ESE 2025
Prelims Solutions

Electrical Engineering

Set-C

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1. Which one of the following commutated converters is working on the principle of natural commutation?
   (a) Series-parallel commutated converter
   (b) Series commutated converter
   (c) Parallel commutated converter
   (d) Line commutated converter

Ans. (d)

End of Solution

2. In a single-phase full-wave controlled rectifier circuit with midpoint configuration, two SCRs (M-2) and
   (a) an autotransformer with centre-tapped secondary windings are employed
   (b) a three-phase transformer with centre-tapped secondary windings are employed
   (c) a single-phase transformer with centre-tapped secondary windings are employed
   (d) a central tapping transformer with secondary windings are employed

Ans. (c)

End of Solution

3. The reverse recovery current of a power diode is 10 μs and the rate of fall of current is about 200 A/μs. What is the storage charge?
   (a) 10 mC (b) 100 mC
   (c) 400 mC (d) 40 mC

Ans. (a)

$$Q_R = \frac{1}{2} \times I_{Rm} \times t_{rr} = \frac{1}{2} \times 2000 \times 10\,\mu s = 10\ mC$$

End of Solution

4. The advantageous feature of AC drives with a current source DC link converter is
   (a) speed setting range up to 1 : 100
   (b) high degree of motor protection
   (c) reduced costs
   (d) control structure more simple

Ans. (b)

End of Solution

5. When an AC main is ON, the rectifier circuit will supply the power to the inverter as well as to the battery, therefore, it acts as a
   (a) UPS system (b) power conditioner
   (c) static switch (d) rectifier cum charger

Ans. (d)

End of Solution

6. Based on the use of resonant tank, the resonant converters are classified as
1. resonant DC link converters
2. resonant AC link converters
3. resonant switch converters
4. load resonant converters

Select the correct answer.

(a) 1, 2, 3 and 4 (b) 1, 2 and 3 only
(c) 1, 2 and 4 only (d) 2, 3 and 4 only

Ans. (a)

End of Solution

7. If resonant elements are added to the DC-DC converters, then the resulting converters are known as

(a) semiconductor devices (b) resonant switch converters
(c) component inductances (d) multi-resonant switches

Ans. (b)

End of Solution

8. The resonant technique processes power in sinusoidal form. The power switches are often turned off under

(a) minimum current (b) zero current
(c) high current (d) device current

Ans. (b)

End of Solution

9. DC to DC converters basically consist of two conversion stages, namely
(a) DC to AC resonant inverters and AC to DC rectifier
(b) AC to DC resonant inverters and DC to AC rectifier
(c) DC to AC converters and AC to DC rectifier
(d) AC to DC converters and DC to AC rectifier

Ans. (a)

End of Solution

DIRECTIONS: Each of the following SIX (06) items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
(c) Statement (I) is true but Statement (II) is false
(d) Statement (I) is false but Statement (II) is true

10. **Statement (I):** If the capacitance of an overhead line is high, the line draws more charging current, which compensates or cancels the lagging component of load current.
Statement (II): The resultant current flowing in the line is reduced.

Ans. (a)

End of Solution

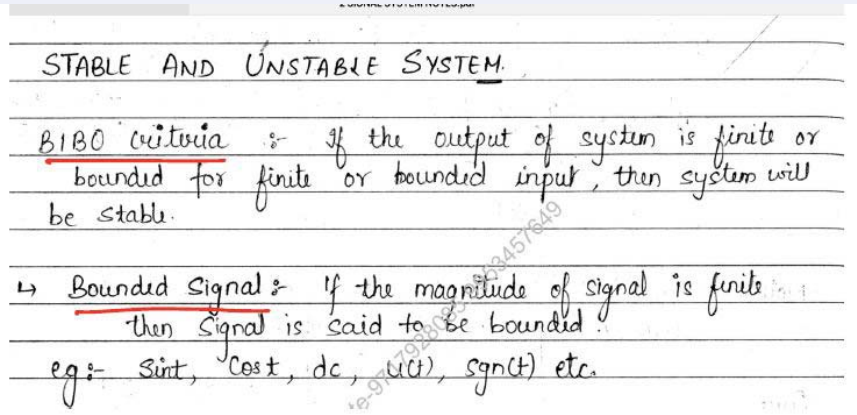
11. **Statement (I):** Voltage control and reactive power control are interrelated and need to be considered together.
Statement (II): The voltage variation at a load is an indication of the unbalance between the reactive power generated and absorbed by that load.

Ans. (b)

End of Solution

12. **Statement (I):** BIBO stands for Bounded Input Bounded Output. The meaning of the word 'bounded' is some finite value.
Statement (II): A system is said to be stable, if it follows BIBO principle, i.e., every bounded input produces bounded output.

Ans. (b)


STABLE AND UNSTABLE SYSTEM

BIBO criteria :- If the output of system is finite or bounded for finite or bounded input, then system will be stable.

↳ Bounded Signal :- If the magnitude of signal is finite then signal is said to be bounded.

eg :- sint, cost, dc, u(t), sgn(t) etc.

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End of Solution

13. **Statement (I):** Insulation resistance falls with increase in temperature; in some cases, there is a marked decrease in insulation resistance.
Statement (II): The resistivity of the insulator is considerably lowered in the presence of moisture.

Ans. (d)

End of Solution

14. **Statement (I):** A computer's control unit does not perform any actual processing of jobs, but acts as the central nervous system for other components of the computer systems.
Statement (II): It obtains instructions from a program stored in main memory, interprets the instructions and issues signals causing other units of the system to execute them.

Ans. (a)

End of Solution

15. **Statement (I):** The resistivity of ferrites is very much higher than that of ferromagnetic metals.
Statement (II): The ferrites are chemical compounds and electrons in them are subject to restraint of valence forces.

Ans. (a)

End of Solution

16. Which one of the following power plants is suitable for supplying peak loads?
(a) Nuclear power plant
(b) Steam power plant
(c) Hydropower plant
(d) Gas turbine power plant

Ans. (c)

End of Solution

17. The specific rotational speed (N_s) for a water turbine is

(a) $\frac{N\sqrt{P_t}}{H^{2.25}}$
(b) $\frac{P_t\sqrt{N}}{H^{1.25}}$
(c) $\frac{N\sqrt{P_t}}{H^{1.25}}$
(d) $\frac{P_t\sqrt{N}}{H^{2.25}}$

where, P_t is output in metric hp
N is actual rotational speed of the turbine
H is effective head in metres

Ans. (c)

End of Solution

18. A steam power station of 100 MW capacity uses coal of calorific value of 6400 kcal/kg. The thermal efficiency of the station is 30% and electrical generation efficiency is 92%. When the coal station is working at full load, the coal required per hour will be nearly
(a) 38.3 tonnes
(b) 48.7 tonnes
(c) 54.7 tonnes
(d) 64.3 tonnes

Ans. (b)
Coal calorific value in kJ/kg
$= 6400 \times 4.186 = 69790.4$ kJ/Kg

Heat input required for 1 hour

$$= 100 \times 10^6 \times 3600 = 3.6 \times 10^8 \text{ kJ}$$

With efficiency of Balr and general:

$$\text{Heat input} = \frac{3.6 \times 10^8}{0.3 \times 0.92} = 1.304 \times 10^9 \text{ KJ}$$

$$\text{Mass of coal (kg)} = \frac{1.304 \times 10^9}{26790.4} = 48.7 \text{ tonnes}$$

End of Solution

19. The insulation resistances R_1 and R_2 of a live 2-wire network are measured by earthing each main in turn through a milliammeter in series with a high resistance r. When the supply voltage is 500 V, the values of r = 20000 Ω, i_1 = 1 mA and i_2 = 0.5 mA, the insulation resistances R_1 and R_2 respectively are

(a) 0.47 MΩ and 0.28 MΩ (b) 0.94 MΩ and 0.28 MΩ
(c) 0.47 MΩ and 0.47 MΩ (d) 0.94 MΩ and 0.47 MΩ

Ans. (d)

End of Solution

20. The advantages of supercritical steam power plants are

1. low grade fossil fuels can be used
2. NO_2 emissions are completely eliminated
3. SO_2 emissions are reduced and complete burning of coal occurs

Which of the above advantages are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

End of Solution

21. A 3-phase, 10000 kVA, 11 kV alternator has a sub-transient reactance of 8%. If 3-phase short circuit occurs at its terminals, the fault power will be nearly

(a) 125 MVA (b) 135 MVA
(c) 145 MVA (d) 155 MVA

Ans. (a)

$$\frac{10}{0.08} = 125 \text{ MVA}$$

End of Solution

22. The operating time t of a static time-current relay is

(a) $\dfrac{IM}{K^n - I_p^n}$ (b) $\dfrac{KM}{I^n - I_p^n}$

(c) $\dfrac{IM}{K^n + I_p^n}$ (d) $\dfrac{KM}{I^n + I_p^n}$

where, M is time multiple setting,
I is multiple of tap current
I_p is multiple of tap current which pickup occurs
n is characteristic index of the relay
K is design constant of the relay

Ans. (b)

End of Solution

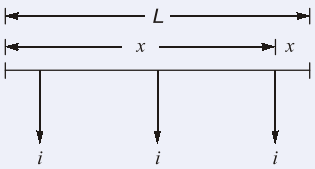
23. A uniformly distributed load on a 1 A/m length, 500 m is rated at 220 V. The distributor is fed from one end at 220 V. If the loop resistance is 2×10^{-5} Ω/m, the voltage drop at a distance of 400 m from the feeding point will be

(a) 5.2 V (b) 4.2 V
(c) 3.4 V (d) 2.4 V

Ans. (d)

$$V = Ri\left(Lx - \frac{x^2}{2}\right)$$

$$= 2\times10^{-5}\times1\left(500\times400 - \frac{400^2}{2}\right) = 2.4\ \text{V}$$



$$R_{(\Delta V)_x} = Ri\left[Lx - \frac{x^2}{2}\right] = 2.4\ \text{V}$$

End of Solution

24. Which one of the following distributors is having greater reliability and better flexibility?

(a) Ring main distributor (b) Tree distributor
(c) Radial distributor (d) Tapered distributor

Ans. (a)

End of Solution

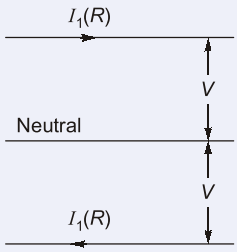
25. An existing DC three-wire system is to be converted into a 3-phase, 4-wire system by adding a fourth wire equal in cross-section to each outer wire of the DC system. For the same supply and load voltages to neutral and balanced conditions, the extra power at unity power factor that can be supplied by the AC system will be

(a) 40% (b) 50%

(c) 60% (d) 70%

Ans. (b)

3 wire DC system:



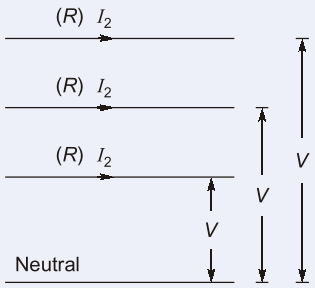
Assume load is balanced no current through neutral

Power supplied = $2\ V \cdot I_1 = P_1$

Power loss, $W_1 = 2 \cdot I_1^2 R$

$$\% \text{ power loss} = \frac{2 \cdot I_1^2 R}{2VI_1} \times 100 \quad \ldots(i)$$

3-ϕ 4, wire DC system:



Neutral does not carry current due to balance

3-ϕ power supplies, $P_2 = 3\ V \cdot I_2$

Power loss, $W_2 = 3 \cdot I_1^2 R$

$$\% \text{ power loss} = \frac{3 \cdot I_2^2 R}{3VI_2} \times 100 \quad \ldots(ii)$$

% power loss is equal

$$\frac{2 \cdot I_1^2 R}{2VI_1} = \frac{3 \cdot I_2^2 R}{3VI_2}$$

$$I_1 = I_2$$

$$\frac{P_2}{P_1} = \frac{3VI_2}{2VI_2} = \frac{3}{2} = 1.5$$

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$\Rightarrow \quad P_2 = (P_1) \times 1.5 = (1 + 0.5)P_1$

Extra power supplied of UPF is 50%

End of Solution

26. Which of the following statements are correct for load flow?

1. Bus admittance matrix is the most economical from the point of view of computer time and memory requirements.
2. The mathematical formulation of the load flow problem results in a system of non-linear equations.
3. In a power system, each node or bus is associated with four quantities.

Select the correct answer.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

27. Fixed and semi-fixed costs being independent of the amount of energy generated are also called

(a) generating costs (b) operating costs
(c) running costs (d) standing costs

Ans. (d)

End of Solution

28. R, L and C in an SCR circuit meant for protecting against $\frac{dv}{dt}$ and $\frac{di}{dt}$ are 4 Ω, 6 μH and 6 μF respectively. If the supply voltage is 300 V, the maximum permissible value of $\frac{di}{dt}$ is

(a) 30×10^6 A/s (b) 40×10^6 A/s
(c) 50×10^6 A/s (d) 60×10^6 A/s

Ans. (c)

$$(V_L)_{max} = L\left(\frac{di}{dt}\right)_{max}$$

$$300 = 6\times10^{-6}\left(\frac{di}{dt}\right)_{max}$$

$$\left(\frac{di}{dt}\right)_{max} = 50 \times 10^6 \text{ A/sec}$$

End of Solution

29. A 3 kV, 750 A power electronics circuit has thyristors with 800 V and 175 A rating. If the derating is of 25%, the number of thyristors in series will be
(a) 8 (b) 7
(c) 6 (d) 5

Ans. (d)

$$\text{DRF} = 1 - \text{string efficiency}$$

$$\text{string efficiency} = \frac{\text{Total string voltage}}{n_s \times (\text{Individual voltage rating of each SCR})}$$

$$0.75 = \frac{3 \times 10^3}{n_s \times 0.75 \times 800}$$

$$n_s = 5$$

End of Solution

30. Depending on the design principles used, gating circuits are very essential to direct
(a) firing pulses to each transistor in an appropriate region of the supply cycle
(b) pulse distribution
(c) firing pulses to each thyristor in an appropriate region of the supply cycle
(d) synchronization of thyristor

Ans. (c)

End of Solution

31. A mathematical abstraction to represent or model the dynamics of a system utilizes three types of variables called
(a) time, frequency and amplitude of the input
(b) input, output and time
(c) input, output and state variables
(d) input, output and frequency

Ans. (c)

End of Solution

32. If it is possible to transfer the system state from any initial state $x(t_0)$ to any other desired state $x(t_f)$ in specified finite time by a control vector $u(t)$, the system is said to be completely
(a) stable (b) observable
(c) state controllable (d) unstable

Ans. (c)

End of Solution

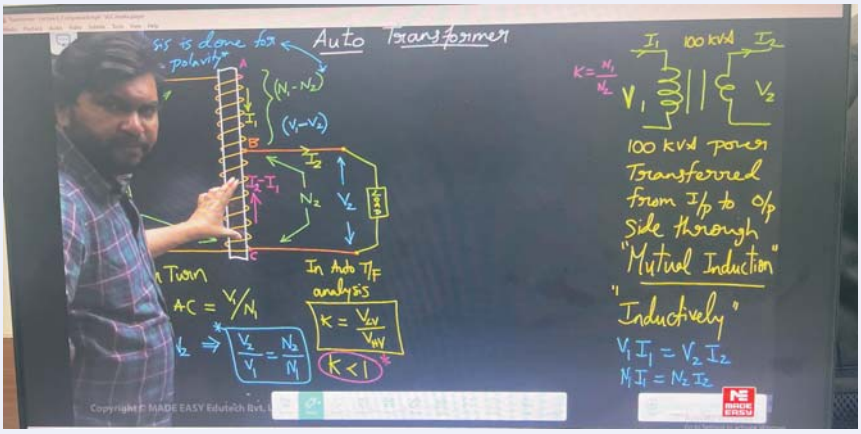
33. If every state $x(t_0)$ can be completely identified by measurements of the output $y(t)$ over a finite time interval, the system is said to be completely
(a) state controllable (b) observable
(c) unstable (d) stable

Ans. (b)

End of Solution

34. If the output voltage in autotransformer is less than the input voltage
(a) the load current is more than the input current
(b) the load current is less than the input current
(c) the load current becomes zero
(d) the input current becomes zero

Ans. (a)
LV side is high current side
$\because \quad V_1 I_1 = V_2 I_2$



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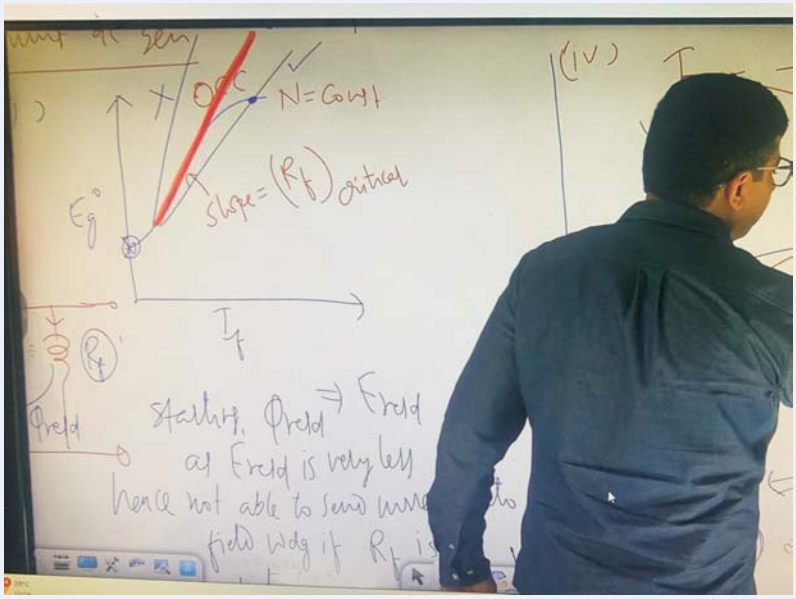
End of Solution

35. The maximum field circuit resistance (for a given speed) with which the shunt generator would just excite is known as its

(a) series field resistance
(b) critical field resistance
(c) shunt field resistance
(d) load field resistance

Ans. (b)



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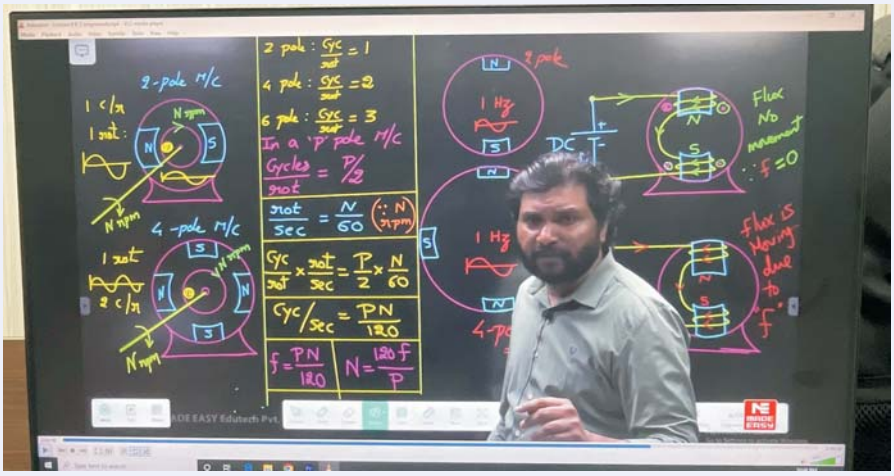
36. The speed at which the rotating magnetic field revolves is called
(a) asynchronous speed (b) synchronous speed
(c) constant speed (d) variable speed

Ans. (b)



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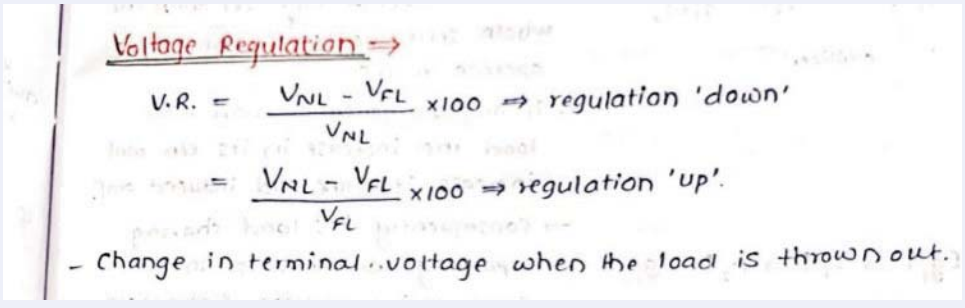
37. A shunt generator is rated at 240 V full load. At no load, the voltage is 252 V. The voltage regulation will be
(a) 5% (b) 6%
(c) 7% (d) 8%

Ans. (a)

$$\%V.R. = \frac{E_0 - V}{V} \times 100$$

$$= \frac{252 - 240}{240} \times 100 = 5\%$$



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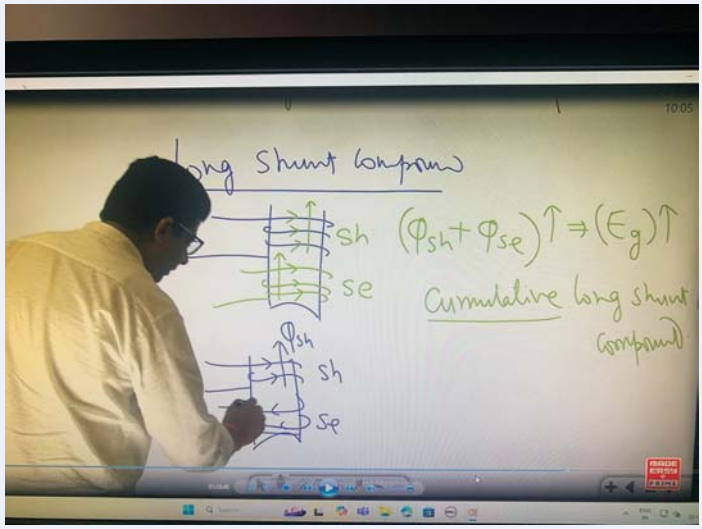
End of Solution

38. When a compound generator has its series field flux aiding its shunt field flux, the machine is said to be

(a) differentially compound
(b) cumulative compound
(c) series machine
(d) shunt machine

Ans. (b)



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End of Solution

39. The load torque developed by synchronous motor at which the motor pulls out of the synchronism is called

(a) breakdown torque
(b) starting torque
(c) pull-in torque
(d) maximum torque

Ans. (a)

End of Solution

40. A 6-pole, 3-phase induction motor is connected to a 50 Hz supply. If it is running at 970 r.p.m., the slip will be

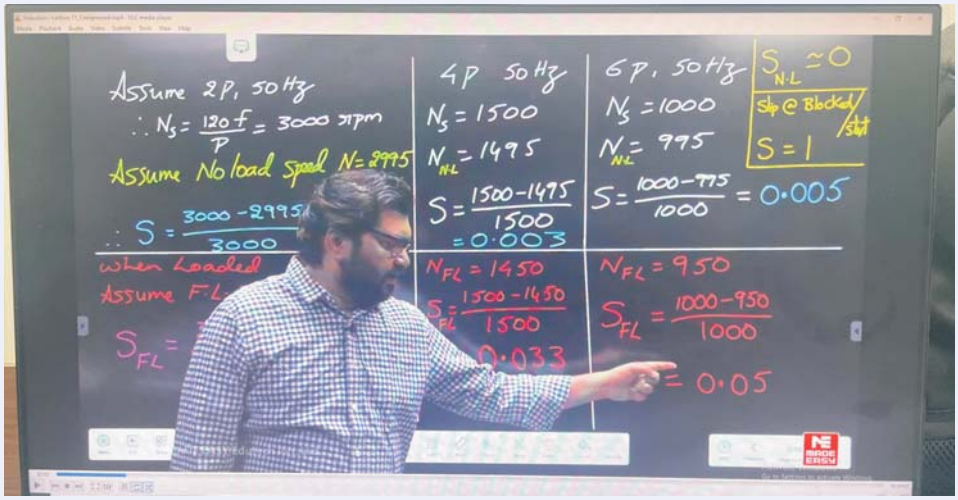
(a) 3% (b) 4%

(c) 5% (d) 6%

Ans. (a)

$$\%S = \frac{1000 - 970}{1000} \times 100 = 3\%$$

$$N_S = \frac{120 \times f}{P} = \frac{120 \times 50}{6} = 1000 \text{ rpm}$$



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41. The stator of a 3-ϕ induction motor has 3 slots per pole per phase. If the supply frequency is 50 Hz, the speed of the rotating stator flux will be

(a) 800 r.p.m. (b) 1000 r.p.m.

