Mock Test 4

Number of Questions: 65 **Section Marks: 65**

SECTION – I GENERAL APTITUDE

Directions for question 1: Choose the most appropriate word from the options given below to complete the following sentence.

1. Despite its known toxicity, lead continues to be used, to the great _____ of human and environmental health.

(A) impediment (B) detriment
(C) chagrin (D) solace

Directions for questions 2 and 3: Select the correct alternative form the given choices.

2. A 7-year old child assembles an object from lego blocks. The object is in the shape of a cylinder surmounted by a hemisphere of radius 7 cm. If the height of the cylinder is 7 cm, find the volume of the object (in cm^3).

(A) $\frac{3\pi}{5}(7^2)$ (B) $\frac{5\pi}{3}(7^3)$
(C) 7^3 (D) $7^3\pi$

3. In a certain code language, if Zoology is called Anthropology, Anthropology is called Ornithology, Ornithology is called Biology, Biology is called Cosmology, Cosmology is called Ecology, Ecology is called Etymology, then what is the study of human called in that language?

(A) Biology (B) Ecology
(C) Ornithology (D) Cosmology

Directions for question 4: Select the pair that best expresses a relationship similar to that expressed in the capitalized pair.

4. BIOLOGY: LIFE

(A) Archaeology: Antiques
(B) Astrology: Stars
(C) Cosmetology: Beauty
(D) Mythology: Myths

Directions for question 5: Fill in the blanks from the options given below:

5. _____ summer monsoon _____ been showing a weakening trend _____ the past century with decreasing rainfall over large regions of _____ Indian subcontinent.

(A) The, has, over, the
(B) The, has, over, no article
(C) A, had, across, no article
(D) The, has, in, the

Directions for questions 6 to 10: Select the correct alternative form the given choices.

6. a, b, c, d are distinct positive integers such that:
$f(a, b, c, d) = \max(a, b, c, d)$
$g(a, b, c, d) = \min(a, b, c, d)$
$h(a, b, c, d)$ = remainder of $(c \times d / a \times b)$
If $(c \times d) > (a \times b)$
$h(a, b, c, d)$ = remainder of $(a \times b) / (c \times d)$
if $(c \times d) < (a \times b)$
Also, a function $fgh\ (a, b, c, d) = f(a, b, c, d) \times g(a, b, c, d) \times h(a, b, c, d)$
the value of $fg[h(12, 11, 8, 16), 17, 9, 16]$ _____

7. Textbooks of medicine say that there is no direct connection between the brain and the lymphatic system, yet a paper published in the journal *Nature* refers to the discovery of exactly such a connection.
Which one of the statements given below is logically valid and can be inferred from the above sentence.

(A) A paper published in the journal *Nature* corroborates the fact that there is no direct connection between the brain and the lymphatic system.
(B) Textbooks of medicine declare that there is no direct connection between the brain and the lymphatic system and this is affirmed by a paper published in the journal *Nature*.
(C) Texts of medicine proclaim that there is no direct connection between the brain and the lymphatic system but a paper published in the journal *Nature* says that such a connection is indeed there.
(D) While textbooks of medicine maintain that there is no direct connection between the brain and the lymphatic system, a paper published in the journal *Nature* claims that the brain and the lymphatic system are connected indirectly.

8. The last decade has witnessed a slow but steady realisation within the Indian government that the threats of the future will come from cyberspace. Unfortunately, while the realisation exists, the Indian security establishment has not been jolted into action in the manner in which the Kargil War or the 26/11 terrorist attack on Mumbai galvanised the nation into adopting a series of corrective measures.
Which of the statement(s) below is/are logically valid and can be inferred from the above passage?

(i) Although the Indian government realizes that the threats of the future will be from cyberspace, it is yet to accord the seriousness which is due to this threat.
(ii) Despite the fact that the Indian government realizes that the future threats will come from cyberspace, it does not consider these threats as devious

as other threats which spurred the government to adopt corrective measures.

(iii) The Indian government considers that the threats from cyberspace will not pose a serious threat to the security of the nation.

(iv) The Indian government fails to consider that the threats from cyberspace could pose a threat to the security of a nation.

(A) Only (i) (B) (i) and (ii)
(C) (iii) and (iv) (D) (i, ii) and (iii)

9. 30 students in class of *BV* School, wrote a test with 4 questions. For each question the number of students who answered correctly, incorrectly and did not attempt are tabulated below. The marks for each question are also listed in the table. There is no negative marking or partial marking.

Q.No.	Marks	Answered correctly	Answered incorrectly	Did not attempt
1	3	15	5	10
2	2	10	7	13
3	2	20	9	1
4	1	11	10	9

If the number of students who attempted all questions is 5, what is the maximum possible number of students who left at least 2 questions unattempted?

(A) 3 (B) 16
(C) 8 (D) None of these

10. The given statement is followed by some courses of action. Assuming the statement to be true, decide which of the given courses of action logically follows for pursuing.

