DETAILED SOLUTIONS

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ESE 2026 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 16

Section A : Electromagnetic Theory + Computer Fundamentals + Electrical Materials [All Topics]

Section B : Systems & Signal Processing + Communication Systems [All Topics]

Section C : BEE-2 + Analog Electronics-2 + Elec. & Electro. Measurements-2 [Part Syllabus]

ANSWER KEY

1. (c)	**16.** (c)	**31.** (c)	**46.** (a)	**61.** (b)
2. (a)	**17.** (d)	**32.** (b)	**47.** (b)	**62.** (b)
3. (c)	**18.** (c)	**33.** (d)	**48.** (a)	**63.** (d)
4. (a)	**19.** (c)	**34.** (a)	**49.** (b)	**64.** (b)
5. (c)	**20.** (b)	**35.** (a)	**50.** (a)	**65.** (c)
6. (a)	**21.** (c)	**36.** (b)	**51.** (b)	**66.** (c)
7. (c)	**22.** (a)	**37.** (d)	**52.** (b)	**67.** (b)
8. (b)	**23.** (d)	**38.** (c)	**53.** (c)	**68.** (c)
9. (c)	**24.** (b)	**39.** (d)	**54.** (c)	**69.** (c)
10. (d)	**25.** (a)	**40.** (a)	**55.** (b)	**70.** (a)
11. (b)	**26.** (a)	**41.** (c)	**56.** (c)	**71.** (d)
12. (d)	**27.** (b)	**42.** (c)	**57.** (c)	**72.** (c)
13. (c)	**28.** (c)	**43.** (c)	**58.** (d)	**73.** (a)
14. (a)	**29.** (d)	**44.** (c)	**59.** (a)	**74.** (a)
15. (b)	**30.** (d)	**45.** (a)	**60.** (b)	**75.** (b)

DETAILED EXPLANATIONS
Section A : Electromagnetic Theory + Computer Fundamentals + Electrical Materials

1. (c)

$$D_n = \rho_s = 2 \text{ nC/m}^2$$

$$\vec{D} = 2\hat{a}_y \text{ nC/m}^2$$

For $y > 0$,
$$\vec{E} = \frac{\vec{D}}{\epsilon_0 \epsilon_r} = \frac{2\times 10^{-9}}{\frac{10^{-9}}{36\pi}\times 4} = 18\pi \hat{a}_y \text{ V/m}$$

For $y < 0$,
$$\vec{E} = 0$$

2. (a)

$$\nabla\times\vec{A} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ (y + z\cos xz) & x & (x\cos xz) \end{vmatrix}$$

$$= (0)\hat{a}_x - (\cos xz - xz\sin xz - \cos xz - xz\sin xz)\hat{a}_y + (1-1)\hat{a}_z$$

$$\nabla\times\vec{A} = 0 \Rightarrow \text{Irrotaional or conservative}$$

$$\nabla\cdot\vec{A} = -z^2 \sin xz - x^2 \sin xz \neq 0$$

Here, $\vec{A}$ is only conservative field but not solenoidal.

3. (c)

$$|\vec{H}| = \frac{I}{2\pi\rho}$$

$$2 = \frac{K\pi}{2\pi\times 2}$$

$$8\pi = K\pi$$

$$K = 8$$

4. (a)

$$\nabla\times\vec{E} = \frac{-\partial\vec{B}}{\partial t}$$

6. (a)

$$\nabla\cdot\vec{A} = 2xz - 6y^2z^2 + Kxy^2$$

$$\nabla\cdot\vec{A}\Big|_{(1,-1,1)} = 2 - 6 + K = K - 4$$

$$K - 4 = -5$$

$$K = -1$$

7. (c)

According to Gauss law,

$$\nabla \cdot \vec{D} = \rho_v$$

$$\Rightarrow \quad \nabla \cdot \vec{D} = \frac{\partial}{\partial x}(3y^2 + 4z) + \frac{\partial}{\partial y}(2xy) + \frac{\partial}{\partial z}(4x)$$

$$\Rightarrow \quad 2x = \rho_v$$

Total charge,

$$Q = \int \rho_v \, dV = \int_0^2 \int_0^1 \int_{-1}^1 2x \, dx \, dy \, dz$$

$$= \left(x^2\right)_0^2 \times 1 \times 2 = 4 \times 1 \times 2 = 8 \text{ C}$$

8. (b)

$$H_{centre} = \frac{I}{2a} \qquad (a = \text{radius})$$

$$|\vec{H}| = \frac{2}{2 \times \frac{1}{2}} = 2 \text{ A/m}$$

9. (c)

