EE - 2021

EE25BTECH11036 - M Chanakya Srinivas

General Aptitude (GA)

1) The people __________ were at the demonstration were from all sections of society.

    a) whose
    b) which
    c) who
    d) whom

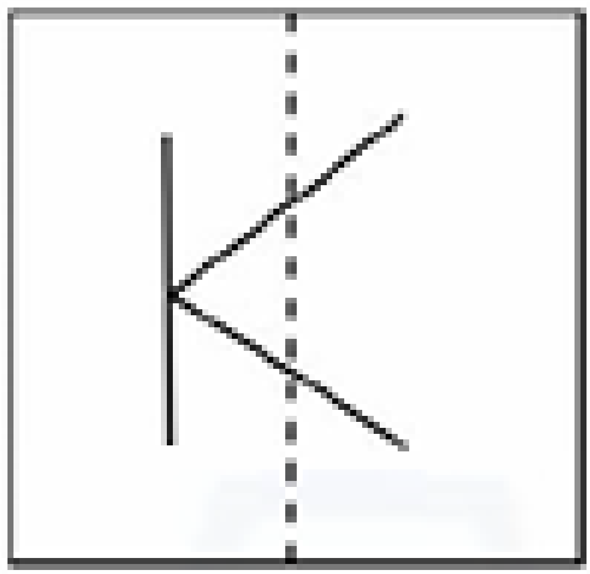
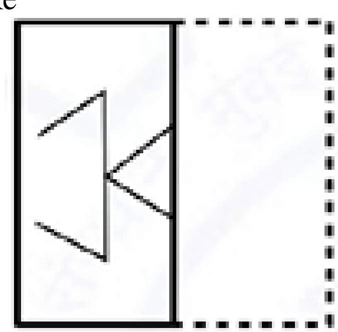
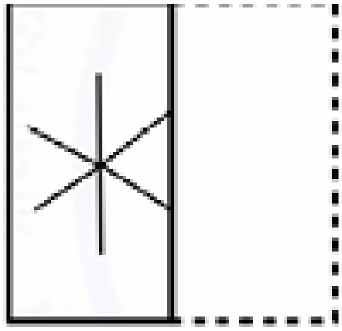
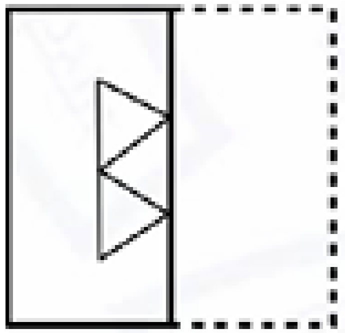


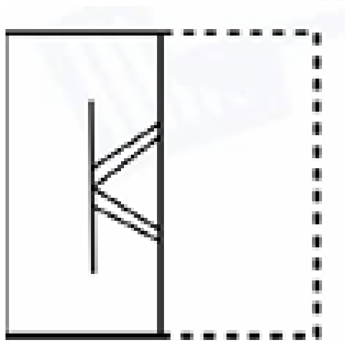
Fig. 1

2) A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like

    a) 

b) 

c) 

d) 

3) For a regular polygon having 10 sides, the interior angle between the sides of the polygon, in degrees, is:

a) 396
b) 324
c) 216
d) 144

4) Which one of the following numbers is exactly divisible by

$$(11^3 + 1)^2$$

a) $11^2 + 1$
b) $11^2 + 11$
c) $11^2 - 1$
d) $11^2 - 11$

5) *Oasis is to sand as island is to* __________
Which one of the following options maintains a similar logical relation in the above sentence?

a) Stone
b) Land
c) Water
d) Mountain

6) The importance of sleep is often overlooked by students when they are preparing for exams. Research has consistently shown that sleep deprivation greatly reduces the ability to focus on memory retention. Hence, cutting down on sleep to study longer hours can be counterproductive. Which one of the following statements is the CORRECT inference from the above passage?

a) Sleeping well alone is enough to prepare for an exam. Studying less number of hours is sufficient.
b) Students are efficient and not wrong in thinking that sleep is a waste of time.
c) If a student is extremely well prepared for an exam,he/she needn't sleep too much.
d) To do well in an exam, adequate sleep must be part of the preparation.

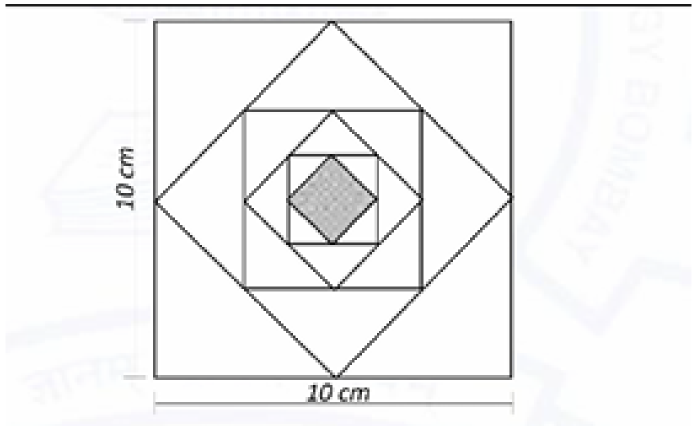


Fig. 2

7) In the figure shown above, each inside square is formed by joining the midpoints of the sides of the outer larger square. The area of the smallest square is $1\,\text{cm}^2$. The area of the largest square is:

a) 12.50
b) 6.25
c) 3.125
d) 1.5625

8) Let X be a continuous random variable denoting the temperature measured. The range of temperature is $[0, 100]$ degree Celsius and let the probability density function of X be

$$f(x) = 0.01 \quad \text{for } 0 \leq X \leq 100$$

The mean of X is:

a) 5.0
b) 25.0
c) 50.0
d) 2.5

9) The number of students passing or failing in an exam for a particular subject are presented in the bar chart.