Statement:

There have been steep increases in the government's expenditures on garbage collection, sorting, storage and recycling.

Courses of action:

(i) Government should encourage people to sort their garbage, by providing them separate bins for dry and wet garbage.

(ii) Once garbage is collected from households, to the extent possible it should be directed towards recycling, so that it can cut down on storage costs.

(iii) The routes of the collection vehicles should be planned in such a way that they are used in a most efficient manner.

(A) Only (i) and (ii) follow
(B) Only (ii) and (iii) follow
(C) Only (i) and (iii) follow
(D) All (i), (ii) and (iii) follow

SECTION – II ELECTRICAL ENGINEERING

11. A letter is selected at random from each of the two words 'FRACTION' and 'DECIMAL'. Probability that the selected letter in a word should NOT be in the other word is _____

(A) 3/14 (B) 5/14
(C) 7/13 (D) 9/13

12. The value of $\lim_{x\to 3} \log_5\left[4x^3+\sqrt{(3x^4+5x^2+1)}\right]$ is _____

13. The absolute error in the process of finding the real root of $x^3 + x^2 + 4x + 4 = 0$ by Newton-Raphson method with initial approximation $x_o = 2$ after one iteration is _____.

14. If 'a' is a positive real number, then which of the following periodic functions with period '$2a$' will have only sine terms in its Fourier series expansion?

(A) $f(x) = \begin{cases} a+x & -a \le x < 0 \\ a-x & 0 \le x \le a \end{cases}$

(B) $f(x) = |x|; -a \le x \le a$
(C) $f(x) = 3x^2 + 5; -a \le x \le a$
(D) $f(x) = x^3 - 2x; -a \le x \le a$

15. The inverse Laplace transform of $\tan^{-1}(s/4)$ is _____

(A) $\frac{\sin 4t}{t}$ (B) $\frac{-\sin 4t}{t}$
(C) $\frac{4\sin t}{t}$ (D) $\frac{-4\sin t}{t}$

16. The stand still impedance of stator and rotor of 3-phase, 400v, 50 Hz, 4 – pole induction motor are $(0.04 + j0.4)$ and $(0.04 + j0.45)\frac{\Omega}{ph}$. When machine is rotating at a rated speed of 1440 rpm. Power developed is _____ kW (Neglect no-load current.)

17. A 6-pole, 800 conductor, wave connected seperately excited DC generator having a terminal voltage of 80V with a load impedance of 15Ω. The armature and field resistances are 0.4Ω and 200Ω respectively _____ volts will be the terminal volage, if the machine is rewounded for lap connection and Speed was doubled without change in load resistance and excitation.

18. 1 – ϕ, 200V transformer is drawing 5A at 0.2 pf lag under no-load condition from *LV* Side. The no-load pf, if the transformer is excited with 400V from *LV* side is _____

(A) 0.2 lag (B) 0.4 lag
(C) 0.1 lag (D) 0.2 lead

19. In a four disc string insulator, the capacitance between pin and earth is 4μF. Earth disc capacitance is 50μF. For uniform distribution of voltage across string, the least guarding capacitance required is _____μF.

20. A generating station plant has installed capacity of 500 MW, capacity factor of 0.8 and annual load factor of 85%. Then the minimum reserve capacity of the station _____.

(A) 29.42 MW
(B) 470.58 MW
(C) 31.25MW
(D) Insufficient data

21. A star connected 3-phase 11 kV, 40 MVA alternator has the positive and negative sequence reactance of alternator are 0.25 p.u and 0.20 p.u respectively. If the positive sequence current of alternator is 2 p.u for a single to ground fault. Then the zero sequence reactance is _____ p.u

22. Two wattmeters are used to measure the power in a 3 phase balanced system. What is the power factor of the load when one watt meter reads thrice the other?

(A) 0 (B) 0.6
(C) 0.76 (D) 0.866

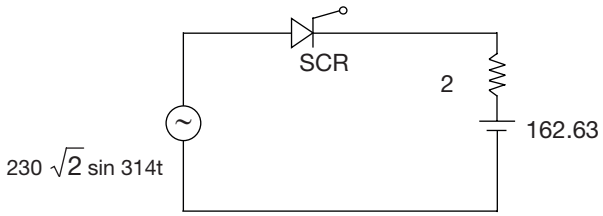
23. The accuracy of Kelvin's double bridge for the measurement of low resistance is high because the bridge

(A) uses four resistance arms
(B) uses one capacitor as bridge arm
(C) uses a low resistance link between standard and test resistance
(D) uses an indicating low resistance galvanometer

24. A step up chopper has load voltage of 600V and is supplied from a constant dc source of 150V. If the OFF time of the chopper is 40 μs and desired output voltage is 300V find ON time of the chopper?