The magnitude of magnetic flux density at a distance 'R' due to infinite current filament is,

$$B = \frac{\mu I}{2\pi R}$$

11. (b)

Since,

1. $$\vec{r} \cdot (\nabla \times \vec{r}) = \vec{r} \cdot \left[\left(\frac{\partial z}{\partial y} - \frac{\partial y}{\partial z}\right)\hat{a}_x + \left(\frac{\partial x}{\partial z} - \frac{\partial z}{\partial x}\right)\hat{a}_y + \left(\frac{\partial y}{\partial x} - \frac{\partial x}{\partial y}\right)\hat{a}_z\right]$$

$$= x\left(\frac{\partial z}{\partial y} - \frac{\partial y}{\partial z}\right) + y\left(\frac{\partial x}{\partial z} - \frac{\partial z}{\partial x}\right) + z\left(\frac{\partial y}{\partial x} - \frac{\partial x}{\partial y}\right) \neq 0$$

2. $$\nabla \cdot \vec{r} = \left(\frac{\partial}{\partial x}\hat{a}_x + \frac{\partial}{\partial y}\hat{a}_y + \frac{\partial}{\partial z}\hat{a}_z\right)\left(x\hat{a}_x + y\hat{a}_y + z\hat{a}_z\right)$$

$$= \frac{\partial x}{\partial x} + \frac{\partial y}{\partial y} + \frac{\partial z}{\partial z} = 3$$

3. $$\nabla(\vec{r} \cdot \vec{r}) = \nabla(x^2 + y^2 + z^2)$$

$$= 2x\,\hat{a}_x + 2y\,\hat{a}_y + 2z\,\hat{a}_z = 2\vec{r}$$

4. $$\nabla \cdot (\nabla \times \vec{r}) = \frac{\partial z}{\partial x \partial y} - \frac{\partial y}{\partial x \partial z} + \frac{\partial x}{\partial z \partial y} - \frac{\partial z}{\partial x \partial y} + \frac{\partial y}{\partial x \partial z} - \frac{\partial x}{\partial y \partial z} = 0$$

Hence, statement 2, 3 and 4 are correct.

12. (d)

Potential at centre of a ring is given by,

$$V = \frac{Q}{4\pi\varepsilon_0 R};$$

Where 'R' is the radius of a ring

Net potential, $$V = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{1} - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} \ldots\right]$$

$$= \frac{Q}{4\pi\varepsilon_0}\left[\left\{1 + \frac{1}{4} + \frac{1}{16} + \ldots\right\} - \left\{\frac{1}{2} + \frac{1}{8} + \ldots\right\}\right]$$

Using geometric progression sum:

We get, $$S_1 = 1 + \frac{1}{4} + \frac{1}{16} + \ldots$$

$$= \frac{1}{1 - \frac{1}{4}} = \frac{4}{3}$$

and $$S_2 = \frac{1}{2} + \frac{1}{8} + \ldots$$

$$= \frac{1/2}{1 - \frac{1}{4}} = \frac{2}{3}$$

Now, net potential, $$V = \frac{Q}{4\pi\varepsilon_0}\left[\frac{4}{3} - \frac{2}{3}\right] = \frac{Q}{6\pi\varepsilon_0}$$

13. (c)

The force per unit area on the capacitor plate,

$$F = \frac{\rho_s^2}{2\varepsilon_0}\ \text{N/m}^2$$

Now, total force, $$F = \frac{Q^2}{2\varepsilon_0 A^2} \times A$$

$$F = \frac{Q^2}{2\varepsilon_0 A}\text{N}$$

Therefore option (c) is correct.

