_2(R + sL)}{JLs^2 + (JR - U_2L)s + k_1k_2 - U_2R}$

d)  $\frac{k_1 - U_2(sL - R)}{JLs^2 - (JR + U_2L)s - k_1k_2 + U_2R}$

7) The transfer function of the system is given by:

$$x(t) = \begin{pmatrix} 1 & 2 \\ 2 & 0 \end{pmatrix} + \begin{pmatrix} 1 \\ 2 \end{pmatrix} u(t)$$

$$y(t) = \begin{pmatrix} 1 & 0 \end{pmatrix} x(t)$$

The options for the transfer function are:

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a)  $\frac{(s+2)}{s^2 - 2s - 2}$

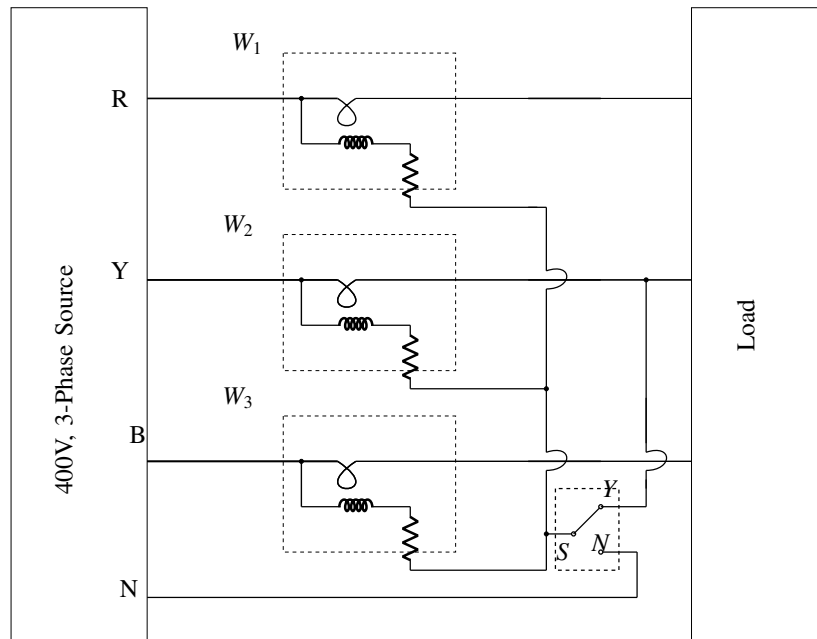
c)  $\frac{(s+4)}{s^2 + s - 4}$

b)  $\frac{(s-2)}{s^2 + s - 4}$

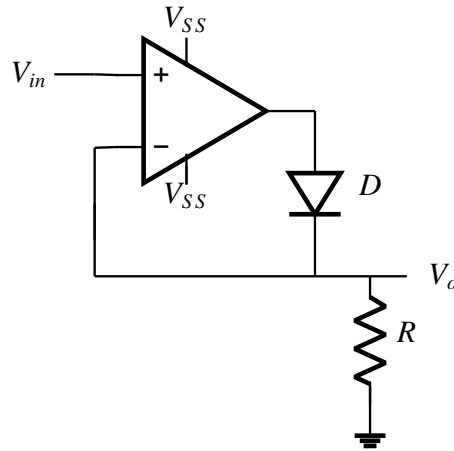
d)  $\frac{(s+4)}{s^2 - s - 4}$

8) The load shown in the figure is supplied by a 400 V (line-to-line), 3-phase source RYB sequence. The load is balanced and inductive, drawing 3464 VA. When the switch  $S$  is in position  $N$ , the three wattmeters  $W_1$ ,  $W_2$ , and  $W_3$  read 577.35 W each. If the switch is moved to position  $Y$ , the readings of the wattmeters in watts will be:

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- 9) The approximate transfer characteristic for the circuit shown below with an ideal operational amplifier and diode is as follows:



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- 10) The output expression for the Karnaugh map shown below is

$AB \backslash CD$	00	01	11	10
00	0	0	0	0
01	1	0	1	1
11	1	0	1	1
10	0	0	0	0

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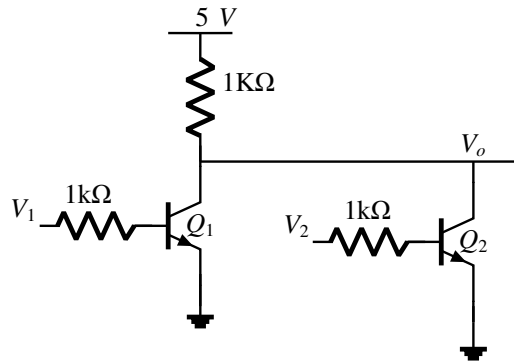
- a)  $\overline{BD} + BCD$       b)  $\overline{BD} + AB$       c)  $\overline{BD} + ABC$       d)  $B\overline{D} + ABC$

- 11) A load is supplied by a 230 V, 50 Hz source. The active power  $P$  and the reactive power  $Q$  consumed by the load are such that  $1 \text{ kW} \leq P \leq 2 \text{ kW}$  and  $1 \text{ kVAR} \leq Q \leq 2 \text{ kVAR}$ . A capacitor connected across the load for power factor correction generates 1 kVAR reactive power. The worst case power factor after power factor correction is

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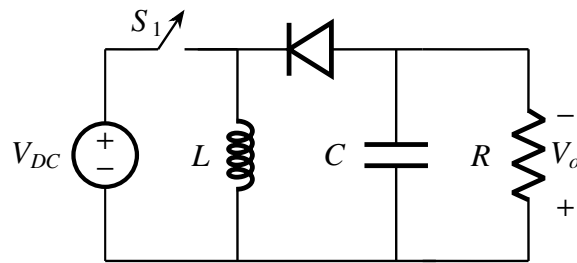
- a) 0.447 lag      b) 0.707 lag      c) 0.894 lag      d) 1

- 12) The logical gate implemented using the circuit shown below where  $V_1$  and  $V_2$  are inputs with (0 V as digital 0 and 5 V as digital 1) and  $V_{OUT}$  is the output, is



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- 13) The input voltage  $V_{DC}$  of the buck-boost converter shown below varies from 32 V to 72 V. Assume that all components are ideal, inductor current is continuous, and output voltage is ripple-free. The range of duty ratio  $D$  of the converter for which the magnitude of the steady-state output voltage remains constant at 48 V is [GATE 2017]



a)  $\frac{2}{5} \leq D \leq \frac{3}{5}$

b)  $\frac{2}{3} \leq D \leq \frac{3}{4}$

c)  $0 \leq D \leq 1$

d)  $\frac{1}{3} \leq D \leq \frac{2}{3}$