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ESE- 2018 (Prelims) - Offline Test Series   Test- 15

ELECTRONICS & TELECOMMUNICATION ENGINEERING

SUBJECT: SIGNALS & SYSTEMS + BASIC ELECTRICAL ENGINEERING + ADVANCED COMMUNICATION + ADVANCED ELECTRONICS

SOLUTIONS

01. Ans: (d)

Sol: $x(t) = \cos t + \sin\sqrt{3}t$

$$T_1 = \frac{2\pi}{1} = 2\pi$$

$$T_2 = \frac{2\pi}{\sqrt{3}} = \frac{2\pi}{\sqrt{3}}$$

$$\frac{T_1}{T_2} = \frac{2\pi}{\frac{2\pi}{\sqrt{3}}} = \sqrt{3} \Rightarrow \text{irrational number}$$

$\therefore$ x(t) is non-periodic

02. Ans: (c)

Sol: $y(t) = \sum_{k=-\infty}^{\infty} x(t)\,\delta(t - kT_s)$

$y(t)$ = ------ + $x(t)\ \delta(t+T_s)$ + $x(t)\ \delta(t)$ + $x(t)\ \delta(t-T_s)$ + -----

The above system is linear, time variant

03. Ans: (b)

Sol: $$\int_{-\infty}^{\infty} e^{-t}\ \delta'(t)dt = \frac{-d}{dt}\left[e^{-t}\right]_{t=0} = e^{-t}\Big|_{t=0} = 1$$

04. Ans: (d)

05. Ans: (c)

Sol: $$x(\infty) = \underset{Z\to1}{Lt}(z-1)X(z)$$

$$= \underset{Z\to1}{Lt}\frac{z+1}{3(z+0.9)} = \frac{2}{3(1.9)} = 0.3508$$

06. Ans: (a)

Sol: $$H(z) = \frac{z}{z+1}$$

$$H_{inv}(z) = \frac{z+1}{z} = \frac{Y(z)}{X(z)} = 1 + z^{-1}$$

$Y(z) = X(z) + z^{-1}X(z)$

$y(n) = x(n) + x(n-1)$

07. Ans: (a)

Sol: From the given data the transfer function is

$$H(z) = \frac{k}{(z-2)\left(z-\frac{1}{2}\right)}$$

Non-anticipative means causal and it is possible only when ROC $|z| > 2$

$\Rightarrow$ Right sided

08. Ans: (d)

09. Ans: (c)

Sol: $x(n) = 1, \quad 0 \le n \le N-1$

$\quad = 0,$ otherwise

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j\frac{2\pi}{N}nk}$$

$$= \sum_{n=0}^{N-1} e^{-j\frac{2\pi}{N}nk}$$

$$= \frac{1-e^{-j2\pi k}}{1-e^{-j\frac{2\pi}{N}k}}$$

$X(0) = 0, \; k \ne 0$

$X(0) = N, \; k = 0$

$X(k) = N\delta(k)$

10. Ans: (c)

Sol: $y(n) - ay(n-1) = x(n)$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{1-az^{-1}}$$

$h(n) = (a)^n u(n)$

11. Ans: (d)

12. Ans: (c)

Sol: Using area property

$$\text{Area of } \left(e^{-\pi t^2}\right) \times \text{Area of } \left(e^{-\pi t^2}\right) = \text{Area of } \left(Ae^{-\frac{\pi t^2}{2}}\right)$$

$$\text{Area of } \left(e^{-at^2}\right) = \int_{-\infty}^{\infty} e^{-at^2} dt = \sqrt{\frac{\pi}{a}}$$

$$\sqrt{\frac{\pi}{\pi}} \times \sqrt{\frac{\pi}{\pi}} = A\sqrt{\frac{\pi}{\frac{\pi}{2}}} \Rightarrow A = \frac{1}{\sqrt{2}}$$