(c) 1200 r.p.m. (d) 1500 r.p.m.

Ans. (d)

Given, slots/pole/phase,

f = 50 Hz (No. of poles not mentioned)

For 3-phase winding slot/pole

= 9

If P = 2 slots = 18

P = 4 slots = 36

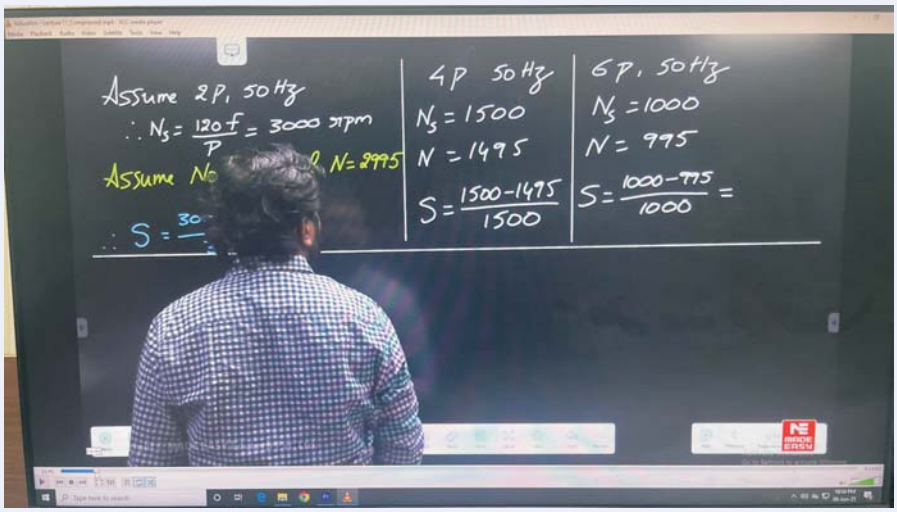
P = 6 slots = 54

As per options 2 poles not possible

Next possibility is 4 poles

36 slots, 4 poles is a standard

For 4 poles, $N_S = 1500$ rpm



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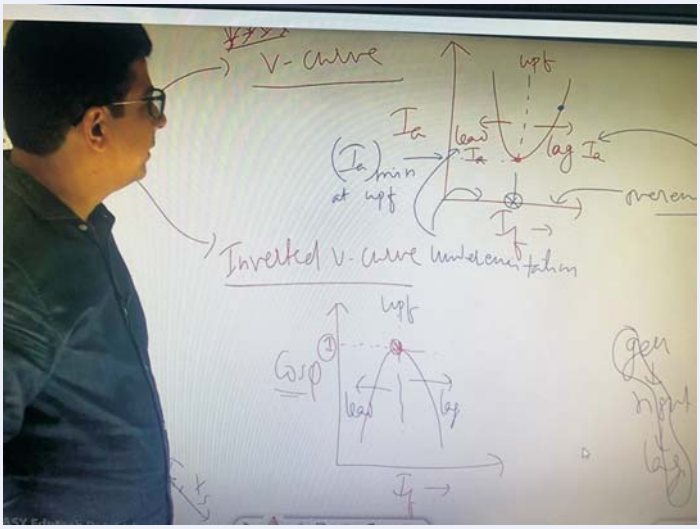
End of Solution

42. The graph between armature current (I_a) and field current (I_f) of a synchronous motor for a constant load is called

(a) Z-curve
(b) T-curve
(c) C-curve
(d) V-curve

Ans. (d)



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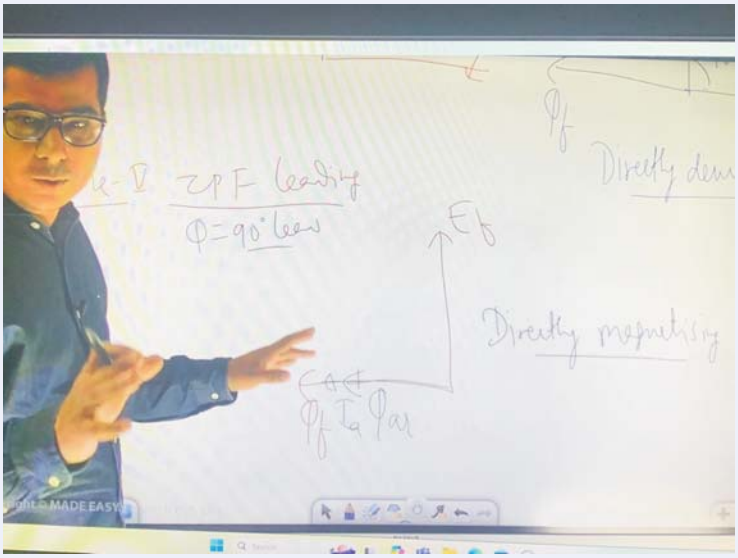
43. In salient-pole machines, the resultant air gap flux is increased as in a cylindrical rotor alternator when armature reaction flux ϕ_a for $\psi = 90°$

(a) leading aids the field flux ϕ_f (b) lagging aids the field flux ϕ_f

(c) leading opposes the field flux ϕ_f (d) lagging opposes the field flux ϕ_f

Ans. (a)



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End of Solution

44. A stepper motor has a step angle of 10° and is required to rotate at 200 r.p.m. The pulse rate of the motor will be

(a) 120 steps/s (b) 130 steps/s

(c) 140 steps/s (d) 150 steps/s

Ans. (a)

Given, step angle, $\alpha = 10°$,

speed = 200 rpm

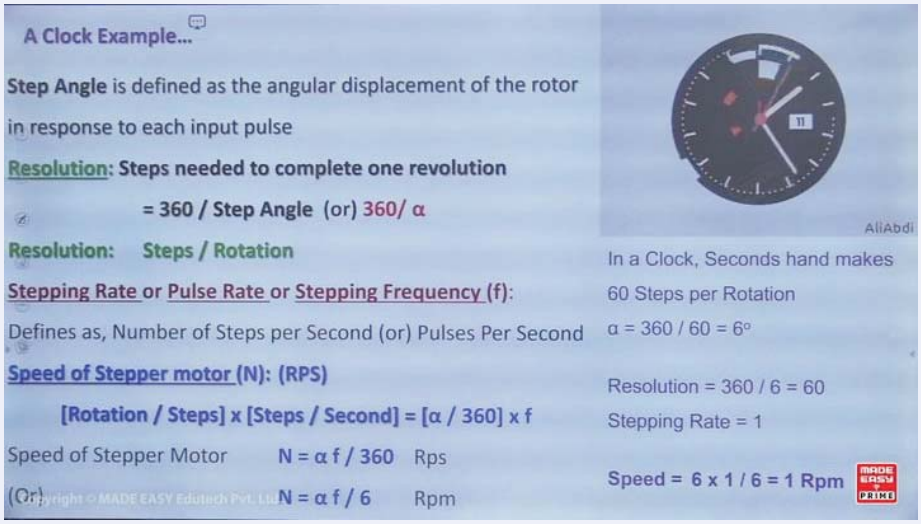
Pulse rate 'steps/sec' is to be calculated

$$\text{No. of steps per rev} = \frac{360}{\alpha} = \frac{360}{10} = 36 \text{ steps/rev}$$

$$\text{Rev/sec} = \frac{200}{60} = \frac{10}{3} \text{rev/sec}$$

$$\frac{\text{Steps}}{\text{Rev}} \times \frac{\text{Rev}}{\text{Sec}} = \frac{\text{Steps}}{\text{Sec}}$$

$$36 \times \frac{10}{3} = 120 \text{ steps/sec}$$



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45. A four-stack VR stepper motor has a step angle of 1.8°. The number of its rotor teeth will be

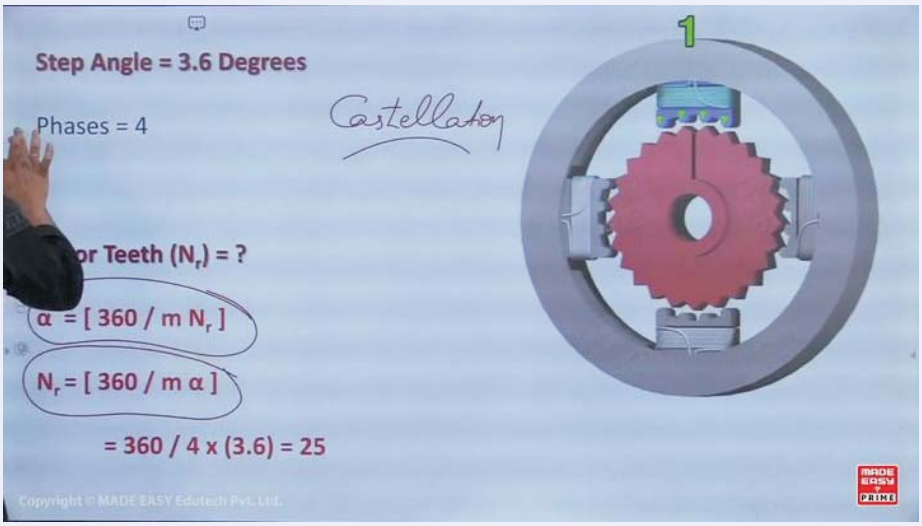
(a) 48 (b) 50

(c) 52 (d) 54

Ans. **(b)**

$$\text{Step angle} = \frac{360}{m \cdot N_r} \qquad (\text{where } m = \text{no. of stacks, } N_r = \text{rotor teeth})$$

$$\therefore \quad N_r = \frac{360}{m(\text{step angle})} = \frac{360}{4 \times 1.8} = 50$$



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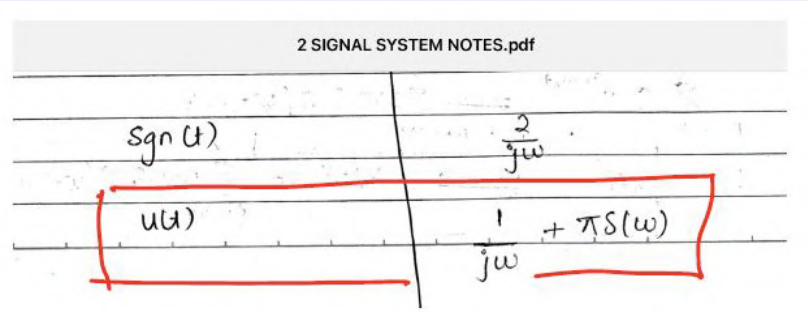
End of Solution

46. The Fourier transform of unit step function $u(t)$ is

(a) $u(t) \leftrightarrow \pi\delta(\omega)$ (b) $u(t) \leftrightarrow \frac{1}{j\omega}$

(c) $u(t) \leftrightarrow \pi\delta(\omega) + \frac{1}{j\omega}$ (d) $u(t) \leftrightarrow \pi\delta(\omega) - \frac{1}{j\omega}$

Ans. (c)



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End of Solution

47. Consider the following signals:
$x_1(t) = 10\cos(100\pi t)$; $x_2(t) = 10\cos(50\pi t)$.
If both are sampled at $f_s = 75$ Hz, the sampled signals $x_1(n)$ and $x_2(n)$ are

(a) $10\cos\left(\frac{2\pi}{3}n\right)$ and $10\cos\left(\frac{2\pi}{3}n\right)$ (b) $\cos\left(\frac{\pi}{n}\right)$ and $2\cos\left(\frac{\pi}{n}\right)$

(c) $\cos\left(\frac{2\pi}{n}\right)$ and $\cos\left(\frac{\pi}{n}\right)$ (d) $\cos\left(\frac{2\pi}{3}n\right)$ and $\cos\left(\frac{2\pi}{3}n\right)$

Ans. (a)

$$x_1(n) = 10\cos\left(100\pi\frac{n}{75}\right) \quad \text{i.e. } x_1(t)\big|_{t=nTs=\frac{n}{fs}}$$

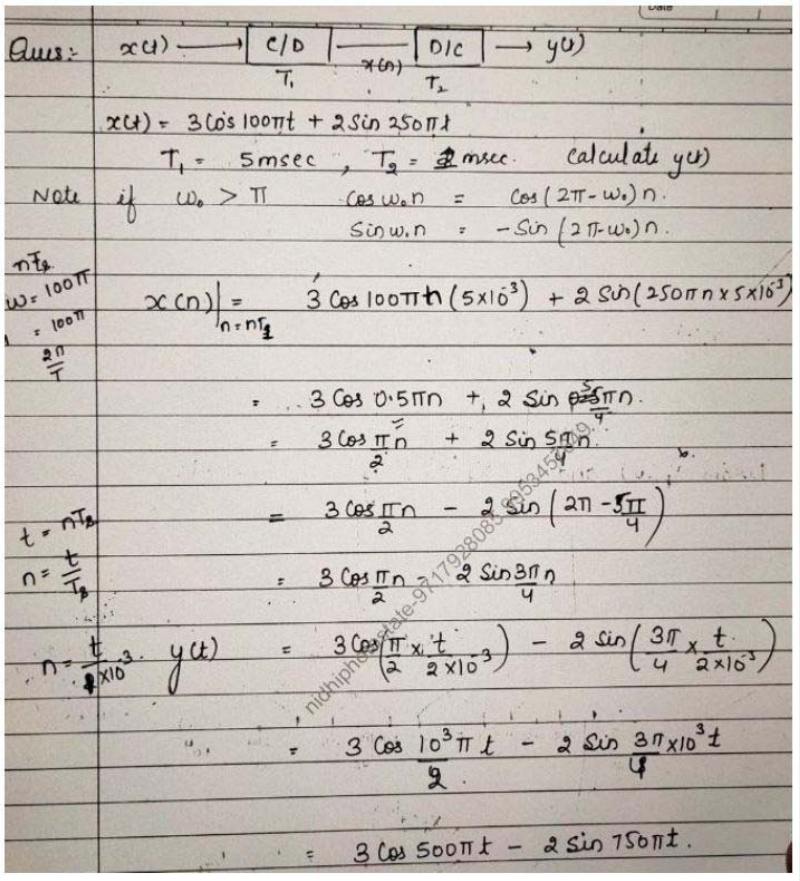
$$= 10\cos\left(\frac{4\pi}{3}n\right)$$

$$= 10\cos\left(2\pi - \frac{4\pi}{3}\right)n \quad [\text{If } \omega_0 > \pi \text{ then } \cos\omega_0 n = \cos[(2\pi - \omega_0)n]$$

$$= 10\cos\frac{2\pi}{3}n$$

$$x_2(n) = 10\cos\left(50\pi \times \frac{n}{75}\right)n \quad \text{i.e. } x_2(t)\big|_{t=nTs=\frac{n}{fs}}$$

$$= 10\cos\left(\frac{2\pi}{3}n\right)$$



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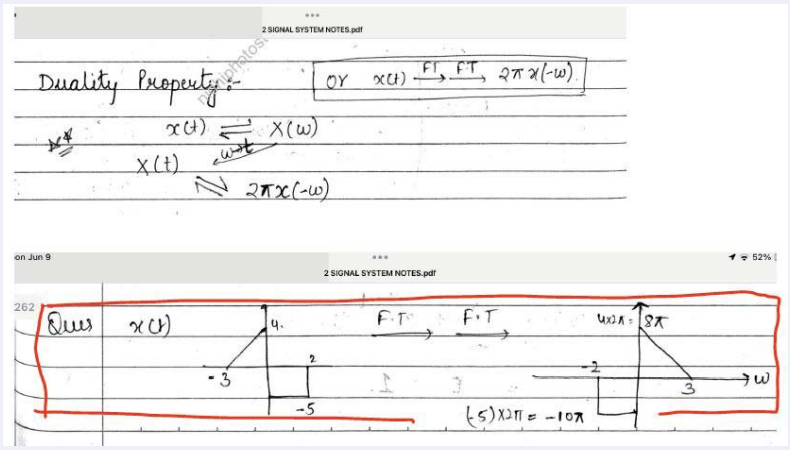
End of Solution

48. When the Fourier transform and inverse Fourier transform are similar but not quite identical, then this symmetry leads to a property called

(a) proportional (b) multiplication

(c) convolution (d) duality

Ans. (d)



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End of Solution

49. Consider $H_a(s) = \dfrac{1}{(s+1)^2}$ and $T = 0.1$s. Using bilinear transformation, $H(z)$ is

(a) $\dfrac{0.0476}{(1-0.9048z)^2}$ (b) $\dfrac{0.0476(1+z)^2}{(1-0.9048z^{-1})^2}$

(c) $\dfrac{0.0476}{(1-0.9048z^{-1})^2}$ (d) $\dfrac{0.0476(1+z^{-1})^2}{(1-0.9048z^{-1})^2}$

Ans. (d)

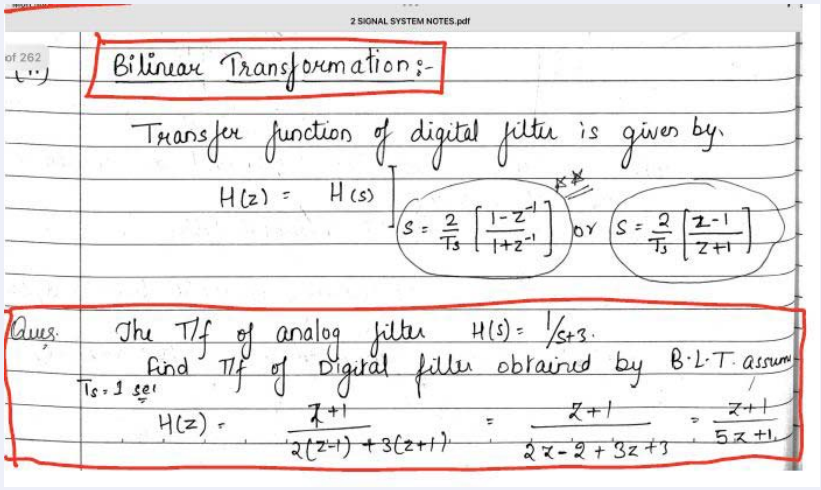
$$H(z) = H_a(s)\Big|_{s=\frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)=20\left(\frac{1-z^{-1}}{1+z^{-1}}\right)}$$

$$= \frac{1}{\left[20\dfrac{(1-z^{-1})}{1+z^{-1}}+1\right]^2}$$

$$= \frac{(1+z^{-1})^2}{[20(1-z^{-1})+1+z^{-1}]^2}$$

$$= \frac{(1+z^{-1})^2}{(21-19z^{-1})^2} = \frac{(1+z^{-1})^2}{(21)^2\left(1-\dfrac{19}{21}z^{-1}\right)} = \frac{0.0022(1+z^{-1})^2}{(1-0.9048z^{-1})^2}$$

Note: most apropriate answer is (d).