14. (a)

The expression for force per meter length is,

$$F = \frac{\mu_0 I_1 I_2}{2\pi D}$$

Where, $I_1 = I_2 = 40$ A

distance, $D = 5 \times 10^{-2}$

$$F = 2 \times 10^{-7} \times \frac{40 \times 40}{5 \times 10^{-2}} = 6.4 \times 10^{-3} \text{ N}$$

The direction of force will be repulsive in nature, (as both wires carrying current in opposite direction)

Then, $F = -6.4 \times 10^{-3}$ N

15. (b)

The identify; Div Curl $F = 0$

If Div $G = 0$, then the vector G is expressible as Curl of another vector.

16. (c)

32 bit

Opcode	Reg	Reg	Mem	Immediate
6 bit	$\log_2 32$	$\log_2 32$	$\log_2 1K$	6 bit
	↓	↓	↓	
	5 bit	5 bit	10 bit	

Unsigned constant = $(2^6 - 1) = 63$

17. (d)

Gantt chart:

	P_1	P_2	P_3	P_4	P_3	P_4	P_3	P_4	P_2	P_3	P_4	P_2	P_3	P_4	P_1	P_2	P_3	P_4

0 1 2 3 4 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Process	Arrival Time	Burst Time	C.T.	TAT
P_1	1	2	18	17
P_2	2	4	19	17
P_3	3	6	20	17
P_4	4	8	21	17
				Average TAT = 68/4 = 17

18. (c)

I_8: ACC → MBR

I_2: IR [Add] → MAR

I_7: MBR → M[MAR]

19. (c)

Since address is of 16-bit. So skip 2 Bytes

In PC-relative mode:

Effective address = Address field value (ACC) + PC

= 300 + 102 = 402

21. (c)

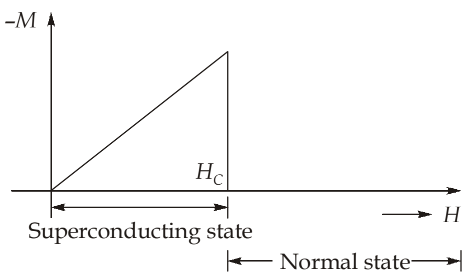
In indexed addressing mode effective address is calculated by adding indexed value to the register content.

In relative addressing mode effective address is calculated by adding relative value (difference between first address and last address) to the register content.

In based addressing mode effective address is calculated by adding constant value to the base register content.

22. (a)

For type-I super conductor the change of state from superconducting state to normal state and vice-versa is abrupt.



23. (d)

An object whose storage class is auto, is reinitialized at every function call whereas an object whose storage class static persist its value between different function calls.

When the function fun ( ) is called for the first time, value of *i* and j are printed and sequentially incremented. During the second function call, *i* retains its incremented value whereas j is reinitialized, hence *i* will print 2 and j will print 5 again. The same will happen at third function call, *i* will print 3 and j will print 5.

24. (b)

Diamagnetic materials has small and negative value of magnetic susceptibility.

25. (a)

Electrons in valence bands are not capable to gain energy from external electric field.

26. (a)

- Polarization of a pyroelectric material changes on heating.
- Every pyroelectric material is piezoelectric material but converse is not true.

27. (b)

Let the distance between point P_1 and P_2 be x.

$$dV = -E \cdot dl \Rightarrow 8$$

$$= -(40\hat{a}_x)\cdot(-x\,\hat{a}_x)$$

$$8 = 40x$$

$$x = \frac{8}{40} = 0.2 \text{ i.e. } 20 \text{ cm}$$

$$\frac{dW}{dq} = dV$$

If it is a unit charge then work done = potential difference

Work done in bringing unit charge from P_2 to P_1 = 8 J

28. (c)

Force on a current carrying conductor

$$\vec{F} = I(\vec{L} \times \vec{B}) = 20[4\hat{z} \times 0.1(\hat{y} - \hat{x})]$$

$$= 20[0.4\hat{z} \times (\hat{y} - \hat{x})]$$

$$= 20[0.4(-\hat{x} - \hat{y})] = -8(\hat{x} + \hat{y})$$

∴ Force per unit length $= \dfrac{-8(\hat{x} + \hat{y})}{4} = -2(\hat{x} + \hat{y})\text{N/m}$

29. (d)