13. Ans: (a)

Sol: $r_{xh}(\tau) = x(\tau) * h(-\tau) = e^{-\tau}u(\tau) * e^{\tau}u(-\tau)$

Apply Fourier transform

$$S_{XH}(\omega) = \frac{1}{(1+j\omega)(1-j\omega)}$$

$$= \frac{1}{2}\left[\frac{2}{\omega^2+1}\right] \xleftrightarrow{\text{I.F.T}} \frac{1}{2}e^{-|t|}$$

14. Ans: (b)

Sol: Step response of the system is $s(t) = e^{-t}u(t)$

$\therefore$ Impulse response is

$$h(t) = \frac{d}{dt}s(t)$$

$$= \delta(t) - e^{-t}u(t)$$

$\therefore$ Output due to r(t) = $\dot{s}(t) * r(t)$

$$= s(t) * \dot{r}(t) = e^{-t}u(t) * u(t) = \left(1-e^{-t}\right)u(t)$$

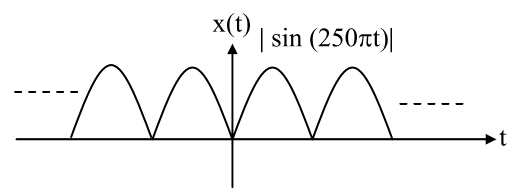
15. Ans: (b)

Sol: Ex: x(t) = u(t+1) u(1–t) = rect (t/2) is an energy signal but u(t+1) and u(1-t) are individually power signals. So statement (3) is FALSE

16. Ans: (b)

Sol: The exponential Fourier series coefficient of x(t)

is $C_0 = \frac{2}{\pi}$, $C_n = \frac{2}{\pi\left(1-4n^2\right)}$



Fundamental frequency is 250 Hz (not 125 Hz)

so the ideal filter will retain the d.c component in the output

17. Ans: (c)

Sol: $tu(t-2) - 2u(t) = (t-2+2)u(t-2) - 2u(t)$

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

18. Ans: (a)

Sol: $\text{Cos}^2(\omega_0 t)\, u(t) = \frac{1+\cos 2\omega_0 t}{2} u(t)$

$$= \frac{1}{2}u(t) + \frac{1}{2}\cos 2\omega_0 t\, u(t)$$

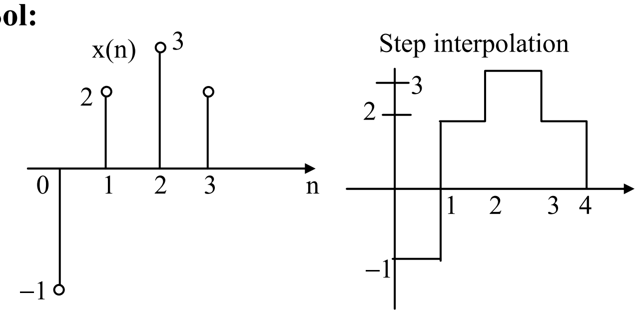
$$= \frac{1}{2s} + \frac{1}{2}\frac{s}{4\omega_0^2 + s^2}$$

$$= \frac{1}{2}\left[\frac{4\omega_0^2 + s^2 + s^2}{s(4\omega_0^2 + s^2)}\right] = \frac{1}{2} \times \frac{4\omega_0^2 + 2s^2}{s(4\omega_0^2 + s^2)}$$

$$= \frac{2\omega_0^2 + s^2}{s(4\omega_0^2 + s^2)}$$

19. Ans: (b)

Sol:



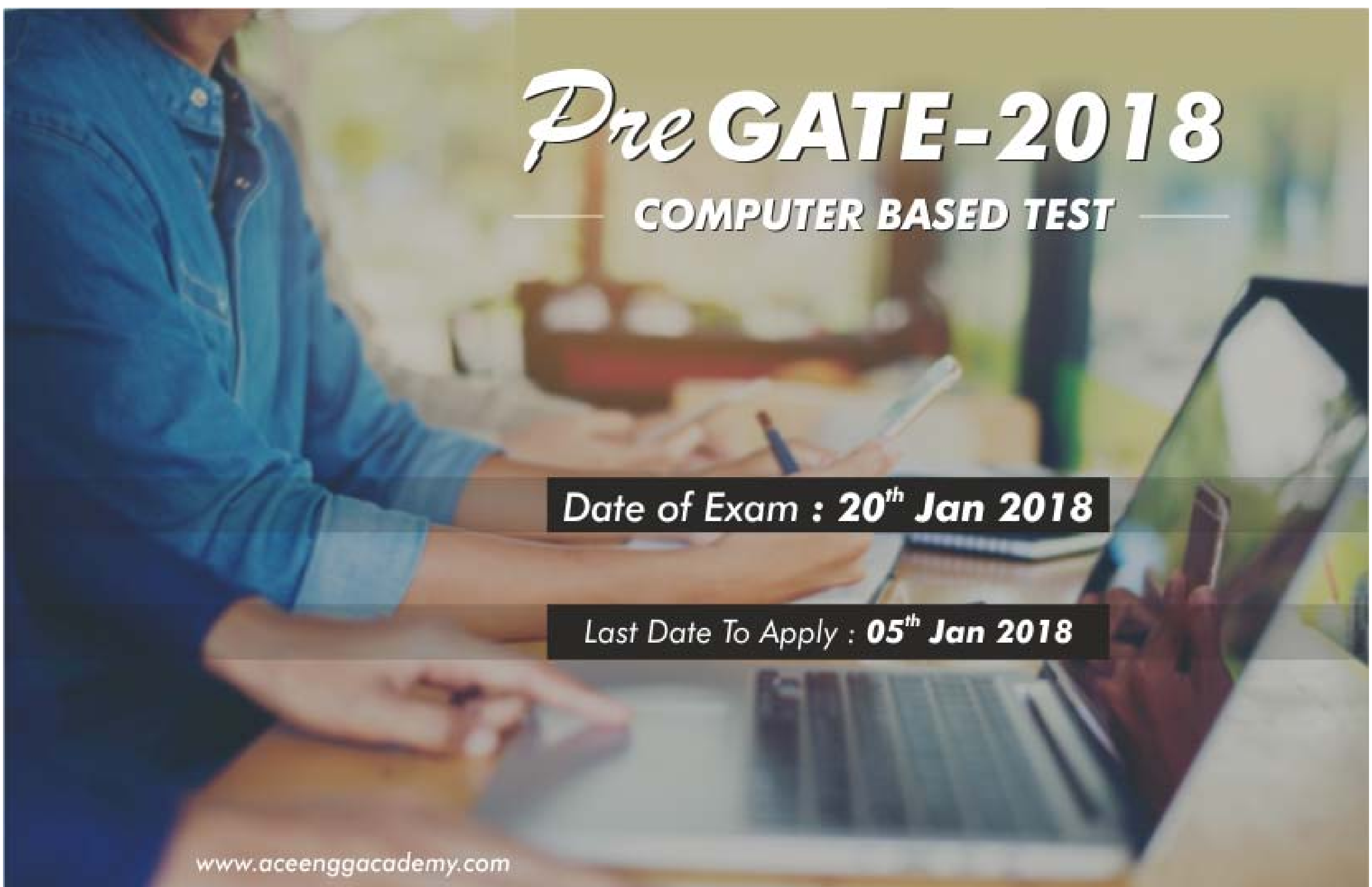
20. Ans: (c)

Sol: Since it is symmetric with $n = 0$

$\Rightarrow$ phase $= 0$

$$t_p(\omega) = \frac{-\theta(\omega)}{\omega} = 0$$

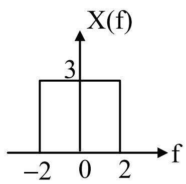
$$t_g(\omega) = \frac{-d\theta(\omega)}{d\omega} = 0$$