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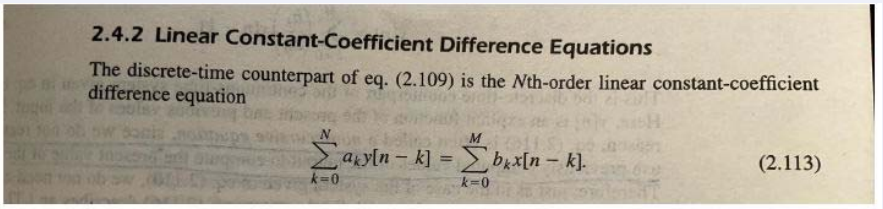
End of Solution

50. Which one of the following systems can be represented by the given general difference equation?

$$y(n) = -\sum_{k=1}^{N} a_k y(n-k) + \sum_{k=1}^{N} b_k x(n-k)$$

(a) DFS
(b) CFS
(c) LTI
(d) LSF

Ans. (c)



2.4.2 Linear Constant-Coefficient Difference Equations

The discrete-time counterpart of eq. (2.109) is the Nth-order linear constant-coefficient difference equation

$$\sum_{k=0}^{N} a_k y[n-k] = \sum_{k=0}^{M} b_k x[n-k]. \qquad (2.113)$$

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End of Solution

51. What is the convolution of the given two sequences?

$x(n) = e^{-n^2}$, for all n and $h(n) = 3n^2$, for all n

(a) $3.521n^2 + 1.5$ (b) $1.625n + 1$

(c) 1.598 (d) $5.318n^2 + 2.654$

Ans. (d)

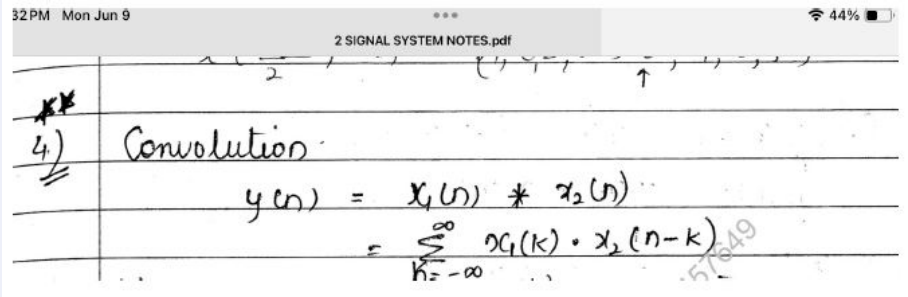
$$y(n) = x(n) * h(n) = \sum_{k=\infty}^{\infty} x(k)h(n-k)$$

Put $n = 0$:

$$y(0) = \sum_{k=\infty}^{\infty} x(k)h(-k) = \sum_{k=-\infty}^{\infty} e^{-K^2} \cdot 3(-k)^2$$

$$= \sum_{k=-\infty}^{\infty} e^{-K^2} \cdot 3K^2 = \frac{3\sqrt{\pi}}{2} = 2.654$$

Only option (d) satisfied.



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End of Solution

52. For type-2 system with unit ramp input, the steady-state error e_{ss} is

(a) ∞ (b) $\frac{1}{K}$

(c) 0 (d) $\frac{1}{1+K}$

Ans. (c)

End of Solution

53. A transfer function of a linear time-invariant system is defined to be the ratio of the Laplace transform of

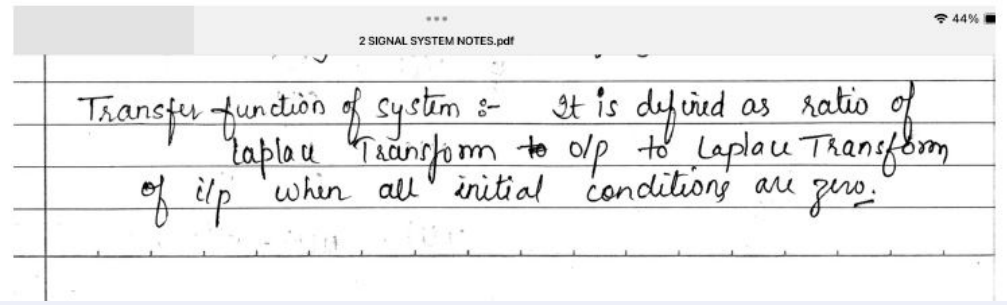
(a) the output variable to the Laplace transform of the input variable under the assumption that all the initial conditions are zero

(b) the input variable to the Laplace transform of the output variable under the assumption that all the initial conditions are not zero

(c) the output variable to the Laplace transform of the input variable under the assumption that all the initial conditions are not zero

(d) the input variable to the Laplace transform of the output variable under the assumption that all the initial conditions are zero

Ans. (a)



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End of Solution

54. For a unity feedback control system, the forward path transfer function is given by $G(s) = \dfrac{10}{(05s+1)(s+5)}$. The position and velocity error constants for this system will be respectively

(a) 2 and ∞ (b) 2 and 0

(c) 20 and ∞ (d) 20 and 0

Ans. (b)

$$GH = \frac{10}{(1+0.5s)(s+5)}$$

$$= 0$$

$$K_p = \lim_{s\to 0} GH = 2$$

$$K_v = \lim_{s\to 0} s(GH) = 0$$

End of Solution

55. A system is described by the differential equation

$$3\frac{d^2c(t)}{dt^2}+5\frac{dc(t)}{dt}+c(t) = r(t) + 3r(t-2)$$

The transfer function of the system is

(a) $\dfrac{1+3e^{-2s}}{3s^2-5s-1}$ (b) $\dfrac{1-3e^{-2s}}{3s^2-5s-1}$

(c) $\dfrac{1+3e^{-2s}}{3s^2+5s+1}$ (d) $\dfrac{1-3e^{-2s}}{3s^2+5s+1}$

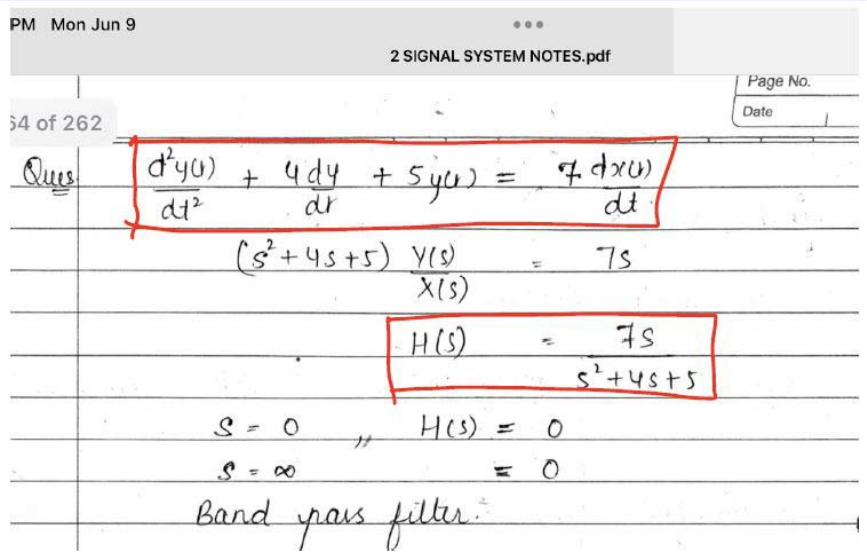
Ans. (c)

By applying Laplace transform

$3s^2C(s) + 5sC(s) + C(s) = R(s) + 3R(s)\cdot e^{-2s}$

$$\Rightarrow \quad \frac{C(s)}{R(s)} = \frac{1+3e^{-2s}}{3s^2+5s+1}$$

$$\Rightarrow \quad H(s) = \frac{1+3e^{-2s}}{3s^2+5s+1}$$



MADE EASY Class Notes

End of Solution

56. The steady-state errors for type 1, type 2 and type 3 systems with parabolic input are respectively

(a) infinite, constant value and zero
(b) constant value, infinite and zero
(c) infinite, zero and constant value
(d) constant value, zero and infinite

Ans. (a)

End of Solution

57. The Laplace transform of the function

$$f(t) = t^n e^{-at}$$

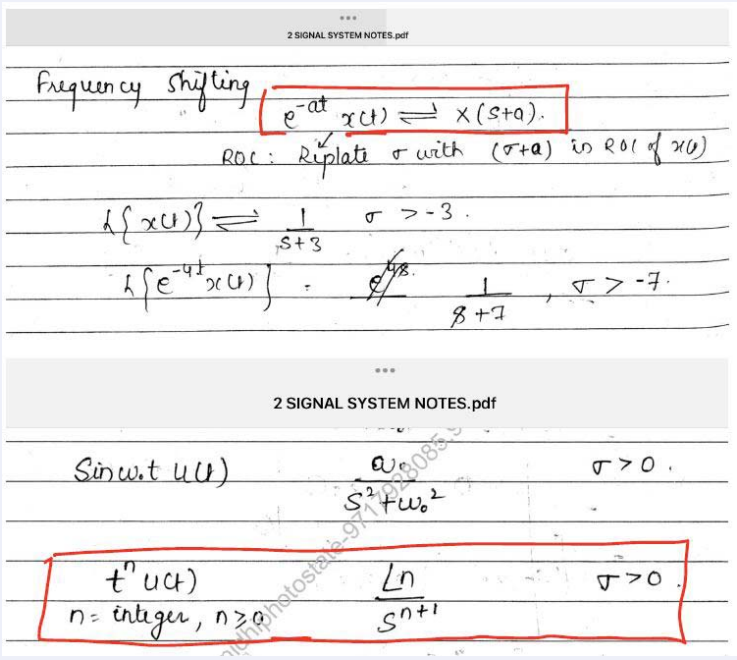
is

(a) $\frac{n!}{(s+a)^{n+1}}$
(b) $\frac{n!}{(s-a)^{n-1}}$
(c) $\frac{n!}{(s+a)^{n-1}}$
(d) $\frac{n!}{(s-a)^{n+1}}$

Ans. (a)

$$t^n u(t) \rightleftharpoons \frac{\lfloor n}{s^{n+1}}$$

$$t^n e^{-at} u(t) \rightleftharpoons \frac{\lfloor n}{(s+a)^{n+1}}$$



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End of Solution

58. If any root of the characteristic equation has a positive real part or if there is a repeated root on the $j\omega$-axis, the system is

(a) conditionally stable
(b) limitly stable
(c) stable
(d) unstable

Ans. (d)

End of Solution

59. Consider the unity feedback system given by

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

The phase margin is

(a) 0°
(b) 45°
(c) 120°
(d) 180°

Ans. (d)

$$GH = \frac{1}{(s+1)^2},$$

$$\omega_{gc} = 0$$

$$P_m = 180° + 2\tan^{-1}(\omega_{gc}) = 180°$$

End of Solution

60. For the system having open-loop transfer function $G(s)H(s) = \frac{K}{s(s+2)(s+3)}$ the breakaway point is nearly

(a) –0.245
(b) –0.785
(c) 1.585
(d) –3.345

Ans. (b)

$$K = -(s^3 + 5s^2 + 6s)$$

$$\frac{dK}{ds} = -(3s^2 + 10s + 6) = 0$$

$$s = \frac{-10 \pm \sqrt{100 - 72}}{6} = -0.78, -2.55$$

End of Solution

61. A carrier signal having 10 V peak amplitude is amplitude modulated by three different modulating frequencies with peak amplitude levels of 2 V, 3 V and 4 V respectively. The modulation index of the resultant complex AM signal will be nearly

(a) 0.44 (b) 0.54

(c) 0.62 (d) 0.72

Ans. (b)

Given carrier amplitude,

$$A_C = 10 \text{ V}$$

Message amplitudes,

$$A_{m1} = 2 \text{ V}$$
$$A_{m2} = 3 \text{ V}$$
$$A_{m3} = 4 \text{ V}$$

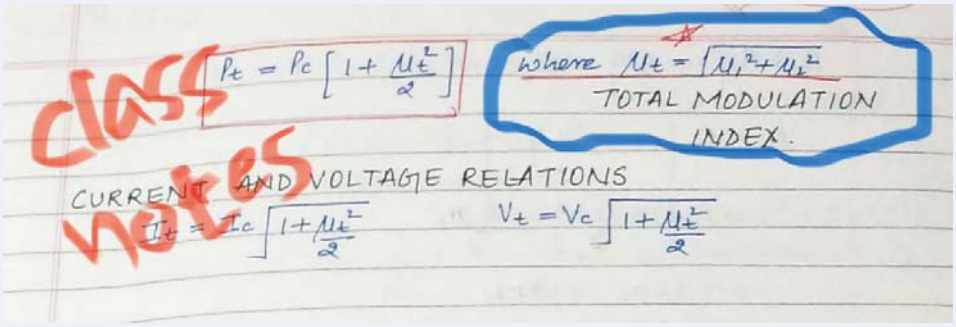
$$\mu_1 = \frac{A_{m1}}{A_c} = 0.2$$

$$\mu_2 = \frac{A_{m2}}{A_c} = 0.3$$

$$\mu_3 = \frac{A_{m3}}{A_c} = 0.4$$

Resulant modulation index,

$$\mu_t = \sqrt{\mu_1^2 + \mu_2^2 + \mu_3^3} = 0.538 \approx 0.54$$



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End of Solution

62. An AC signal having constant amplitude of 10 V, but variable frequency is applied across a simple low-pass R-L circuit with a cut-off frequency of 1 kHz. If R is 1 kΩ, the value of L will be nearly

(a) 130 mH (b) 140 mH
(c) 150 mH (d) 160 mH

Ans. (d)

$$f = \frac{R}{2\pi L}$$

$$\Rightarrow \quad L = \frac{R}{2\pi f} = \frac{1\times10^3}{2\pi\times1\times10^3} = 0.159$$

$$L = 159 \approx 160 \text{ mH}$$

End of Solution

63. It is desired to design a microcontroller-based periodic signal generator with minimum and maximum time period specifications of 125 ns and 100 ms. Then the system clock frequency will be

(a) 8 MHz (b) 10 MHz
(c) 12 MHz (d) 14 MHz

Ans. (a)

End of Solution

64. An amplitude modulated amplifier has a radio frequency output of 50 W at 100% modulation. If the internal loss in the modulator is 10 W, the unmodulated carrier power will be

(a) 10 W (b) 20 W
(c) 30 W (d) 40 W

Ans. (d)

Given that output power of modulated Amplifier = 50 W

Internal loss = 10 W

Total power, $P_t = 50 + 10 = 60$ W

$\mu = 100\% = 1$

$$P_t = P_c\left[1+\frac{\mu^2}{2}\right]$$

$$60 = P_c\left[1+\frac{1}{2}\right]$$

$$P_c = 40 \text{ W}$$

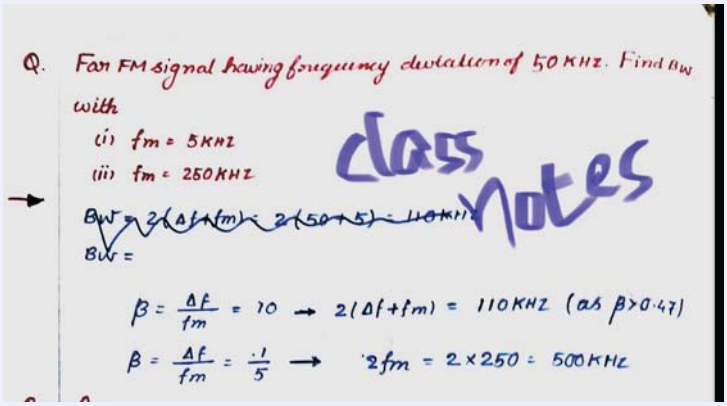
End of Solution

65. The maximum deviation allowed in an FM broadcast system is 75 kHz. If the modulating signal is a single-tone sinusoid of 10 kHz, the bandwidth of the FM signal will be

(a) 140 kHz (b) 150 kHz
(c) 160 kHz (d) 170 kHz

Ans. (d)

Given, $\Delta f = 75$ kHz
$f_m = 10$ kHz
Bandwidth $= 2[\Delta f + f_m]$
$= 170$ kHz



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End of Solution

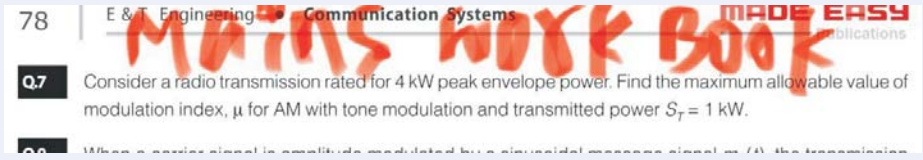
66. The Peak Envelope Power (PEP) in suppressed carrier signal is

(a) $\frac{V_p^2}{2R_L}$ (b) $\frac{2V_p^2}{R_L}$
(c) $\frac{V_p^2}{R_L}$ (d) $\frac{2V_p^2}{R_L^2}$

Where, V_p is peak signal voltage R_L is load resistance.

Ans. (c)

Peak envelope power $= \frac{V_p^2}{R_L}$



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End of Solution

67. An open-circuit noise voltage generator across a 100 kΩ resistor over a frequency range direct current 20 kHz at room temperature of 25° C will be nearly
(a) 4.9 μV (b) 5.7 μV
(c) 6.5 μV (d) 7.3 μV

Ans. (b)

Given, $R = 100\ k\Omega$
Bandwidth, $B = 20\ kHz$
$T = 25° + 273 = 298°\ K$

Noise voltage, $V_n = \sqrt{4KTBR}$

Bottem an constant, $K = 1.38 \times 10^{-23}$ Joule/Kelvin

$$V_n = \sqrt{4\times(1.38\times10)^{-23}\times(298)\times(20\times10^3)\times(100\times10^3)}$$
$$= 5.7\ \mu V$$

1.24 An amplifier has a bandwidth of 4 MHz with 10 kΩ as the input resistor. What is the rms noise voltage at the input to this amplifier if the room temperature is 25°C ?
(a) 35.28 μV (b) 40.55 μV
(c) 25.65 μV (d) 14.62 μV
[ESE-2023]

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End of Solution

68. A voice signal band limited to 3.4 kHz and pulse code is sampled at 8 kHz using 64 quantization levels. If ten such signals are time division multiplexed using one 5-bit synchronizing word, the minimum channel bandwidth will be
(a) 410 kHz (b) 520 kHz
(c) 430 kHz (d) 340 kHz

Ans. (b)

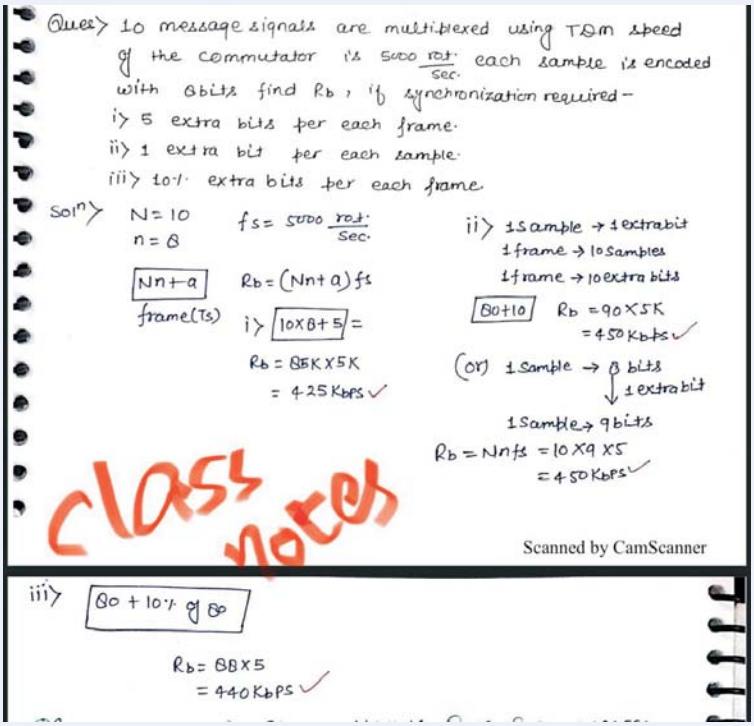
Number of signals, $N = 10$
$f_s = 8\ kHz$
$L = 64,\ n = 6$
Synchronization bits, $a = 5$

Minimum channel bandwidth $= \frac{R_b}{2}$

$R_b = (N_n + a)f_s$
$= [10 \times 6 + 5] \times 8\ k$
$= 520\ kHz$

Minimum channel bandwidth $= 260\ kHz$ (Option not matching)

Note:
if binary sequence represented with full width rectangular pulses, then minimum channel bandwidth = R_b = 520 kHz



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End of Solution

69. Six analog information signals, each band limited to 4 kHz, are required to be time division multiplexed and transmitted by a TDM system. The minimum transmission bandwidth of the PAM/TDM channel will be

(a) 40 kHz (b) 32 kHz
(c) 24 kHz (d) 16 kHz

Ans. (c)

Given, $N = 6$

Each message bandwidth,

$f_m = 4$ kHz

f_s = Nyquist rate = $2f_m = 8$ kHz

Default, $n = 1$ bit/sample

$R_b = Nnf_s = 48$ kHz

Minimum transmission bandwidth

$$= \frac{R_b}{2} = 24 \text{ kHz}$$

Q.22 Four signals each band-limited to 5 kHz are sampled at twice the Nyquist rate. The resulting PAM samples are transmitted over a single channel after time division multiplexing. The theoretical minimum transmission bandwidth of the channel should be equal to

