General Aptitude

Q. No. 1 – 5 Carry One Mark Each

1. A generic term that includes various items of clothing such as a skirt, a pair of trousers and a shirt as

(A) fabric (B) textile (C) fibre (D) apparel

Answer: (D)

2. Choose the statement where underlined word is used correctly.

(A) The industrialist had a personnel jet.

(B) I write my experience in my personnel diary.

(C) All personnel are being given the day off.

(D) Being religious is a personnel aspect.

Answer: (C)

3. Based on the given statements, select the most appropriate option to solve the given question.

What will be the total weight of 10 poles each of same weight? Statements:

(I) One fourth of the weight of a pole is 5 kg

(II) The total weight of these poles is 160 kg more than the total weight of two poles.

(A) Statement II alone is not sufficient

(B) Statement II alone is not sufficient

(C) Either I or II alone is sufficient

(D) Both statements I and II together are not sufficient.

Answer: (C)

4. Consider a function $f(x) = 1 - |x|$ on $-1 \le x \le 1$. The value of x at which the function attains a maximum, and the maximum value of function are:

(A) $0, -1$ (B) $-1, 0$ (C) 0, 1 (D) -1, 2

Answer: (C)

Exp: $f(x) = 1 - |x|$ on $-1 \le x \le 1$

$$f(-1) = 1 - |-1| = 1 - 1 = 0$$
$$f(-0.5) = 1 - |-0.5| = 1 - 0.5 = 0.5$$
$$f(0) = 1 - |0| = 1$$
$$f(0.5) = 1 - |0.5| = 0.5$$
$$f(1) = 1 - |1| = 1 - 1 = 0$$

$\therefore$ maximum value occurs at x = 0 and maximum value is 1.

5. We ___________ our friend's birthday and we __________ how to make it up to him.

(A) completely forgot --- don't just known

(B) forget completely --- don't just know

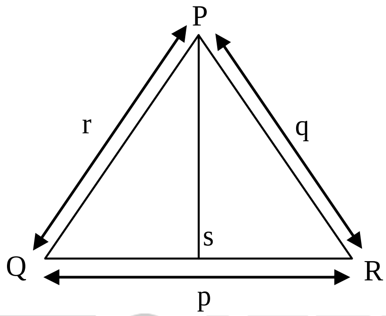
(C) completely forget --- just don't know

(D) forgot completely --- just don't know

Answer: (C)

Q. No. 6 – 10 Carry Two Marks Each

6. In a triangle PQR, PS is the angle bisector of $\angle QPR$ and $\angle QPS = 60^{o}$. What is the length of PS?



(A) $\frac{(q+r)}{qr}$ (B) $\frac{qr}{(q+r)}$ (C) $\sqrt{(q^{2}+r^{2})}$ (D) $\frac{(q+r)^{2}}{qr}$

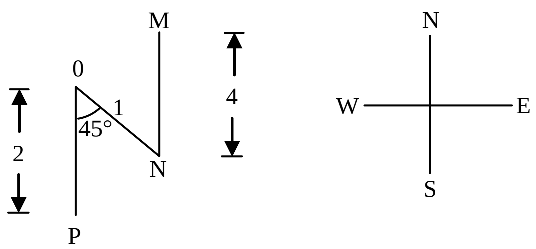
Answer: (B)

7. Four branches of a company are located at M,N,O, and P. M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. What is the distance between M and P in km?

(A) 5.34 (B) 6.74 (C) 28.5 (D) 45.49

Answer: (A)

Exp:



8. If p, q, r, s are distinct integers such that:

f (p, q, r, s) = max (p, q, r, s)

g (p, q, r, s) = min (p, q, r, s)

h (p, q, r, s) = remainder of (p × q)/(r × s) if (p × q) > (r × s) or remainder of (r × s)/(p × q) if (r × s) > (p × q)

Also a function fgh (p, q, r, s) = f(p, q, r, s) × g(p, q, r, s) × h(p, q, r, s)

Also the same operations are valid with two variable function of the form f(p, q).
What is the value of fg (h(2, 5, 7, 3), 4, 6, 8)?

Answer: 8

Exp: f g (h(2,5,7,3),4,6,8)
=fg(1,4,6,8)
=f(1,4,6,8)xg(1,4,6,8)=8x1=8

9. If the list of letters, P, R, S, T, U is an arithmetic sequence, which of the following are also in arithmetic sequence?

I. $2P, 2R, 2S, 2T, 2U$

II. $P-3, R-3, S-3, T-3, U-3$

III. P^2, R^2, S^2, T^2, U^2

(A) I only
(B) I and II
(C) II and III
(D) I and III

Answer: (B)

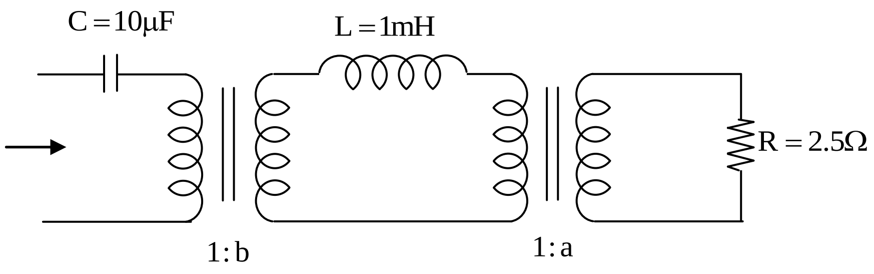
10. Out of the following four sentences, select the most suitable sentence with respect to grammer and usage:
(A) Since the report lacked needed information, it was of no use to them.
(B) The report was useless to them because there were no needed information in it.
(C) Since the report did not contain the needed information, it was not real useful to them
(D) Since the report lacked needed information, it would not had been useful to them.

Answer: (A)

Electrical Engineering

Q. No. 1 – 25 Carry One Mark Each

1. Find the transformer ratios a and b that the impedance (Z_{in}) is resistive and equal 2.5Ω when the network is excited with a sine wave voltage of angular frequency of 5000 rad/s.

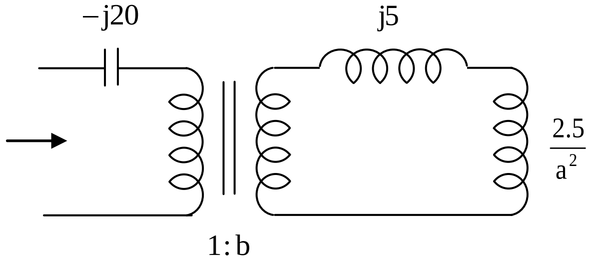


(A) a = 0.5, b = 2.0
(B) a = 2.0, b = 0.5
(C) a = 1.0, b = 1.0
(D) a = 4.0, b = 0.5

Answer: (B)

Exp: $X_c = -j20\,\Omega$

$X_L = j\,5\Omega$

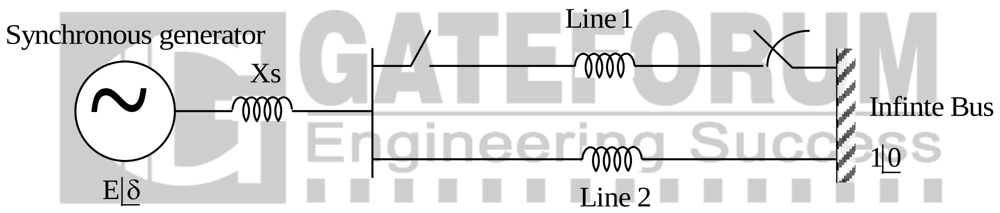


$$Z_{in} = \frac{1}{b^2}\left[\frac{2.5}{a^2} + j5\right] - j20 \qquad -20 + \frac{5}{b^2} = 0$$

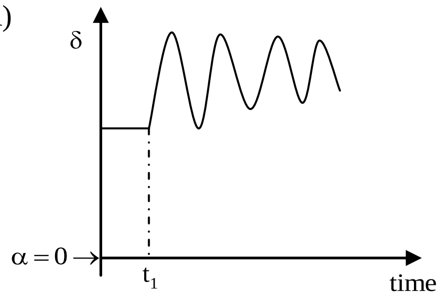
$$b = 0.5$$

$$\frac{2.5}{a^2b^2} = 2.5 \Rightarrow a = 2$$

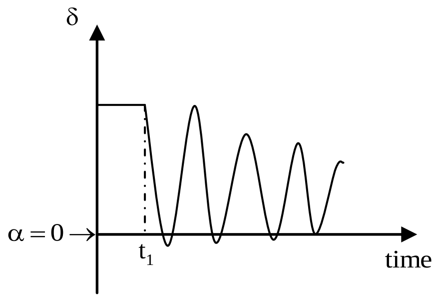
2. The synchronous generator shown in the figure is supplying active power to an infinite bus via two short, lossless transmission lines, and is initially in steady state. The mechanical power input to the generator and the voltage magnitude E are constant. If one line is tripped at time t_1 by opening the circuit breakers at the two ends (although there is no fault), then it is seen that the generator undergoes a stable transient. Which one of the following waveforms of the rotor angle δ shows the transient correctly?