21. Ans: (c)

Sol: Use Plancheral's relation $\int_{-\infty}^{+\infty} x(t)y(t)dt = \int_{-\infty}^{+\infty} X(f)Y(f)df$

$$\overset{x(t)}{\frac{12\sin 4\pi t}{4\pi t}} \xleftrightarrow{F.T}$$



$$\overset{y(t)}{\mathrm{Cos}(2\pi t)} \longleftrightarrow \overset{Y(f)}{\frac{\delta(f-1)+\delta(f+1)}{2}}$$

$$\int_{-\infty}^{\infty} X(f)Y(f)df = \frac{1}{2}\int_{-\infty}^{\infty} X(f)\delta(f-1)df + \frac{1}{2}\int_{-\infty}^{\infty} X(f)\delta(f+1)df$$

$$= \frac{1}{2}\left[X(1)+X(-1)\right] = \frac{1}{2}[3+3] = 3$$

22. Ans: (b)

Sol: A. Delta function Fourier transform is constant function $\rightarrow$ 3

B. Gate function Fourier transform is sampling function $\rightarrow$ 4

C. Gaussian function Fourier transform is Gaussian function $\rightarrow$ 2

D. Sinusoidal function Fourier transform is Delta function $\rightarrow$ 3

23. Ans: (b)

Sol: Hysteresis loss is given by,

$W_h = \eta\ B^{1.6}\ f.V$

Where

B = flux density

f = frequency

V = volume of core.

24. Ans: (c)

Sol: For maximum power transfer, Source resistance = load resistance

$$8 = \left(\frac{N_1}{N_2}\right)^2 \times 2$$

$$\Rightarrow \frac{N_1}{N_2} = 2$$

$$\Rightarrow N_1 = 80$$

25. Ans: (b)

Sol: In the above graph

X – Point is in lag load

Y- Point is in lightly capacitive load

Z – Point is in heavily capacitive load

26. Ans: (d)

Sol: hysteresis loss $P_h \propto f$ and eddy current loss $P_e \propto f^2$

[$\therefore$ since $\frac{V}{f}$ ratio is constant]

The % decrease in hysteresis loss is

$$= \frac{P_{h1}-P_{h2}}{P_{h1}}\times 100 = \frac{50-30}{50}\times 100$$

$$= \frac{20}{50}\times 100$$

$= 40\%$

The % decrease in eddy current loss

$$= \frac{P_{e1}-P_{e2}}{P_{e1}}\times 100 = \frac{50^2-30^2}{50^2}\times 100$$

$$= \frac{25-9}{25}\times 100$$

$= 64\%$

27. Ans: (c)

Sol: The current in the armature conductors of a dc machine is alternating.

28. Ans: (a)

Sol: In order to produce torque the armature mmf in a dc machine should be

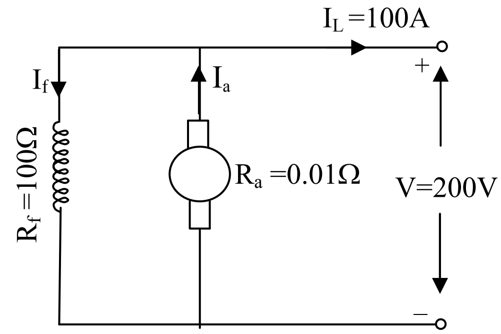
1. Stationary w.r.t field poles
2. Will have rotate with armature speed (N) in opposite to armature direction.

29. Ans: (d)

Sol: Given I_L =100 A, V = 200 V,

Shunt field resistance R_f = 100 Ω,

Armature resistance, R_a = 0.01 Ω



We know that $I_a = I_L + I_f$

$$I_f = \frac{V}{R_f} = \frac{200}{100} = 2\text{A}$$

$\therefore$ I_a = 100+2 =102 A

Generated emf $(E_a) = V + I_a R_a$

$= 200 + 102 \times 0.01$

$= 201.02$ V

30. Ans: (a)

Sol: The ration of maximum torque to full load torque ,$T_m/T_f = (a^2 + s^2)/2as$

Where

s = Full load slip = 0.04

a = slip at maximum torque

$= R_2/X_2$

$= 0.01/0.1$

$= 0.1$

$T_m/T_f = ((0.1)^2 + (0.04)^2)/(2 \times 0.1 \times 0.04)$

$= 1.45$

31. Ans: (c)

Sol: The synchronous speed is, $N_s = \frac{120 \times 50}{6}$

$= 1000$ RPM

Rotor is driven in opposite direction with speed 1000 RPM

Hence, slip $= \frac{1000 + 1000}{1000} = 2$

Frequency of voltage across the slip ring

$= sf = 2 \times 50 = 100$Hz

32. Ans: (c)

Sol: If air gap increases then reluctance for magnetic path increases.