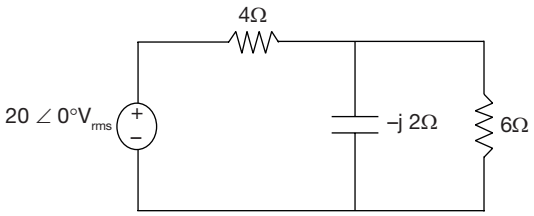
(A) 5 μsec (B) 10 μsec
(C) 30 μsec (D) 40 μsec

25. A dc battery is charged through a resistor R as shown in the below figure. Assume that the *SCR* is fired in every cycle for the supply voltage 230V, 50Hz. What will be the maximum conduction angle of the thyristor.



(A) 30° (B) 60°
(C) 120° (D) 150°

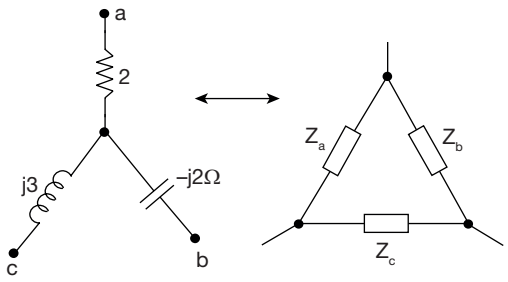
26. Consider the circuit show in below figure



The average power delivered by the source is_____.

(A) 37.85W, $pf = 0.93$ (Leading)
(B) 75.7W, $pf = 0.93$ (Leading)
(C) 75W, $pf = 0.93$ (Lagging)
(D) 37.85W, $pf = 0.93$ (Lagging)

27. Consider the networks shown in below figure



The ratio between the $|Z_a|$ and $|Z_c|$ is _____.

28. Find the value of gain for which the closed loop transfer function will have a pole on the real axis at –4.

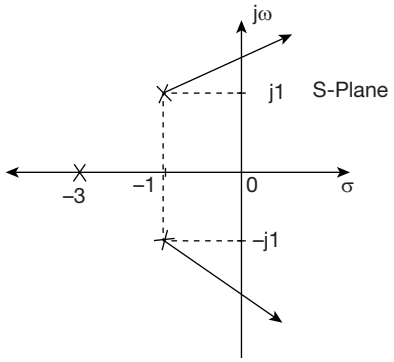
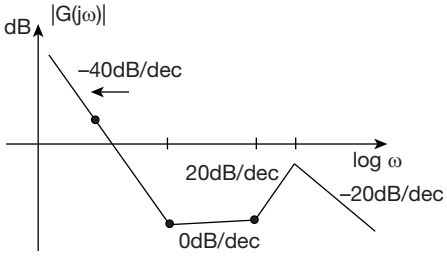


Figure: Root locus plot

(A) $K = 8$ (B) $K = 10$
(C) $K = 5$ (D) $K = 2$

29. The asymptotic Bode magnitude plot of a minimum phase transfer function is shown in the figure.



This transfer function has
(A) 3 poles and 2 zeros (B) 4 poles and 3 zeros
(C) 4 poles and 2 zeros (D) 3 poles and 1 zeros.

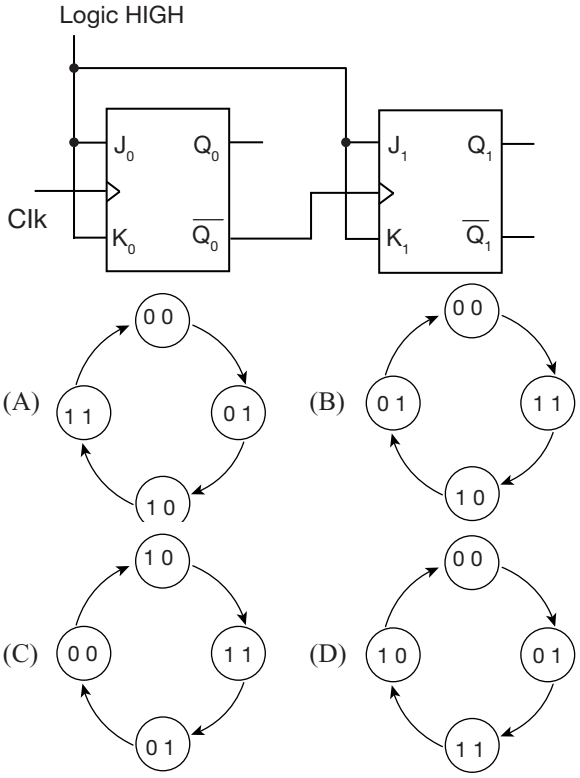
30. Let $X(z) = \frac{1}{1-z^{-3}}$ be the z – transform of a Non-causal signal $x[n]$, then the values of $x[-1]$ and $x[-3]$ is _____
(A) 0 and 0 (B) 0 and 1
(C) 1 and 0 (D) 1 and 1

31. Two signals $x_1(t)$ and $x_2(t)$ are given as
$x_1(t) = 8\ \text{sinc}_2(200t)\ \cos(800\pi t)$
$x_2(t) = 10\ \text{sinc}(200t)$
if the Nyquist sampling rate N_1 and N_2 respectively, the ratio N_1/N_2 is

32. A transistor is connected in common emitter configuration as an amplifier. The parameters of the transistor specified are: I_B = 20 μA, β = 100 and I_C = 2.5 mA. Then the value of I_{CEO} is ____mA.