(a) 5 kHz (b) 20 kHz
(c) 40 kHz (d) 80 kHz [ESE-2000]

End of Solution

70. By applying the time-shifting property, what is the z-transform of the following signal?

$$X(z) = \frac{z^{-1}}{1-3z^{-1}}$$

(a) $x(n) = (3)^{n+1} \cdot u(n+1)$ (b) $x(n) = (3)^{n-1} \cdot u(n+1)$

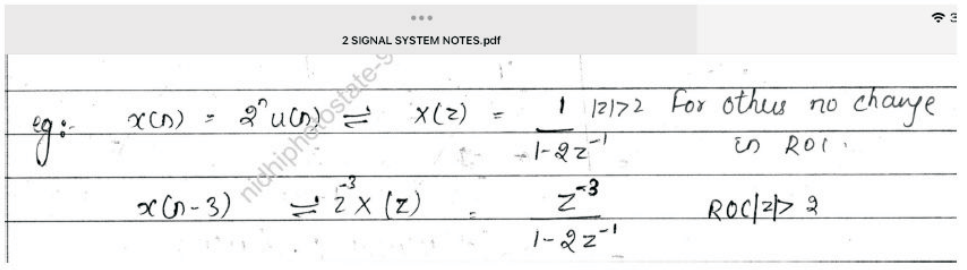
(c) $x(n) = (3)^{n+1} \cdot u(n-1)$ (d) $x(n) = (3)^{n-1} \cdot u(n-1)$

Ans. (d)

$$X(z) = \frac{z^{-1}}{1-3z^{-1}}$$

$$3^n u(n) \rightleftharpoons \frac{1}{1-3z^{-1}}$$

$$3^{n-1}u(n-1) \rightleftharpoons \frac{z^{-1}}{1-3z^{-1}}$$



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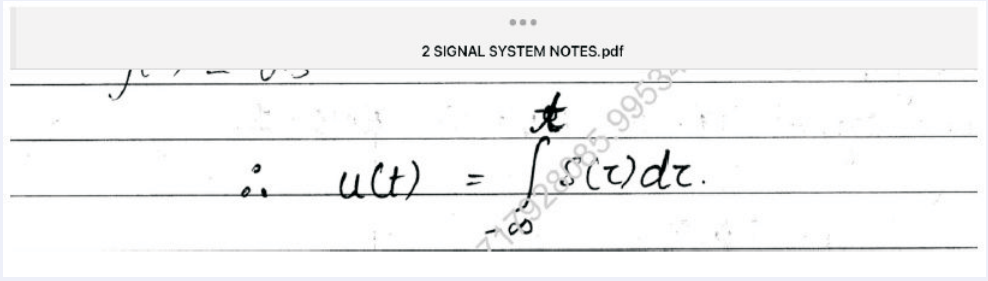
End of Solution

71. The relationship between the unit step and delta function is

(a) $\int u(t)dt = \delta(t)$ (b) $\int \delta(t)dt = r(t)$

(c) $\int r(t)dt = r(t)$ (d) $\int \delta(t)dt = u(t)$

Ans. (d)



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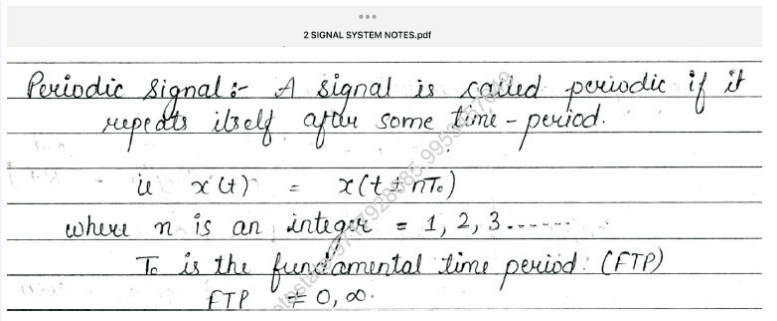
72. Which one of the following time signals is said to be periodic with period T_p for which the signal is advanced in time and hence it remains unchanged?

(a) Even
(b) Odd
(c) Continuous
(d) Discrete

Ans. (c)



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73. Consider a continuous-time system with input $x(t)$ and output $y(t)$:

$$y(t) = x(\sin t)$$

The system is

(a) causal
(b) non-casual
(c) invertible
(d) time-variant

Ans. (b, d)

Given system, $y(t) = x(\sin t)$

At $t = \pi$:

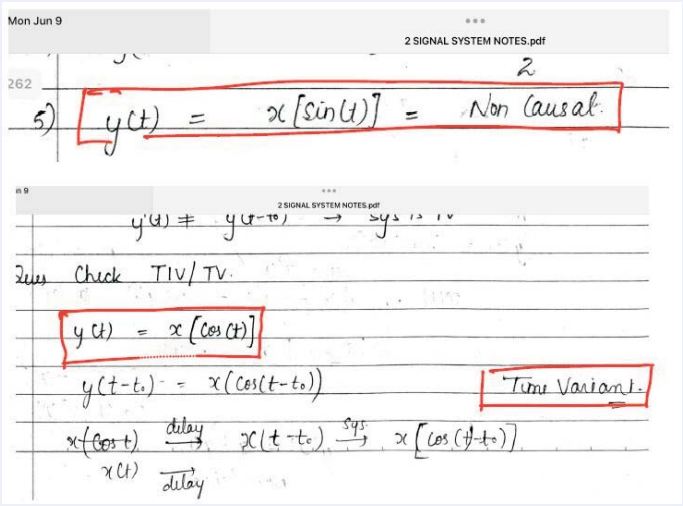
$$y(-\pi) = x[\sin(-\pi)] = x(0)$$

For $y(-\pi)$, the input $x(0)$ is a future input

So, the system is non-causal

System also violates the time-invariance property.

So, the system is time-variant.



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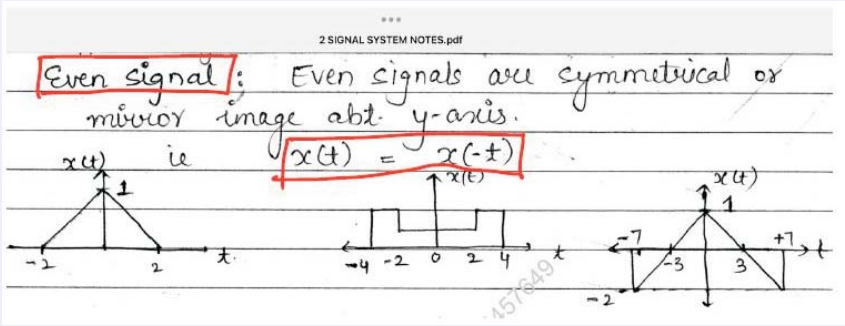
74. In the Fourier series representation, the condition for the even symmetry is

(a) $x(t) = x(-t)$ (b) $x(t) = -x(-t)$

(c) $x(t) = -x\left(t + \frac{T}{2}\right)$ (d) $x(t) = x\left(t + \frac{T}{2}\right)$

Ans. (a)



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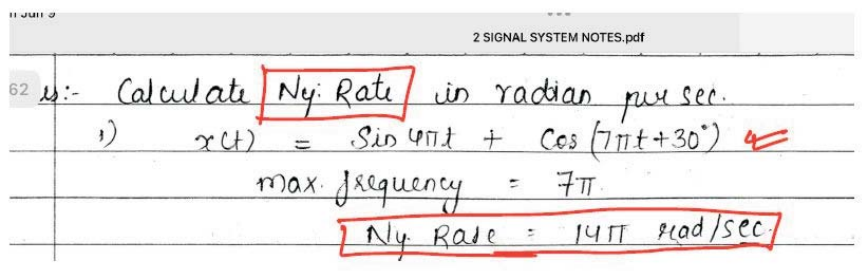
75. Consider that the signal $x_a(t) = 10\cos 2\pi(1000)t + 5\cos 2\pi(5000)t$ is to be sampled. The Nyquist rate is

(a) 5 kHz (b) 10 kHz

(c) 15 kHz (d) 20 kHz

Ans. (b)

Nyquist rate = $2f_m$ = 2 × 5000 = 10000 Hz
= 10 kHz



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76. The leakage current I_{CEO} from collector to emitter with the base lead open in common-emitter configuration is

(a) $I_{CO}(1 + \beta_{DC})$ (b) $I_{CO}(1 + \alpha_{DC})$

(c) $I_{CO}(1 - \beta_{DC})$ (d) $I_{CO}(1 - \alpha_{DC})$

where, I_{CO} is leakage current from collector to base with the emitter open

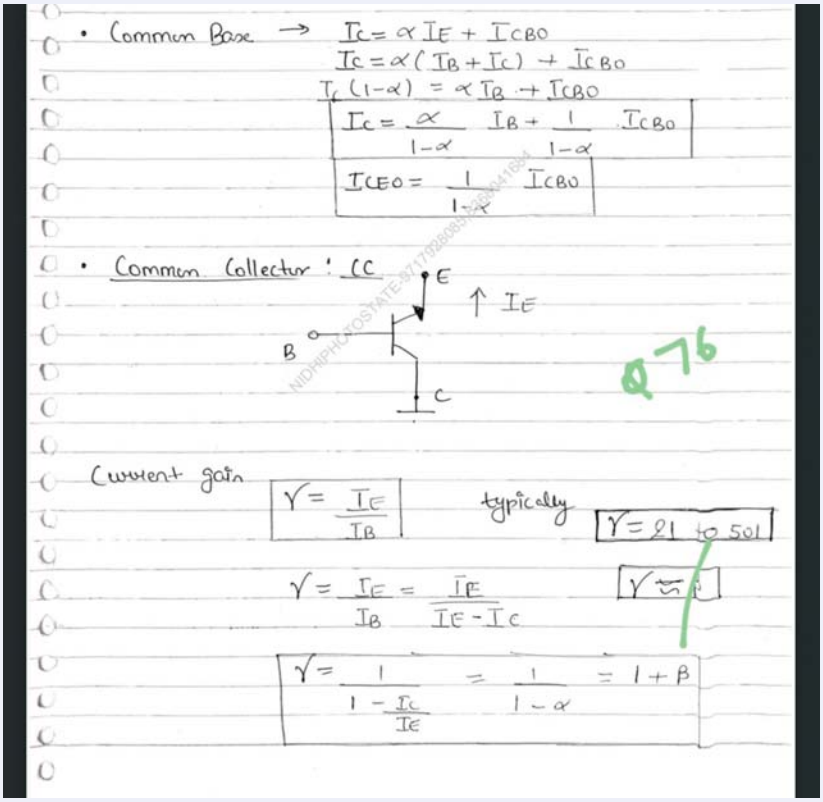
α_{DC} is DC current gain in common-base configuration

α_{DC} is DC current gain in common-emitter configuration

β_{DC} is DC current gain in common-emitter configuration.

Ans. (a)

$$I_{CEO} = (1 + \beta)I_{CBO}$$



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77. Which one of the following represents the level of energy of the valence electrons of an atom bound under the effect of electromagnetic force between the electrons and nucleus?

(a) *VB* (b) *CB*

(c) E_C (d) *EB*

Ans. (a)

VB (Valence band)

End of Solution

78. Ripple is the variation of output voltage about DC which is

(a) quite small in a half-rectified wave

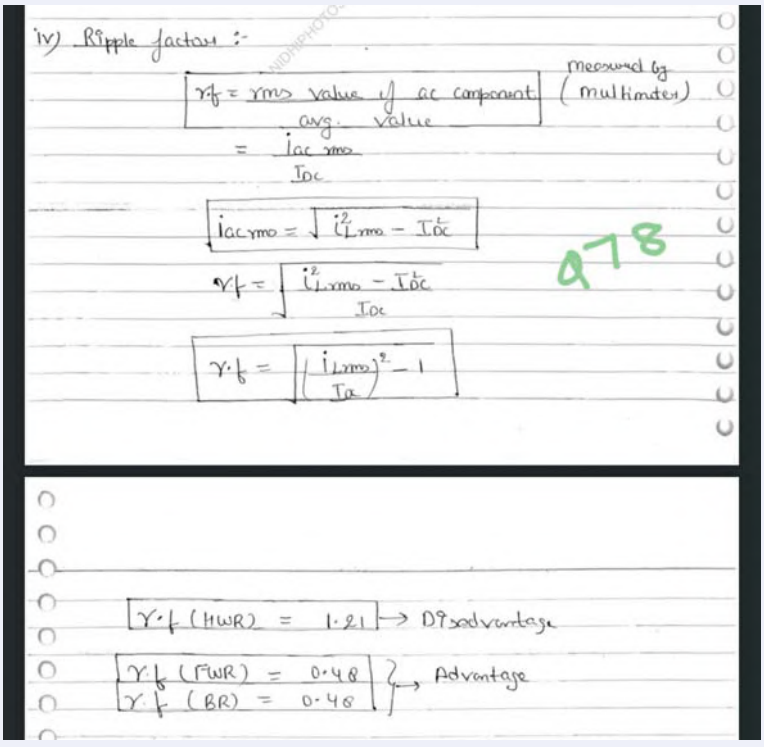
(b) same in a half-rectified wave

(c) quite large in a half-rectified wave

(d) same in a full-rectified wave

Ans. (c)

Quite large in half rectified wave.



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79. The rise time of certain amplifier is 35 ns. What is the approximate bandwidth of the amplifier?

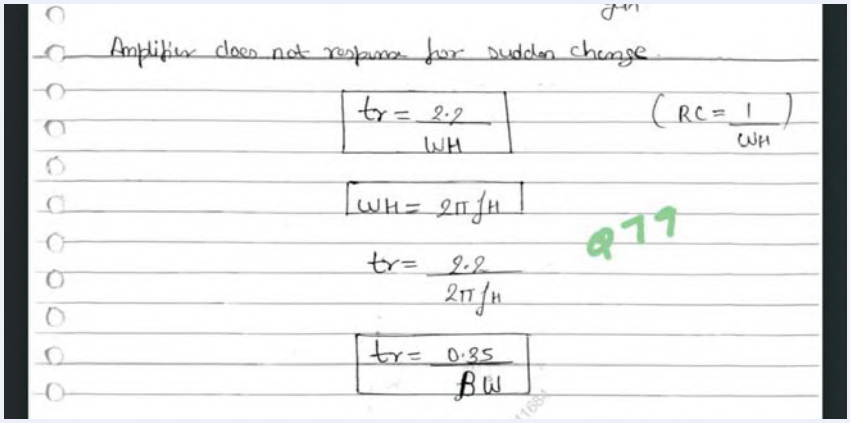
(a) 10 MHz (b) 35 MHz

(c) 28.5 MHz (d) 1 MHz

Ans. (a)

$$t_r = \frac{0.35}{BW}$$

$$BW = \frac{0.35}{t_r} = \frac{0.35}{35\ ns} = 10\ MHz$$



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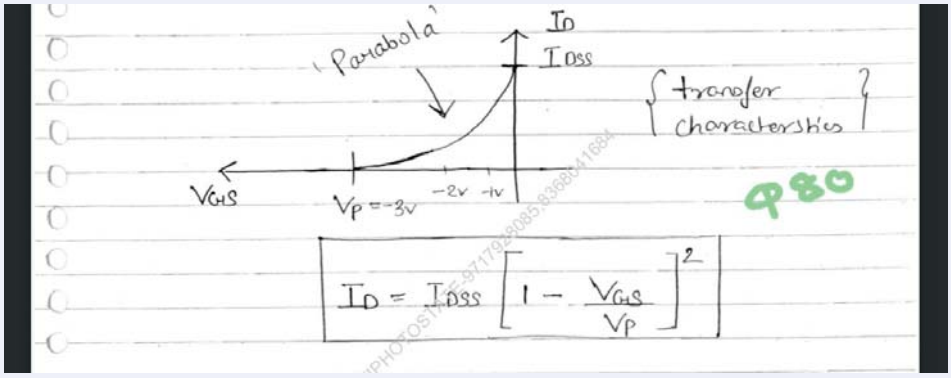
80. For JFET, I_{DSS} = 6 mA, V_P = –4.5 V and V_{GS} = –2 V. The value of I_D will be nearly
(a) 0.9 mA (b) 1.9 mA
(c) 2.7 mA (d) 3.7 mA

Ans. (b)

$$I_D = I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^2$$

$$= G_{MA}\left(1-\frac{-2}{-4.5}\right)^2$$

$$= 1.9 \text{ mA}$$



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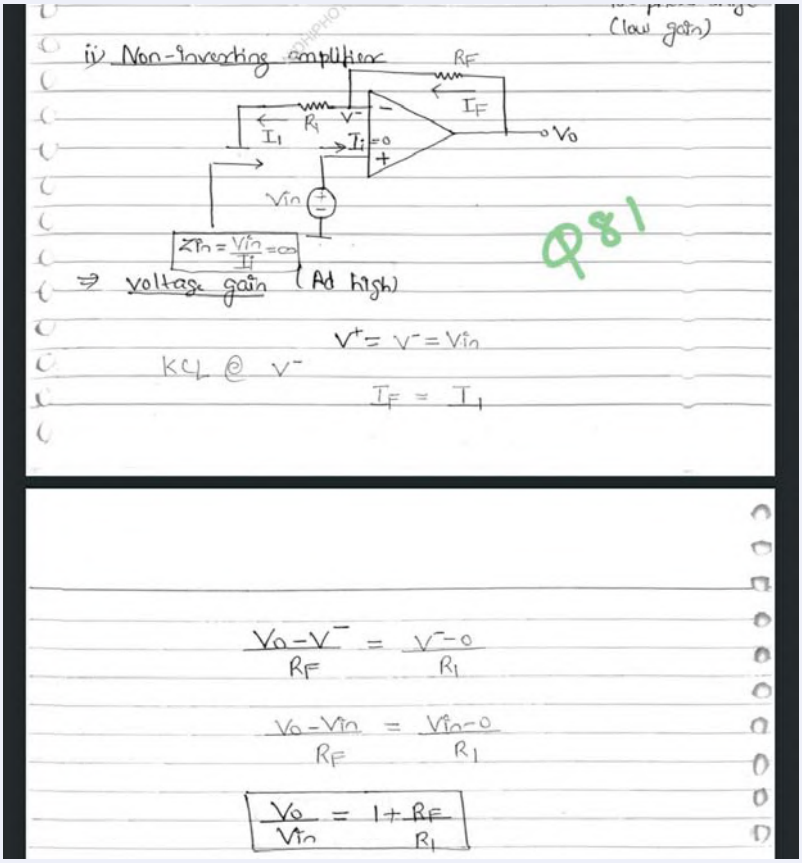
81. If the feedback network is purely resistive, then negative feedback is introduced as feedback voltage V_f and output voltage V_o are in phase, and such amplifier is called

(a) summing amplifier
(b) inverting amplifier
(c) non-inverting amplifier
(d) integrator amplifier

Ans. (c)

Non inverting amplifier.



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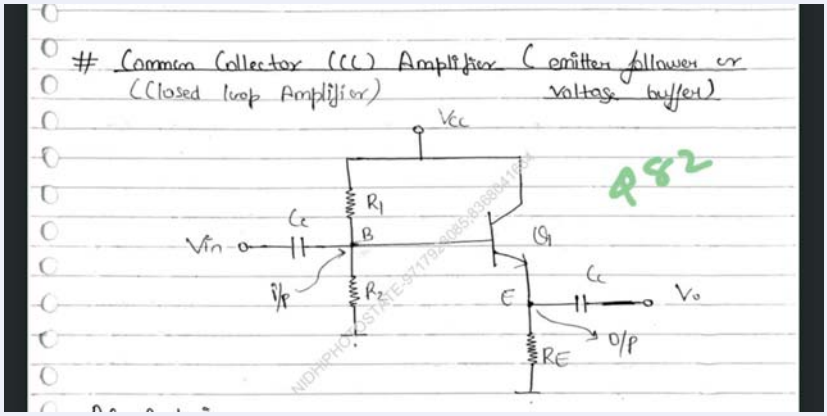
82. Which one of the following amplifiers transmits the input to the output terminals and is used as a buffer amplifier?

(a) Common-emitter amplifier
(b) Common-base amplifier
(c) Common-collector amplifier
(d) Common-source amplifier

Ans. (c)

Common collector amplifier is called emitter follower.

Common collector amplifier as buffer.



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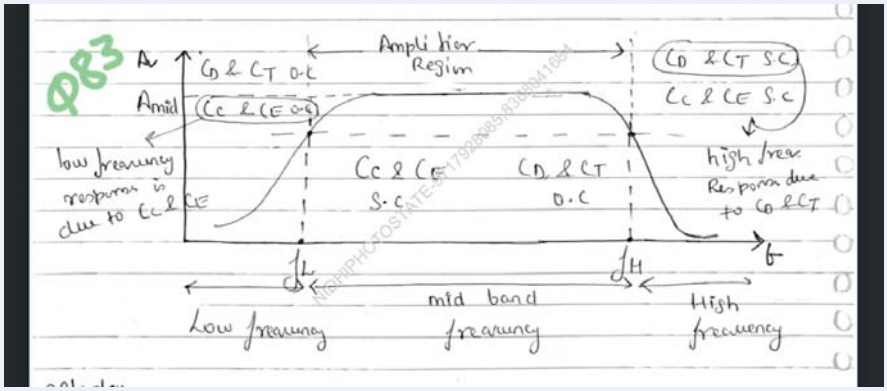
83. In the low-frequency range, the gain is influenced by the coupling capacitor C_c. The amplifier behaves like an

(a) R-C high-pass filter
(b) R-C low-pass filter
(c) R-C all-pass filter
(d) R-C notch filter

Ans. (a)

R-C high pass filter.