$\uparrow$ Reluctance $= \frac{\ell \uparrow}{\mu_0 \mu_r a}$.

So as to produce the rated flux the magnetizing current demand will be more, because of which the power factor decreases $\phi = \frac{NI\mu \uparrow}{R \uparrow}$

33. Ans: (c)

Sol: Zero regulation is for the leading power factors which are very close to UPF.

for Ex: 0.95 lead means almost UPF but lead.

$\therefore$ Armature reaction is mostly cross magnetization and least magnetization

34. Ans: (c)

Sol: The prime mover speed of parallel connecting alternators can be anything which is depends on number of poles but frequency of an incoming alternator must be same to that of already existing alternator.

$f = \frac{P.N}{120}$; so, to get fixed frequency, if $P \uparrow$

$\Rightarrow$ N should be reduce.

Here P = number of poles of the machines and N = speed of rotor.

35. Ans: (c)

Sol: $P = \sqrt{3}\, V_L\, I_L \cos\phi\; 500 \times 1000$

$= \sqrt{3} \times 3.3 \times 1000 \times I_L \times 0.8$

$I_L = 109.346$ A.

36. Ans: (b)

Sol: Average load $= \frac{1500 \times 12 + 1000 \times 12}{24}$

$= 1250$ kW

Load factor $L_f = \frac{1250}{1500} \Rightarrow 0.8333$

37. Ans: (b)

Sol: Fertile materials are those which can be transformed into fissile materials, but they can't sustain chain reactions.

When a neutron bombards a fertile material like U-238 or Th-232 (thorium), they absorb the neutron and fissile material is obtained. Thus U-238 is converted into Plutonium-239 which can be used as fuel in other reactors similarly Thorium can be converted into fissile U-233.

38. Ans: (c)

Sol: $Z_{p.u(new)} = Z_{pu(old)} \times \frac{MVA_{(new)}}{MVA_{(old)}} \times \left(\frac{kV_{old}}{kV_{new}}\right)^2$

$$= 0.2 \times \frac{150}{50} \times \left(\frac{11}{22}\right)^2$$

$$= 0.2 \times 3 \times \frac{1}{4}$$

$$= 0.15 \text{ pu}$$

39. Ans: (c)

Sol: Load factor = $\frac{\text{average load}}{\text{maximum load}}$

Capacity factor
= load factor × utilization factor.

40. Ans: (a)

Sol: All the lead acid, lithium ion and Ni-cd batteries are rechargeable batteries.

41. Ans: (a)

42. Ans: (c)

Sol:

Microwave band	**Frequency used in satellite communication**
1. L – band	1 – 2 GHz
2. S – band	2 – 4 GHz
3. C – band	4 – 8 GHz
4. X – band	8 – 12 GHz
5. KU – band	12 – 18 GHz
6. K – band	18 – 24 GHz
7. Ka – band	24 – 30 GHz

43. Ans: (d)

Sol: The radio altimeter on board of an aircraft is basically fitted in FM CW radar which is used to find the height of the aircraft from the ground surface.

44. Ans: (b)

Sol: Radar range is directly proportional to antenna diameter. So range will increased by 4 times, if diameter is increased by 4 times.