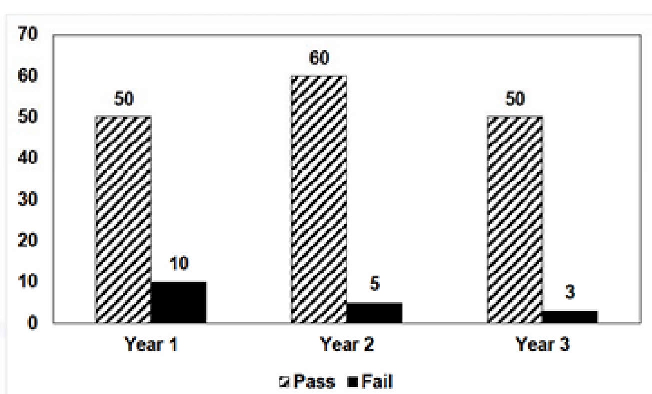


Fig. 3

Students who pass the exam cannot appear for the exam again. Students who fail the exam in the first attempt may appear for the exam in the following year. Students always pass the exam in their second attempt.
The number of students who took the exam for the first time in the year 2 and year 3 respectively, are:

a) 65 and 53
b) 60 and 50
c) 55 and 50
d) 55 and 48

10) Seven cars P, Q, R, S, T, U and V are parked in a row not necessarily in that order. The cars T and U should be parked next to each other. The cars S and V also should be parked next to each other, whereas P and Q cannot be parked next to each other. Q and S must be parked next to each other. R is parked to the immediate right of V. T is parked to the left of U.
Based on the above statements, the only **INCORRECT** option given below is:
a) There are two cars parked in between Q and V.
b) Q and R are not parked together.
c) V is the only car parked in between S and R.
d) Car P is parked at the extreme end.

Electrical Engineering (EE)

11) Let p and q be real numbers such that

$$p^2 + q^2 = 1$$

The eigenvalues of the matrix

$$\begin{pmatrix} p & q \\ q & -p \end{pmatrix}$$

are

a) i and $-i$
b) 1 and -1
c) pq and $-pq$
d) pq and $-pq$

12) Let

$$p(z) = z^3 + (2 + i)z^2 + (2 + 3i)z + (i + 2),$$

where z is a complex number. Which one of the following is true?
a) $\overline{p(z)} = p(\overline{z})$ for all z
b) The sum of the roots of $p(z) = 0$ is a real number
c) The complex roots of the equation $p(z) = 0$ occur in conjugate pairs
d) All the roots cannot be real

13) Let $f(x)$ be a real-valued function such that $f''(x_0) = 0$ for some $x_0 \in (0, 1)$ and $f'''(x_0) \neq 0$ for all $x \in (0, 1)$. Then $f(x)$ has
a) two local minima in $(0, 1)$
b) one local minimum in $(0, 1)$
c) exactly one local maximum in $(0, 1)$
d) no distinct local minima in $(0, 1)$

14) For the network shown, the equivalent Thevenin voltage and Thevenin impedance as seen across terminals a-b are:

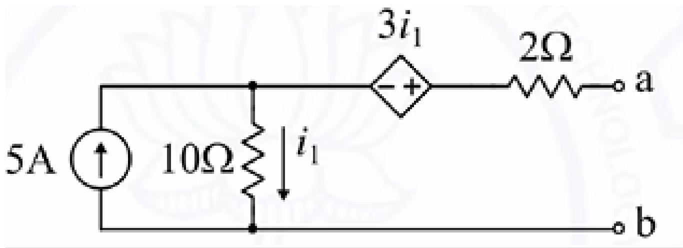


Fig. 4

a) $10\angle 0^{\circ}$ V in series with $12\,\Omega$
b) $10\angle 0^{\circ}$ V in series with $j2\,\Omega$
c) $5\angle 0^{\circ}$ V in series with $j2\,\Omega$
d) $5\angle 0^{\circ}$ V in series with $12\,\Omega$

15) Which one of the following vector functions represents a magnetic field $\mathbf{B}(x, y, z)$, x, y, and z are unit vectors along x-, y-, and z- axes, respectively?
a) $10x\hat{i} + 20y\hat{j} - 30z\hat{k}$
b) $10x\hat{i} + 20y\hat{j} + 10z\hat{k}$
c) $10x\hat{i} + 20y\hat{j} - 30z\hat{k}$
d) $10x\hat{i} - 30x\hat{j} + 20y\hat{z}$

16) If the input $x(t)$ and output $y(t)$ of a system are related as

$$y(t) = \max(x(t), 0),$$

then the system is

a) linear and time-variant
b) linear and time-invariant
c) non-linear and time-invariant
d) non-linear and time-variant