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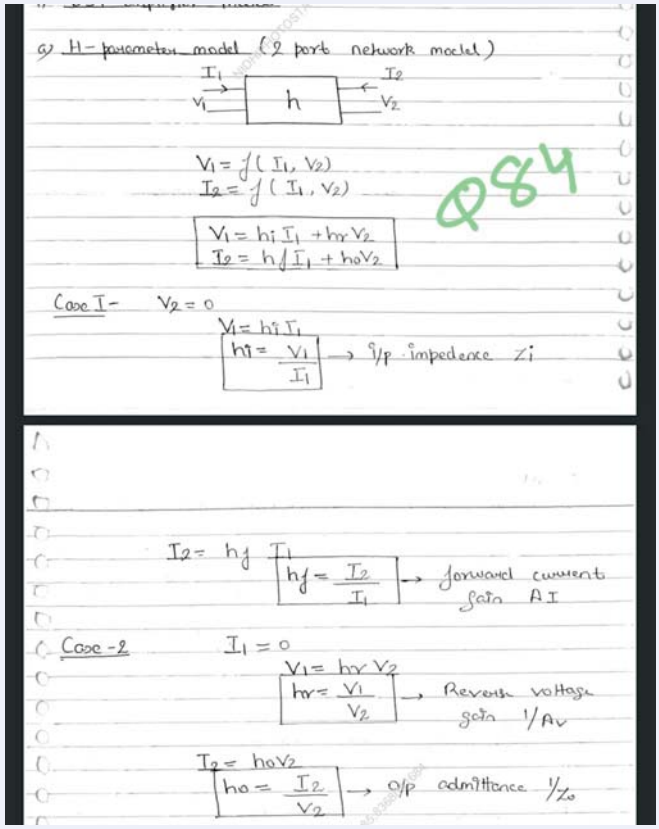
84. The word 'hybrid' in *h*-parameters indicates that
(a) the units of four parameters are same
(b) the units of four parameters are hybrid and do not belong to one physical quantity
(c) the parameters are used in transmission line theory
(d) the parameters are used in different types of amplifiers

Ans. (b)
The units of four parameters are hybrid and do not belong to one physical quantity.



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85. An amplifier has an open-loop gain of 1000. This gain varies by ±100, and feedback is introduced to ensure that the voltage gain varies by not more than ±0.1%. The gain with feedback A_F will be

(a) 5 (b) 10

(c) 15 (d) 20

Ans. (b)

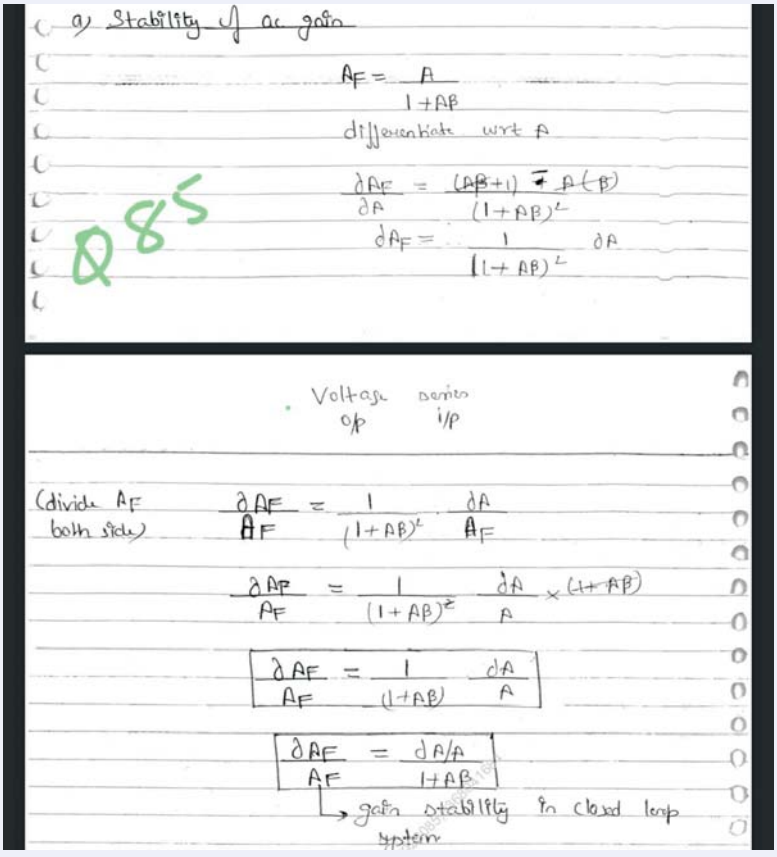
$$A = 1000$$

$$\partial A = 10\% \text{ of } A$$

$$\partial A_F = 0.1\% \text{ of } A_F$$

$$1 + A\beta = \frac{\frac{\partial A}{A}}{\frac{\partial A_F}{A_F}} = \frac{10}{0.1} = 100$$

$$A_F = \frac{A}{1 + A\beta} = \frac{1000}{100} = 10$$



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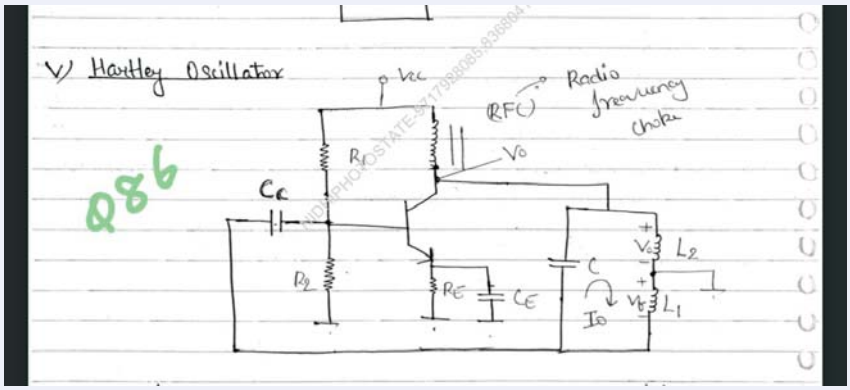
86. In L-C oscillators, radio frequency choke (RFC) is used
(a) to produce high frequency
(b) to provide stability to oscillator
(c) to prevent high-frequency current flowing through the power supply
(d) to provide positive feedback

Ans. (c)

To prevent high frequency current flowing through the power supply.



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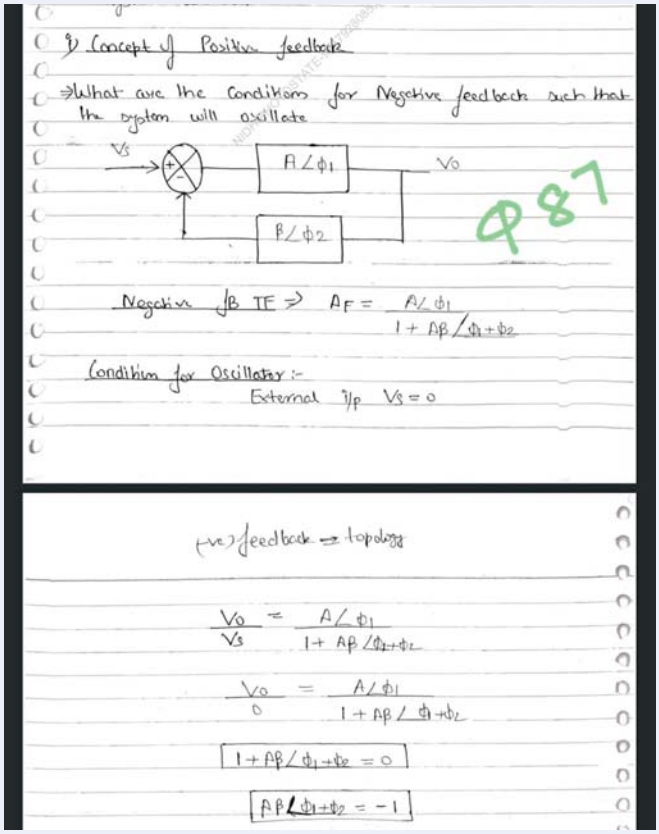
87. A sinusoidal oscillator is an amplifier with
(a) negative feedback and does not require any input
(b) negative feedback and does not require any active device
(c) positive feedback and does not require any input
(d) positive feedback and does not require any active device

Ans. (c)
Positive feedback and does not require any input.



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88. The output signal of an op-amp with a slew rate of 2 V/μs has a maximum value of 10 V. The maximum frequency for undistorted output voltage will be nearly

(a) 32 kHz (b) 36 kHz

(c) 42 kHz (d) 46 kHz

Ans. (a)

$$V_o = A_F\, V_m \sin \omega t$$

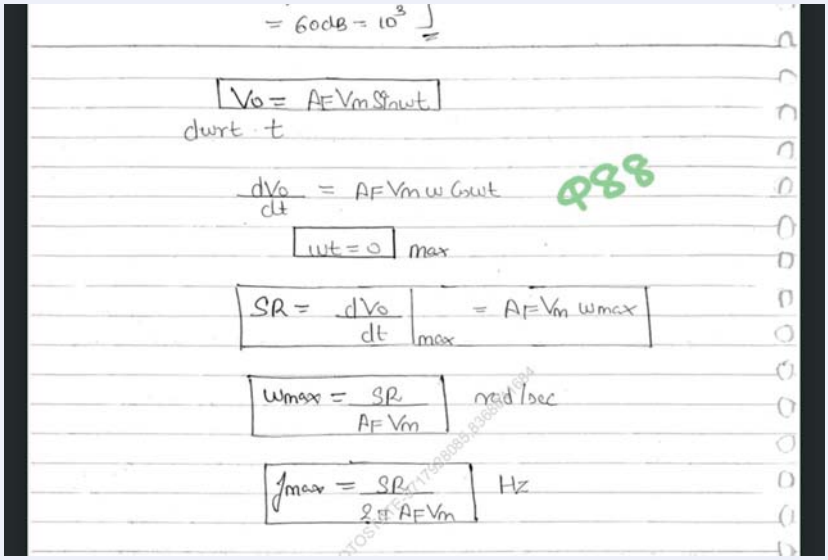
$$\text{S.R.} = \frac{dv_o}{dt} = A_F V_m \cos\omega t\, \omega_n$$

$$\text{SRI}_{max} = A_F\, V_m\, \omega_{max}$$

$$f_{max} = \frac{SR}{2\pi A_F V_m} = \frac{SR}{2\pi V_{o,max}}$$

$$= \frac{2V}{10^{-6} \times 2 \times 3.14 \times 10}$$

$$= 32 \text{ kHz}$$



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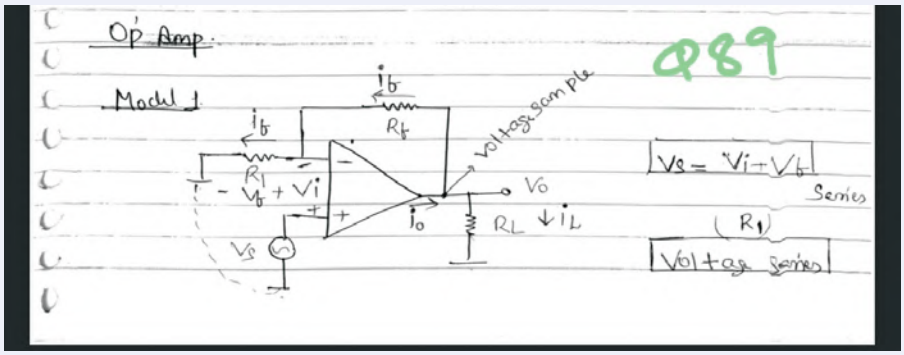
89. Non-inverting amplifier with feedback exhibits the characteristics of the perfect
(a) current amplifier (b) voltage amplifier
(c) current-to-voltage converter (d) voltage-to-current converter

Ans. (b)

Non-inverting amplifier with feedback exhibits voltage amplifier.



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90. For a 12-bit A/D converter of an input clock frequency of 1 MHz, the maximum conversion required time will be nearly
(a) 2 ms (b) 4 ms
(c) 6 ms (d) 8 ms

Ans. (a)

Given : $n = 12$

Max. possible count $= 2^{n-1}$

$= 2^{11} = 2048$

Maximum conversion time

$= 2048 \times 1\ \mu sec$

≈ 2 msec

End of Solution

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91. The output voltage of LVDT is 1.5 V at maximum displacement. At a load of 0.5 MΩ, the deviation from linearity is maximum and it is ±0.003 V from a straight line through origin. The linearity at the given load will be

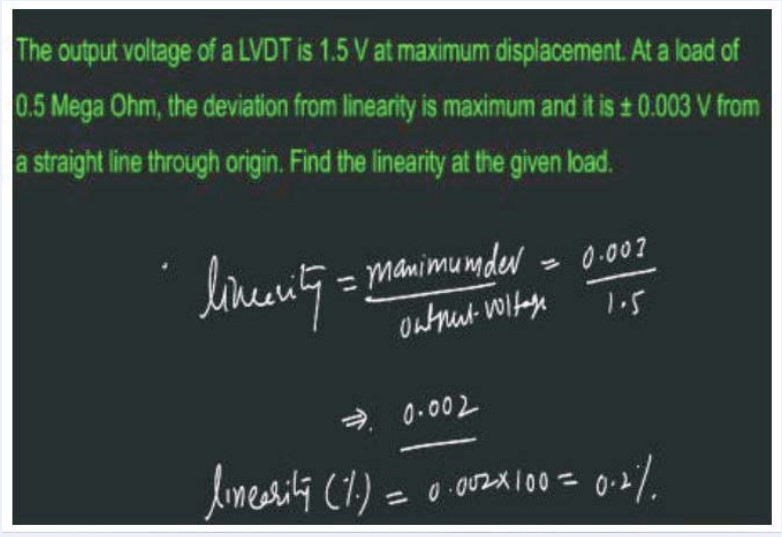
(a) ±0.1% (b) ±0.2%

(c) ±0.3% (d) ±0.4%

Ans. (b)

$$\% \text{ Linearity} = \left(\frac{\text{Maximum deviation}}{\text{Maximum output voltage}}\right) \times 100$$

$$= \left(\frac{0.003 \text{ Volts}}{1.5 \text{ Volts}}\right) \times 100 = 0.2\%$$



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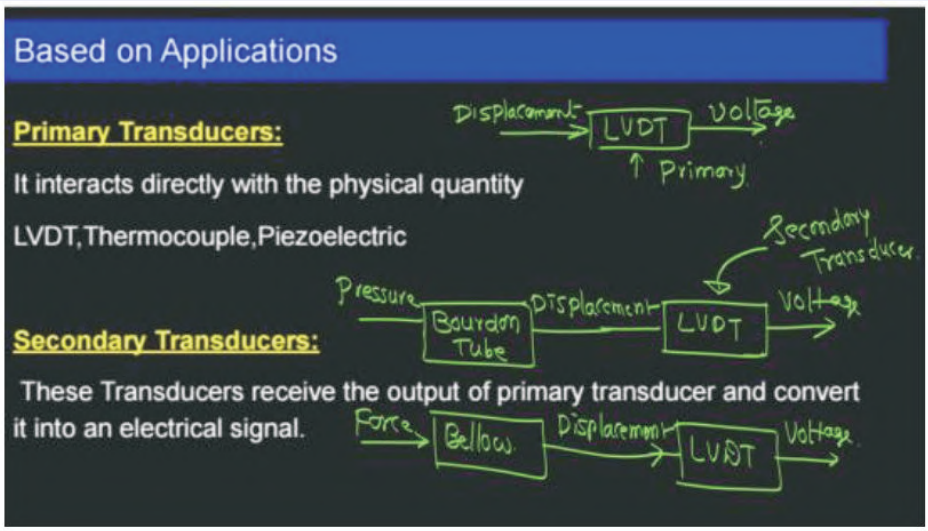
92. Force-summing devices are used
(a) to add different forces
(b) to convert the applied force into displacement
(c) to measure forces
(d) to convert the displacement into force

Ans. (b)
Converts the applied force into displacement.



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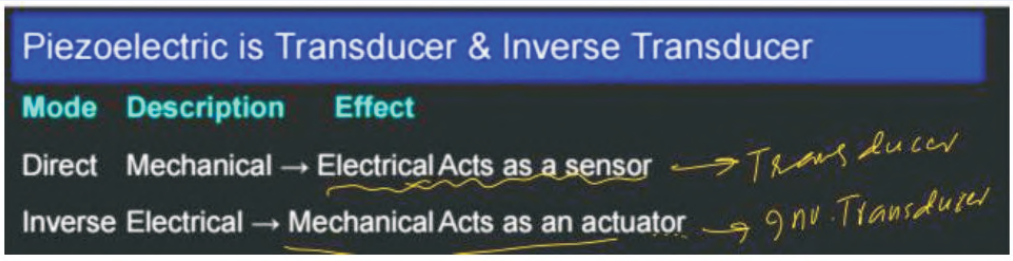
End of Solution

93. Which one of the following can act as inverse transducer, when a voltage is applied across its surfaces?
(a) Electrical resistance potentiometer (b) LVDT
(c) Capacitive transducer (d) Piezoelectric crystal

Ans. (d)
Piezoelectric crystal



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End of Solution

94. What is the full form of the following expression?

$$Y = \Pi M(0,1,3,4)$$

(a) $(A+B+C)(A+B+\bar{C})(A+\bar{B}+\bar{C})(\bar{A}+B+C)$

(b) $(\bar{A}+B+C)(A+\bar{B}+C)(A+B+\bar{C})(\bar{A}+B+C)$

(c) $(A+B+C)(A+\bar{B}+\bar{C})(A+\bar{B}+\bar{C})(\bar{A}+B+\bar{C})$

(d) $(A+B+\bar{C})(A+B+\bar{C})(A+\bar{B}+\bar{C})(\bar{A}+B+C)$

Ans. **(a)**

Given expression

$$Y = \Pi M(0,\ 1,\ 3,\ 4)$$

Given expression is in minterm form.

Drawing the K-map of the above expression :

	$(B+C)$	$(B+\bar{C})$	$(\bar{B}+\bar{C})$	$(\bar{B}+C)$
A	0 (0)	0 (1)	0 (3)	(2)
$\bar{A}$	0 (4)	(5)	(7)	(6)

Writing the minterm expression :

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

End of Solution

95. Which one of the following operators replaces certain statements of the if-then-else form in C/C++?

(a) , Operator
(b) * Operator
(c) & Operator
(d) ? Operator

Ans. **(d)**

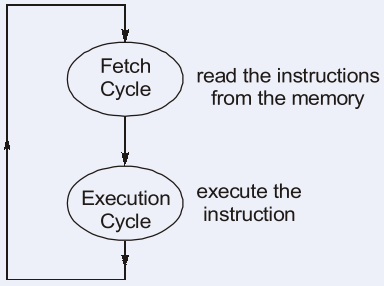
Ternary (or) conditional operation (? :) is used to specify the conditional selection operation (if stmt).

End of Solution

96. The necessary steps that the processor has to carry out for fetching an instruction from the memory and executing it, constitute

(a) an interrupt
(b) an addressing
(c) an instruction cycle
(d) a control signal

Ans. (c)



"Instruction Cycle"

End of Solution

97. The total storage capacity of a floppy disk having 80 tracks and storing 128 bytes/sector is 163840 bytes. How many sectors does the disk have?

(a) 18
(b) 16
(c) 14
(d) 12

Ans. (b)

$$\text{Disc capacity} = \frac{\#\text{ tracks}}{\text{disc}} * \frac{\#\text{sectors}}{\text{track}} * \frac{\#\text{bytes}}{\text{sector}}$$

$$163840\text{B} = 80 * x * 128\text{B}$$

$$x = \frac{163840}{10240} = 16$$

End of Solution

98. Which one of the following buses is used to control the access to and use of data and address buses by various units which share the bus in a computer system?

(a) Data bus (b) Address bus
(c) Power bus (d) Control bus

Ans. (d)

Control Bus : Group of various control and timing signals for operations of CPU like Read, Write.

- Data bus:
  Purpose: it is used to transfer data between processor, memory & i/o devices
  Length: It is of 8 bits in length for 8085
  Direction: Data bus is bidirectional.
  Note: there is no separate data bus in 8085, the lower order address lines can be used either as address or data bus, using a signal known as ALE- address latch enable
  If ALE = 1; All 16 lines are used as address lines.
  ALE = 0; $A_{15} - A_8$ - Address Bus
  $AD_7 - AD_0$ Data bus(Multiplexed Address/Data Bus).
- **Control bus**: It is group of different control, timing & status for various operations of the processor
  It doesn't have any direction as every signal is performing different task
  Ex, RD, WR , ALE

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End of Solution

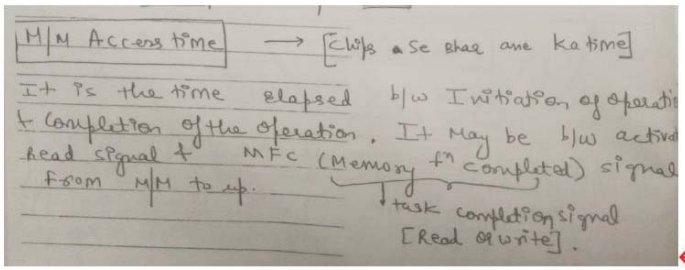
99. If at time t_0, the address from which data is to be retrieved is placed in MAR and at time t_1, the required data is available in MDR, the elapsed time $(t_1 - t_0)$ is called

(a) cycle time of the memory (b) write time of the memory
(c) read time of the memory (d) access time of the memory

Ans. (d)

Access time of the memory/memory access time. After the address is placed on address bus, the time required to retrieve data from memory and place on data bus.