According to Snell's law, the permeabilities of the two media are related as

$$\mu_0 \tan \theta_1 = \mu \tan \theta_2$$

$$\tan \theta_1 = 15 \tan \theta_2 \quad \text{...(i)}$$

Now, the given flux density in medium 2 is

$$\overrightarrow{B_2} = 1.2\hat{a}_y + 0.8\hat{a}_z$$

Thus, the normal and tangential components of the magnetic flux density in medium 2 are:

$$\overrightarrow{B_{2n}} = 0.8\hat{a}_z$$

$$\overrightarrow{B_{2t}} = 1.2\hat{a}_y$$

From the above figure, we have:

$$\tan \theta_2 = \frac{B_{2n}}{B_{2t}} = \frac{0.8}{1.2} = \frac{2}{3}$$

or, $$\theta_2 = \tan^{-1}\left(\frac{2}{3}\right)$$

From equation (1):

$$\tan \theta_1 = 15 \tan \theta_2$$

$$\tan \theta_1 = 15 \times \frac{2}{3}$$

$$\theta_1 = \tan^{-1}(10)$$

Thus, the angular deflection is

$$\theta_1 - \theta_2 = \tan^{-1}(10) - \tan^{-1}\left(\frac{2}{3}\right)$$

30. (d)

Electric field, $\vec{E} = -\nabla V$

So,
$$\vec{E} = -\left[\frac{\partial V}{\partial r}\hat{a}_r + \frac{1}{r}\frac{\partial V}{\partial \theta}\hat{a}_\theta + \frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}\hat{a}_\phi\right]$$

$$\vec{E} = -\left[20\sin\theta\cos\phi\frac{\partial}{\partial r}(r^{-2})\hat{a}_r + \frac{1}{r}\frac{20}{r^2}\cos\phi\frac{\partial}{\partial\theta}(\sin\theta)\hat{a}_\theta\right.$$
$$\left. + \frac{1}{r\sin\theta}\frac{20}{r^2}\sin\theta\frac{\partial}{\partial\phi}(\cos\phi)\hat{a}_\phi\right]$$

$$\vec{E} = -\left[20\sin\theta\cos\phi\left(\frac{-2}{r^3}\right)\hat{a}_r + \frac{20}{r^3}\cos\phi\cos\theta\hat{a}_\theta + \frac{20}{r^3}(-\sin\phi)\hat{a}_\phi\right]$$

$$\vec{E}\Big|_{\left(2,\frac{\pi}{2},0\right)} = -\left[20\sin\frac{\pi}{2}\cos 0^\circ\left(\frac{-2}{8}\right)\hat{a}_r + \frac{20}{8}\cos 0^\circ\cos\frac{\pi}{2}\hat{a}_\theta + \frac{20}{8}\left(-\sin(0^\circ)\hat{a}_\phi\right)\right]$$

$$\vec{E} = -\left[20\times\left(\frac{-1}{4}\right)\hat{a}_r + 0 + 0\right] = 5\hat{a}_r \text{ V/m}$$

31. (c)

Divergence of a vector $= \bar{\nabla}\cdot\bar{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$

$$\bar{\nabla}\cdot\bar{A} = \frac{\partial}{\partial x}(4xy) + \frac{\partial}{\partial y}(xz) + \frac{\partial}{\partial z}(xyz) = 4y + xy$$

At point, $P(1, -2, 3)$

$$\bar{\nabla}\cdot\bar{A} = 4(-2) + (1)(-2)$$
$$= -8 - 2 = -10$$

33. (d)

4	5	6	6	6
3	3	3	3	3
2	2	2	2	2
1	1	1	7	1

4 + 1 + 1 + 1 + 1 = 8

34. (a)

It is transferring 16000 bits in 1 second.

1 character takes 500 micro seconds.

∴ Processor accesses main memory in every micro second.

∴ $\frac{1}{500}\times 100\% = 0.2\%$

35. (a)

$$\log_2 (205) \approx 8$$
$$\log_2 (128) = 7$$

Opcode (8)	Destination (7)	Source (7)	Immediate (10)

← 32 →

$\therefore$ 10 bits required for immediate field.

37. (d)

All given statements are correct.