17) Two discrete-time linear time-invariant systems with impulse responses

$$h_1[n] = (\delta[n] + \delta[n-1]), \quad h_2[n] = \delta[n] + \delta[n-2]$$

are connected in cascade, where $\delta[n]$ is the Kronecker delta. The impulse response of the cascaded system is
a) $2\delta[n] + 2\delta[n-1] + \delta[n-2] + \delta[n-3]$
b) $\delta[n] + \delta[n-1] + 2\delta[n-2] + \delta[n-3]$
c) $\delta[n] + 2\delta[n-1] + \delta[n-2] + 2\delta[n-3]$
d) $\delta[n] + \delta[n-1] + \delta[n-2] + \delta[n-3]$

18) Consider the table given:

Constructional feature	**Machine type**	**Mitigation**
(P) Damper bars	**(S) Induction motor**	**(X) Hunting**
(Q) Skewed rotor slots	**(T) Transformer**	**(Y) Magnetic locking**
(R) Compensating winding	**(U) Synchronous machine**	**(Z) Armature reaction**
	(V) DC machine	

Fig. 5

The correct combination that relates the constructional feature, machine type and mitigation is

a) P-U-X, Q-V-Y, R-W-Z
b) P-U-X, Q-V-Z, R-W-Z
c) P-U-X, Q-V-Z, R-W-T
d) P-U-X, Q-V-T, R-W-Z

19) Consider a power system consisting of N number of buses. Buses in this system are categorized as generator (PV), load (PQ), and slack (O). The number of generator buses is N_g, the number of load buses is N_l. The balanced Newton-Raphson method is employed to solve the power flow problem. Let ΔP, ΔQ and $\Delta|V|$ denote the mismatches. The Jacobian matrix J is of the form below:

$$\begin{pmatrix} \Delta P \\ \Delta Q \end{pmatrix} = J \begin{pmatrix} \Delta\delta \\ \Delta|V| \end{pmatrix}$$

The dimension of the sub-matrix J_1 is

a) $(N_g + N_l - 1) \times (N_g + N_l - 1)$
b) $(N_g + N_l - 1) \times N_l$
c) $N_l \times (N_g + N_l - 1)$
d) $N_l \times N_l$

20) Two generators have cost functions in h. Their incremental-cost characteristics are

$$\frac{dF_1}{dP_1} = 40 + 0.2P_1,$$
$$\frac{dF_2}{dP_2} = 30 + 0.4P_2.$$

They need to deliver a combined load of 260 MW. Ignoring the network losses, for economic operation, the generations P_1 and P_2 (in MW) are

a) $P_1 = 40$, $P_2 = 130$
b) $P_1 = 180$, $P_2 = 80$
c) $P_1 = 120$, $P_2 = 140$
d) $P_1 = 100$, $P_2 = 120$

21) For the closed-loop system shown, the transfer function is

$$\frac{C(s)}{R(s)} = \frac{E(s)}{R(s)} \cdot \frac{G}{1 + GH}$$

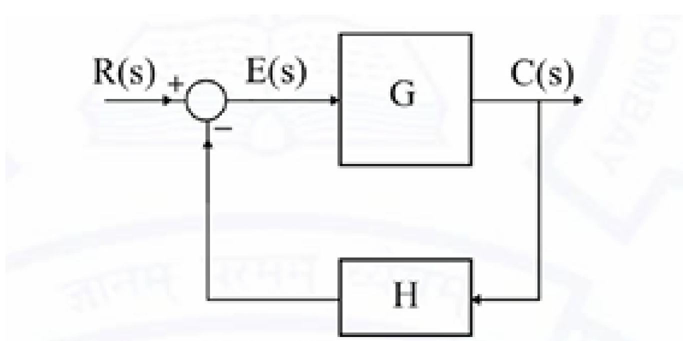


Fig. 6

a) $\dfrac{G}{1 + GH}$
b) $\dfrac{GH}{1 + GH}$
c) $\dfrac{G}{1 - GH}$
d) $\dfrac{G}{1 + G - H}$

22) Inductance is measured by

a) Schering bridge
b) Maxwell bridge
c) Kelvin bridge
d) Wien bridge

23) Suppose the circles

$$x^2 + y^2 + ax + 6 = 0$$

and

$$x^2 + y^2 + bx - 4 = 0$$

intersect each other orthogonally at the point $(1, 2)$. Then $a + b =$ __________.

24) In the given circuit, the value of capacitor C that makes current $i = 0$ is

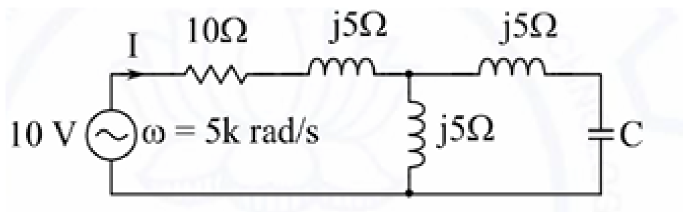


Fig. 7

25) Two single-core power cables have solid circular conductors of radius 0.7 cm and are concentric with sheath. Both cables use the same dielectric of relative permittivity 2.5. The capacitance of one cable is 80 pF/m and the other is 100 pF/m. The ratio of the dielectric thicknesses of the two cables is __________.