After the address is placed on to the address bus through MAR-Memory addres register and the data retrived on to the data bus and loaded in to MDR i.e memory data register.



← Class Handout

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100. In TFT LCD monitor, TFT stands for
(a) Thick Film Transistor (b) Thin Film Transistor
(c) Time Film Transistor (d) Through Film Transistor

Ans. (b)
TFT : Thin film transistor

End of Solution

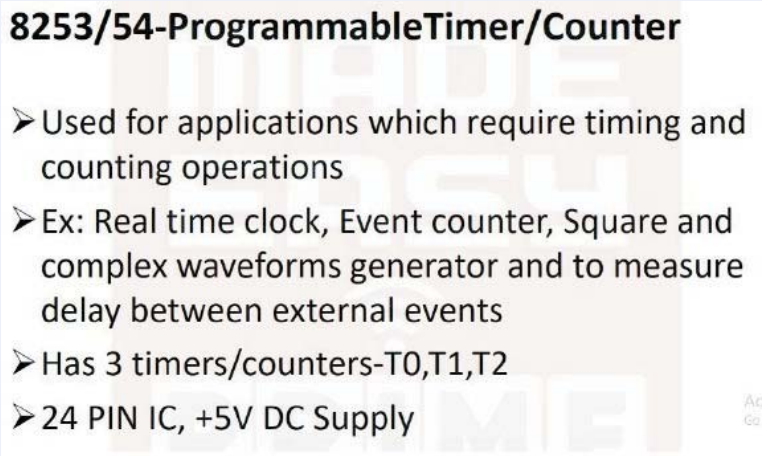
101. Which one of the following is the low-level software that schedules tasks, allocates storage, and handles the interface to peripheral hardware?
(a) DMA (b) CPU
(c) I/O device (d) Kernel

Ans. (d)
"OS" is responsible to allocate the hardware resources efficiently among the user programs.

End of Solution

102. Which one of the following is used for generation of an accurate time delay for event counting, rate generation, complex waveform generation applications?
(a) Programmable timer/counter (b) DMA controller
(c) Match coprocessor (d) Programmable interrupt controller

Ans. (a)
Programmable timer/counter. For example : 8253/8254.



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103. The wrapping-up of data and functions into a single unit is known as
(a) encapsulation (b) abstraction
(c) inheritance (d) polymorphism

Ans. (a)
Encapsulation is a fundamental concept in OOP where data (variables) and the methods (functions) that operate on that data are bundled together into a single unit typically a class.

End of Solution

104. Which one of the following file operations is used with random access files to first position read/write pointer to a specific place in file so that the data can be read from, or written to that position?
(a) Read (b) Write
(c) Seek (d) Set attribute

Ans. (c)
Seek operation moves the file pointer also called the file offset to a specific byte position in the file. This allows random access instead of reading the file sequentially.

End of Solution

105. Which one of the following not only translates the code into machine language but also executes it?
(a) Interpreter (b) Linker
(c) Loader (d) Compiler

Ans. (a)
Interpreter : Converts high level lanaugage to machine level language but line by line exeuction, i.e., result can be seen.

Softwares:
Compiler: converts HLL to machine level language, where entire program is converted at a time Ex; Turbo C, XLC, Javac
Interpreter: HLL—MLL line by line,Ex: M-BASIC
Assembler: Assembly program to Machine code(object program). Ex.MASM—microsoft macro assembler.
Cross Assembler: Used to translate opcodes of one processor in to opcodes of another processor.
Loader: used to load the program into memory, it also converts hex code to binary(ex; .EXE file)

MADE EASY Study Material

End of Solution

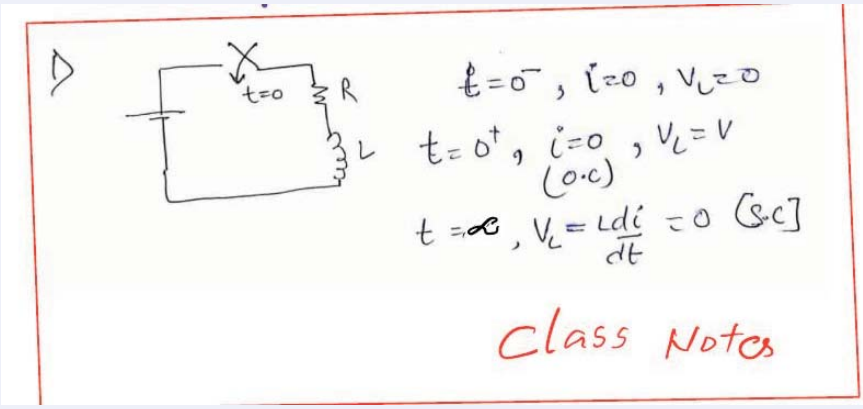
106. When a series R-L circuit is connected to a voltage V at $t = 0$, the current passing through the inductor L at $t = 0^+$ is

(a) $\frac{V}{R}$ (b) ∞

(c) 0 (d) $\frac{V}{L}$

where, V is voltage applied; R is resistance; L is inductor.

Ans. (c)



MADE EASY Class Notes

End of Solution

107. Which of the following statements for a balanced 3-phase circuit are correct?

1. The total instantaneous power $p = 3P$, where P is the real power per phase.
2. The sum of three currents at any instant is zero.
3. The sum of instantaneous reactive powers is zero.

Select the correct answer.

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

Ans. (a)

End of Solution

108. In a 3-phase balanced star-connected system, the line voltages are

(a) 90° ahead of their respective phase voltages

(b) 90° behind their respective phase voltages

(c) 30° ahead of their respective phase voltages

(d) 30° behind their respective phase voltages

Ans. (c)

End of Solution

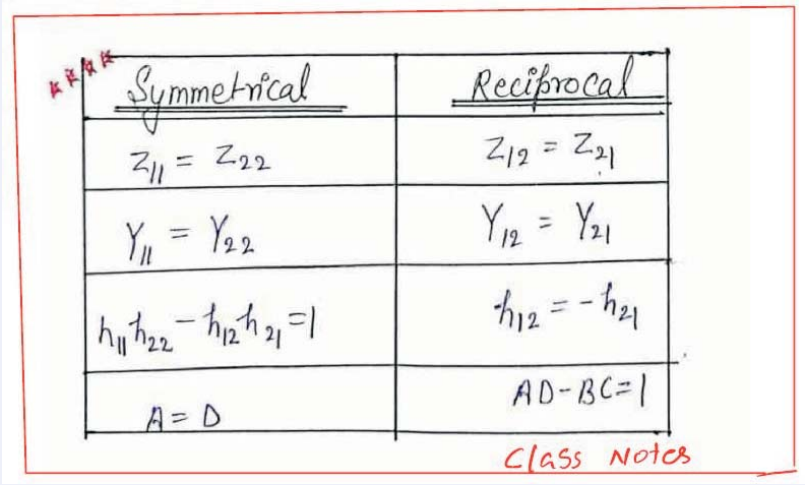
109. Which of the following conditions for a 2-port symmetrical electrical network are correct? (Assume standard notations)

1. $y_{11} = y_{22}$
2. $A = D$
3. $h_{11} = h_{22}$

Select the correct answer.

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (a)



MADE EASY Class Notes

End of Solution

110. Consider the following network function :

$$H(s) = \frac{10s}{(s^2 + 300s + 10^6)}$$

The quality factor Q is

(a) 5.3
(b) 4.7
(c) 3.3
(d) 2.7

Ans. (c)

Given : $H(s) = \dfrac{10s}{s^2 + 300s + 10^6}$

Characteristic equation $= s^2 + 300s + 10^6$ ...(1)

On comparing above characteristic equation with standard 2nd order equation

$= s^2 + 2\xi\omega_n s + \omega_n^2$

$\therefore \quad \omega_n^2 = 10^6 \Rightarrow \omega_n = 10^3$

and $2\xi\omega_n = 300$

$$2\xi \times 10^3 = 300$$
$$\xi = 0.15$$

Since the quality factor,

$$Q = \frac{1}{2\xi} = \frac{1}{2\times 0.15} = 3.33$$

End of Solution

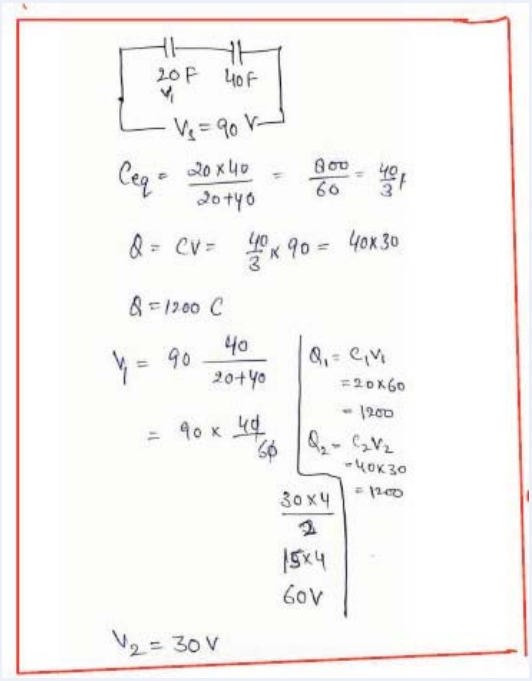
111. Three capacitors of capacitances 10 μF, 20 μF and 40 μF are connected in series across 280 V. The charge of each capacitor will be

(a) 0.6×10^{-3} C (b) 1.6×10^{-3} C

(c) 2.6×10^{-3} C (d) 3.6×10^{-3} C

Ans. (b)

$$\frac{1}{C_{eq}} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40}$$
$$\frac{1}{C_{eq}} = \frac{4+2+1}{40} = \frac{7}{40}$$
$$C_{eq} = \frac{40}{7}$$
$$Q = C_{eq}V = \frac{40\mu}{7} \times 280 = 1600\ \mu C$$
$$= 1.6 \times 10^{-3}\ C$$



MADE EASY Class Notes

End of Solution

112. Which one of the following standards is used to check and calibrate laboratory instrument for accuracy and performance?

(a) International standard
(b) Voltage standard
(c) Working standard
(d) Secondary standard

Ans. (a)

International Standard

End of Solution

113. The expected value of the voltage across a resistor is 80 V. However, the measurement gives a value of 79 V. The percentage of accuracy will be nearly

(a) 92.75%
(b) 94.25%
(c) 96.25%
(d) 98.75%

Ans. (d)

$$\% \text{ Error} = \frac{79-80}{80} \times 100 = 1.25\%$$

$$\% \text{ Accuracy} = 100 - (1.25\%) = 98.75\%$$

Work BooK

Q.7 The expected value of the voltage across a resistor is 80 V. However, the voltmeter reads 79 V. The absolute error in the measurement is

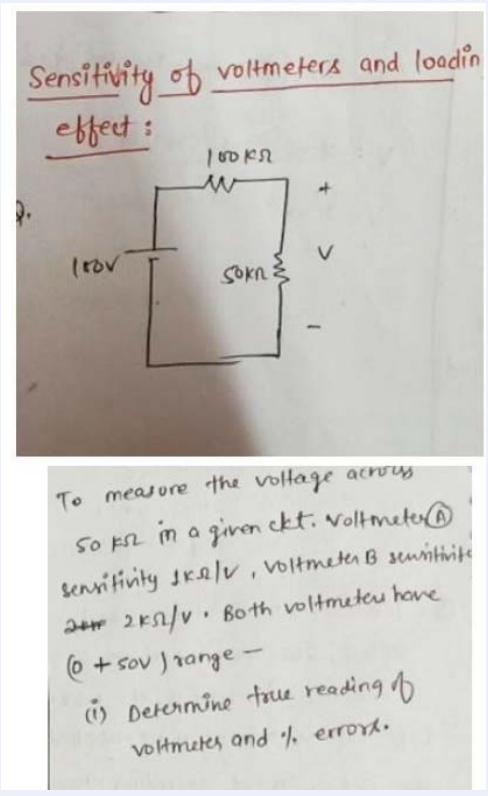
(a) 0.875 V
(b) 0.125 V
(c) 1.00 V
(d) 1.125 V [ESE-2014]

MADE EASY Study Material

End of Solution

114. A meter will give a lower indication of the voltage drop that actually existed before the meter was connected. This effect is called
(a) inductive effect of an instrument
(b) synchronizing effect of an instrument
(c) loading effect of an instrument
(d) capacitive effect of an instrument

Ans. (c)
Loading effect of an instrument

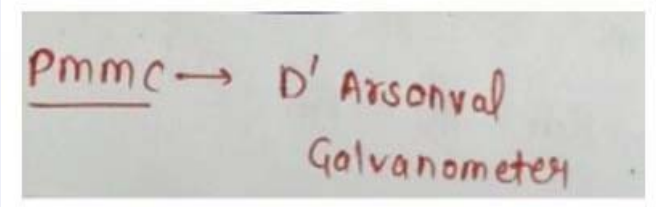


MADE EASY Class Notes

End of Solution

115. The basic permanent magnet moving coil (PMMC) mechanism is often called
(a) d'Arsonval movement (b) G. Arsonval movement
(c) current sensitivity (d) voltage sensitivity

Ans. (a)



MADE EASY Class Notes

End of Solution

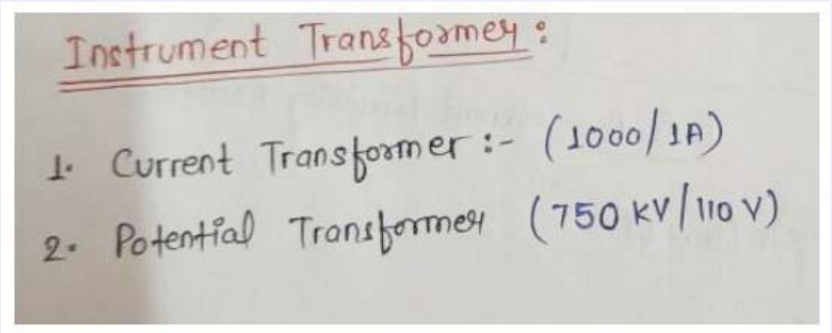
116. In frequency division multiplexing, a typical telemetry carrier frequency of 230 MHz is used with a bandwidth of
(a) ±320 kHz (b) ±490 kHz
(c) ±520 kHz (d) ±590 kHz

Ans. (b)

End of Solution

117. The potential transformer is used to operate voltmeters, potential coils of wattmeters and relays from
(a) high current lines (b) low current lines
(c) high voltage lines (d) low voltage lines

Ans. (c)

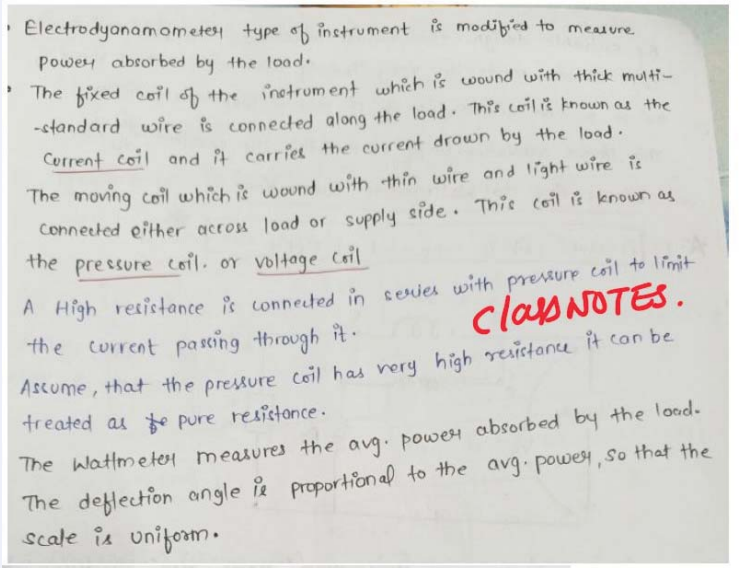


MADE EASY Class Notes

End of Solution

118. The output power wattmeter is designed to measure the output power
(a) inversely in an arbitrary load (b) directly in an arbitrary load
(c) squared in an arbitrary load (d) indirectly in an arbitrary load

Ans. (b)



MADE EASY Class Notes

End of Solution

119. The nominal ratio K_n for a current transformer is

(a) $\frac{\text{Primary winding current}}{\text{Secondary winding current}}$

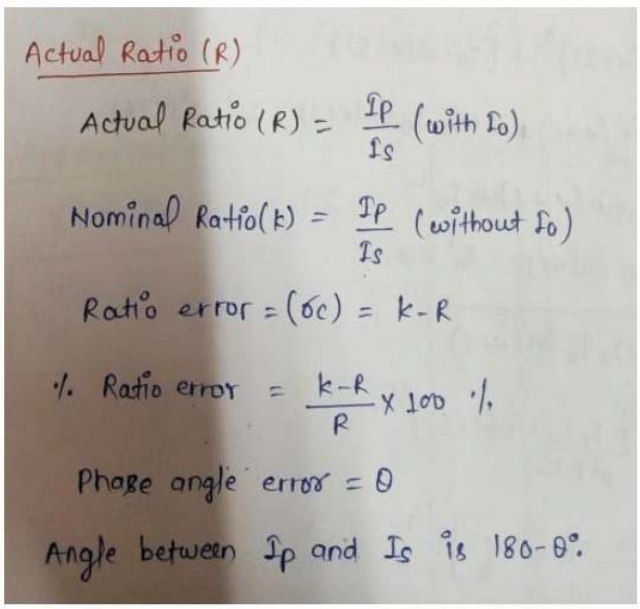
(b) $\frac{\text{Rated primary winding current}}{\text{Rated secondary winding current}}$

(c) $\frac{\text{Secondary winding current}}{\text{Primary winding current}}$

(d) $\frac{\text{Rated secondary winding current}}{\text{Rated primary winding current}}$

Ans. **(b)**

$$K_n = \frac{I_{p,\text{rated}}}{I_{s,\text{rated}}} \text{ for C.T.}$$



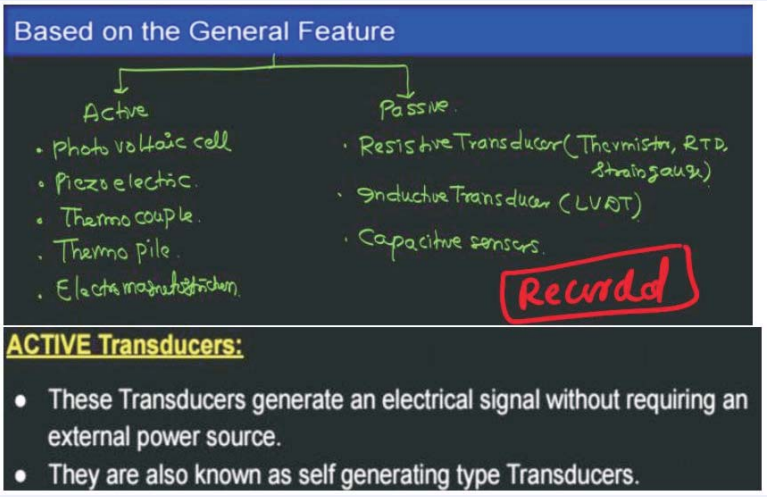
MADE EASY Class Notes

End of Solution

120. Which one of the following generates an electrical signal directly in response to the physical parameter and does not require an external power source for its operation?

(a) Active transducer
(b) Passive transducer
(c) Amplifier
(d) Rectifier

Ans. (a)



MADE EASY Class Lecture

End of Solution

121. A very weak form of magnetism that is non-permanent persists only while an external field is being applied. It is induced by a change in the orbital motion of electrons due to an applied magnetic field. This form of magnetism is called

(a) ferromagnetism
(b) ferrimagnetism
(c) paramagnetism
(d) diamagnetism

Ans. (d)

Diamagnetism is a very weak form of magnetism that is non-permanent and persists only when external field is being applied. It is induced by a change in the orbital motion of electrons due to an applied magnetic field.

End of Solution

122. The magnetic moments of diamagnetic material are mainly due to
(a) orbital angular momentum of the electrons
(b) electron spin angular momentum of the electrons only
(c) nuclear spin angular momentum of the electrons only
(d) both electron spin angular momentum and nuclear spin angular momentum of the electrons

Ans. **(a)**
It is induced by a change in the orbital motion of electrons due to applied magnetic field.

End of Solution

123. The magnetic flux density on the surface of an iron face is 1.6 T, which is a typical saturation level value for ferromagnetic material. If the value of $\mu\ 4\pi \times 10^{-7}$ H/m, the force density on the iron face will be nearly
(a) 0.25×10^6 N/m^2 (b) 1.0×10^6 N/m^2
(c) 2.0×10^6 N/m^2 (d) 4.0×10^6 N/m^2

Ans. **(b)**

$$\text{The force density} = \frac{1}{2}\frac{B^2}{\mu_o}$$
$$= \frac{1}{2} \times \frac{1.6 \times 1.6}{4\pi \times 10^{-7}}$$
$$= 1.01 \times 10^6 \text{ N/m}^2$$

End of Solution

124. When a ferromagnetic substance is magnetized, there are small changes in its dimensions. The phenomenon is known as
(a) deformation (b) polarization
(c) magnetostriction (d) magnetization

Ans. **(c)**
When magnetic materials are magnetized, changes in dimensions are generally observed. This property of material is known as magnetostriction.