38. (c)

Atomic packing fraction for face centre cubic structure : $\dfrac{4 \times \text{Volume of atom}}{\text{Volume of cube}}$

For face centered cube

No. of atoms per unit cell:

$$\frac{1}{8} \times 8 + 6 \times \frac{1}{2} = 4$$

For face centered cubic system,

$$4r = a\sqrt{2}$$

Where r is atomic radius and a is cube side length

$$r = \frac{a\sqrt{2}}{4} = \frac{a}{2\sqrt{2}}$$

$$\therefore \text{ Atomic packing fraction} = \frac{4 \times \frac{4}{3}\pi\left(\frac{a}{2\sqrt{2}}\right)^3}{a^3} = 4 \times \frac{4}{3}\pi \times \frac{a^3}{8 \times 2\sqrt{2}\, a^3} = \frac{\pi}{3\sqrt{2}}$$

39. (d)

Power loss in dielectric, $P_L = (2\pi \epsilon_0) E^2 (A \cdot d) f \epsilon_r' \tan\delta$

So, $P_L \propto E^2$

$\therefore$ Option (d) is correct.

40. (a)

Using conductivity equation,

$$\tan \theta_H = \mu B$$

Where, μ = mobility

B = magnetic flux density

$\therefore$ Hall angle, $\theta_H = \tan^{-1} (\mu B)$

41. (c)

Ionic and electronic polarization both are possible in ionic solid dielectrics.

42. (c)

- Entropy of material at superconducting state is minimum.
- Perfect diamagnetism and zero resistivity are two independent properties of super conducting state, and Meissner effect is not due to zero resistance state in superconductor.

43. (c)

Ferrites have low dielectric loss and low saturation magnetization compared to ferromagnetic materials.

44. (c)

The imaginary part of the dielectric constant is a measure of the dielectric loss in the substance.

45. (a)

Both the statements are correct and statement-II is correct explanation of statement-I.

Section B : Systems & Signal Processing + Communication Systems

46. (a)

Both statements are correct.

47. (b)

$$y(t) = x(t) * h(t)$$

$$z(t) = \frac{d}{dt}y(t)$$

Using convolution property

$$\frac{dy(t)}{dt} = \frac{d}{dt}[x(t)*h(t)] = \left[\frac{d}{dt}x(t)*h(t)\right]$$

$$= 2\delta(t+2) * r(t-1)$$

$$= 2r(t+2-1)$$

$$= 2r(t+1)$$

48. (a)

Given, $$x(t) = \cos^2 2t\, u(t) = \left(\frac{1+\cos 4t}{2}\right)u(t)$$

$\therefore$ $$L[x(t)] = X(s)$$

$$= L\left[\left(\frac{1+\cos 4t}{2}\right)u(t)\right] = \frac{1}{2}L[u(t)] + L[(\cos 4t\, u(t)]$$

$$= \frac{1}{2}\left[\frac{1}{s} + \frac{s}{s^2+4^2}\right] = \frac{1}{2}\left[\frac{2s^2+16}{s(s^2+16)}\right]$$

49. (b)

Differentiating $y(z)$:

$$\frac{dY(z)}{dz} = \frac{1\times a}{(1-az^{-1})}\cdot z^{-2}$$

Multiplying with z:

$$-\frac{z\,dY(z)}{dz} = -\frac{a\cdot z^{-2}\cdot z}{(1-az^{-1})}$$

Let, $$X(z) = \frac{1}{1-az^{-1}}$$

$$x[n] = a^n\ u[n]$$

$$-\frac{z\,dY(z)}{dz} = -az^{-1}\ X[z]\ ; \qquad |z| > a$$

IZT:

$$ny[n] = -ax\ [n-1]; \qquad |z| > a$$

$$y(n) = \frac{-a}{n}(a)^{n-1}\cdot u[n-1]$$

$\Rightarrow$ $$y[n] = \frac{-(a)^n u[n-1]}{n}$$

50. (a)

The Z-transform of the sequence

$x(n) = \alpha^n\ u(n)$ is given by,

$$X(z) = \frac{Z}{Z-\alpha};\text{ROC};|Z| > |\alpha|$$

Using the time shifting property of Z-transform, we have

$$Z[x(n-m)] = Z^{-m}\ X(z)$$

In the same way.

$$Z[\alpha^{n-2}\ u(n-2)] = z^{-2}Z\left[\alpha^n u(n)\right] = \frac{z^{-2}\cdot z}{z-\alpha} = \frac{1}{Z(Z-\alpha)};\ \text{ROC};|Z| > |\alpha|$$

51. (b)

For signal $g_1(t)$

$$\text{Energy, } E_1 = \int_{-\infty}^{\infty}|g_1(t)|^2\,dt = \int_{-2}^{2}25dt = 100$$

$$\text{Average power, } P_1 = \lim_{T\to\infty}\frac{1}{T}E_1 = 0$$

Since, $g_1(t)$ has finite energy, it's energy signal.

