

- a) $3e^{-2t}$
- b) $\frac{1}{3}e^{-2t}u(t)$
- c) $2e^{-3t}u(t)$
- d) $2e^{-3t}$

5) The Fourier transform $X(\omega)$ of the signal $x(t)$ is given by

$$X(\omega) = \begin{cases} 1, & \text{for } |\omega| < W_0 \\ 0, & \text{for } |\omega| > W_0 \end{cases}$$

Which one of the following statements is true?

- a) $x(t)$ tends to be an impulse as $W_0 \rightarrow \infty$.
- b) $x(0)$ decreases as W_0 increases.
- c) At $t = \frac{\pi}{2W_0}$, $x(t) = -\frac{1}{\pi}$.
- d) At $t = \frac{\pi}{2W_0}$, $x(t) = \frac{1}{\pi}$.

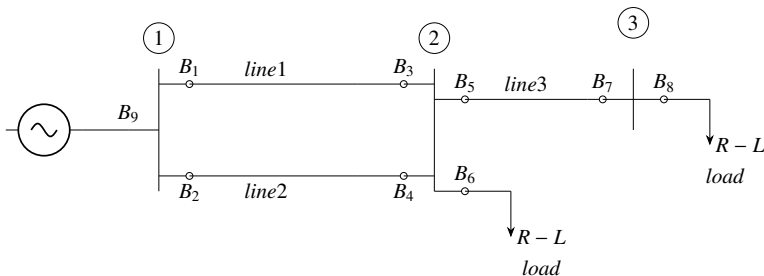
6) The Z-transform of a discrete signal $x[n]$ is

$$X(z) = \frac{4z}{(z - \frac{1}{5})(z - \frac{2}{3})(z - 3)} \text{ with ROC} = R.$$

Which one of the following statements is true?

- a) Discrete-time Fourier transform of $x[n]$ converges if R is $|z| > 3$
- b) Discrete-time Fourier transform of $x[n]$ converges if R is $\frac{2}{3} < |z| < 3$
- c) Discrete-time Fourier transform of $x[n]$ converges if R is such that $x[n]$ is a left-sided sequence
- d) Discrete-time Fourier transform of $x[n]$ converges if R is such that $x[n]$ is a right-sided sequence

7) For the three-bus power system shown in the figure, the trip signals to the circuit breakers B_1 to B_9 are provided by over current relays R_1 to R_9 , respectively, some of which have directional properties also. The necessary condition for the system to be protected for short circuit fault at any part of the system between the bus 1 and the R-L loads with isolation of minimum portion of the network using minimum number of directional relays is



- a) R_3 and R_4 are directional over current relays blocking faults towards bus 2
- b) R_3 and R_4 are directional over current relays blocking faults towards bus 2 and R_7 is directional over current relay blocking faults towards bus 3
- c) R_3 and R_4 are directional over current relays blocking faults towards line 1 and line 2, respectively, R_7 is directional over current relay blocking faults towards line 3 and R_5 is directional over current relay blocking faults towards bus 2
- d) R_3 and R_4 are directional over current relays blocking faults towards line 1 and line 2, respectively.

- 8) The expressions of fuel cost of two thermal generating units as a function of the respective power generation P_{G1} and P_{G2} are given as

$$F_1(P_{G1}) = 0.1aP_{G1}^2 + 40P_{G1} + 120 \text{ Rs/hour} \quad 0 \text{ MW} \leq P_{G1} \leq 350 \text{ MW}$$

$$F_2(P_{G2}) = 0.2P_{G2}^2 + 30P_{G2} + 100 \text{ Rs/hour} \quad 0 \text{ MW} \leq P_{G2} \leq 300 \text{ MW}$$

where a is a constant. For a given value of a , optimal dispatch requires the total load of 290 MW to be shared as $P_{G1} = 175$ MW and $P_{G2} = 115$ MW. With the load remaining unchanged, the value of a is increased by 10% and optimal dispatch is carried out. The changes in P_{G1} and the total cost of generation, $F (= F_1 + F_2)$ in Rs/hour will be as follows:

- a) P_{G1} will decrease and F will increase
- b) Both P_{G1} and F will increase
- c) P_{G1} will increase and F will decrease
- d) Both P_{G1} and F will decrease

- 9) The four stator conductors (A, A', B and B') of a rotating machine are carrying DC currents of the same value, the directions of which are shown in the figure (i). The rotor coils $a - a'$ and $b - b'$ are formed by connecting the back ends of conductors 'a' and 'a'' and 'b' and 'b'', respectively, as shown in figure (ii). The e.m.f. induced in coil $a - a'$ and coil $b - b'$ are denoted by $E_{a-a'}$ and $E_{b-b'}$, respectively. If the rotor is rotated at uniform angular speed ω rad/s in the clockwise direction then which of the following correctly describes the $E_{a-a'}$ and $E_{b-b'}$?

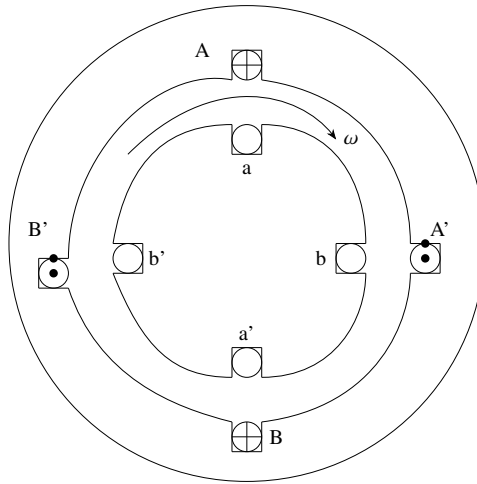


Fig. 9: figure (i): Cross-sectional view

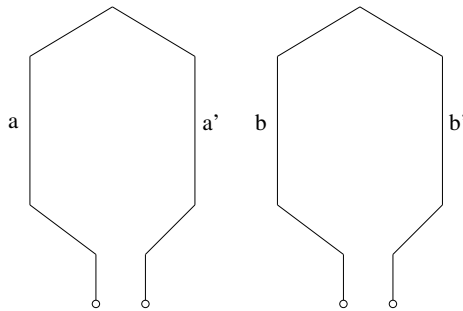


Fig. 9: figure (ii): rotor winding connection diagram

- a) $E_{a-a'}$ and $E_{b-b'}$ have finite magnitudes and are in same phase
- b) $E_{a-a'}$ and $E_{b-b'}$ have finite magnitudes with $E_{b-b'}$ leading $E_{a-a'}$
- c) $E_{a-a'}$ and $E_{b-b'}$ have finite magnitudes with $E_{a-a'}$ leading $E_{b-b'}$
- d) $E_{a-a'} = E_{b-b'} = 0$

10) The chopper circuit shown in figure (i) feeds power to a 5 A DC constant current source. The switching frequency of the chopper is 100kHz. All the components can be assumed to be ideal. The gate signals of switches S_1 and S_2 are shown in the figure (ii). Average voltage across the 5A current source is

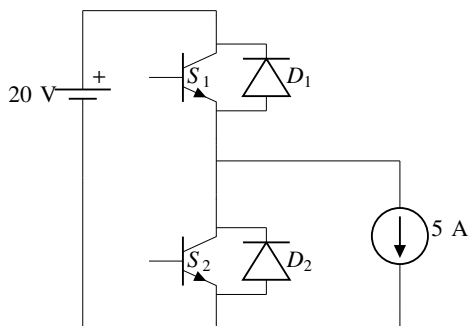


Fig. 10: figure (i)

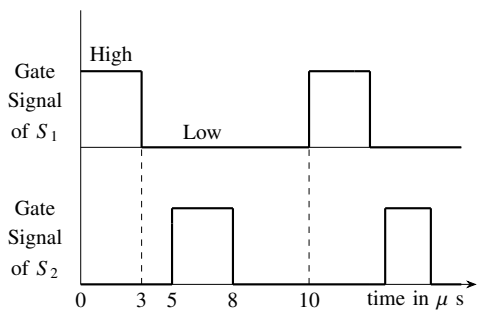
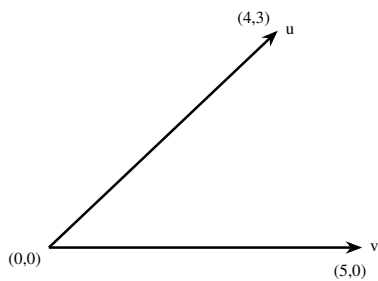