33. An *n*-channel *JFET* having a pinch-off voltage of –4V shows a trans conductance of 1.5 mA/V. If its maximum trans conductance is 2 mA/V, then the applied Gate to source voltage in volts _____.

34. For the counter shown in figure, find the state diagram for the states $Q_1\ Q_0$?



35. In a lossless dielectric media magnetic field component is given as $\overline{H} = 10\cos(10^8 t - x)\hat{a}_z$ mA/m, then wave is said to be polarized along
(A) x-axis (B) y-axis
(C) z-axis (D) x-z plane

36. The maximum volume of a cylindrical cistern with open top of surface area (Area of bottom and side) 108π square feet is _____
(A) 216 π cubic feet (B) 432 cubic feet
(C) 864 cubic feet (D) 1728 cubic feet

37. If the eigenvalues of a 3 × 3 matrix A are –1, 2 and 5 then the determinant of the inverse of the matrix $A + 2I_3$, where I_3 is the identity matrix of order 3 × 3 is _____
(A) $\frac{-1}{10}$ (B) $\frac{1}{10}$
(C) $\frac{-1}{28}$ (D) $\frac{1}{28}$

38. In a city, 60% of the youngsters are engineering graduates and 40% of the youngsters are science graduates. Among the engineering graduates, 45% are self employed where as 30% of the science graduates are self employed. If an youngster is selected at random from that city, who is self employed, then the probability that the person is a science graduate is _____

39. If $u(x, y) = \cos x \cdot \cosh y$ is the real part of an analytic function $f(z) = u(x, y) + i\,v(x, y)$ where $z = x + iy$ and $i = \sqrt{-1}$, then the imaginary part $v(x, y)$ of $f(z)$ is _____
(A) $-\cos x \cdot \cosh y$ (B) $\sin x \cdot \sinh y$
(C) $-\sin x \cdot \sinh y$ (D) $\cos x \cdot \sinh y$

40. The general solution of the differential equation $\frac{dy}{dx} = \cos(x + y - 3)$ is _____
(A) $y = (3 - x) + 2\tan^{-1}(x + c)$
(B) $y = (3 + x) - 2\tan^{-1}(x + c)$
(C) $y = [\tan^{-1}(3 - x)] + x + c$
(D) $y = [2\tan^{-1}(3 - x)] + 3x + c$

41. A small squirrel cage induction motor has a starting current of five times the full load current and a full load slip of 0.04. Calculate the per unit starting torque when the motor is started by stator resistance starting with motor current limited to 4 p.u.
(A) 8 p.u (B) 0.64 p.u
(C) 0.8 p.u (D) 0.016 p.u

42. A 3-phase, *Y*/*Y* transformer with isolated neutral winding is excited from a pure sinusoidal voltage source without applying any load. The induced EMF in the secondary of the transformer is
(A) Sinusoidal, since 3rd order harmonic magnetizing current is not flowing in the primary winding
(B) Non-sinusoidal, since 3rd order harmonic magnatizing current is not flowing in the primary winding
(C) Sinusoidal, since 3rd harmonic magnatizing current is flowing in the primary winding

(D) Non-sinusoidal, since 3rd harmonic magnatizing current is flowing in the primary winding.

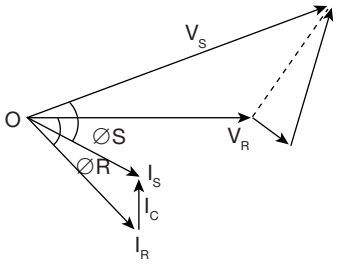
43. A 3000v, 3 – phase, 6 – pole, Y – connected synchronous motor runs at 1000 r.p.m. The excitation is constant and corresponds to an open-circuit terminal voltage of 3000V. The resistance is negligible as compared with synchronous reactance of 4 Ω per phase. The power input for an armature current of 250 A is _____ MW.

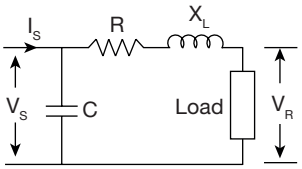
44. A generator connected through a 6 cycle CB to a transformer is rated 8000 kVA, 11 kV with reactance of $X_d^{11} = 8\%$ and $X_d = 80\%$. It is operating at no load and rated voltage, when a 3-phase short circuit occurs between the breaker and transformer. The sustained short circuit current in breaker is _____ A(rms values)

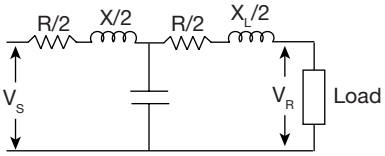
45. The Thevenin's equivalent impedance of a bus bar in a three phase 500 kV system is 0.40 p.u at a base of 600 MVA. Calculate the reactive power needed to boost the voltage by 5 kV at the bus bar.