45. Ans: (a)

46. Ans: (d)

Sol: Critical frequency

$$f_c = \sqrt{81 \times N_{max}} = \sqrt{81 \times 10^{10}} = 9 \times 10^5 \text{ Hz}$$

47. **Ans: (d)**

48. **Ans: (c)**

49. **Ans: (c)**

Sol: $T_e = (F-1)T_0$

$= (10^{0.3}-1)\ 290$

$= 290K$

50. **Ans: (b)**

51. **Ans: (d)**

52. **Ans: (a)**

53. **Ans: (d)**

54. **Ans: (a)**

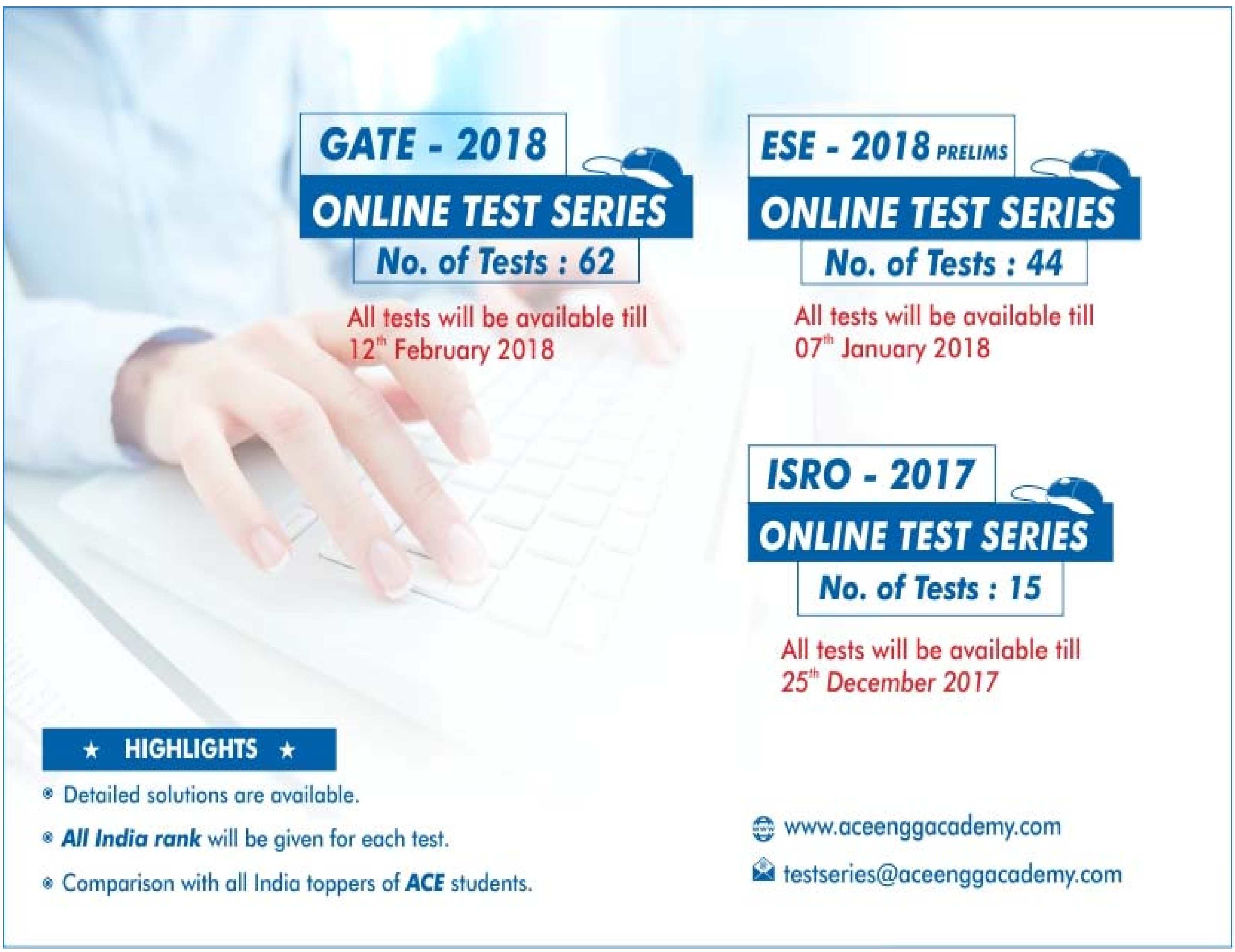
Sol: All are valid laying principles.