For signal $g_2(t)$,

$$\text{Energy, } E_2 = \int_{-\infty}^{\infty} |g_2(t)|^2\, dt = \infty$$

$$\text{Average power, } P_2 = \frac{1}{8}\int_{-4}^{4} |g_2(t)|^2\, dt = \frac{1}{2}\int_{-2}^{2} 25dt = 12.5$$

$g_2(t)$ has finite power and infinite energy hence $g_2(t)$ is power signal.

Alternatively:

Mostly periodic signals are power signals and non-periodic signals are considered as energy signals.

52. (b)

According to Dirichlet conditions $\int_0^T |x(t)| \cdot dt < \infty$

53. (c)

Slope overload distortion will occur if

$$\frac{\partial m(t)}{\partial t} > \frac{\delta}{T_s}$$

$$a > \frac{\delta}{T_s}$$

$$\delta < aT_s$$

54. (c)

Given, $$x(t) = 6\cos\frac{8t}{3} - 2\sin\frac{9t}{4}$$

$$T_1 = \frac{2\pi}{8/3} = \frac{3\pi}{4}$$

$$T_2 = \frac{2\pi}{9/4} = \frac{8\pi}{9}$$

$$\frac{T_1}{T_2} = \frac{3\pi}{4}\times\frac{9}{8\pi} = \frac{27}{32}$$

$$T_0 = 32T_1 = 27T_2 = 24\pi$$

$$\omega_0 = \frac{2\pi}{T_0} = \frac{1}{12}$$

$$x(t) = 6\cos(32\omega_0 t) - 2\sin(27\omega_0 t) \quad \text{...(i)}$$

The generalized trigonometric Fourier series expansion is

$$x(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + b_n \sin(n\omega_0 t) \quad \text{...(ii)}$$

By comparing equation (i) and (ii),

$$\therefore \quad a_{32} = 6$$

$$b_{27} = -2$$

55. (b)

Exponential Fourier series expansion of $x(t)$ is

$$x(t) = \sum_{n=-\infty}^{\infty} X_n e^{jn\omega_0 t}$$

Where X_n is exponential Fourier series coefficient

$$\therefore \quad x(t) = \sum_{n=-1,-3}^{1,3}$$

$$\omega_0 = \frac{2\pi}{T} = \frac{2\pi}{8} = \frac{\pi}{4} = \left(X_1 e^{j\frac{\pi}{4}t} + X_{-1} e^{-j\frac{\pi}{4}t}\right) + \left(X_3 e^{j\frac{3\pi}{4}t} + X_{-3} e^{-j\frac{3\pi}{4}t}\right)$$

$$= 2\left(e^{j\frac{\pi}{4}t} + e^{-j\frac{\pi}{4}t}\right) + 4\left(e^{j\frac{3\pi}{4}t} - e^{-j\frac{3\pi}{4}t}\right)$$

$$= 4\cos\frac{\pi t}{4} + (-8)\sin\frac{3\pi}{4}t$$

$$\therefore \quad x(t) = 4\cos\frac{\pi t}{4} - 8\sin\frac{3\pi t}{4}$$

56. (c)

Convolution in time domain is equal to multiplication in s-domain

$$LT[X_1(t) * X_2(t)] = X_1(s)\, X_2(s)$$

$$= \left(\frac{3}{s^2+9}\right)\left(\frac{s}{s^2+4}\right)$$

$$= \frac{\frac{3}{5}s}{s^2+4} - \frac{\frac{3}{5}s}{s^2+9}$$

Apply inverse Laplace transform

$$y(t) = x_1(t) * x_2(t)$$

$$= \frac{3}{5}\cos 2t\, u(t) - \frac{3}{5}\cos 3t\, u(t)$$

$$y(\pi) = \frac{3}{5}\cos(2\pi)u(\pi) - \frac{3}{5}\cos(3\pi)u(\pi)$$

$$= \frac{3}{5} + \frac{3}{5} = \frac{6}{5} = 1.2$$

57. (c)