26) In the given circuit, for voltage $V = 10\sin(\omega t)$ V, the value of R should be

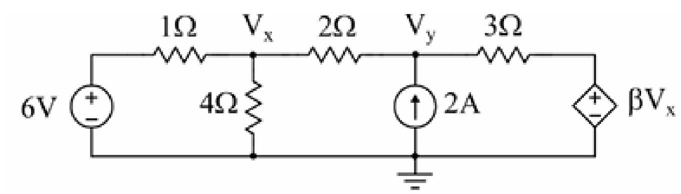


Fig. 8

27) A $1\,\mu C$ point charge is held at the origin of a Cartesian coordinate system. A second point charge of $-1\,\mu C$ is moved from $(0, 10, 0)$ m to $(5, 5, 5)$ and subsequently to $(5, 0, 0)$ then total work done is mJ.

28) The power input to a 500 V, 50 Hz, 6-pole, 3-phase induction motor running at 975 rpm is 60 kW. The rotor copper loss is 1 kW. If the total friction and windage losses are 2.5 kW, then the efficiency is __________ %.

29) An alternator with internal voltage of 1 pu and synchronous reactance of 0.4 pu is connected by a transmission line to an infinite bus of 1 pu voltage. The transmission line reactance is 0.1 pu. The maximum power (in pu) that can be supplied by the alternator is __________.

30) The Bode magnitude plot for the transfer function $\dfrac{V_0(s)}{V_i(s)}$ of the circuit is shown. The value of R is __________ (round off to 2 decimal places).

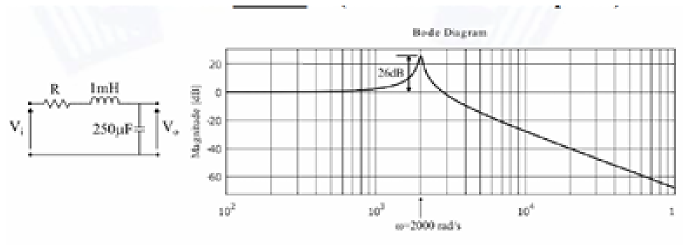


Fig. 9

31) A signal generator having a source resistance of $50\,\Omega$ is used to generate a 1 kHz sinusoidal voltage. The open-circuit output voltage is 1 V (rms). When connected to a load resistance $R_L = 50\,\Omega$, the power delivered to the load (in mW, correct to one decimal place) is:

a) 5.0 b) 7.1 c) 10.0 d) 20.0

32) A 10-bit successive binary up-counter is clocked with a frequency $f_{clk} = 100$ MHz. The maximum frequency that can be detected at the output of the most significant bit (MSB) Q9 is (in MHz):

a) 48.8 b) 50.0 c) 55.0 d) 55.6

33) In the circuit shown, the input V_i is a sinusoidal AC voltage having an RMS value of 230 V $\pm$ 20%.

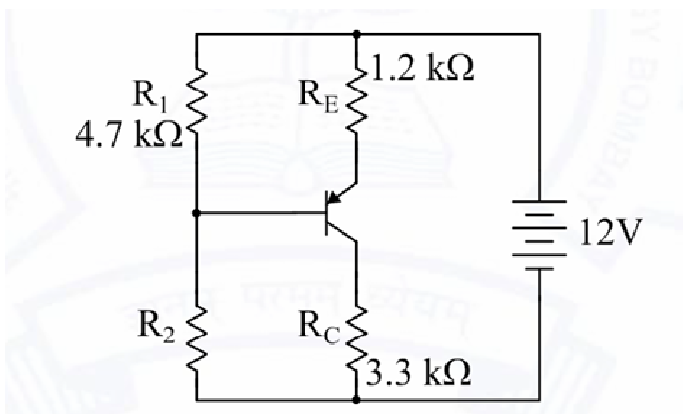


Fig. 10

The worst-case peak-inverse voltage (PIV) seen across any diode is V. (Round off to 2 decimal places).

a) 276.00 V
b) 325.27 V
c) 390.71 V
d) 460.00 V

34) In the BJT circuit shown, the β of the PNP transistor is 100. Assume $V_{BE} = 0.7$ V. The biasing resistors R_1, R_2 will be (in kΩ):

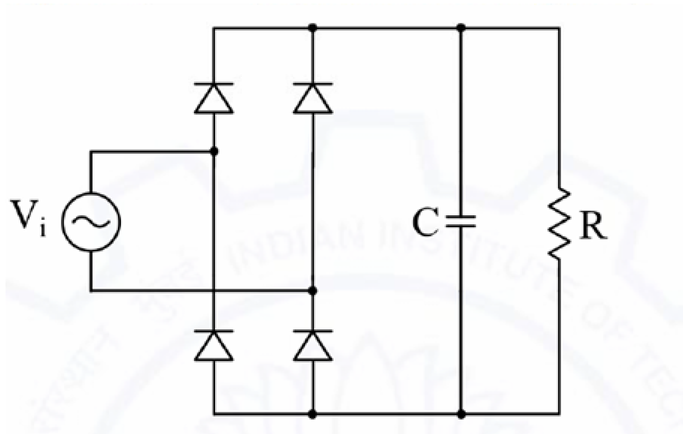


Fig. 11

a) $R_1 = 4.7$, $R_2 = 3.3$

b) $R_1 = 47$, $R_2 = 33$

c) $R_1 = 470$, $R_2 = 330$

d) $R_1 = 3.12$, $R_2 = 1.2$

35) In the circuit shown, the input is a sinusoidal AC voltage having an RMS value of $230\,V$ at 50 Hz. The power dissipated across the resistor R using two ideal diodes is (rounded off to 2 decimal places):