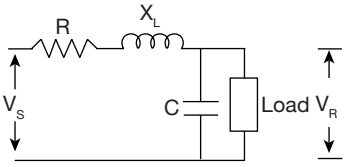
(A) 45 MVAR injected (B) 45 MVAR, extracted
(C) 15 MVAR injected (D) 15 MVAR extracted

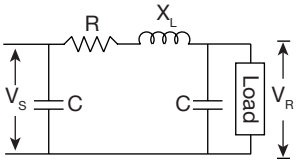
46. For the following phasor diagram single line diagram of a power system is



(A)


(B)


(C)


(D)


47. A coil was tested using a Q-meter and the following results were obtained:

Tuning capacitance setting	Oscillatory frequency
2700 pF	3 MHz
80 pF	9 MHz

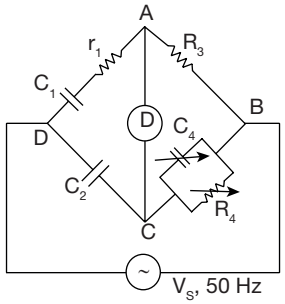
The self capacitance of the coil will be

(A) 121.25 μF (B) 173.2μF
(C) 247.5 pf (D) 314.5 pf

48. A lissajous plates on an oscilloscope is stationary and has 6 horizontal tangencies and 2 vertical tangencies. The frequency horizontal input is 5000 Hz. What will be the frequency of vertical input

(A) 2500 Hz (B) 5000 Hz
(C) 15000 Hz (D) 20000 Hz

49. A low voltage schering bridge circuit is shown below:



The arm impedances are given as AB:R_3 = 150Ω, BC:C_4 = 0.5μF, R_4 = 400Ω and CD:C_2 = 100μF.
At balanced bridge what will be the dissipation factor

(A) 0.01 (B) 0.0254
(C) 0.0314 (D) 0.0628

50. A single phase, half bridge inverter is feeding power into a load of resistance 20Ω, dc input to the inverter is 200V. Find the power delivered to the load due to fundamental output current and the power factor respectively

(A) 405.28W, UPF (B) 543.22W, 0.799 lag
(C) 764.5W, 0.799 lag (D) 1621.12W, UPF

51. A single phase full converter is connected to an AC supply of 325sin(314t) volts. It operates at a firing angle, $\alpha = \frac{\pi}{6}$. The load current is maintained constant at 10A and the load voltage is 150V. The source inductance will be

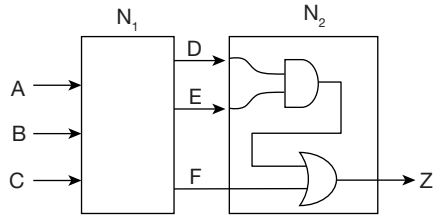
(A) 17.1 mH (B) 29.2 mH
(C) 35.4 mH (D) 70.8 mH

52. A three phase full converter is supplying a purely resistive load at 299V d.c for 0° firing angle. The output voltage for 90° firing angle would be

(A) 0V (B) 40V
(C) 60V (D) 120V

53. A combinational circuit is divided into two sub sections N_1 and N_2 as shown. The truth table of N_1 is given. Assume that the input combinations ABC = 101, and

ABC = 001 never occur. Find the output expression for Z.

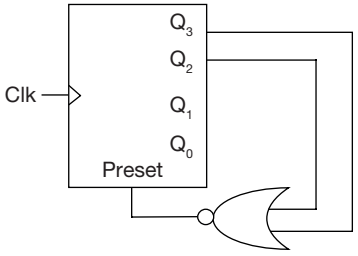


A	B	C	D	E	F
0	0	0	0	0	1
0	0	1	1	0	0
0	1	0	1	1	0
0	1	1	1	1	1
1	0	0	0	0	0
1	0	1	1	0	1
1	1	0	0	1	1
1	1	1	0	1	0

(A) $\overline{A}B+\overline{A}\overline{C}+B\overline{C}$ (B) $\overline{A}+\overline{B}C$