By Carson's rule,

$$\begin{aligned} BW &= 2(\Delta f + f_m) \\ &= 2(50 + 0.5) \\ &= 101 \text{ kHz} \end{aligned}$$

58. (d)

$$SQNP = \frac{3}{2}2^{2n}$$

Given, $n_1 = n,$

$n_2 = n + 1$

$$(SQNR)_1 = \frac{3}{2}2^{2n}$$

$$(SQNR)_2 = \frac{3}{2}2^{2(n+1)} = \frac{3}{2}2^{2n+2} = \frac{3}{2}\cdot 2^{2n}\cdot 2^2$$

So, $$\frac{(SQNR)_1}{(SQNR)_2} = \frac{2^2}{1} = 4$$

So, improvement in SQNR is independent of 'n'.

59. (a)

The function for the given waveform is,

$$f(t) = tu(t) - (t-1)u(t-1) - 3u(t-1) + 2u(t-2)$$

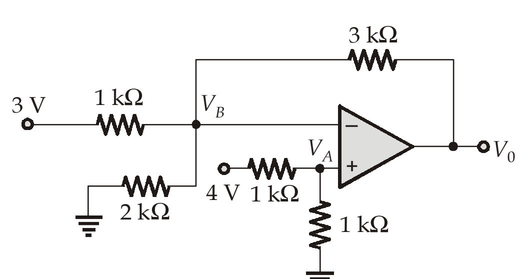
$$L\{f(t)\} = \int_0^\infty f(t)e^{-st}\cdot dt = \frac{1}{s^2} - \frac{e^{-s}}{s^2} - \frac{3e^{-s}}{s} + \frac{2e^{-2s}}{s}$$

$$= \frac{1 - e^{-s} - 3se^{-s} + 2se^{-2s}}{s^2}$$

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

Section C : BEE-2 + Analog Electronics-2 + Elec. & Electro. Measurements-2

61. (b)



From virtual short, $V_B = V_A$

$$V_A = \frac{1\text{ k}\Omega}{1\text{ k}\Omega + 1\text{ k}\Omega} \times 4\text{ V} = 2\text{ V}$$

By writing KCL at inverting terminal, we get,

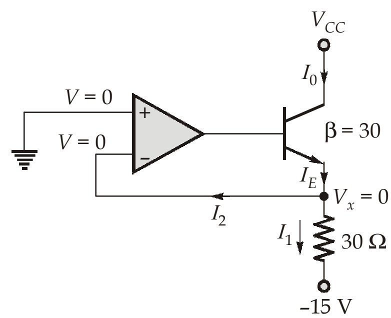
$$\frac{V_B - 3\text{ V}}{1\text{ k}\Omega} + \frac{V_B}{2\text{ k}\Omega} + \frac{V_B - V_0}{3\text{ k}\Omega} = 0$$

$$6[2\text{ V} - 3\text{ V}] + 3(2\text{ V}) + 2(2\text{ V} - V_0) = 0$$

$$2V_0 = -6\text{ V} + 6\text{ V} + 4\text{ V} = 4\text{ V}$$

$$V_0 = 2\text{ V}$$

62. (b)



Now, $I_1 = \frac{0-(-15)}{30} = 0.5\text{ A}$

Applying KCL at node V_x, $I_E = I_1 + I_2$

Since $I_2 = 0$

$$I_E = I_1$$

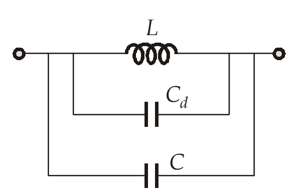
$$I_0 = I_C = \frac{\beta}{\beta+1} I_E = \frac{30}{31} \times 0.5 = 0.483\text{ A}$$

63. (d)

Both given statements are correct.