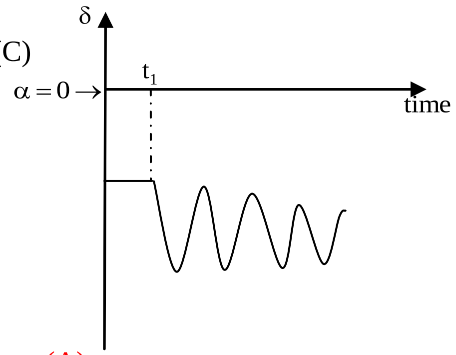
(A)



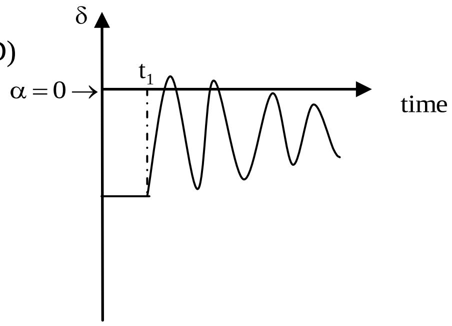
(B)



(C)



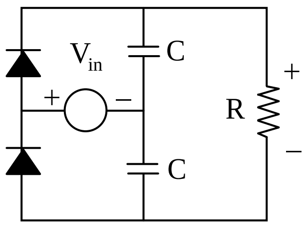
(D)



Answer: (A)

Exp: For generator δ is +Ve. After fault $\delta\uparrow$ increases

3. In the following circuit, the input voltage Vin is $100\ \sin(100\pi t)$. For $100\pi RC = 50$, the average voltages across R (in volts) under steady-state is nearest to



(A) 100 (B) 31.8 (C) 200 (D) 63.6

Answer: (C)

Exp: Given circuit is voltage doubler

V_m = Voltage across each capacitor = 100V

Voltage across two capacitors (in steady state)

$= 2V_m = 200V$

4. A 4-pole, separately excited, wave wound DC machine with negligible armature resistance is rated for 230 V and 5 kW at a speed of 1200 rpm. If the same armature coils are reconnected to forms a lap winding, what is the rated voltage (in volts) and power (in kW) respectively at 1200 rpm of the reconnected machine if the field circuit is left unchanged?

(A) 230 and 5 (B) 115 and 5 (C) 115 and 2.5 (D) 230 and 2.5

Answer: (B)

Exp In wave wound, no. of parallel paths is 2.

In lap wound, no of parallel paths is A = p = 4.

$\therefore$ Rated voltage $= \frac{230 \times 2}{4} = 115V$

As no. of parallel paths is divided into four from two, the voltage reduces to half but power remains the same.

5. Given $f(z) = g(z) + h(z)$, where f, g, h are complex valued functions of a complex variable z. Which one of the following statements is TRUE?

(A) If f(z) is differential at z_0, then g(z) and h(z) are also differentiable at z_0.

(B) If g(z) and h(z) are differentiable at z_0, then f(z) is also differentiable at z_0.

(C) If f(z) is continuous at z_0, then it is differentiable at z_0.

(D) If f(z) is differentiable at z_0, then so are its real and imaginary parts.

Answer: (B)

Exp: Given $f(z) = g(z) + h(z)$

$f(z), g(z), h(z)$ are complex variable functions

(c) is not correct, since every continuous function need not be differentiable

(D) is also not correct

Let g(z) = x h(z) = iy

$$\Rightarrow \quad g(z) = x + i0 \qquad h(z) = 0 + iy$$

$$u = x \quad v = 0 \qquad u = 0 \quad v = y$$

$$\frac{\partial x}{\partial x} = 1 \ \frac{\partial x}{\partial x} = 0 \qquad \frac{\partial y}{\partial x} = 0 \ \frac{\partial \vartheta}{\partial x} = 0$$

$$\partial \vartheta = 0 \ \partial \vartheta = 0 \qquad \frac{\partial x}{\partial y} = 0 \ \frac{\partial \vartheta}{\partial y} = 1$$

Cauchy – rieman equation as of g(z), h(z) are failed.

∴ f(z) and g(z) are not differentiable

But $f(z) = x + iy$

$$u + x \qquad v = y$$

$$\frac{\partial u}{\partial x} = 1 \qquad \frac{\partial v}{\partial x} = 0$$

$$\frac{\partial u}{\partial x} = \frac{\partial u}{\partial y} \qquad \frac{\partial u}{\partial y} = \frac{-\partial v}{\partial x}$$

∴ f(z) in differentiable

∴ i.e, f(z) is differential need not imply g(z) and h(z) are differentiable

∴ Ans (B)

i.e, g(z) and h(z) are differentiable then f(z) = g(z) + h(z) is differentiable.

6. A 3-bus power system network consists of 3 transmission lines. The bus admittance matrix of the uncompensated system is

$$\begin{bmatrix} -j6 & j3 & j4 \\ j3 & -j7 & j5 \\ j4 & j & -j8 \end{bmatrix} \text{pu.}$$

If the shunt capacitance of all transmission line is 50% compensated, the imaginary part of the 3rd row 3rd column element (in pu) of the bus admittance matrix after compensation is

(A) $-j\,7.0$ (B) $-j\,8.5$ (C) $-j\,7.5$ (d) $-j\,9.0$

Answer: (B)

Exp: $$y_{Bus} = \begin{bmatrix} y_{10} + y_{12} + y_{13} & -y_{12} & -y_{13} \\ -y12 & y_{20} + y_{21} + y_{23} & -y_{23} \\ -y_{13} & -y_{23} & y_{30} + y_{31} + y_{32} \end{bmatrix}$$

$$y_{31} = y_{13} = -j4$$
$$y_{32} = y_{23} = -j5$$

$$y_{30} + y_{31} + y_{32} = -j8$$
$$y_{30} + (-j4) + (-j5) = -j8$$
$$y_{30} = j1$$

after compensating, $y_{30} = \frac{j1}{2}$

$\therefore y_{30} + y_{31} + y_{32}$ (new) $= j0.5 - j4 - j5 = -j8.5$

7. A shunt-connected DC motor operates at its rated terminal voltage. Its no-load speed is 200 radians/second. At its rated torque of 500 Nm, its speed is 180 radian/second. The motor is used to directly drive a load whose load torque T_L depends on its rotational speed (in radians/second), such that $T_L = 2.78 \times \omega_T$. Neglecting rotational losses, the steady-state speed (in radian/second) of the motor, when it drives this load is _________.

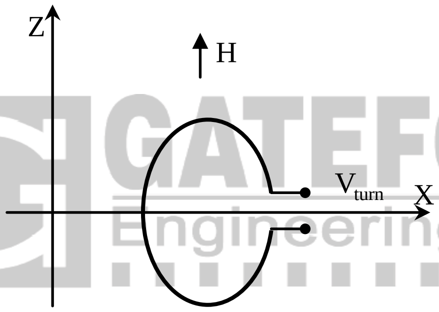
Answer: 179.86

Exp: Under steady state load torque = motor torque

$500 = 2.78 \times \omega_T$

$\therefore \omega_T = 178.88$ rad/sec

8. A circular turn of radius 1 m revolves at 60 rpm about its diameter aligned with the x-axis as shown in the figure. The value of μ_0 is $4\pi \times 10^{-7}$ in SI unit. If a uniform magnetic field intensity $\vec{H} = 10^7 \hat{z}$ A/m is applied, then the peak value of the inducted voltage, V_{turn} (in volts), is __________.



Answer: 247.92

Exp: $V_{emf} = \oint_L (\bar{V} \times \bar{B}).dl$

$= \oint_L (r\omega a_\phi \times \mu H a_z).dl$

$= \oint r\omega\mu H a_\rho.dl$

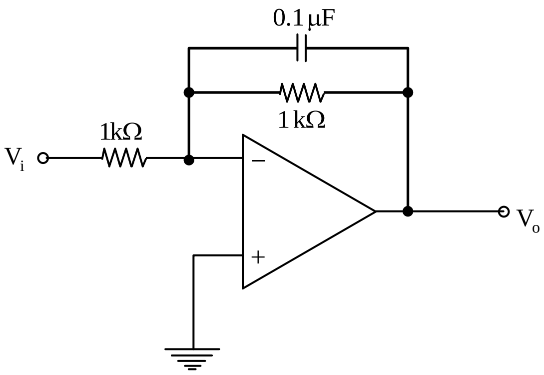
$= r\omega\mu H \left(\frac{2\pi r}{2}\right)$

$V_{emf} = \omega\mu H \pi r^2$

$= 6.28 \times 4\pi \times 10^{-7} \times 10^7 \times \pi(1)^2$

$\boxed{V_{emf} = 247.92 \text{ V}}$

9. The operational amplifier shown in the figure is ideal. The input voltage (in Volt) is $V_i = 2\sin(2\pi \times 2000t)$. The amplitude of the output voltage V_o (in Volt) is ________.



Answer: 1.25

Exp:

$$Z_1 = 1k;\ Z_2 = \frac{1\times10^3 \times \frac{1}{0.1\times10^{-6}s}}{10^3 + \frac{1}{0.1\times10^{-6}s}}$$

$$= \frac{10^3}{j0.1\times10^{-3}\omega + 1}$$

$\omega = 2\pi \times 2000\ \text{rad/sec}$

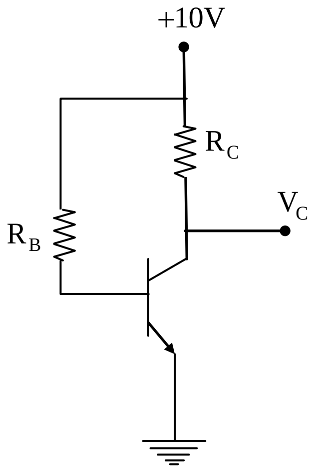
$$Z_2 = \frac{10^3}{1 + j0.1\times2\pi\times2000\times10^{-3}} = \frac{10^3}{1 + j1.25}$$

$$V_0 = \frac{-Z_2 V_i}{Z_1} = -\frac{10^3 \times 2\sin(2\pi\times2000t)}{(1 + j1.25)\times10^3} = -\frac{2\sin(2\pi\times2000t)}{1.6\angle 51.3}$$

$$V_0 = -1.25\sin(2\pi 2000t - 51.3)$$

Amplitude of the output voltage =1.25V

10. In the following circuit, the transistor is in active mode and $V_C = 2V$. To get $V_C = 2V$. To get $V_C = 4V$, we replace R_C with R_C'. Then the ratio R_C'/R_C is ________.