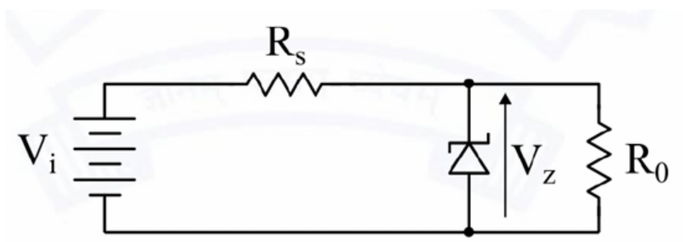


Fig. 12

a) 48.3 W   b) 50.2 W   c) 52.3 W   d) 55.0 W

36) In the circuit shown, a 5 V Zener diode is used to regulate the voltage across load R_L. The input is an unregulated DC voltage with minimum value of 8 V and maximum value of 10 V. The Zener diode has a maximum power dissipation of 2 W. Ignoring the Zener diode's knee current, the minimum value of R_s (in Ω) is:

a) 8   b) 10   c) 12   d) 15

37) Suppose the probability that a rain storm occurs in a town on any day is p, where $0 < p < 1$. If a rain storm occurs, it is independent of whether it has rained on earlier days. The probability that it rains on exactly the 5th day after no rain on the first 4 days is:

a) $(1-p)^4 p$ b) $(1-p)^5$ c) p^5 d) $\frac{p}{1-p}$

38) Let $(1+j), (1-j), (5+j), (5-j)$ be the vertices of a rectangle in the complex plane. Assuming the contour is traversed counter-clockwise direction, the value of the contour integral $\oint_C \frac{dz}{z}$ is:

a) $j\pi$ b) $-j\pi$ c) $2\pi j$ d) 0

39) In the circuit, switch 'S' is in the closed position for a very long time. If the switch is opened at time $t = 0$, then $i(t)$ in amperes, for $t \geq 0$ is

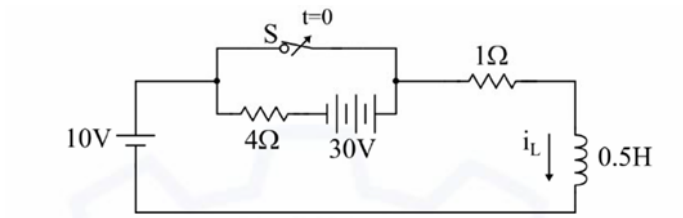


Fig. 13

a) $8e^{-10t}$
b) 10
c) $8 + 2e^{-10t}$
d) $10(1 - e^{-2t})$

40) The input impedance, $Z_{in}(s)$, for the network shown is

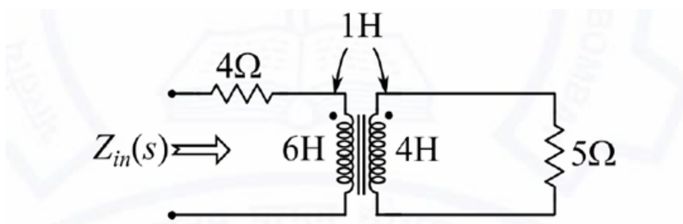


Fig. 14

a) $6s + 4$
b) $7s + 4$
c) $\frac{2s^3+46s+20}{4s+5}$
d) $\frac{2s^3+46s+20}{4s+5}$

41) The causal signal with z-transform $\dfrac{z}{(z-a)^2}$ is ($u[n]$ is the unit step signal)

a) $a^n u[n]$
b) $(n+1)a^n u[n]$
c) $na^{n-1}u[n]$
d) $n^2 a^{n-2} u[n]$

42) Let $f(t)$ be an even function, i.e. $f(-t) = f(t)$ for all t. Let the Fourier transform of $f(t)$ be defined as

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$$

Suppose

$$\frac{dF(\omega)}{d\omega} = -F(\omega) \quad \forall\, \omega, \quad F(0) = 1$$

a) $F(\omega) = 1$
b) $F(\omega) = 0$
c) $F(\omega) = e^{-\omega}$
d) $F(\omega) = e^{-\omega^2}$

43) In a single-phase transformer, the total iron loss is 250 W at nominal voltage of 440 V and frequency 50 Hz. The iron loss is 80 W at 220 V and 25 Hz. Then, at nominal voltage and frequency, the hysteresis loss and eddy current loss respectively are

a) 160 W and 90 W
b) 200 W and 60 W
c) 250 W and 200 W
d) 50 W and 250 W

44) In the figure shown, self-impedances of the two transmission lines are $j1.5\ \Omega$ each, and $j0.5\ \Omega$ is the mutual impedance. Both voltage sources in the figure are in phase. Given that $|E_1| = |E_2| = 1$, the maximum steady-state real power that can be transferred from Bus-1 to Bus-2 is:

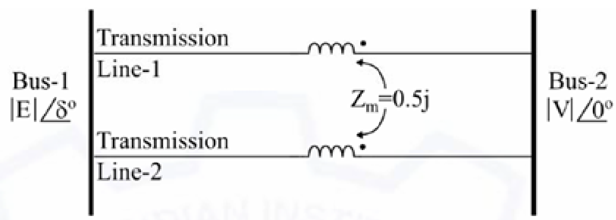


Fig. 15

a) $|E_1||E_2|$
b) $\dfrac{|E_1||E_2|}{2}$
c) $2|E_1||E_2|$
d) $\dfrac{|E_1||E_2|}{3}$