(C) $\overline{A}+B\overline{C}$ (D) $\overline{A}+\overline{B}C+B\overline{C}$

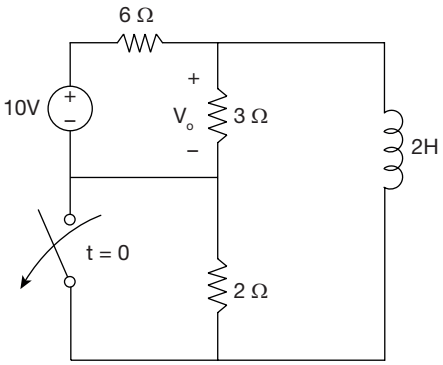
54. A Binary down sequence, asynchronous counter with synchronous and active high preset input is shown in the figure with the decoding logic shown. The counter works as a (consider initially all flip flops at preset state)



(A) Mod – 3 counter (B) Mod – 12 counter

(C) Mod – 13 counter (D) Mod – 14 counter

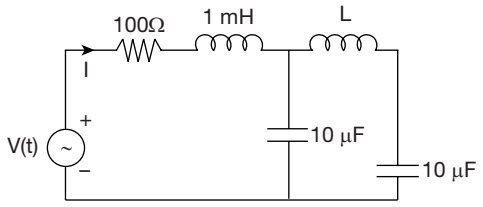
55. Find $V_o(t)$ for $t > 0$



(A) $\frac{5}{3}(1-e^{0.5t})$volts (B) $\frac{5}{3}\cdot(1-e^{-2t})$volts

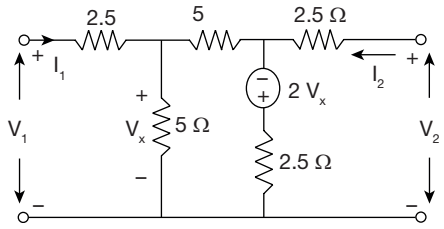
(C) $\frac{5}{3}(1+e^{-0.5t})$ volts (D) $\frac{3}{5}(1-2.\,e^{-2t}\}$ volts

56. In the circuit shown, the current I flowing through the 100 Ω resistor will be zero, If the value of L is _____ H.



(consider $V(t) = 5\sin 1000\,t$ V)

57. Consider the network shown below



The value of Z_{11}(In Ω) is _____.

58. A unity feedback system has $G(s)H(s) = \frac{k}{s(1+as)}$ with 'a' and 'k' are constants. If the peak over shoot value is 50%, then the relation between 'a' and 'k' should be _____.

(A)$ak = 2.32$ (B) $k.a = 5.38$

(C) $\frac{a}{k} = 4.2$ (D) $\sqrt{ak} = 3.2$

59. The characteristic equation of a feedback control system is $s^3 + (K + 2)\,s^2 + 3Ks + 20 = 0$. If the system is marginally stable, then the frequency of oscillations is _____ rad/sec.

60. Consider the particular system state equation are

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}-1 & 1\\ 2 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}2\\ 3\end{bmatrix}u$$

$y = [-1\ 2]\,[x]$

The transfer function of the system is

(A) $\frac{2s-13}{s^2+s-2}$ (B) $\frac{-4s+13}{s^2+s+2}$

(C) $\frac{(4s+11)}{s^2+s-2}$ (D) $\frac{-(4s+11)}{s^2+s-2}$

61. The doping concentration on the n-side and p-side of a Si diode are 2.5×10^{16} cm^{-3} and 1×10^{16} cm^{-3}, respectively. A forward bias of 0.4V is applied to the diode. At $T = 300^o$ k, the hole concentration at the edge of the depletion region on the n-side is _____.

(Consider $n_i = 1.5 \times 10^{10}$ atoms/cm^3)

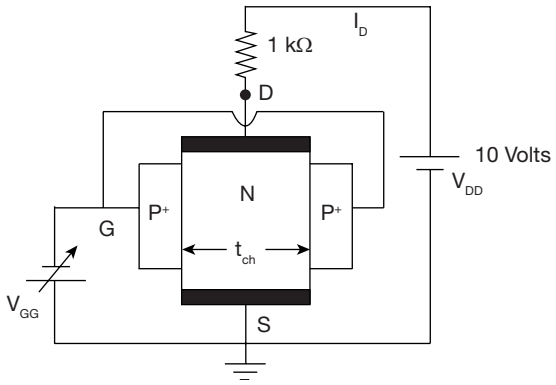
(A) 4.32×10^{10} atoms/cm^3

(B) 3.42×10^{9} atoms/cm^3

(C) 4.32×10^{12} atoms/m^3
(D) 3.42×10^{9} atoms/m^3

62. The change in collector voltage is from 1.5V to 3V, while the V_{BE} remains constant. If the collector current change is restricted to be less than are equal to 4%, the necessary value of early voltage is _____.
(A) $V_A \geq 36$ V (B) $V_A \leq 37.5$ V
(C) $V_A \geq 34$ V (D) $V_A \leq 25$ V

63. The channel resistance of an *N*-channel *JFET* shown in the figure below is 600 Ω when the full channel thickness (t_{ch}) of 10μm is available for conduction. When V_{GG} is 0*V*, the channel depleted by 1 μm on each side due to the built in voltage ($V_{bi} = -1V$) when V_{GG} is 3 Volt, the current I_D is