64. (b)

Let the self distributed capacitance be C_d



$\therefore$ Resonance frequency, $f_0 = \frac{1}{2\pi\sqrt{L(C + C_d)}}$

Given, $f_1 = 4$ MHz;

$$C_1 = 400\text{ pF}$$

$$f_2 = 8\text{ MHz}$$

$$C_2 = 80\text{ pF}$$

$$f_1 = \frac{1}{2\pi\sqrt{L(C_1 + C_d)}};$$

and $$f_2 = \frac{1}{2\pi\sqrt{L(C_2 + C_d)}}$$

so, $$\frac{f_2}{f_1} = \sqrt{\frac{C_1 + C_d}{C_2 + C_d}}$$

$$\frac{8}{4} = \sqrt{\frac{400 + C_d}{80 + C_d}}$$

$$4 = \frac{400 + C_d}{80 + C_d}$$

$$80 + C_d = 100 + \frac{C_d}{4}$$

$$3\frac{C_d}{4} = 20$$

$$C_d = \frac{80}{3}\text{pF} = 26.67 \text{ pF}$$

65. (c)

In CE amplifier voltage gain and current gain both are high.

66. (c)

The given circuit is a Astable multivibrator so the output is a square wave. Due to zener diodes the output will not be able to go beyond 6 V. Here $V_{UT} = V_{LT} = 3$ V, so it is a square wave of 50% duty cycle $\frac{T}{2} = RC\ln\left(\frac{1+\beta}{1-\beta}\right)$

Where $$\beta = \frac{R_2}{R_1 + R_2} = 0.5$$

$$T = 2RC\ln\left(\frac{1+0.5}{1-0.5}\right)$$

$$T = 2 \times 10 \times 10^3 \times 10 \times 10^{-6} \times \ln(3)$$

$$T \approx 220 \text{ msec}$$

67. (b)

Deflection sensitivity, $$S = \frac{Ll_d}{2dE_a} = \frac{0.5 \times 1.5 \times 10^{-2}}{2 \times 5 \times 10^{-3} \times 2000} = 0.375 \text{ mm/V}$$

Deflection factor, $$G = \frac{1}{S} = \frac{1}{0.375} = 2.66 \text{ V/mm}$$

68. (c)

0.5 percent of reading $= 0.005 \times 5.00$

$= 0.025$ V

The display for 5.00 reading on 10 V scale of $3\frac{1}{2}$ digit meter is 05.00 as there are four digit positions. The digit in the LSD has a value 0.01 V

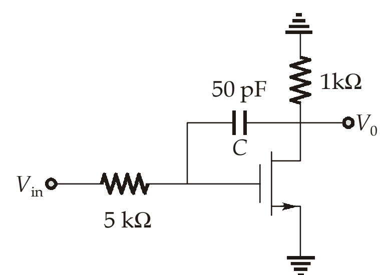
$\therefore$ Total possible error = 0.025 + 0.01 = 0.035 V

69. (c)

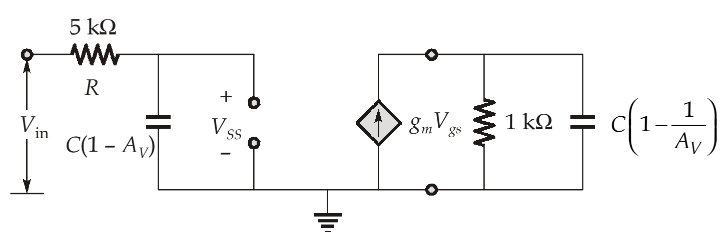
- Loaded voltage gain of an amplifier is always less than the no-load gain.
- Smaller the internal resistance of the signal source, greater is the overall gain.

70. (a)

With respect to AC



Taking Miller's equivalent and assume $r_0 = \infty$



$$A_V = -g_m R_D = -0.01 \times 10^3 = -10$$

Small signal input pole frequency,

$$f = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 5 \times 10^3 \times 50 \times 10^{-12}(1+10)} = 57.87 \text{ kHz}$$

71. (d)

Deflection sensitivity, $S = \frac{D}{E_d} = \frac{Ll_d}{2dE_a}$

$\therefore$ No relation between sensitivity and deflection voltage.

73. (a)

The operating point always depends on transistor parameters and transistor parameters varies with temperature so the operating point also changes with temperature. so (a) is correct.

Main effect is due to reverse saturation current which doubles for every 10°C rise in temperature.

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