45) A 3-Bus network is shown. Consider generators as ideal voltage sources. If rows 1, 2 and 3 of Y_{bus} matrix correspond to Bus 1, 2 and 3 respectively, then Y_{bus} of the network is

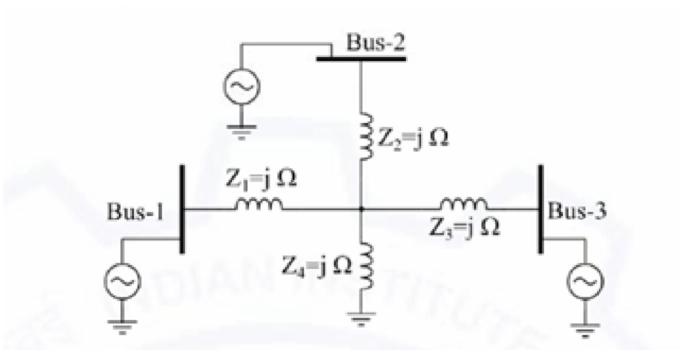


Fig. 16

a) $\begin{pmatrix} j4 & -j4 & 0 \\ -j4 & j6 & -j2 \\ 0 & -j2 & j2 \end{pmatrix}$
b) $\begin{pmatrix} j2 & -j2 & 0 \\ -j2 & j6 & -j4 \\ 0 & -j4 & j4 \end{pmatrix}$
c) $\begin{pmatrix} j4 & -j4 & 0 \\ -j4 & j8 & -j4 \\ 0 & -j4 & j4 \end{pmatrix}$
d) $\begin{pmatrix} j2 & -j2 & 0 \\ -j2 & j4 & -j2 \\ 0 & -j2 & j2 \end{pmatrix}$

46) Suppose I_a, I_b, and I_c are a set of unbalanced current phasors in a three-phase system. The phase-B zero-sequence current $= I_{b0} = 0.1\angle 0^\circ$ p.u. Phase-A current, $I_a = 1\angle 0^\circ$ p.u. and phase-C current, $I_c = 0.2\angle 0^\circ$ p.u. Then I_b in p.u. is

a) $1.2\angle 0^\circ$
b) $0.7\angle 0^\circ$
c) $1\angle -120^\circ + 0.1\angle 0^\circ$
d) $1\angle -120^\circ - 0.1\angle 0^\circ$

47) A counter is constructed with three D Flip-Flops. The logic output pairs are named $(Q_2, \overline{Q}_2), (Q_1, \overline{Q}_1), (Q_0, \overline{Q}_0)$. The counter is required to count the input clock pulses in the sequence as defined in the Gray-code: $000, 001, 011, 010, 110, 111, 101, 100$, repeatedly. Note that the bits are listed in $Q_2Q_1Q_0$ format. The combinational logic expression for input B is

a) Q_0Q_2
b) $Q_0Q_2 + Q_0\overline{Q}_2$
c) $Q_0\overline{Q}_1 + Q_2\overline{Q}_1$
d) $Q_0Q_1^n + Q_2\overline{Q}_0$

48) Let A be a 10×10 matrix such that $A^T = -A$ is a null matrix, and let I be the 10×10 identity matrix. The determinant of $A + I$ is .

49) A three-phase balanced voltage is applied to the load shown. The phase sequence is RYB. The ratio $\frac{I_R}{I_Y}$ is

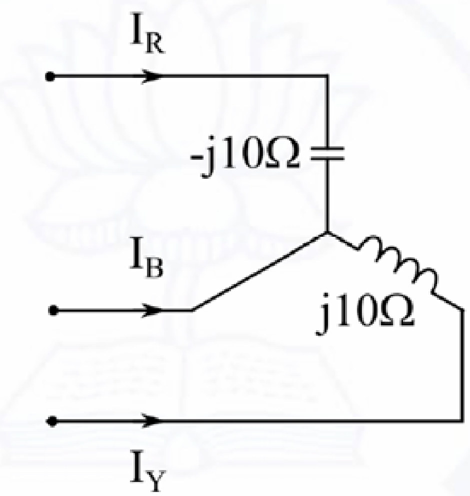


Fig. 17

50) In the given circuit, for maximum power to be delivered to R_L, its value should be Ω (round off to 2 decimal places).

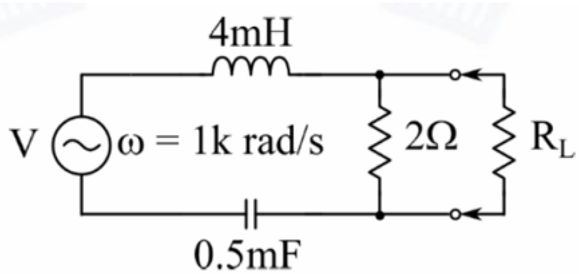


Fig. 18

51) One coulomb of point charge moving with a uniform velocity $10\,\hat{a}_x$ enters the region $z \geq 0$ having a magnetic flux density

$$\mathbf{B} = (10^{-3}y\,\hat{a}_x + 10^{-3}x\,\hat{a}_y)\,\mathrm{T}.$$

The magnitude of force on the charge at $t = 0^+$ is N. ($\hat{a}_x, \hat{a}_y, \hat{a}_z$ are unit vectors along x, y and z-axis respectively.)

52) Consider a large parallel plate capacitor. The gap d between the two plates is filled entirely with a dielectric slab of relative permittivity ϵ_r. The plates are initially charged to a potential difference of V volts and are then disconnected from the source. If the dielectric slab is pulled out completely, the ratio of the new electric field E_2 in the gap to the original electric field E_1 is .