Answer: 0.75

Exp: we have $V_c = 2V$;

$I_c R_c = 10 - 2 = 8$ … (i)

We have V_c=4V

$I_c R_c' = 10 - 2 = 8$ … (ii)

$$\frac{(2)}{(1)}=\frac{I_cR_c'}{I_cR_c}=\frac{6}{8};\quad \frac{R_c'}{R_c}=\frac{3}{4}=0.75$$

11. The Laplace transform of $f(t)=2\sqrt{t/\pi}$ is $s^{-3/2}$. The Laplace transform of $g(t)=\sqrt{1/\pi t}$ is

(A) $3s^{-5/2}/2$ (B) $s^{-1/2}$ (C) $s^{1/2}$ (D) $s^{3/2}$

Answer: (B)

Exp: Given that laplace transform of $f(t)=2\sqrt{\frac{t}{\pi}}$ is $s^{-3/2}$.

Given as $g(f)=\frac{1}{\sqrt{\pi t}}$

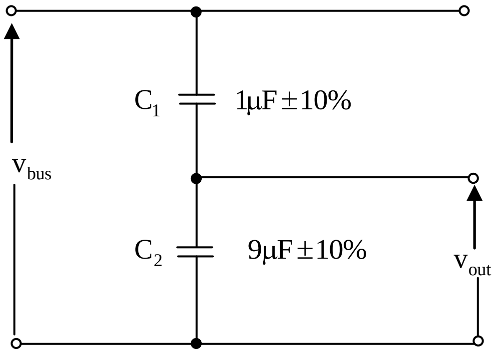
$$\Rightarrow g(t)=\frac{2\sqrt{t/\pi}}{2t}=\frac{f(t)}{2t}$$

$$L\{g(t)\}=L\left\{\frac{f(t)}{2t}\right\}=\frac{1}{2}\int_s^0\{f(t)\}ds$$

$$=\frac{1}{2}\int_s^\infty s^{-3/2}ds=\frac{1}{2}\left(\frac{s^{\frac{-3}{2}+1}}{\frac{-3}{2}+1}\right)_s^\infty$$

$$=\frac{1}{2}(-2)\left[0-s^{-1/2}\right]=s^{-1/2}=\frac{1}{\sqrt{s}}$$

12. A capacitive voltage divider is used to measure the bus voltage V_{bus} in a high-voltage 50 Hz AC system as shown in the figure. The measurement capacitor C_1 and C_2 have tolerances of $\pm10\%$ on their normal capacitance values. If the bus voltage V_{bus} is 100 kV rms, the maximum rms output voltage V_{out} (in kV), considering the capacitor tolerance, is ___________.



Answer: 12

Exp: $V_{out} = V_{bus}\left[\frac{X_{c_2}}{X_{c1}+X_{c_2}}\right] = V_{bus}\left[\frac{\frac{1}{c_2}}{\frac{1}{c_1}+\frac{1}{c_2}}\right]$

$= V_{bus}\left[\frac{c_1}{c_1+c_2}\right]$

$c_1 + c_2 = (1\mu F \pm 10\%) + (9\mu F \pm 10\%) = (1\mu \pm 0.1) + (9\mu + 0.9)$

$= (10\mu \pm 1) = 10\mu F \pm 10\%$

$\frac{c_1}{c_1+c_2} = \frac{1\mu \pm 10\%}{10\mu \pm 10\%} = 0.1 \pm 20\%$

$\therefore V_{out} = 100\times10^3(0.1 \pm 20\%)$

$= 10\text{ kV} \pm 20\% = 10k + 2k \text{ (or)} 10k - 2k = 12k \text{ or } 8k$

13. Match the following

P. Stokes's Theorem	1. $\oiint D.ds = Q$
Q. Gauss's Theorem	2. $\oint f(z)dx = 0$
R. Divergence Theorem	3. $\iiint(\nabla.A)dv = \oiint A.ds$
S. Cauchy's Integral Theorem	4. $\iint(\nabla\times A).ds = \oint A.dl$

(A) P-2, Q-1, R-4, S-3
(B) P-4, Q-1, R-3, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

Answer: (B)

14. Consider the following Sum of Products expression, F.

$F = ABC + \bar{A}\bar{B}C + A\bar{B}C + \bar{A}BC + \bar{A}\bar{B}\bar{C}$

The equivalent Product of Sums expression is

(A) $F = (A+\bar{B}+C)(\bar{A}+B+C)(\bar{A}+\bar{B}+C)$

(B) $F = (A+B+\bar{C})(A+B+C)(\bar{A}+\bar{B}+\bar{C})$

(C) $F = (\bar{A}+B+\bar{C})(A+\bar{B}+\bar{C})(A+B+C)$

(D) $F = (\bar{A}+\bar{B}+C)(A+B+\bar{C})(A+B+C)$

Answer: (A)

Exp: Given minterm is

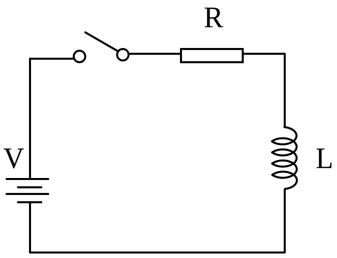
$F = \Sigma m(0,1,3,5,7)$

$F = \pi m(2,4,6)$

So product of sum expression is

$F = (A+\bar{B}+C)(\bar{A}+B+C)(\bar{A}+\bar{B}+C)$

15. A series RL circuit is excited at t = 0 by closing a switch as shown in the figure. Assuming zero initial conditions, the value of $\frac{d^2i}{dt^2}$ at $t = 0^+$ is



(A) $\frac{V}{L}$ (B) $\frac{-V}{R}$ (C) 0 (D) $\frac{-RV}{L^2}$

Answer: (D)

Exp: $i = i_L(t) = \frac{V}{R}\left(1 - e^{\frac{-Rt}{L}}\right)$

$$\frac{di_L}{dt} = \frac{V}{L}\left(e^{\frac{-Rt}{L}}\right)$$

$$\frac{di^2}{dt^2} = -\frac{R}{L^2}Ve^{\frac{-Rt}{L}}$$

$$\left.\frac{di^2}{dt^2}\right|_{t=0} = -\frac{RV}{L^2}$$

16. We have a set of 3 linear equations in 3 unknowns. $'X \equiv Y'$ means X and Y are equivalent statements and $'X \equiv Y'$ means X and Y are not equivalent statements.

P: There is a unique solution.

Q: The equations are linearly independent.

R: All eigenvalues of the coefficient matrix are nonzero.

S: The determinant of the coefficient matrix is nonzero.

Which one of the following is TRUE?

(A) $P \equiv R \equiv Q \equiv S$ (B) $P \equiv R \not\equiv Q \equiv S$

(C) $P \equiv Q \not\equiv R \equiv S$ (D) $P \not\equiv Q \not\equiv R \not\equiv S$

Answer: (A)

17. Match the following:

Instrument Type	Used for
P. Permanent magnet moving coil	1. DC only
Q. Moving iron connected through current transformer	2. AC only
R. Rectifier	3.AC and DC
S. Electrodynamometer	

(A) P – 1, Q – 2, R – 1, S – 3	(B) P – 1, Q – 3, R – 1, S – 2	(C) P – 1, Q – 2, R – 3, S – 3	(D) P – 3, Q – 1, R – 2, S – 1

Answer: (C)

18. Two semi-infinite dielectric regions are separated by a plane boundary at y=0. The dielectric constant of region 1 (y<0) and region 2 (y>0) are 2 and 5, Region 1 has uniform electric field $\vec{E} = 3\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$, where $\hat{a}_x, \hat{a}_y$, and $\hat{a}_z$ are unit vectors along the x, y and z axes, respectively. The electric field region 2 is

(A) $3\hat{a}_x + 1.6\hat{a}_y + 2\hat{a}_z$ (B) $1.2\,\hat{a}_x + 4\,\hat{a}_y + 2\hat{a}_z$

(C) $1.2\hat{a}_x + 4\hat{a}_y + 0.8\hat{a}_z$ (D) $3\hat{a}_x + 10\hat{a}_y + 0.8\hat{a}_z$

Answer: (A)

Exp: (1) (2)

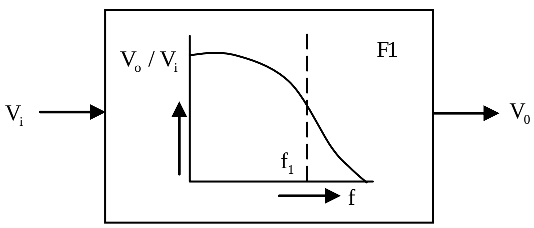
$y < 0$ y>0

$E_1 = 3ax + 4ay + 2az$ E_z= y=0

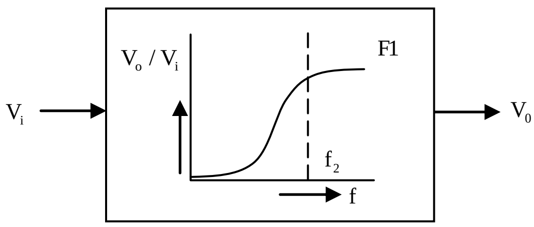
$$E_2 = 3a_x + \frac{2}{5}(4a_y) + 2a_z$$

$$E_z = 3a_x + 1.6a_y + 2a_z$$

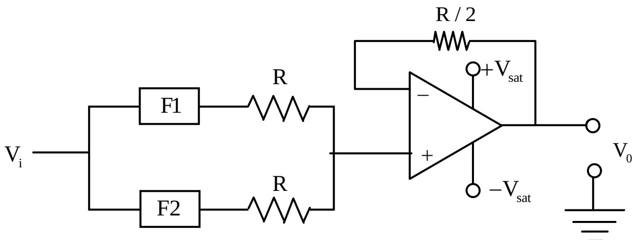
19. The filters F1 and F2 having characteristics as shown in Figures (a) and (b) are connected as shown in Figure (c).