55. **Ans: (a)**

Sol: NPDU = Packet

TPDU = Segment

DPDU = Frame



56. Ans: (d)

Sol:

32 $\boxed{\text{C}}$

NID 24 HID 8

2^8-2 hosts per network

256–2=254

57. Ans: (b)

Sol: In an octet, maximum value is 255 but in 1, 2, 3 there are values beyond 255.

So, Invalid.

136.19.5.240 is valid.

58. Ans: (c)

Sol: For private key cryptosystem, Two users maintain 1 secret key

3 users maintain 1+2 secret key

n users maintain 1+2+....+n–1 secret keys $= \frac{n(n-1)}{2}$

For public key cryptosystem, each user maintain 2 keys, one key is public key and the other key is private key

$\therefore$ n users maintain 2n keys

59. Ans: (b)

Sol: (1)

$$\left.\begin{aligned} M' &= M^e \bmod n \\ M &= (M')^d \bmod n \end{aligned}\right\} \text{Encryption and Decryption}$$

(2) Is false

(3) Is true ed = 1 mod ϕ(n)

d is the inverse of e

e is public key

d is private key

(4) Is false

60. Ans: (c)

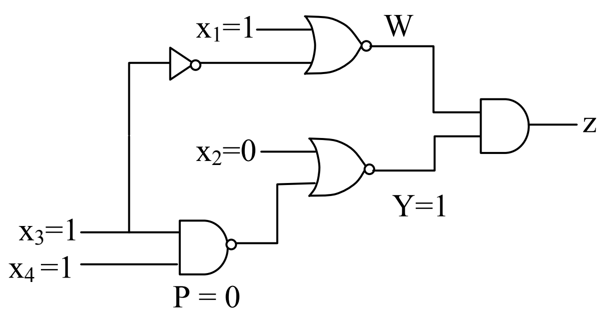
61. Ans: (c)

62. Ans: (a)

Sol: Statement (1), (2) and (3) are properties of SOS technology. SOS technology completely avoids latch-up problem and allows lower parasitic capacitances compared to conventional twin-tub CMOS process. But this technology comes with disadvantage of higher cost. Hence, it is used especially in deep submicron devices.

63. Ans: (d)

Sol: To set s-a-0 at x_1, we drive x_1 high



To observe the output Y =1 $\Rightarrow X_2 = 0$ & P = 0

To control $x_1 \Rightarrow X_3 = 1$

$\therefore (x_1,x_2,x_3,x_4) = (1,0,1,1)$

64. Ans: (c)

Sol: ROM based design doesn't require logic minimization.

65. Ans: (c)

Sol: In the case of Control hazard, instruction pre-fetched in the pipeline is flushed out to fetch the new instruction which control is now pointing.

66. Ans: (a)

Sol: $H(S)_{APF} = \dfrac{s-\alpha}{s+\alpha}$

67. Ans: (c)

Sol: Zeros can be conjugate reciprocal pairs

$Z = 4, \dfrac{1}{4}$

68. Ans: (d)

69. Ans: (b)

Sol: By double field revolving theory we confirmed that resultant RMF in single phase induction machine is zero. Hence is called not self starting machine.

The three phase induction motor is self starting motor, the starter is used to limit the inrush of starting current.

70. Ans: (a)

Sol: The distribution transformers are designed for minimum core losses because Primary windings of distribution transformers are energized throughout the day.
Where as, in case of power transformers are designed for minimum copper losses.

71. Ans: (a)

72. Ans: (a)

73. Ans: (a)

Sol: 24 voice channels are multiplexed.

$$\frac{(24\times 8)+1}{125 micro}\frac{bits}{\sec}=1.544 Mbps$$

74. Ans: (a)

Sol: In packet switching, a packet can be forwarded before the next packet is fully arrived in. So increases throughput.

75. Ans: (b)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