(A) 10 mA
(B) 5 mA
(C) 0 mA
(D) None of these

64. If $f(t) = 0$, outside the interval $[T_1, T_2]$ furthermore, $|f(t)| < \infty$, The ROC of the signal's bilateral Laplace transform $F(s)$ is _____
(A) The entire *S*-plane
(B) A parallel strip – not containing the $j\omega$ axis.
(C) A parallel strip containing the $j\omega$ axis.
(D) None of these

65. A signal is represented by $x(t) = \begin{cases} 1 & ; \ |t| < 2 \\ 0 & ; \ |t| > 2 \end{cases}$

The fourier transform of the convoluted signal $y(t) = x(3t) \otimes x\left(\frac{t}{3}\right)$ is_____

(A) $\frac{2}{\omega^2}\sin\left(\frac{2\omega}{3}\right)\sin(6\omega)$

(B) $\frac{4}{\omega^2}\sin\left(\frac{2\omega}{3}\right)\sin(6\omega)$

(C) $\frac{4}{\omega^2}\sin\left(\frac{2\omega}{3}\right)\sin(6\omega)$

(D) None of these

Answer Keys

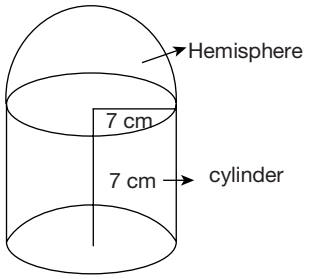
Section – I

1. B	**2.** B	**3.** C	**4.** D	**5.** A	**6.** 68	**7.** C	**8.** A	**9.** C	**10.** D
11. B	**12.** 3	**13.** 1.8	**14.** D	**15.** B	**16.** 85.2 to 85.8		**17.** 53 to 53.5		**18.** A
19. 1.3 to 1.36		**20.** A	**21.** 0.05	**22.** C	**23.** C	**24.** D	**25.** D	**26.** B	
27. 0.9 to 1.1		**28.** B	**29.** B	**30.** B	**31.** 5.5 to 6.5		**32.** 0.48 to 0.52		
33. –1.1 to –0.9		**34.** A	**35.** B	**36.** A	**37.** D	**38.** 0.29 to 0.3		**39.** C	**40.** A
41. B	**42.** B	**43.** 1.23 to 1.25		**44.** 0.418 to 0.42		**45.** C	**46.** C	**47.** C	**48.** C
49. D	**50.** A	**51.** B	**52.** B	**53.** C	**54.** C	**55.** B	**56.** 0.15 to 0.25		
57. 4.1 to 4.2		**58.** B	**59.** 2.2 to 2.4		**60.** C	**61.** A	**62.** A	**63.** B	**64.** A
65. C									

Hints and Explanations

1. 'Toxicity' gives the clue to the correct answer. Something which is toxic is detrimental (harmful). Hence it is logical to say that despite its known 'toxicity', lead continues to be used to the detriment of human and environmental health. The word solace (relief; comfort) runs contrary to what is stated in the sentence. The word chagrin (annoyance) is too mild to be used for something which is toxic. The word impediment (hindrance; obstacle) does not make sense here.
Choice (B)

2.



Volume of the hemisphere $= \left(\frac{1}{2}\right)\left(\frac{4}{3}\right)\pi r^3$

$= \left(\frac{2}{3}\right)(\pi)(7^3)$

Volume of the cylinder $= \pi r^2 h = 7^3\pi$

Total volume $= (\pi)7^3\left[1+\frac{2}{3}\right] = \frac{5\pi}{3}(7^3)$ Choice (B)

3. The study of man is called Anthropology. Form the point, "Anthropology is called ornithology", we can say that Ornithology is the word that is used to refer to Anthropology.

Choice (C)

4. Biology is the study of life, Mythology is the study of myths. Archaeology is not the study of antiques, it is the specific study of historic or prehistoric peoples and their cultures by analysis of their antifacts, inscriptions, monuments etc, especially those that have been excavated. Astrology is the study that assumes and attempts to interpret the influence of heavenly bodies on human affairs. Cosmetology is the art or profession of applying cosmetics. Only option D expresses a relationship which is similar to that expressed by the headwords.

Choice (D)

5. The reference is to a specific monsoon hence, the definite article 'the' is more appropriate in the first blank. The present perfect continuous tense 'has been showing' is apt in the second blank because here, the reference is to a trend which started sometime in the past and is still continuing. In the third blank, the reference is to something which took place during a specific time period. This is best denoted using the preposition 'over'. The definite article is required in the fourth blank because the reference is to a particular subcontinent.

Choice (A)

6. $h\,(12, 11, 8, 16) = 12 \times 11 > 8 \times 16$

$132 > 128$

Remainder when 132 is divided by 128 = 4.