(a)



(b)



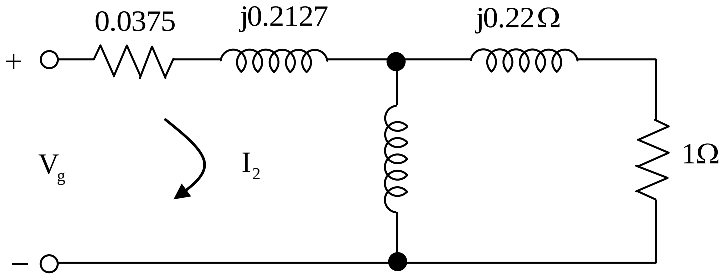
(c)

The cut-off frequencies of F1 and F2 are f_1 and f_2 respectively. If $f_1 < f_2$, the resultant circuit exhibits the characteristics of a

(A) Band-pass filter (B) Band-stop filter (C) All pass filter (D) High-Q filter

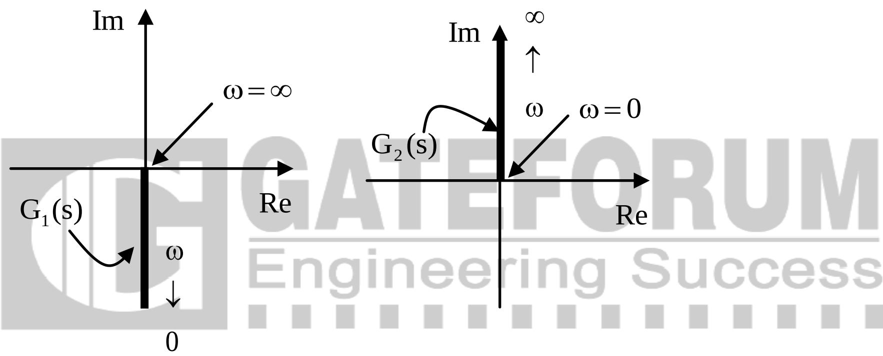
Answer: (B)

20. The figure shows the per-phase equivalent circuit of a two-pole three-phase induction motor operating at 50 Hz. The “air-gap” voltage, V_g across the magnetizing inductance, is 210 V rms, and the slip, is 0.005. The torque (in Nm) produced by the motor is ______.



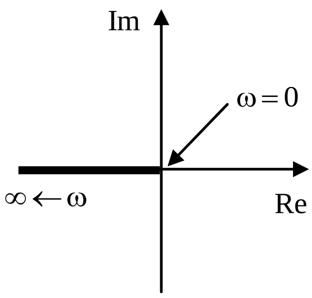
Answer: 401.88

21. Nyquist plot of two functions $G_1(s)$ and $G_2(s)$ are shown in figure.

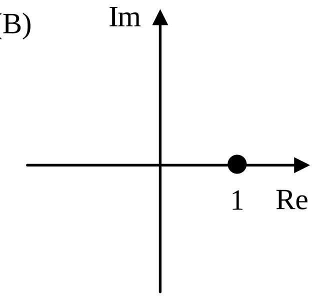


Nyquist plot of the product of $G_1(s)$ and $G_2(s)$ is

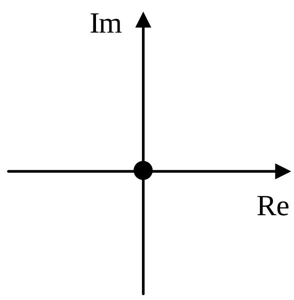
(A)



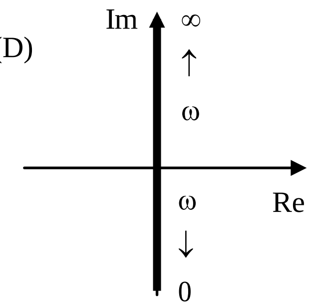
(B)



(C)



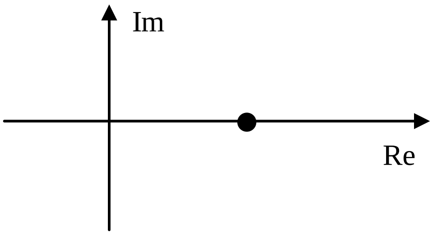
(D)



Answer: (B)

Exp: $G_1(s) = \frac{1}{s}; G_2(s) = 5$

$G_1G_2(s) = 1$



22. A 3-phase balanced load which has a power factor of 0.707 is connected to balanced supply. The power consumed by the load is 5kW. The power is measured by the two-wattmeter method. The readings of the two wattmeters are

(A) 3.94 kW and 1.06 kW
(B) 2.50 kW and 2.50 kW
(C) 5.00 kW and 0.00 kW
(D) 2.96 kW and 2.04 kW

Answer: (A)

Exp: $P_1 = V_L I_L \cos(30 - \phi)$

$P_2 V_L I_L \cos(30 + \phi)$

$$\cos\phi = \cos\left[\tan^{-1}\frac{\sqrt{3}(p_1 - p_2)}{p_1 + p_2}\right]$$

$$= \cos\phi\left[\tan^{1}\sqrt{3}\left[\frac{3.94 - 1.06}{5}\right]\right] = 45^{o}$$

satisfiying only for(A)

23. An open loop control system results in a response of $e^{-2t}(\sin 5t + \cos 5t)$ for a unit impulse input. The DC gain of the control system is ________.

Answer: 0.241

Exp: $g(t) = e^{-2}[\sin 5t + \cos 5t]$

$$G(s) = \frac{5}{(s+2)^2 + 5^2} + \frac{s+2}{\{s+2\} + 5^2}$$

DC gain means $|G(s)|_s = 0$

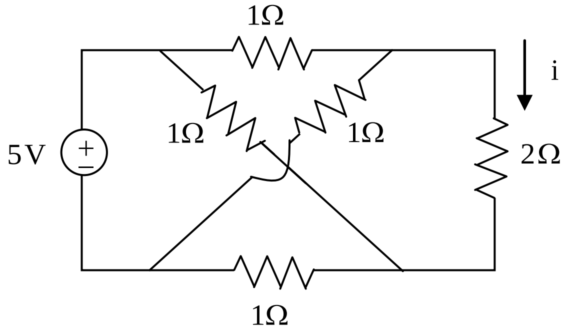
$$G(0) = \frac{5}{2^2 + 5^2} + \frac{2}{2^2 + 5^2} = \frac{7}{29}$$

24. When a bipolar junction transistor is operating in the saturation mode, which one of the following statement is TRUE about the state of its collector-base (CB) and the base-emitter (BE) junctions?

(A) The CB junction is forward biased and the BE junction is reverse biased.
(B) The CB junction is reversed and the BE junction is forward biased.
(C) Both the CB and BE junctions are forward biased.
(D) Both the CB and BE junctions are reverse biased.

Answer: (C)

25. The current i (in Ampere) in the 2Ω resistor of the given network is ____ .



Answer: 0

Exp: The Network is balanced Wheatstone bridge.

$\Rightarrow i = 0$ Amp

Q. No. 26 – 55 Carry Two Marks Each

26. A 220 V, 3-phase, 4-pole, 50 Hz inductor motor of wound rotor type is supplied at rated voltage and frequency. The stator resistance, magnetizing reactance, and core loss are negligible. The maximum torque produced by the rotor is 225% of full load torque and it occurs at 15% slip. The actual rotor resistance is $0.03\Omega/\text{phase}$. The value of external resistance (in Ohm) which must be inserted in a rotor phase if the maximum torque is to occur at start is ________.