Fig. 10: figure(ii)

- a) 10 V
b) 6 V

- c) 12 V
d) 20 V

11) In the figure, the vectors \mathbf{u} and \mathbf{v} are related as: $A\mathbf{u} = \mathbf{v}$ by a transformation matrix \mathbf{A} . The correct choice of \mathbf{A} is



$$\text{a) } \begin{pmatrix} 4 & 3 \\ 5 & 5 \\ -1 & 5 \\ 4 & 5 \\ 5 & 5 \end{pmatrix}$$

$$\text{b) } \begin{pmatrix} 4 & 3 \\ 5 & 5 \\ 4 & 5 \\ 5 & 5 \end{pmatrix} - \begin{pmatrix} 4 & 3 \\ 5 & 5 \\ 4 & 5 \\ 5 & 5 \end{pmatrix}$$

$$\text{c) } \begin{pmatrix} 4 & 3 \\ 5 & 5 \\ 4 & 5 \\ 5 & 5 \end{pmatrix}$$

$$\text{d) } \begin{pmatrix} 4 & 3 \\ 5 & 5 \\ 4 & 5 \\ 5 & 5 \end{pmatrix}$$

- 12) One million random numbers are generated from a statistically stationary process with a Gaussian distribution with mean zero and standard deviation σ_o . The σ_o is estimated by randomly drawing out 10,000 numbers of samples (x_n). The estimates $\hat{\sigma}_1$, $\hat{\sigma}_2$ are computed in the following two ways.

$$\hat{\sigma}_1^2 = \frac{1}{10000} \sum_{n=1}^{10000} x_n^2$$

$$\hat{\sigma}_2^2 = \frac{1}{9999} \sum_{n=1}^{10000} x_n^2$$

Which of the following statements is true?

$$\text{a) } E(\hat{\sigma}_2^2) = \hat{\sigma}_o^2$$

$$\text{b) } E(\hat{\sigma}_2) = \sigma_o$$

$$\text{c) } E(\hat{\sigma}_1^2) = \hat{\sigma}_o^2$$

$$\text{d) } E(\hat{\sigma}_1) = E(\hat{\sigma}_2)$$

- 13) A semiconductor switch needs to block voltage V of only one polarity ($V > 0$) during OFF state as shown in figure(i) and carry current in both directions during ON state as shown in figure(ii). Which of the following switch combinations will realize the same?

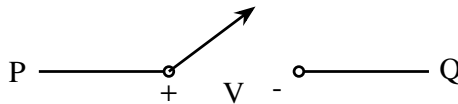


Fig. 13: figure(i)

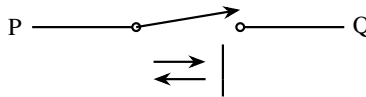
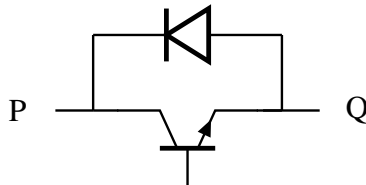
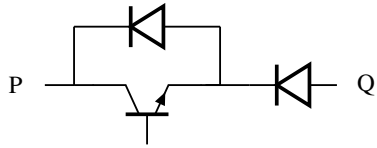


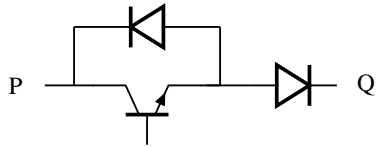
Fig. 13: figure(ii)



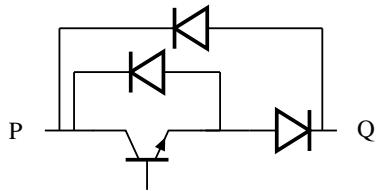
a)



b)



c)



d)