53) Consider a continuous-time signal $x(t)$ defined by $x(t) = 1$ for $|t| > 1$, and $x(t) = |t|$ for $|t| \leq 1$. Let the Fourier transform of $x(t)$ be defined as

$$X(\omega) = \int_{-\infty}^{\infty} x(t)e^{-j\omega t}dt.$$

The maximum magnitude of $X(\omega)$ is .

54) A belt-driven DC shunt generator running at 300 RPM delivers 100 kW to a 200 V DC grid. It continues to run as a motor when the belt breaks, taking 10 kW from the DC grid. The armature resistance is 0.02 Ω, and the field resistance is 60 Ω. For the same field current in both operating conditions, the speed of the motor is RPM. (Round off to 2 decimal places)

55) An 8-pole, 50 Hz, three-phase, slip-ring induction motor has an effective rotor resistance of 0.08 p.u. per phase. Its speed at maximum torque is 650 RPM. The additional resistance per phase that must be inserted in the rotor to achieve maximum torque at start is Ω. (Round off to 2 decimal places). Neglect magnetizing current and stator leakage impedance. Consider equivalent circuit parameters referred to stator.

56) Consider a closed-loop system as shown,

$$G_p(s) = \frac{144}{s(s+10)} \quad \text{is the plant transfer function, and} \quad G_c(s) = 1 \text{ is the compensator.}$$

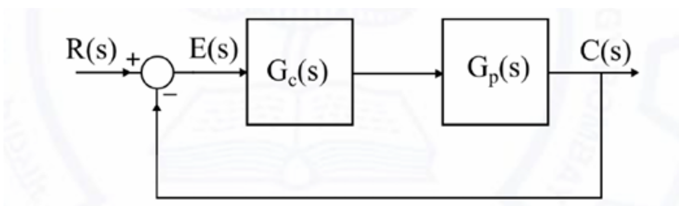


Fig. 19

For a unit-step input, the output response has damped oscillations. The damped natural frequency is rad/s. (Round off to 2 decimal places)

57) In the given figure, plant $G_p(s) = \frac{2}{(s+10)(s+1)(s+2)}$ and compensator $G_c(s) = \frac{1+Ts}{1+T's}$. The external disturbance input is $D(s)$. It is desired that when the disturbance is a unit step, the steady-state error should not exceed 0.1 unit. The minimum value of K is . (Round off to 1 decimal place)

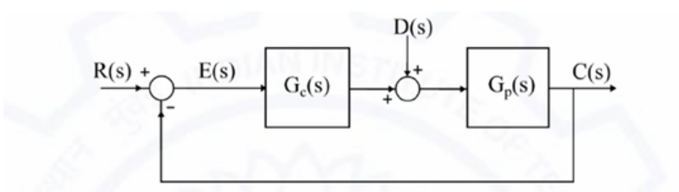


Fig. 20

58) The waveform shown in solid line is obtained by clipping a full-wave rectified sinusoid (shown dashed). The ratio of the RMS value of the full-wave rectified waveform to the RMS value of the clipped waveform is . (Round off to 2 decimal places)

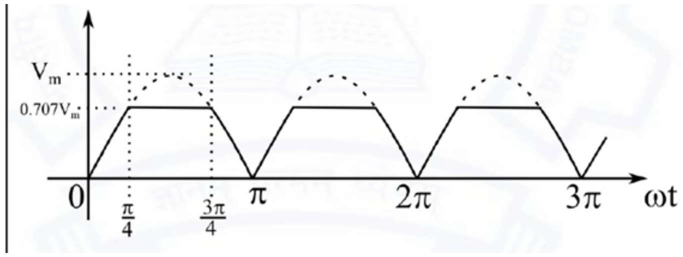


Fig. 21

59) The state space representation of a first-order system is given as

$$\dot{x} = -x + u, \quad y = x$$

where, x is the state variable, u is the control input and y is the controlled output. Let $u = -Kx$, be the control law, where K is the controller gain. To place a closed-loop pole at -2, the value of K is

a) 1
b) 2
c) 3
d) 4

60) An air-core radio frequency transformer as shown has a primary winding and a secondary winding. The mutual inductance M between the windings of the transformer is _ μH. (Round off to 2 decimal places).