Answer: 0.17

Exp: $S_{mt} = \frac{r^2}{x_2}$

$0.15 = \frac{r_2}{x_2} = \frac{0.03}{x_2} \Rightarrow x_2 = 0.2\Omega$

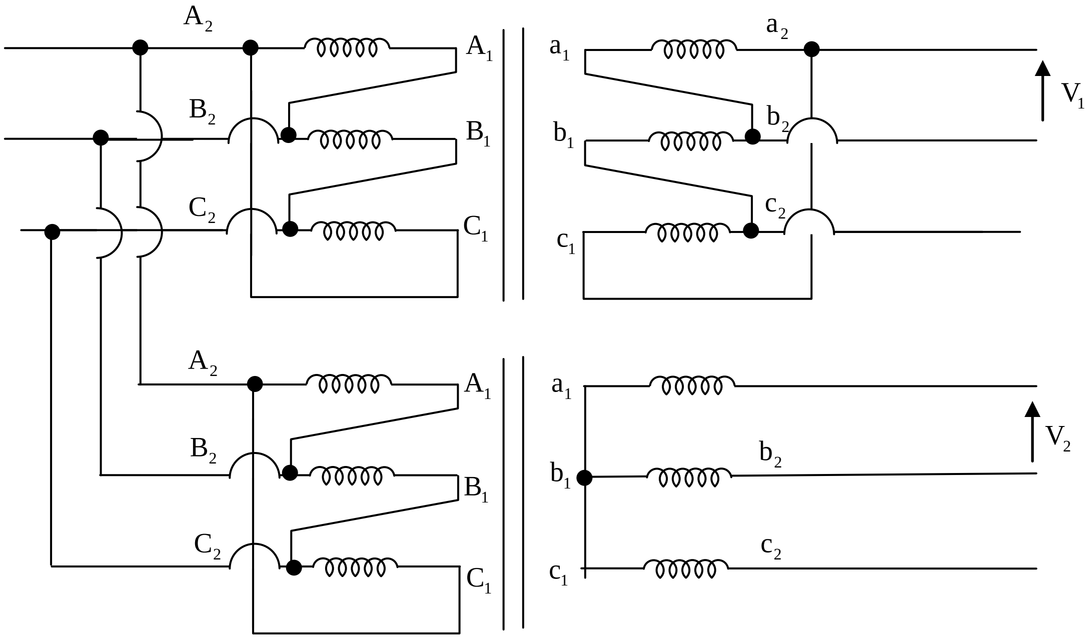
For $T_{est} = T_{emax}$,

$\frac{T_{est}}{T_{em}} = \frac{2}{\frac{1}{S_{mT}} + S_{mT}} = 1 \Rightarrow S_{mT} = 1$

$1 = \frac{r_2'}{x_2} \Rightarrow r_2' = x_2 = 0.2\Omega$

Extra resistance $= 0.2 - 0.03 = 0.17\Omega/\text{p4}$

27. Two three-phase transformers are realized using single-phase transformers as shown in the figure.



The phase different (in degree) between voltage V_1 and V_2 is ________.

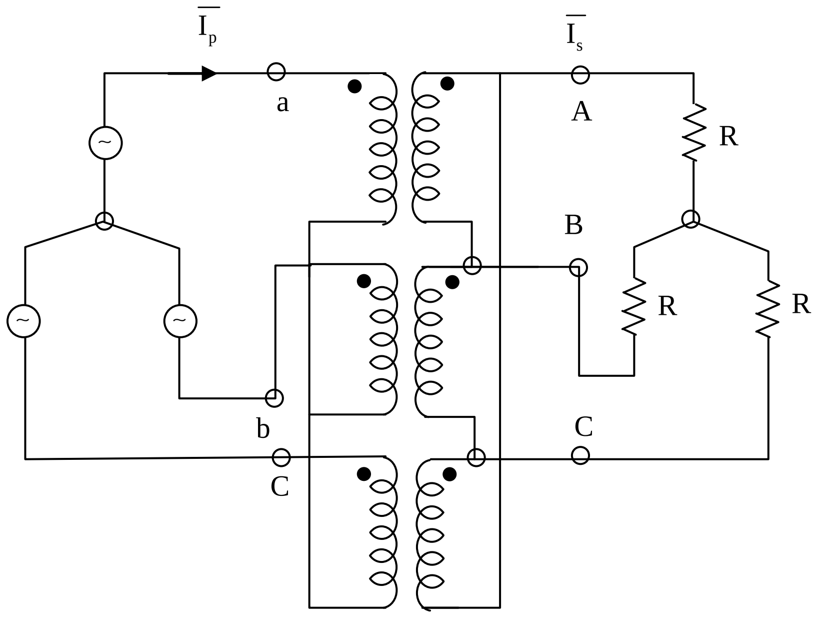
Answer: 30

Exp: Upper transformer secondary is connected in Δ

Bottom transformer secondary is connected in Y

Phase angle between delta voltage & star voltage is 30^o.

28. A balanced (positive sequence) three-phase AC voltage source is connected to a balanced, start connected through a star-delta transformer as shown in the figure. The line-to-line voltage rating is 230 V on the star side, and 115 V on the delta side. If the magnetizing current is neglected and $\overline{I_s} = 100\angle 0^o$ A, then what is the value of $\overline{I_p}$ in Ampere?



(A) $50\angle 30^o$ (B) $50\angle -30^o$ (C) $50\sqrt{3}\angle 30^o$ (D) $200\angle 30^0$

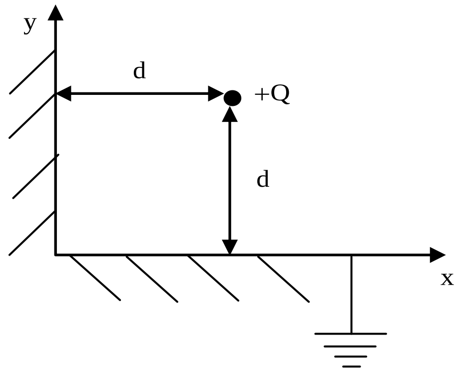
Answer: (A)

Exp: It's a Ydll connection.

$$\therefore \left[\frac{230}{\sqrt{3}}\angle -30^o\right] I_p = 115\angle 0\left(\frac{110\angle 0}{\sqrt{3}}\right)$$

$$\Rightarrow I_p = 50\angle 30^o$$

29. Two semi-infinite conducting sheets are placed at right angles to each other as shown in the figure. A point charge of +Q is placed at a distance of d from both sheets. The net force on the charge is $\frac{Q^2}{4\pi\varepsilon_0}\frac{K}{d^2}$, where K is given by



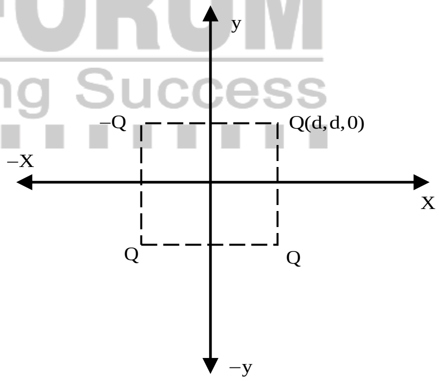
(A) 0 (B) $-\frac{1}{4}\hat{i}-\frac{1}{4}\hat{j}$

(C) $-\frac{1}{8}\hat{i}-\frac{1}{8}\hat{j}$

(D) $\frac{1-2\sqrt{2}}{8\sqrt{2}}\hat{i}+\frac{1-2\sqrt{2}}{8\sqrt{2}}\hat{j}$

Answer: (D)

Exp: $F = F_1 + F_2 + F_3$



$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2d)^3}\left[-2da_x - 2da_y + \frac{1}{2\sqrt{2}}\left(2da_x + 2da_y\right)\right]$$

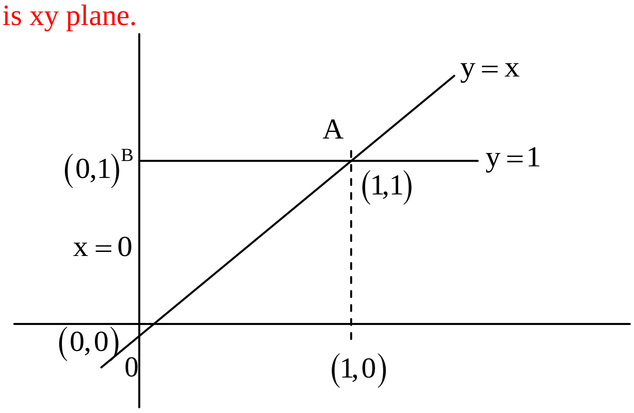
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{d^2}\left[\frac{1-2\sqrt{2}}{8\sqrt{2}}a_x + \frac{1-2\sqrt{2}}{8\sqrt{2}}a_y\right]$$

So, $\boxed{\text{Ans}:(D)}$

30. The volume enclosed by the surface $f(x,y)=e^x$ over the triangle bounded by the line x=y; x=0; y=1 in the xy plane is ______.

Answer: 0.72

Exp: Triangle is banded by x = y, x = 0, y = 1 is xy plane.



$$\text{Required volume} = \int\int_{0AB} f(x,y)\,dxdy$$

$$= \int_{x=0}^{1}\int_{y=x}^{1} e^{x} dxdy$$

$$= \int_{x=0}^{1} e^{x}.(y)_{x}^{1} dx$$

$$= \int_{x=0}^{1} e^{x}(1-x)dx = \int_{x=0}^{1}\left(e^{x} - xe^{x}\right)dx$$

$$= \left(e^{x}\right)_{0}^{1} - \left(e^{x}(x-1)\right)_{0}^{1}$$

$$= \left(e^{1}-1\right) - \left[0-(-1)\right] = e - 2 = 0.72$$

31. For the system governed by the set of equations:

$dx_1 / dt = 2x_1 + x_2 + u$

$dx_2 / dt = -2x_1 + u$

$y = 3x_1$

the transfer function Y(s)/U(s) is given by

(A) $3(s+1)/(s^2-2s+2)$ (B) $3(2s+1)(s^2-2s+1)$

(C) $(s+1)/(s^2-2s+1)$ (D) $3(2s+1)(s^2-2s+2)$

Answer: (A)

Exp: $\frac{dx_1}{dt} = 2x_1 + x_2 + 4$

$\frac{dx_2}{dt} = -2x_1 + 4$

$y = 3x_1$

Considering the standard equation

$x_i = Ax + BU$

$y = Cx + DU$

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}2 & 1\\ -2 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}[4]$$

$$y = [3 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Transform function $C(SI-A)^{-1}B$

$$G(s)=\begin{bmatrix}3 & 0\end{bmatrix}\left[\begin{bmatrix}s & 0\\ 0 & s\end{bmatrix}-\begin{bmatrix}2 & 1\\ -2 & 0\end{bmatrix}\right]^{-1}\begin{bmatrix}1\\ 1\end{bmatrix}$$

$$\begin{bmatrix}3 & 0\end{bmatrix}\begin{bmatrix}s-2 & -1\\ 2 & s\end{bmatrix}^{-1}\begin{bmatrix}1\\ 1\end{bmatrix}$$

$$\begin{bmatrix}3 & 0\end{bmatrix}\begin{bmatrix}s & 1\\ -2 & s-2\end{bmatrix}\begin{bmatrix}1\\ 1\end{bmatrix}$$

$$s^2-2s+2$$

$$=\frac{1}{s^2-s+2}\begin{bmatrix}3 & 0\end{bmatrix}\begin{bmatrix}s+1\\ -2+s-2\end{bmatrix}$$

$$=\frac{1}{s^2-2s+2}\begin{bmatrix}3 & 0\end{bmatrix}\begin{bmatrix}s+1\\ s-4\end{bmatrix}$$

$$=\frac{3(s+1)}{s^2-2s+2}$$

32. For linear time invariant systems, that are Bounded Input Bounded stable, which one of the following statement is TRUE?