End of Solution

125. In Fe_3O_4, each cubic unit cell contains $8Fe^{2+}$ and $16Fe^{3+}$ ions, the unit cell edge length is 0.839 nm and Bohr magnetons/unit cell is 32 and the value of Bohr magneton is 9.27×10^{-24} A-m^2/Bohr magneton is saturation magnetization will be
(a) 1×10^5 A/m (b) 3×10^5 A/m
(c) 5×10^5 A/m (d) 7×10^5 A/m

Ans. (c)

The saturation magnetization

$$M_s = \frac{n_8 \mu_8}{a^3}$$

$$= \frac{(32 \text{ Bohr magnetrons/unit cell})(9.27 \times 10^{-24} \text{ A-m}^2/\text{Bohr magnetron})}{(0.839 \times 10^{-9} \text{m})^3 / \text{unit-cell}}$$

$= 5 \times 10^5$ A/m

End of Solution

126. Which one of the following statements is **not** correct for Fermi level?

(a) When all the electrons have been accommodated in a metal atom, the number per level drops abruptly to zero, at an energy value E_f called Fermi level.

(b) The magnitude of Fermi level increases with the number of electrons per unit volume of the metal.

(c) The magnitude of Fermi level decreases with the number of electrons per unit volume of the metal.

(d) The extra electrons can only be accommodated in the higher energy levels.

Ans. (c)

The Fermi energy level is given as

$$E_F = \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3}$$

where, h = Planck's constant

m = mass of electron

n = number of electrons/m^3

$E_F \propto n^{2/3}$

The magnitude of Fermi level increases with the number of electrons per unit volume of the metal.

End of Solution

127. Electrons are emitted with zero velocity for a certain metal surface for $c = 3 \times 10^8$ m/ s Å = 10^{-10} m, when it is exposed to radiations of λ = 6800 Å. The threshold frequency of the metal will be nearly

(a) 2.6×10^{14} Hz (b) 2.8×10^{14} Hz

(c) 3.6×10^{14} Hz (d) 4.4×10^{14} Hz

Ans. (d)

Electrons are emitted with zero velocity.

So, $\lambda = \lambda_o$ (threshold wavelength)

$\therefore$ The threshold frequency of metal will be

$$V_o = \frac{c}{\lambda_o} = \frac{3 \times 10^8}{6800 \times 10^{-10}} = 4.4 \times 10^{14} \text{ Hz}$$

End of Solution

128. The materials which possess a permanent magnetic moment in the absence of an external field and manifest very large and permanent magnetizations are
(a) ferromagnetic (b) antiferromagnetic
(c) ferrimagnetic (d) superferrimagnetic

Ans. (a)
Ferromagnetic materials possess permanent magnetic moment in the absence of external field and are strong magnetized.

End of Solution

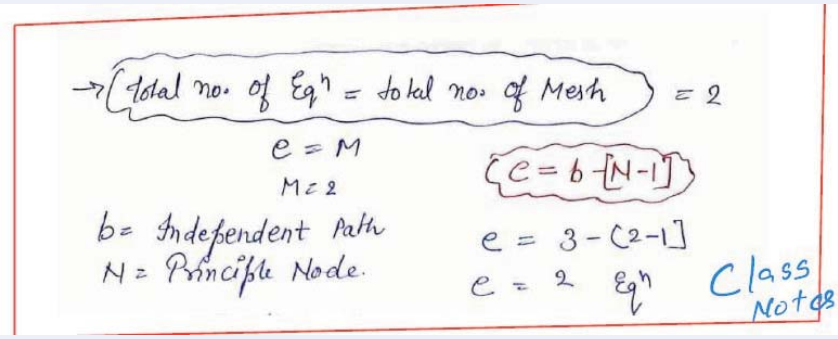
129. The magnetic inductance becomes zero inside a superconductor when it is cooled below T_c in a weak external field. The magnetic flux is expelled from the interior of the superconductor. This effect is called
(a) Boltzmann effect (b) Meissner-Ochsenfeld effect
(c) critical temperature effect (d) critical flux effect

Ans. (b)
The repulsion of magnetic flux lines from the interior of a magnetic material below critical temperature is known as Meissner's effect.

End of Solution

130. In a network, the number of linearly independent mesh equations (M) is
(a) $B + (N + 1)$ (b) $B - (N - 1)$
(c) $B + (N - 1)$ (d) $B - (N + 1)$
where, B is number of branches in a network
N is number of nodes including the reference node

Ans. (b)



MADE EASY Class Notes

End of Solution

MADE EASY students top in ESE 2024

• 4 Streams 4 Toppers all 4 MADE EASY Students • 40 out of 40, in Top 10 • 197 out of total 206 Vacancies (95% Selections)

CE 10 in Top 10

AIR	Name	Course
1	ROHIT DHONDGE	CLASSROOM COURSE
2	HARSHIT PANDEY	CLASSROOM COURSE
3	LAXMIKANT	CLASSROOM COURSE
4	D MADHANKUMAR	CLASSROOM COURSE
5	AMAN PRATAP SINGH	CLASSROOM COURSE
6	SANCHIT GOEL	CLASSROOM COURSE
7	SUNIL SEERVI	CLASSROOM COURSE
8	ROHIT KUMAR	CLASSROOM COURSE
9	ANKIT MEENA	TEST SERIES & IGP
10	BADUGU RAJESH	ONLINE COURSE

ME 10 in Top 10

AIR	Name	Course
1	MUNISH KUMAR	TEST SERIES & IGP
2	RAJESH KASANIYA	ONLINE COURSE
3	GOLLANGI SATEESH	TEST SERIES & IGP
4	D. AJINKYA RADHAKISAN	CLASSROOM COURSE
5	BANKURU NAVEEN	CLASSROOM COURSE
6	CHANDAN JOSHI	ONLINE COURSE
7	DINESH KR. SHARMA	CLASSROOM COURSE
8	SHAILENDRA SINGH	CLASSROOM COURSE
9	KRISHNA K. DWIVEDI	CLASSROOM COURSE
10	V. AKSHAY SANTOSH	IGP

EE 10 in Top 10

AIR	Name	Course
1	RAJAN KUMAR	CLASSROOM COURSE
2	SATYAM CH. KHAIRNAR	CLASSROOM COURSE
3	PRIYANSHU MUDGAL	ONLINE COURSE
4	NAMAN AGARWAL	ONLINE COURSE
5	MAYANK KUMAR SINGH	CLASSROOM COURSE
6	RITVIK KOK	ONLINE COURSE
7	MANTHAN SHARMA	CLASSROOM COURSE
8	MAYANK JAIMAN	ONLINE COURSE
9	ANMOL SINGH	ONLINE COURSE
10	AKSHIT PARASHARI	ONLINE COURSE

E&T 10 in Top 10

AIR	Name	Course
1	HIMANSHU THAPLIYAL	CLASSROOM COURSE
2	YASHASVI VIJAYVARGIYA	CLASSROOM COURSE
3	UNNATI CHANSORIA	ONLINE COURSE
4	RAJIV RANJAN MISHRA	CLASSROOM COURSE
5	PARAG SAROHA	ONLINE COURSE
6	CHANDRIKA GADGIL	CLASSROOM COURSE
7	DEBARGHYA CHATTERJEE	CLASSROOM COURSE
8	VIDHU SHREE	ONLINE COURSE
9	T. PIYUSH DAYANAND	CLASSROOM COURSE
10	RAJVARDHAN SHARMA	CLASSROOM COURSE

MADE EASY students top in GATE 2025

• 10 All India Rank 1 (CE, ME, IN, ES & EE) • 46 Selections in Top 10 • 401 Selections in Top 100

CE 10 in Top 10

AIR	Name	Course
CE 1	ABHAY SINGH	CLASSROOM COURSE
CE 2	HARSHVARDHAN SINGH	CLASSROOM COURSE
CE 3	PANKAJ MEENA	CLASSROOM COURSE
CE 4	HARSHIL MAHESHWARI	ONLINE COURSE
CE 5	KARTIK POKHRIYAL	CLASSROOM COURSE
CE 6	SHIVANAND CHAURASIA	ONLINE COURSE
CE 6	NIMISH UPADHYAY	ONLINE COURSE
CE 9	TARUN YADAV	CLASSROOM COURSE
CE 10	ADNAN QUASAIN	CLASSROOM COURSE
CE 10	RAHUL SINGH	ONLINE COURSE

ME+PI 14 in Top 10

AIR	Name	Course
ME 1	RAJNEESH BIJARNIYA	CLASSROOM COURSE
ME 2	GOLLANGI SATEESH	ONLINE COURSE
ME 3	NIMESH CHANDRA	CLASSROOM COURSE
PI 3	ADITYA KUMAR PRASAD	CLASSROOM COURSE
PI 5	KULDEEP SINGH NARUKA	CLASSROOM COURSE
PI 6	KAUSHAL KUMAR KAUSHIK	ONLINE COURSE
PI 7	WALEED SHAIKH	TEST SERIES
ME 7	ABHINN	CLASSROOM COURSE
ME 8	GOUTAM KUMAR	TEST SERIES
ME 10	ASHUTOSH KUMAR	CLASSROOM COURSE
ME 10	JETTI GANATEJA	TEST SERIES
ME 10	MUHAMMED SINAN K	TEST SERIES
ME 10	PITCHIKA KUMAR VASU	ONLINE COURSE
PI 10	M GOPU GANESH	TEST SERIES

EE+CS 6 in Top 10

AIR	Name	Course
EE 1	PRADIP CHAUHAN	TEST SERIES
EE 2	KAILASH GOYAL	CLASSROOM COURSE
EE 6	PUNEET SONI	TEST SERIES
EE 6	SHIVAM KUMAR GUPTA	TEST SERIES
CS 9	OMHARI	TEST SERIES
EE 10	NEELAVA MUKHERJEE	POSTAL PACKAGE & TEST SERIES

IN+EC 9 in Top 10

AIR	Name	Course
IN 1	KAILASH GOYAL	CLASSROOM COURSE
EC 2	ANKUSH PHILIP JOHN	POSTAL PACKAGE & TEST SERIES
IN 2	S. BHATTACHARYA	TEST SERIES
IN 5	SACHIN YADAV	TEST SERIES
EC 5	M. M. NAFEEZ	TEST SERIES
EC 6	PENTELA BHAVANI	TEST SERIES
IN 6	UTKARSH PATIL	CLASSROOM COURSE
IN 7	DEV J. PATEL	TEST SERIES
EC 9	CHILUKURI S. CHARAN	TEST SERIES

ES+XE 7 in Top 10

AIR	Name	Course
ES 1	YASH JAIN	CLASSROOM COURSE
ES 2	JITESH CHOUDHARY	CLASSROOM COURSE
ES 2	TARUN YADAV	CLASSROOM COURSE
XE 3	ROHAN KUMAR BISWAL	TEST SERIES
ES 5	SACHIN KUMAR	CLASSROOM COURSE
ES 7	ANKIT KUMAR	CLASSROOM COURSE
XE 9	APAR HARSH CHANDRA	CLASSROOM COURSE

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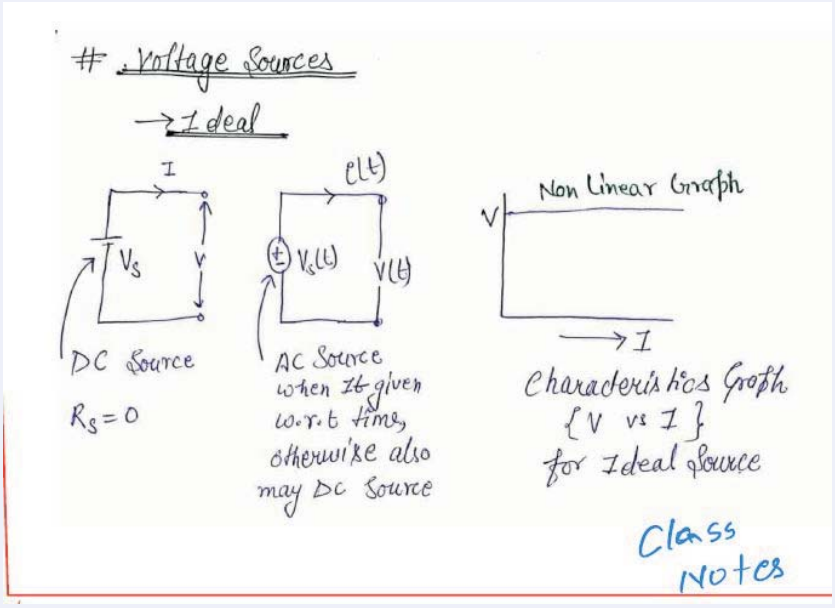
131. Which one of the following never dissipates energy but only stores it?
(a) Pure capacitor (b) Pure resistor
(c) Conductor (d) Ideal diode

Ans. (a)

End of Solution

132. An ideal voltage source is defined as energy source whose terminal voltage (V) is
(a) proportional to load with infinite internal resistance
(b) dependent on the output current
(c) independent of the output current
(d) proportional to load with finite internal resistance

Ans. (c)

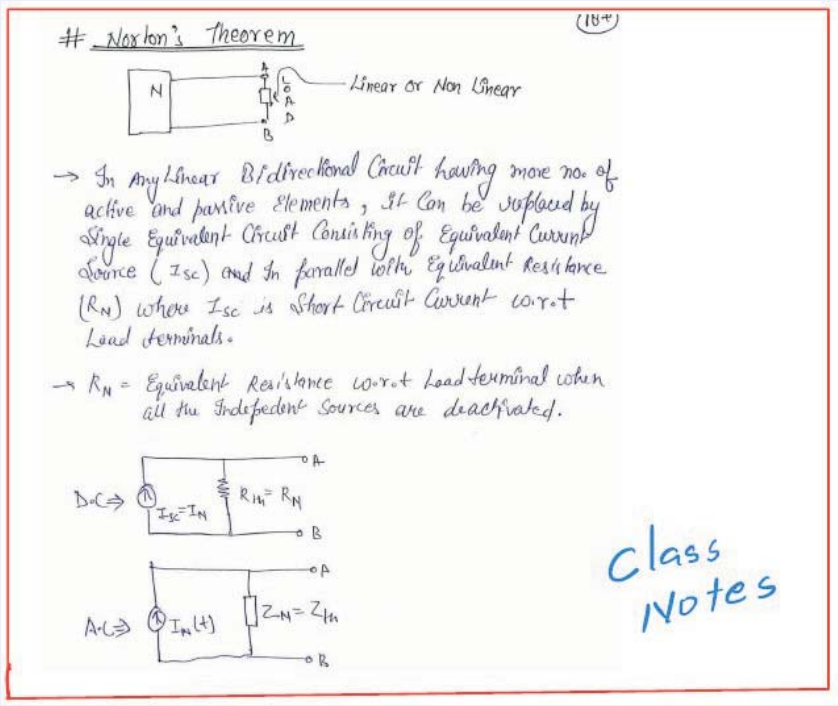


MADE EASY Class Notes

End of Solution

133. Norton's theorem states that any two-terminal linear network with current sources, voltage sources and resistances can be replaced by an equivalent circuit consisting of a
(a) voltage source in parallel with a resistance
(b) voltage source in series with a resistance
(c) current source in series with a resistance
(d) current source in parallel with a resistance

Ans. (d)

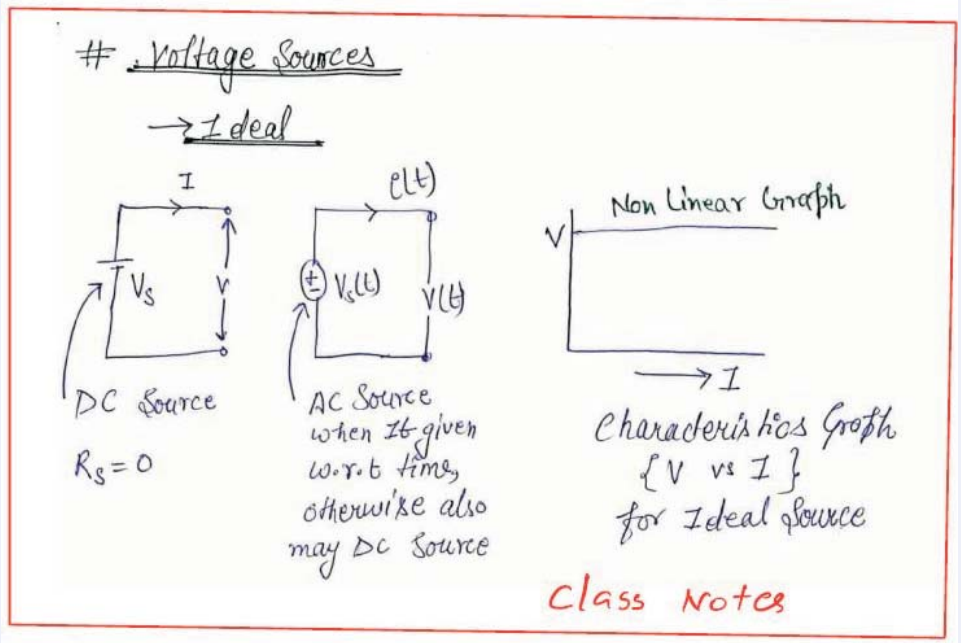


MADE EASY Class Notes

End of Solution

134. An ideal voltage source is a two-terminal element in which the
(a) current i_s is completely independent of the voltage
(b) voltage v_s is completely independent of the current i_s through its terminals
(c) current i_s is completely independent through its terminals
(d) voltage v_s is completely dependent on current i_s through its terminals

Ans. (b)



MADE EASY Class Notes

End of Solution

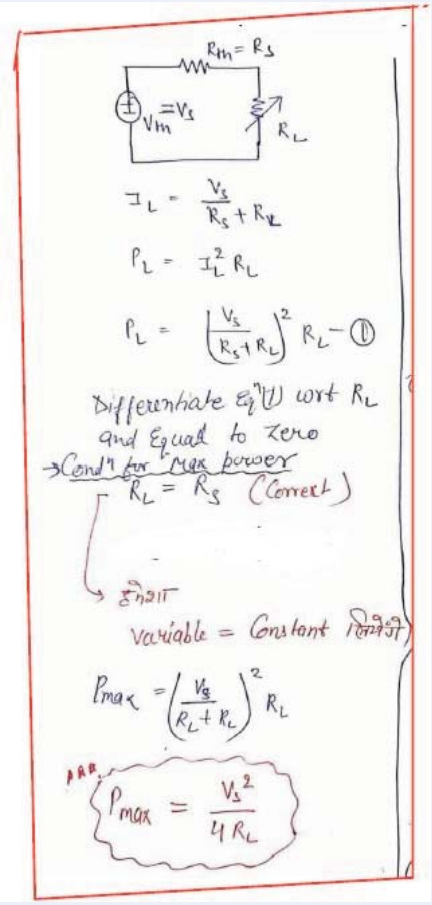
135. A circuit consists of a voltage source with 50 V and an internal resistance of 25 Ω. If a load is connected to the voltage source, the maximum power drawn by the load resistance of 25 Ω will be

(a) 15 W (b) 20 W

(c) 25 W (d) 30 W

Ans. (c)

$$P = \frac{V^2}{4R} = \frac{50 \times 50}{4 \times 25} = 25 \text{ W}$$



MADE EASY Class Notes

End of Solution

136. What is the value of b such that the system of homogeneous equations

$$2x + y + 2z = 0$$
$$x + y + 3z = 0$$
$$4x + 3y + bz = 0$$

has non-trivial solution?

(a) 4 (b) 6

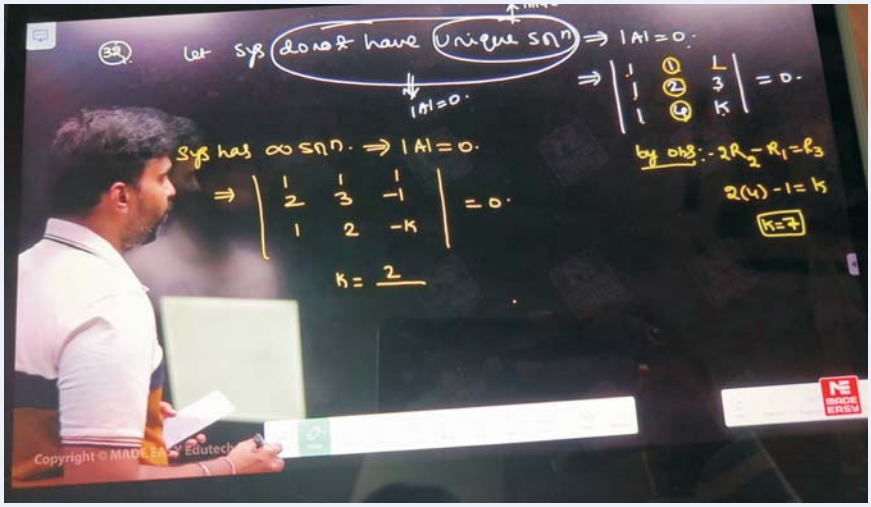
(c) 8 (d) 10

Ans. (c)

System have non-trivial solution iff $|A| = 0$

$$= \begin{vmatrix} 2 & 1 & 2 \\ 1 & 1 & 3 \\ 4 & 3 & b \end{vmatrix} = 0$$

$$\Rightarrow \quad 2(b - 9) - 1(b - 12) + 2(3 - 4) = 0$$
$$\Rightarrow \quad b - 6 - 2 = 0$$
$$\Rightarrow \quad b = 8$$



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End of Solution

137. The orthogonal trajectories of the hyperbolas $x^2 - y^2 = c$ are

(a) $x^2 + y^2 = c$ (b) $x + y = c$

(c) $xy = c$ (d) $x^2 + y^2 + 2x = c$

Ans. (c)

Given family of curves :

$$x^2 - y^2 = c \qquad \ldots(1)$$

Differentiating w.r.t. 'x' on both sides

$$2x - 2y\frac{dy}{dx} = 0$$

Replace slope of tangent $\left(\frac{dy}{dx}\right)$ by slope of normal $\left(-\frac{dy}{dx}\right)$

we get $2x + 2y\frac{dy}{dx} = 0$

Solving the differential equation, we get orthogonal trajectory to given family of curves

$$2x = -2y\frac{dx}{dy}$$

Variable separable : $\int \frac{1}{x}dx = \int -\frac{1}{y}dy$

$$\log x + \log y = \log c$$

$$\log (xy) = \log c$$

we get $xy = c$

$\therefore$ Required orthogonal trajectories of given curves is $xy = c$.