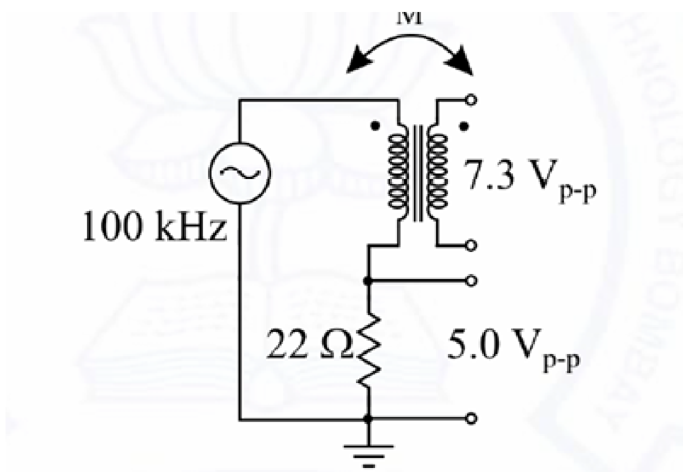


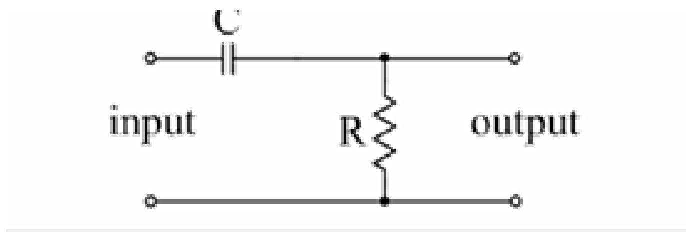
Fig. 22

$$f = 100\,\text{kHz}, \quad V_p = 22.05\,V_{pp}, \quad V_s = 7.3\,V_{pp}$$

61) A 100 kHz square wave, switching between 0 V and 9 V, is applied to a CR high-pass filter circuit as shown. The resistance R is 5 kΩ and the capacitance C is 1 nF. The RMS output voltage of the circuit is _ V. (Round off to 2 decimal places.)

62) A CMOS Schmitt-trigger inverter has a low output level of 0 V and a high output level of 5 V. Its input thresholds of 1.4 V and 2.4 V. The input capacitance and output resistance of the Schmitt-trigger are negligible. The frequency of the oscillator shown is _ Hz. (Round off to 2 decimal places.)

$$R = 10\,\text{k}\Omega, \quad C = 47\,\text{nF}$$



H

Fig. 23

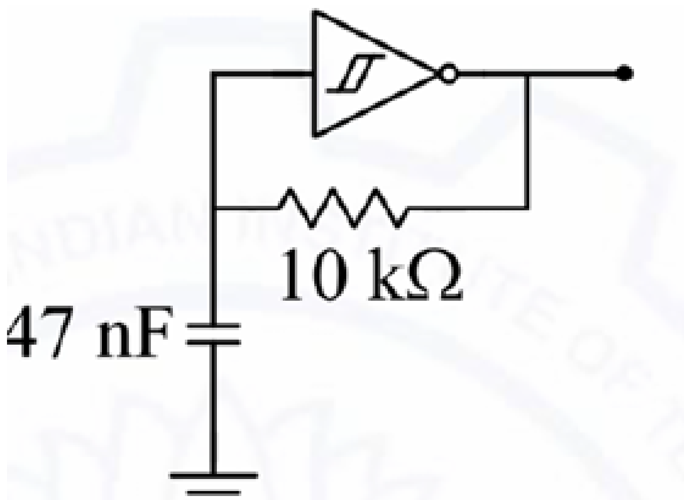


Fig. 24

63) Consider the boost converter shown. Switch Q is operating at 25 kHz with a duty cycle of 0.4. Assume the diode and switch to be ideal. Under steady-state condition, the average resistance R_{eq} as seen by the source is _ Ω. (Round off to 2 decimal places.)

$$V_{in} = 15\,V, \quad L = 30\,\mu H, \quad C = 100\,\mu F, \quad R = 10\,\Omega$$

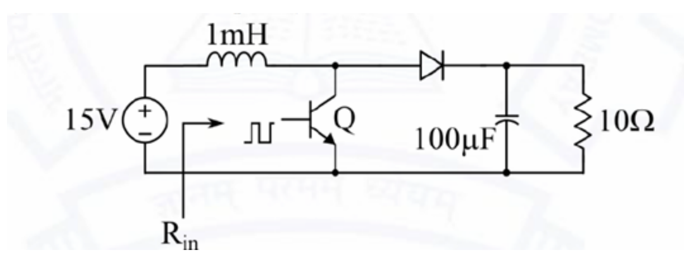


Fig. 25

64) Consider the buck-boost converter shown. Switch Q is operating at 25 kHz and 0.75 duty cycle. Assume diode and switch to be ideal. Under steady-state condition, the average current flowing into the inductor is _ A. (Round off to 2 decimal places.)

$$V_{in} = 20\,V, \quad L = 1\,mH, \quad C = 100\,\mu F, \quad R = 10\,\Omega$$

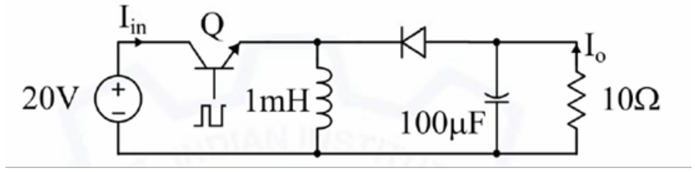


Fig. 26

65) A single-phase full-bridge inverter fed by a 325 V DC produces a symmetric quasi-square waveform across *ab* as shown. To achieve a modulation index of 0.9, the angle ϕ expressed in degrees should be _. (Round off to 2 decimal places.)

$$V_{dc} = 325\,V$$

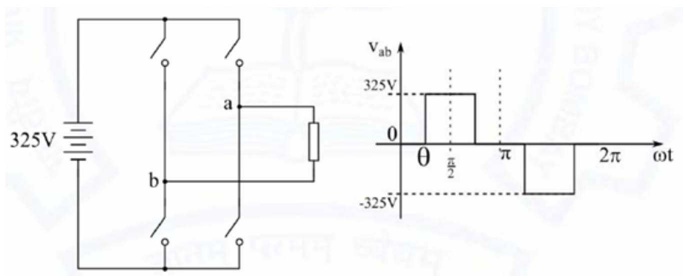


Fig. 27