(A) The impulse response will be integral, but may not be absolutely integrable.

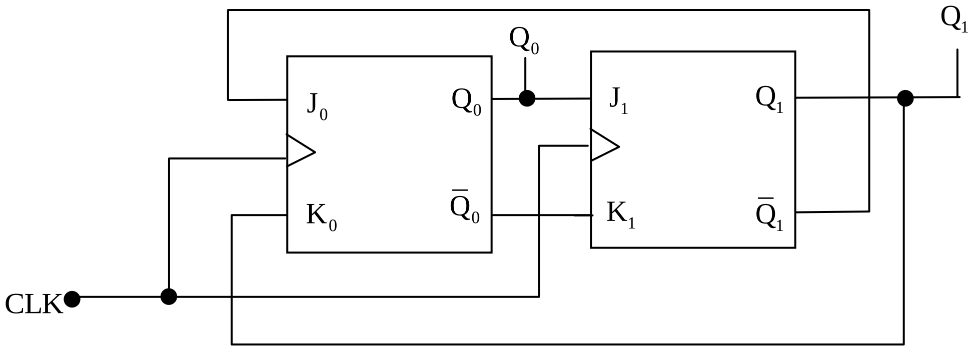
(B) The unit impulse response will have finite support.

(C) The unit step response will be absolutely integrable.

(D) The unit step response will be bounded.

Answer: (B)

33. In the following sequential circuit, the initial state (before the first clock pulse) of the circuit is $Q_1Q_0=00$. The state (Q_1Q_0), immediately after the 333[rd] clock pulse is



(A) 00 (B) 01 (C) 10 (D) 11

Answer: (B)

Exp:

$J_1(Q_0)$	$K_1(\bar{Q}_0)$	$J_0(\bar{Q}_1)$	$K_0(Q_1)$	Q_1	Q_0
–	–	–	–	0	0
0	1	1	0	0	1
1	0	1	0	1	1
1	0	0	1	1	0
0	1	0	1	0	0

If is a Johnson (MOD-4) counter. Divide 333 by 4, so it will complete 83 cycle and remainder clock is 1, at the completion of cycles output's in at $Q_1Q_0 = 00$ so, next at 333^{rd} clock pulse output is at $Q_1Q_0 = 01$.

34. A three-phase, 11 kV, 50 Hz, 2 pole, star connected, cylindrical rotor synchronous motor is connected to an 11 kV, 50 Hz source, Its synchronous reactance is 50Ω per phase, and its stator resistance is negligible. The motor has a constant field excitation. At a particular load torque, its stator current is 100A at unity power factor. If the load torque is increased so that the stator current is 120 A, then the load angle (in degrees) at this node is ____.

Answer: 47.27

Exp: $E_f = V_t - I_a \times S$

$$= \frac{11}{\sqrt{3}} kV - j100\times 50 \ = 6350 - j5000$$

$$|E_f| = 8082.23$$

$$(I_a \times S)^2 = E_f^{\,2} + V_t^2 - 2E_f V_t \cos\delta$$

$$(120\times 50)^2 = 8082.23^2 + 6350^2 - 2\times 8082.23\times 6350\times \cos\delta$$

$$\delta = 47.27°$$

35. Two coins R and S are tossed. The 4 joint events $H_RH_S, T_RT_S, H_RT_S, T_RH_S$ have probabilities 0.28, 0.18, 0.30, 0.24, respectively, where H represents head and T represents tail. Which one of the following is TRUE?

(A) The coin tosses are independent
(B) R is fair, R it not.
(C) S is fair, R is not
(D) The coin tosses are dependent

Answer: (D)

Exp: Given events H_RH_S, T_RT_S, H_RT_S, T_RH_S

If coins are independent

Corresponding probabilities will be

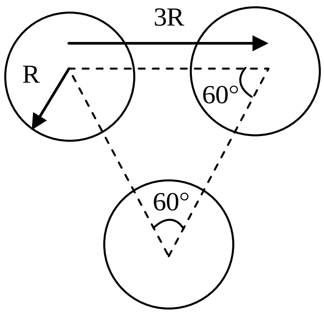
$$\frac{1}{2}.\frac{1}{2}, \ \frac{1}{2}.\frac{1}{2}, \ \frac{1}{2}.\frac{1}{2}, \ \frac{1}{2}.\frac{1}{2}$$

$$= \frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4} \text{ respectively}$$

But given probabilities are 0.28, 0.18, 0.3, 0.24 respectively we can decide whether R is fair or S is fair

$\Rightarrow$ The coin tosses are dependent.

36. A composite conductor consists of three conductors of radius R each. The conductors are arranged as shown below. The geometric mean radius (GMR) (in cm) of the composite conductor is kR. The value of k is ___________.



Answer: 1.193

Exp: $GMR = [0.7788R \times 3R \times 3R]^{1/3}$

$= 1.9137R = kR$

$k = 1.913$

37. The z-Transform of a sequence x[n] is given as $X(z) = 2z+4-4/z+3/z^2$. If y[n] is the first difference of x[n], then Y(z) is given by

(A) $2z+2-8/z+7/z^2-3/z^3$ (B) $-2z+2-6/z+1/z^2-3/z^3$

(C) $-2z-2+8/z-7/z^2+3/z^3$ (D) $4z-2-8/z-1/z^2+3/z^3$

Answer: (A)

Exp: y(n) is first difference of x(n) So

$g(n) = x(n) - x(n-1)$

$\Rightarrow Y(z) = x(Z)(1-z^{-1}) = X(z) - z^{-1}X(z)$

$Y(z) = \left[2z + 4 - 4z^{-1} + 3z^{-2}\right] - \left[2 + 4z^{-1} - 4z^{-2}\right]$

$= 2z + 4 - 4z^{-1} + 3z^{-2} - 2 - 4z^{-1} + 4z^{-2} - 3z^{-3}$

$= 2z + 2 - 8z^{-1} + 7z^{-2} - 3z^{-3}$

38. An open loop transfer function G(s) of a system is

$$G(s) = \frac{K}{s(s+1)(s+2)}$$

For a unity feedback system, the breakaway point of the root loci on the real axis occurs at,

(A) -0.42 (B) -1.58

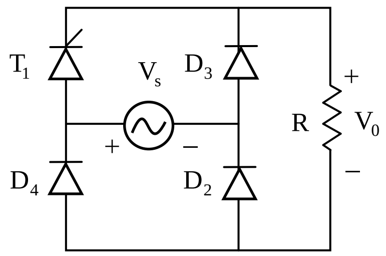
(C) -0.42 and -1.58 (D) None of the above

Answer: (A)

Exp: $1 + \quad G =($

$$s\left(s^2+3s+2\right)+12=0$$
$$-k=s^3+3s^2+2s$$
$$\frac{dK}{ds}=0$$
$$3s^2+6s+s=0$$
S=-0.42 is the solution makes k>0

39. In the given rectifier, the delay angle of the thyristor T_1 measured from the positive going zero crossing of V_s is 30°. If the input voltage V_s is 100 sin(100πt)V, the average voltage across R (in Volt) under steady-state is _______.



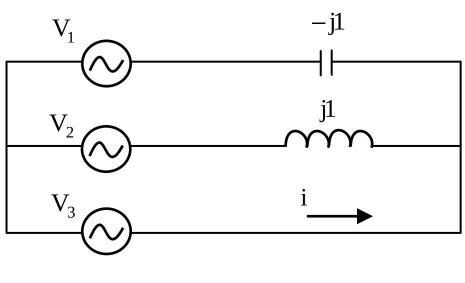
Answer: 61.52

Exp: $\alpha=30°$
$$V_{in}=100\sin(100\pi t)$$
$$V_0=\frac{V_m}{2\pi}[3+\cos\alpha]$$
$$=\frac{100}{2\pi}(3+\cos30°)=61.52V$$

40. Two identical coils each having inductance L are placed together on the same core. If an overall inductance of αL is obtained by interconnecting these two coils, the minimum value of α is ________.

Answer: 0

41. In the given network V_1 = 100∠0°V, V_2 = 100∠-120°V, V_3 = 100∠+120°V. The phasor current i (in Ampere) is



(A) 173.2∠-60° (B) 173.2∠-120° (C) 100.0∠-60° (D) 100.0∠-120°

Answer: (A)

Exp: $-i = \frac{(V_1 - V_3)}{-j} + \frac{(V_3 - V_2)}{j}$

$-i = \frac{100\angle 0^\circ - 100\angle 120^\circ}{1\angle -90^\circ} + \frac{100\angle -120^\circ - 100\angle 120^\circ}{1\angle 90^\circ}$

$i = 173.2\angle -60^\circ$

42. A differential equation $\frac{di}{dt} - 0.2i = 0$ is applicable over -10< t <10. If i(4) = 10, then i(-5) is ________.