End of Solution

138. The value of the integral $\int_C x^2 y\, dS$, where C is the curve defined by

$$x = 3\cos t,\ y = 3\sin t,\ 0 \le t \le \frac{\pi}{2}$$

is

(a) 20 (b) 24

(c) 27 (d) 31

Ans. (c)

$$I = \int_C x^2 y ds$$

Here ds = length element of curve

$$= \int_C x^2 y \sqrt{\left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2}\, df$$

$$= \int_{t=0}^{\pi/2} 9\cos^2 t(3\sin t)\sqrt{(-3\sin t)^2 + (3\cos t)^2}\, dt$$

$$= 81\int_0^{\pi/2} \cos^2 t \sin t\, dt = 81\int_0^1 z^2 dz$$

$$= 81\left(\frac{z^3}{3}\right)_0^1 = 27$$

End of Solution

139. Let D be the region bounded by the closed cylinder $x^2 + y^2 = 16$, $z = 0$, $z = 4$, and $v = 3x^2\hat{i} + 6y^2\hat{j} + z\hat{k}$, then by divergence theorem $\iiint_D (\nabla.v)dV$ is

(a) 46π (b) 64π
(c) 84π (d) 96π

Ans. (b)

D : $x^2 + y^2 = 16$; $z = 0$ to 4 is closed surface

$$\vec{\nabla}\cdot\vec{V} = \frac{\partial}{\partial x}(3x^2) + \frac{\partial}{\partial y}(6y^2) + \frac{\partial}{\partial z}(z)$$

$$\vec{\nabla}\cdot\vec{V} = 6x + 12y + 1$$

Thus, $$\iiint_D (\vec{\nabla}\cdot\vec{V})dV = \iint_R \int_{z=0}^{4} (6x + 12y + 1)\,dz\,dy\,dx$$

$$= \iint_R (6x + 12y)z + z\Big]_0^4 dy\,dx = \iint_R (24x + 48y + 4)\,dy\,dx$$

$$= 24\iint_R (x + 2y)\,dy\,dx + 4\iint_R dy\,dx$$

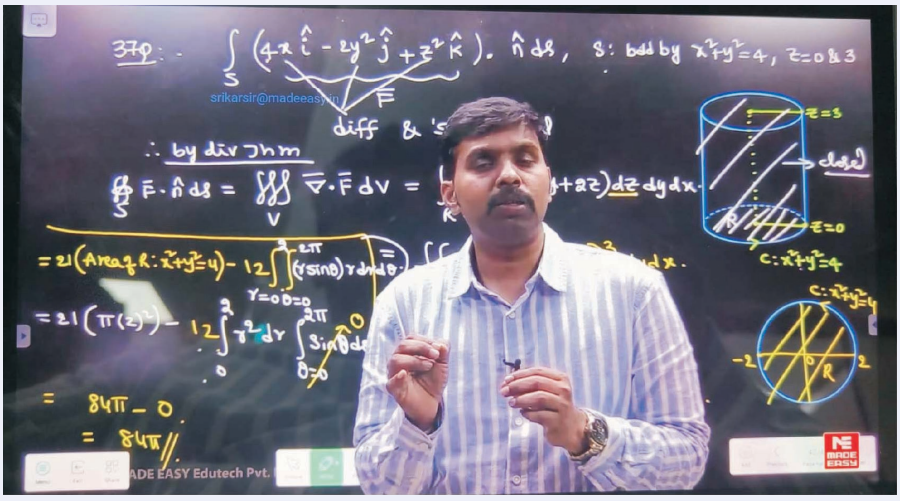
R : $x^2 + y^2 = 42$ in xy-plane

fix x : -4 to 4

y : $-\sqrt{16 - x^2}$ to $\sqrt{16 - x^2}$

$$= 24\int_{-4}^{4}\int_{-\sqrt{y^2-x^2}}^{\sqrt{y^2-x^2}} x\,dy\,dx + 48\int_{-4}^{4}\int_{-\sqrt{y^2-x^2}}^{\sqrt{y^2-x^2}} y\,dy\,dx + 4(\pi(y))$$

$$= 0 + 0 + 64\pi = 64\pi$$



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End of Solution

140. In the Fourier series expansion of the function

$$f(x) = x \sin x, \quad -\pi \le x \le \pi$$

the value of the Fourier coefficient α_1 is

(a) $-\frac{3}{2}$ (b) $-\frac{1}{2}$

(c) $-\frac{2}{3}$ (d) $-\frac{2}{5}$

Ans. **(b)**

$\because$ $f(x)$ is an even function in $[-\pi, \pi]$

$\therefore$ $$a_n = \frac{2}{\pi}\int_0^{\pi} f(x)\cos nx\, dx$$

for $n = 1$:

$$a_1 = \frac{2}{\pi}\int_0^{\pi} x \sin x \cos x\, dx$$

$$= \frac{1}{\pi}\int_0^{\pi} x \sin 2x\, dx$$

$$= \frac{1}{\pi}\left[x\left(\frac{-\cos 2x}{2}\right) - (1)\left(\frac{-\sin 2x}{4}\right)\right]_0^{\pi}$$

$$= \frac{1}{\pi}\left[\frac{\pi}{2}(-1) - 0\right] = \frac{-1}{2}$$

End of Solution

141. The partial differential equation formed by the elimination of arbitrary function from $z = f(x^2 - y^2)$ is

(a) $xp + yq = 0$ (b) $yp - xq = 0$

(c) $yp + zq = 0$ (d) $yp + xq = 0$

Ans. (d)

$$z = f(x^2 - y^2) \quad ...(1)$$

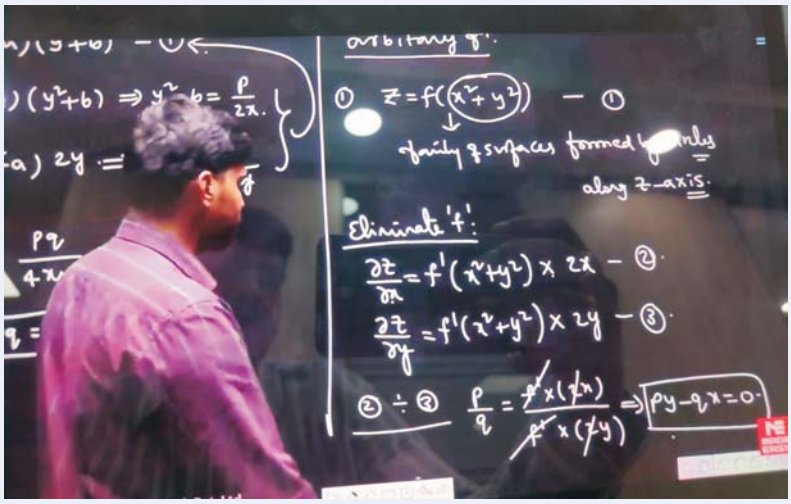
$$\frac{\partial z}{\partial x} = f'(x^2 - y^2) \times 2x \quad ...(2)$$

$$\frac{\partial z}{\partial y} = f'(x^2 - y^2) \times (-2y) \quad ...(3)$$

Dividing eqn. (2) by (3)

$$\frac{p}{q} = \frac{2x}{-2y}$$

$$\Rightarrow \quad py + qx = 0$$



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End of Solution

142. If one solution of the differential equation

$$(x^2 - y^2 - z^2)p + 2xyq = 2xz$$

is $\frac{y}{z} = a$, the other solution is

(a) $x^2 + y^2 + z^2 = b$ (b) $x^2 + y^2 + z^2 = zb$

(c) $x + y + z = b$ (d) $x + y + (1 - b)z = 0$

Ans. (b)

Lagrange's auxilliary equation is

$$\frac{2xdx}{x^2-y^2-z^2} = \frac{dy}{y} = \frac{dz}{z}$$

$$\frac{2x\cdot dx}{x^2-y^2-z^2} = \frac{2ydy}{2y^2} = \frac{2zdz}{2z^2} = \frac{2xdx+2ydy+2zdz}{x^2-y^2-z^2+2y^2+2z^2}$$

$$= \frac{2xdx+2ydy+2zdz}{x^2+y^2+z^2}$$

$$\frac{2xdx+2ydy+2zdz}{x^2+y^2+z^2} = \frac{dz}{z}$$

$$\int \frac{d(x^2+y^2+z^2)}{x^2+y^2+z^2} = \int \frac{dz}{z}$$

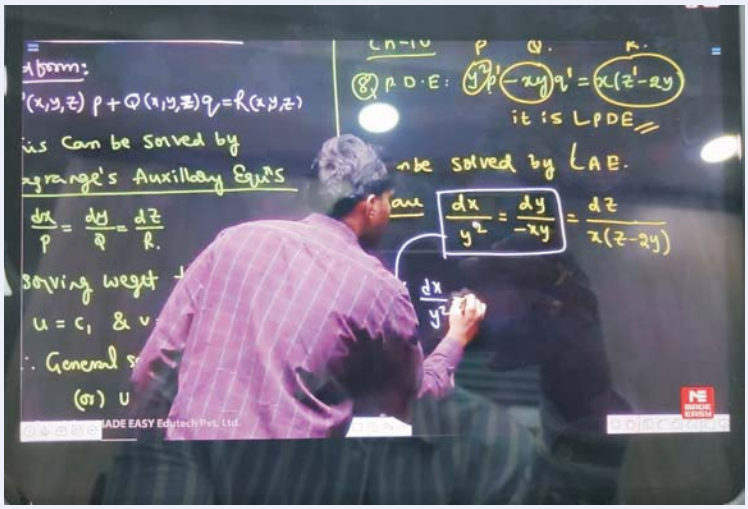
$$\ln(x^2+y^2+z^2) = \ln z + c$$

$$= \ln z + \ln c$$

$$\ln(x^2+y^2+z^2) = \ln zc$$

$$x^2+y^2+z^2 = zc$$

$$x^2+y^2+z^2 = zb$$



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End of Solution

143. The solution of the differential equation $p - x^2 = q + y^2$ is

(a) $z = \left(\frac{x^3}{3} + cx\right) + \left(cy + \frac{y^3}{3}\right) + c_1$ (b) $z = \left(\frac{x^3}{3} - x\right) + \left(cy - \frac{y^3}{3}\right) + c_1$

(c) $z = \left(\frac{x^3}{3} - cx\right) + \left(cy + \frac{y^3}{3}\right) + c_1$ (d) $z = \left(\frac{x^3}{3} + cx\right) + \left(cy - \frac{y^3}{3}\right) + c_1$

Ans. (d)

$$P - x^2 = q + y^2$$

Let $P - x^2 = y^2 + q = c$ (say)

We get $P - x^2 = c$

$$P = c + x^2$$

$$y^2 + q = c$$

$$q = c - y^2$$

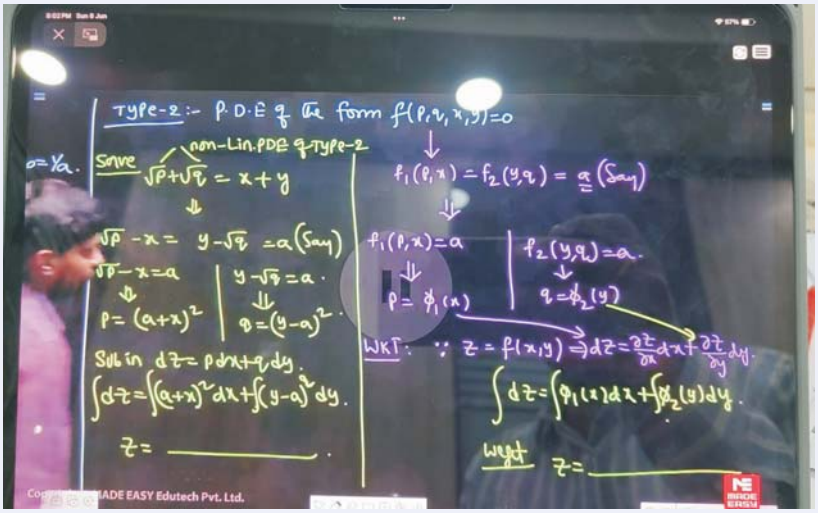
WKT : $dz = Pdx + qdy$

$$dz = (c + x^2)dx + (c - y^2)dy$$

Integrating on both sides,

$$\int dz = \int (c + x^2)dx + \int (c - y^2)dy$$

$$z = \left(cx + \frac{x^3}{3}\right) + \left(cy - \frac{y^3}{3}\right) + c_1$$



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End of Solution

144. The solution of the differential equation $p^2 + q^2 = x + y$ is

(a) $z = \frac{2}{3}(a-x)^{3/2} + \frac{2}{3}(y+a)^{3/2} + b$

(b) $z = \frac{2}{3}(a-x)^{3/2} + \frac{2}{3}(y-a)^{3/2} + b$

(c) $z = \frac{2}{3}(a+x)^{3/2} + \frac{2}{3}(y+a)^{3/2} + b$

(d) $z = \frac{2}{3}(a+x)^{3/2} + \frac{2}{3}(y-a)^{3/2} + b$

Ans. **(d)**

Given partial differential equation is

$$p^2 + q^2 = x + y$$

can be written as

$$p^2 - x = y - q^2 = a \text{ (say)}$$

we get $p^2 - x = a$

$$\Rightarrow \quad p = \pm\sqrt{a+x}$$

and $y - q^2 = a$

$$\Rightarrow \quad q = \pm\sqrt{y-a}$$

WKT : $dz = pdx + qdy$

$$dz = \pm\sqrt{a+x}\,dx \pm \sqrt{y-a}\,dy$$

Integrating on both sides

$$z = \pm\frac{(a+x)^{3/2}}{\frac{3}{2}} \pm \frac{(y-a)^{3/2}}{\frac{3}{2}} + b$$

End of Solution

145. The value of the integral $\int_C z^2 dz$, where C is the arc of the circle $|z| = 2$ from $\theta = 0$ to $\theta = \frac{\pi}{3}$ is

(a) $-\frac{12}{3}$

(b) $-\frac{14}{3}$

(c) $-\frac{16}{3}$

(d) $-\frac{18}{3}$

Ans. (c)

$$I = \int_C z^2 dz$$

$C : |z| = 2, \qquad \theta = 0 \text{ to } \frac{\pi}{3}$

It is open contour (sector)

$$z = 2e^{i\theta}$$
$$dz = 2e^{i\theta} d\theta$$

$\theta : 0 \text{ to } \frac{\pi}{3}$

$$I = \int_{\theta=0}^{\pi/3} 2^2 e^{2i\theta} (2ie^{i\theta}) d\theta$$

$$= 8i \int_0^{\pi/3} e^{3i\theta} d\theta \Big]_{\theta=0}^{\pi/3}$$

$$= \frac{8}{3}\left[e^{i\pi} - e^0\right]$$

$$= \frac{8}{3}[-1-1] = \frac{-16}{3}$$

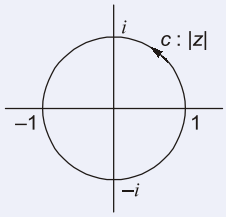
End of Solution

146. The value of the integral $\oint_C \frac{dz}{z(z^2+4)}$, where C is $|z| = 1$, is

(a) 0 (b) $\frac{\pi i}{3}$

(c) $2\pi i$ (d) $\frac{\pi i}{2}$

Ans. (d)



$$I = \oint_c \frac{dz}{z[z^2+4]}$$

$C : |z| = 1$ is a simple closed contour 'c'.

Poles are given by

$$z[z^2 + 4] = 0 \Rightarrow z = 0, \pm 2i$$

$z = 0$ is a simple pole lies inside 'c' but $\pm 2i$ lies outside 'c'.

By CRT :

$$\oint_c f(z)dz = 2\pi i \sum_{i=1}^{n} \text{Res}_i$$

$$= 2\pi i \, \text{Res}_0$$

$$= 2\pi i \left[\frac{\phi(0)}{\psi'(0)}\right] \qquad \left[\because f(z) = \frac{\phi(z)}{\psi(z)}\right]$$

$$= 2\pi i \left[\frac{1}{3(0)^2 + 4}\right]$$

$$= \frac{\pi i}{2}$$

End of Solution

147. The mode and modal ordinate of normal distribution respectively are

(a) μ and $\frac{1}{\sigma\sqrt{2\pi}}$ (b) $\frac{\mu}{2}$ and $\frac{1}{\sigma\sqrt{2\pi}}$

(c) μ and $\frac{\sigma}{\sqrt{2\pi}}$ (d) $\frac{\mu}{2}$ and $\frac{\sigma}{\sqrt{2\pi}}$

Ans. (a)

$\because$ Normal distribution is symmetrical.

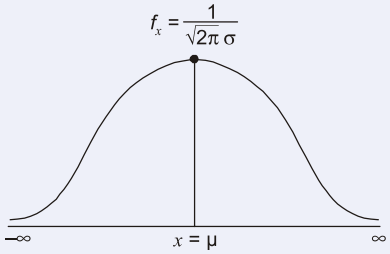
$\therefore$ Mode = Median = Mean = μ

Modal ordinate is given by partial differential equation at mode, i.e.,

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{\left(\frac{x-\mu}{\sigma}\right)^2}{2}} \qquad \{-\infty < x < \infty\}$$

At x = mode = μ

Modal ordinate, $f_x = \frac{1}{\sqrt{2\pi}\,\sigma}$



End of Solution

148. The theoretical density of a metallic soly crystal structure is given by $\rho = \frac{nA}{V_C N_A}$, where n is number of atoms associated with each unit cell, A is atomic weight, V_C is volume of the unit cell. N_A will represent

(a) force in newton
(b) number of particles
(c) Avogadro's number
(d) number of turns

Ans. (c)

$$\rho = \frac{nA}{V_c N_A}$$

where,
ρ = density
n = effective number of atoms per unit cell
A = atomic weight
V_c = Volume of the unit cell
N_A = Avogadro's number

End of Solution

149. The value of packing fraction for face-centred cubic (FCC) structure will be nearly

(a) 0.55
(b) 0.65
(c) 0.75
(d) 0.85

Ans. (c)

Packing fraction for FCC structure = 0.74 ≈ 0.75.

End of Solution

150. The total core loss of a specimen of silicon steel is found to be 1500 W at 50 Hz. Keeping the flux density constant, the loss becomes 3000 W, when the frequency is raised to 75 Hz. The eddy current loss at 75 Hz will be

(a) 1.25 kW
(b) 1.50 kW
(c) 1.75 kW
(d) 2.25 kW

Ans. (d)

Given : Flux density constant

$$P_e \propto B^2 f^2$$
$$\therefore \quad P_e \propto f^2$$
$$P_h \propto B^{1.6} f$$
$$\therefore \quad P_e \propto f$$
$$\text{Core loss} = P_h + P_e$$
$$\Rightarrow \quad Af + Bf^2 = P_i$$

Iron loss (P_i) :

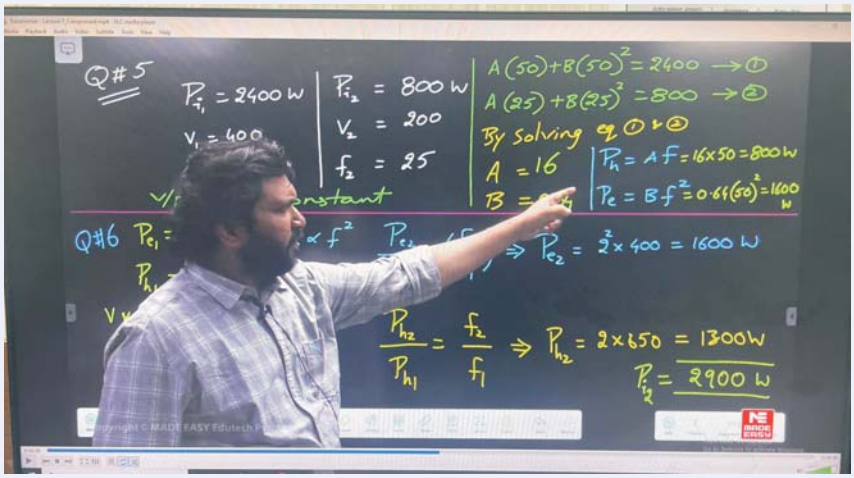
$$A(50) + B(50)^2 = 1500 \quad \ldots(1)$$
$$A(75) + B(75)^2 = 3000 \quad \ldots(2)$$

By solving equation (1) and (2),

$A = 10, \quad B = 0.4$

Eddy current loss, $P_e = Bf^2$

$\therefore \quad P_e$ at 75 Hz $= 0.4(75)^2 = 2250$ W or 2.25 kW



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End of Solution

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