Answer: 1.65

Exp: $\frac{di}{dt} - 0.2i = 0$

$(D - 0.2)\, i(t) = 0$

$D = 0.2$

$i(t) = K e^{0.2t}$

$t = 4;$

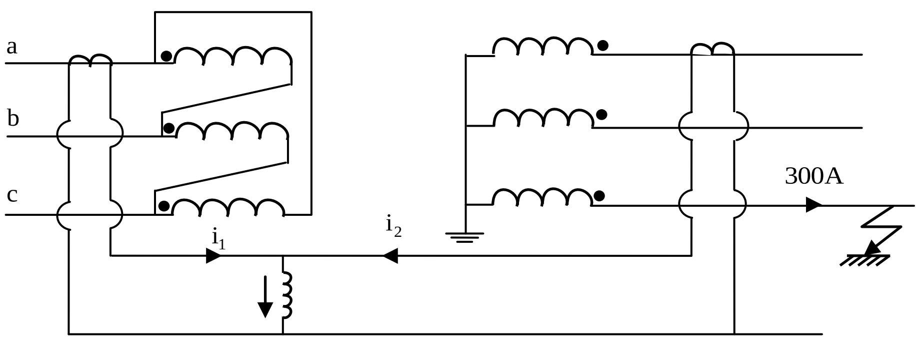
$10 = K e^{0.8}$

K=4.493

$\therefore i(-5) = 4.493 \times e^{-1}$

$i(-5) = 1.65$

43. A 3-phase transformer rated for 33 kV/11 kV is connected in delta/star as shown in figure. The current transformers (CTs) on low and high voltage sides have a ratio of 500/5. Find the currents i_1 and i_2, if the fault current is 300A as shown in figure.



(A) $i_1 = 1/\sqrt{3}A, i_2 = 0A$

(B) $i_1 = 0A, i_2 = 0A$

(C) $i_1 = 0A, i_2 = 1/\sqrt{3}A$

(D) $i_1 = 1/\sqrt{3}A, i_2 = 1/\sqrt{3}A$

Answer: (A)

Exp: $i_2 = 0$ since entire current flows through fault

Primary kVA = Secondary kVA

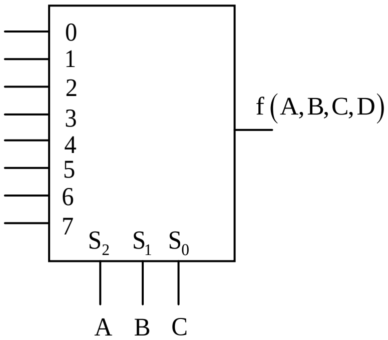
$$\sqrt{3}\times 33000\times I_L=\sqrt{3}\times 11000\times\left(300\times\frac{5}{500}\right)$$

$$I_L=1A$$

$$I_L=\sqrt{3}\,I_{Ph}$$

$$I_{ph}=i_1=\frac{1}{\sqrt{3}}A$$

44. A Boolean function f(A,B,C,D) = $\prod(1,5,12,15)$ is to be implemented using an 8×1 multiplexer (A is MSB). The inputs ABC are connected to the select inputs $S_2S_1S_0$ of the multiplexer respectively.



Which one of the following options gives the correct inputs to pins 0,1,2,3,4,5,6,7 in order?

(A) $D,0,D,0,0,0,\bar{D},D$

(B) $\bar{D},1,\bar{D},1,1,1,D,\bar{D}$

(C) $D,1,D,1,1,1,\bar{D},D$

(D) $\bar{D},0,\bar{D},0,0,0,D,\bar{D}$

Answer: (B)

Exp: Given maxterm $f(A,B,C,D)=\pi(1,5,12,15)$ so minterm

$$f(A,B,C,D)=\Sigma m(0,2,3,4,6,7,8,9,10,11,13,14)$$

	I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7
$\bar{D}(0)$	0	2	4	6	8	10	12	14
$D(1)$	1	3	5	7	9	11	13	15
	$\bar{D}$	1	$\bar{D}$	1	1	1	D	$\bar{D}$

45. The incremental costs (in Rupees/MWh) of operating two generating units are functions of their respective powers P_1 and P_2 in MW, and are given by

$$\frac{dC_1}{dP_1}=0.2P_1+50$$

$$\frac{dC_2}{dP_2}=0.24P_2+40$$

Where

$20MW \le P_1 \le 150\ MW$

$20MW \le P_2 \le 150MW$

For a certain load demand, P_1 and P_2 have been chosen such that dC_1/dP_1 = 76 Rs/MWh and dC_2/dP_2 = 68.8 Rs/MWh. If the generations are rescheduled to minimize the total cost, then P_2 is ______________.

Answer: 136.36

Exp: $\frac{dc_1}{dP_1} = 76 = 0.2P_1 + 50 \Rightarrow P_1 = 130$

$\frac{dc_2}{dP_2} = 68.8 = 0.24P_2 + 40 \Rightarrow P_2 = 120$

$\left.\right\} P_1 + P_2 = 250$

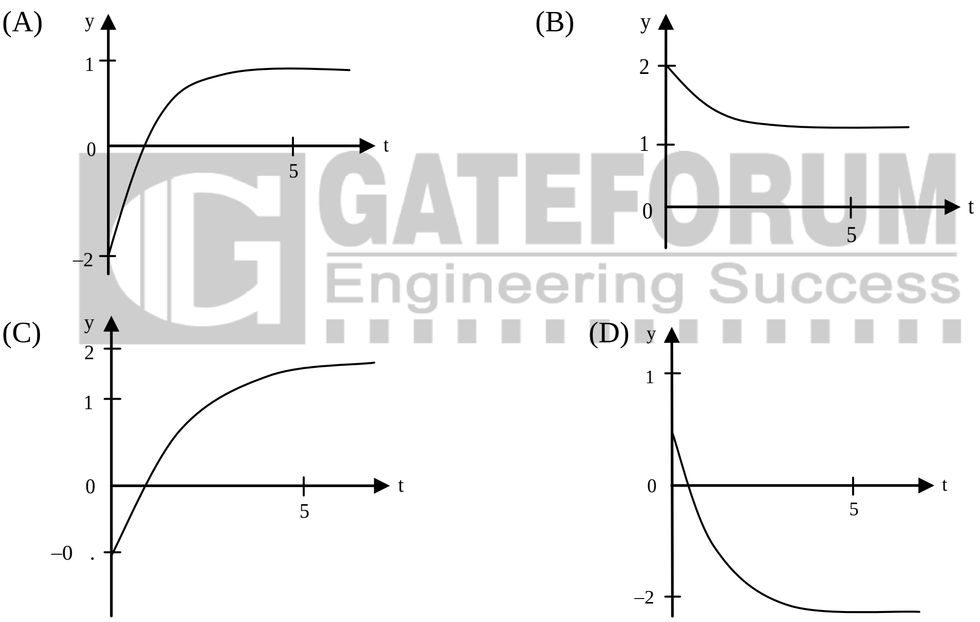
For total cost minimization, $\frac{dc_1}{dp_1} = \frac{dc_2}{dp_2}$

$0.2p_1 + 50 = 0.24p_2 + 40$

$0.2[250 - P_2] + 50 = 0.24P_2 + 40$

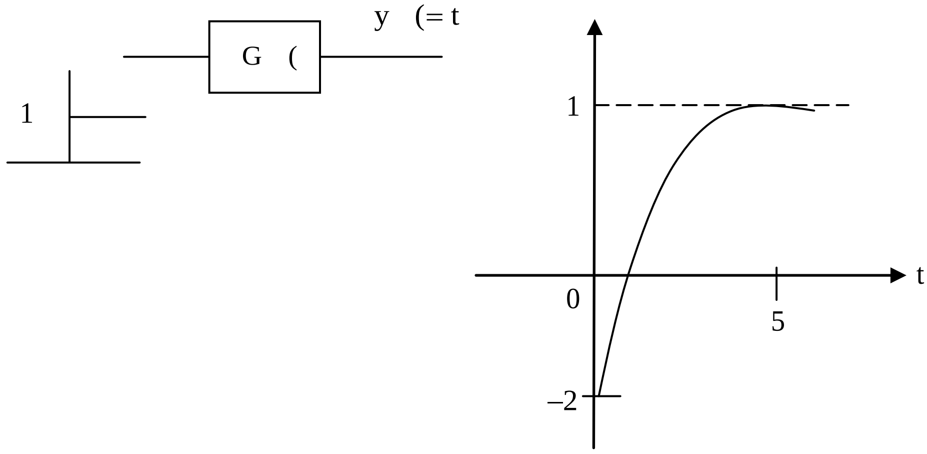
$P_2 = 136.36$

46. The unit step response of a system with the transfer function $G(s) = \frac{1-2s}{1+s}$ is given by which one of the following waveforms?



Answer: (A)

Exp:



$$Y(s) = G(s) \times U(s)$$

$$Y(s) = \frac{(1-2s)}{(1+s)} \cdot \frac{1}{s}$$

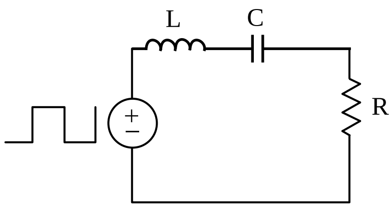
$$Y(s) = \frac{A}{(s)} + \frac{B}{(s+1)}$$

$$A = 1, B = -3$$

$$y(t) = u(t) - 3e^{-t}u(t)$$

$$y(t) = \left(1 - 3e^{-t}\right)u(t)$$

47. A symmetrical square wave of 50% duty cycle has amplitude of ±15V and time period of 0.4π ms. This square wave is applied across a series RLC circuit with R = 5Ω, L = 10 mH, and C = 4μF. The amplitude of the 5000 rad/s component of the capacitor voltage (in Volt) is __________.



Answer: 190.98

Exp: at $\omega_0 = \frac{2\pi}{T} = 5000 \text{rad/sec}$

$$V(t) = \frac{4 \times 15}{\pi} \sin \omega_0 t$$

at ω_0 circuit is under resonance

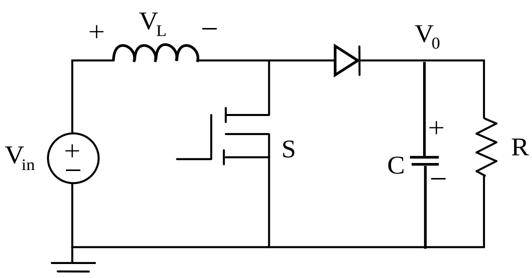
$$V_c = QV \angle -90$$

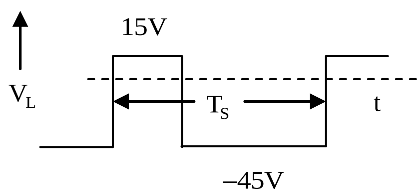
$$Q = \frac{\omega_0 L}{R} = \frac{5000 \times 10m}{5} = 10$$

$$V_c = \frac{10 \times 4 \times 15}{\pi} \angle -90$$

$$|V_c| = \frac{600}{\pi} = 190.98$$

48. For the switching converter shown in the following figure, assume steady-state operation. Also assume that the components are ideal, the inductor current is always positive and continuous and switching period is T_5. If the voltage V_L is as shown, the duty cycle of the switch S is _______.





Answer: 0.75

Exp: $V_S = 15V$

$V_S - V_0 = -45 \Rightarrow V_0 = V_S + 45 = 60V$

$V_0 = \frac{V_S}{1-D}$

$60 = \frac{15}{1-D} \Rightarrow D = 3/4 = 0.75$

49. With an armature voltage of 100V and rated field winding voltage, the speed of a separately excited DC motor driving a fan is 1000 rpm, and its armature current is 10A. The armature resistance is 1Ω. The load torque of the fan load is proportional to the square of the rotor speed. Neglecting rotational losses, the value of the armature voltage (in Volt) which will reduce the rotor speed to 500 rpm is ___________.

Answer: 47.5

Exp: For separately excided DC motor,

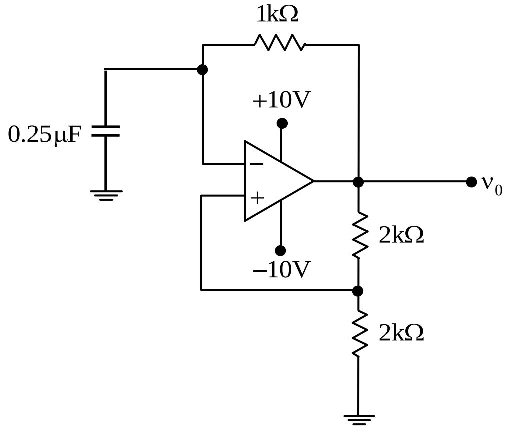
Torque = kI_a & $E=k\omega_m$.

For 1000 rpm, $E_1 = 100 - 10\times1 = 90V$; for 500 rpm, $E_2 = \frac{E_1}{2} = 45V$

$V = 45 + I_{a_2}R_a$, $\frac{I_{a1}}{I_{a2}} = \left(\frac{N_1}{N_2}\right)^2 \left[\because T \propto N^2\right] \Rightarrow Ia_2 = 10\times\left(\frac{500}{1000}\right)^2 = 2.5\text{ A}$

$\Rightarrow V = 45 + 2.5A_1 = 47.5$

50. The saturation voltage of the ideal op-amp shown below is ±10V. The output voltage v_0 of the following circuit in the steady-state is



(A) Square wave of period 0.55 ms
(B) Triangular wave of period 0.55 ms
(C) Square wave of period 0.25 ms
(D) Triangular wave of period 0.25 ms

Answer: (A)

Exp: Astable multivibrator produces square wave.

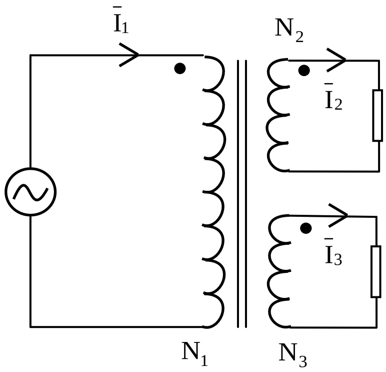
$\beta = \frac{R_2}{R_1 + R_2} = \frac{2}{4} = 0.5$

$$T = 2R_c \log\frac{(1+\beta)}{(1-\beta)} = 2\times1\times10^3\times0.25\times10^{-6}\times\log\left(\frac{1+0.5}{1-0.5}\right)$$

T= 0.55 ms

Square wave of period 0.55 ms.

51. A three-winding transformer is connected to an AC voltage source as shown in the figure. The number of turns are as follows: N_1 = 100, N_2 = 50. If the magnetizing current is neglected, and the currents in two windings are $\bar{I}_2 = 2\angle30°$ A and $\bar{I}_3 = 2\angle150°$ A, then what is the value of the current $\bar{I}_1$ in Ampere?



(A) $1\angle90°$ (B) $1\angle270°$ (C) $4\angle90°$ (D) $4\angle270°$

Answer: (A)

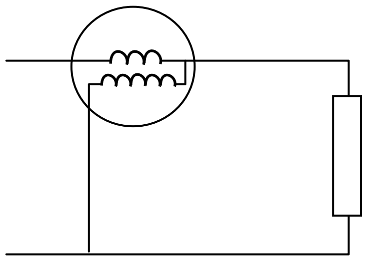
Exp: $I_1N_1 = I_2N_2 + I_3N_3$

$$I_1.100 = 2\angle30\times50 + 2\angle150\times50$$

$$\therefore I_1 = 1\angle30 + 1\angle150$$

$$= 1\angle90°$$

52. The coils of a wattmeter have resistances 0.01Ω and 1000Ω; their inductances may be neglected. The wattmeter is connected as shown in the figure, to measure the power consumed by a load, which draws 25A at power factor 0.8. The voltage across the load terminals is 30V. The percentage error on the wattmeter reading is _________.



Answer: 0.15

Exp: P_{load} = 30×25×08 = 600W

Wattmeter measures loss in pressure coil circuit

$$\text{loss in } P_c = \frac{V^2}{R_P} = \frac{30^2}{1000} = 0.9W$$

$$\text{error} = \frac{0.9}{600} \times 100 = 0.15\%$$

53. Consider a signal defined by

$$x(t) = \begin{cases} e^{j10t} & \text{for} |t| \le 1 \\ 0 & \text{for} |t| > 1 \end{cases}$$

Its Fourier Transform is

(A) $\frac{2\sin(\omega - 10)}{\omega - 10}$

(B) $\frac{2e^{j10}\sin(\omega - 10)}{\omega - 10}$

(C) $\frac{2\sin\omega}{\omega - 10}$

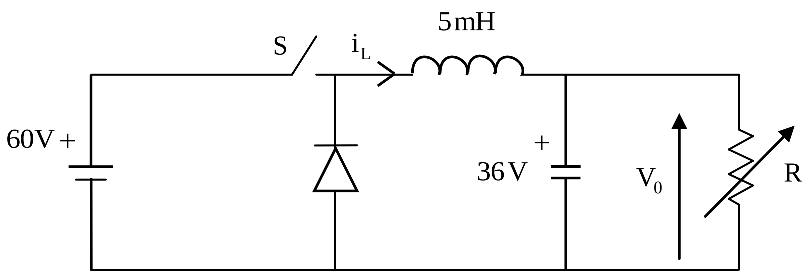
(D) $\frac{e^{j10\omega}2\sin\omega}{\omega}$

Answer: (A)

Exp: $X(\omega) = \int_{-1}^{1} e^{j10t}.e^{-j\omega t}dt = \int_{-1}^{1} e^{j(10-\omega)t}dt$

$$= \frac{e^{j(10-\omega)t}}{j(10-\omega)}\Bigg|_{-1}^{1} = \frac{2\sin(\omega - 10)}{(\omega - 10)}$$

54. A buck converter feeding a variable resistive load is shown in the figure. The switching frequency of the switch S is 100 kHz and the duty ratio is 0.6. The output voltage V_0 is 36V. Assume that all the components are ideal, and that the output voltage is ripple-free. The value of R (in Ohm) that will make the inductor current (i_L) just continuous is _________.



Answer: 2500

Exp: For Buck converter, for inductor current to be continuous,

$$R = \frac{2fL}{(1-D)} = \frac{2 \times 100 \times 10^3 \times 5 \times 10^{-3}}{1-0.6} = 2500$$

55. The following discrete-time equations result from the numerical integration of the differential equations of an un-damped simple harmonic oscillator with state variables x and y. The integration time step is h.

$$\frac{x_{k+1} - x_k}{h} = y_k$$

$$\frac{y_{k+1} - y_k}{h} = -x_k$$

For this discrete-time system, which one of the following statements is TRUE?

(A) The system is not stable for h>0

(B) The system is stable for $h > \frac{1}{\pi}$

(C) The system is stable for $0 < h < \frac{1}{2\pi}$

(D) The system is stable for $\frac{1}{2\pi} < h < \frac{1}{\pi}$

Answer: (A)