$fg\,(h(12,11,8,16),17,9,16) = fg(4,17,9,16)$

$= f\,(4,17,9,16) \times g\,(4,17,9,16) = 17 \times 4 = 68$. Ans: 68

7. Options A and B run contrary to what is stated. Option D is incorrect because it is not mentioned that the brain and the lymphatic system are connected 'indirectly'. Only option C can be logically inferred from the given sentence. Choice (C)

8. Only statement (i) can be inferred from the given passage. It cannot be inferred from the passage that the government does not consider cyber threats as serious as other security threats. Options (iii) and (iv) are illogicall. Choice (A)

9. There are 33 instances of students leaving out a question (The sum of the 4 numbers in column 5) Exactly 5 students attempted all 4 questions. We distribute there 33 instances over all the remaining 25 students there would be 8 more instances. We can collect them to at the most 8 students.

$\therefore$ The maximum possible number of students who left out at least 2 questions is 8. Choice (C)

10. All I, II and III are appropriate and apt courses of action. Choice (D)

11. The number of ways of selecting one letter each from the words 'FRACTION' and 'DECIMAL' is $8 \times 7 = 56$. The selected letter in a word will not be in the other word only if the common letters are not selected.

The common letters in the two words are *A*, *C* and *I*.

The number of ways of selecting the letters from the words such that the selected letter in a word should not be in the other word = (The number of ways of selecting a letter from *F*, *R*, *T*, *O* and *N*) × (The number of ways of selecting a letter from *D*, *E*, *M* and *L*)

$= 5 \times 4 = 20$

$\therefore$ The required probability $= \frac{20}{56} = \frac{5}{14}$ Choice (B)

12. We have $\underset{x\to 3}{Lim}\ \log_5\left[4x^3 + \sqrt{(3x^4+5x^2+1)}\right]$

$= \log_5\left(\underset{x\to 3}{Lim}\left[4x^3 + \sqrt{(3x^4+5x^2+1)}\right]\right)$

$= \log_5\left(108 + \sqrt{289}\right)$

$= \log_5 125 = \log_5 5^3 = 3$ Ans: 3

13. Let $f(x) = x^3 + x^2 + 4x + 4 = 0$

One can observe that $x = -1$ is a real root of $f(x) = 0$

and $f(x) = (x+1)(x^2+4) = 0$

$\therefore$ $x = -1$ is the only real root of $f(x) = 0 f'(x) = 3x^2 + 2x + 4$

Given $x_0 = 2$

$\therefore$ $f(x_0) = f(2) = 24$ and $f'(x_0) = f'(2) = 20$

By Newton-Raphson method the root of $f(x) = 0$ after first iteration is $x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$

$= 2 - \frac{24}{20} = 2 - \frac{6}{5} = \frac{4}{5}$

$x_1 = 0.8$

$\therefore$ The absolute error $= |-1 - 0.8| = 1.8$. Ans: 1.8

14. We know that the Fourier series expansion of a periodic function $f(x)$ of period $2a$ in $[-a, a]$ will have only sine terms if $f(x)$ is an odd function.

Among the functions given in the options, the function given only in option (D) only is odd.

$\therefore$ Its Fourier series expansion will consist of only sine terms. Choice (D)

15. We have to find $L^{-1}\,[\tan^{-1}(s/4)]$

Let $\overline{f}\,(s) = \tan^{-1}(s/4)$

$\therefore \quad L^{-1}[\tan^{-1}(s/4)] = L^{-1}[\overline{f}(s)] = f(t)$, (say)

$\Rightarrow \quad L[f(t)] = \overline{f}(s) = \tan^{-1}(s/4)$

$\therefore \quad L(t\,f(t)) = \dfrac{-d}{ds}\left(\overline{f}(s)\right)$

$$= -\frac{d}{ds}(\tan^{-1}(s/4)) = -\left(\frac{1}{1+\left(\frac{s}{4}\right)^2}\right)\frac{1}{4}$$

$$\therefore \quad L[t\,f(t)] = -\frac{4}{(s^2+16)}$$

$$\Rightarrow \quad t\,f(t) = L^{-1}\left[\frac{-4}{s^2+16}\right] = -L^{-1}\left[\frac{4}{s^2+16}\right]$$

$\therefore \quad t\,f(t) = -\sin 4t$

$$\Rightarrow \quad f(t) = \frac{-\sin 4t}{t}$$

$$\therefore \quad L^{-1}[\tan^{-1}(s/4)] = \frac{-\sin 4t}{t}$$ Choice (B)

16. Referring rotor stator side

$$I_1 = \frac{\left(\frac{400}{\sqrt{3}}\right)}{(0.04+1)+j0.85} = 172.68\angle -39.25$$

Input power $= 3 \times V_{ph} I_{ph} \cos \varnothing$

$$= 3 \times \frac{400}{\sqrt{3}} \times 172.68 \times \cos 39.25$$

$= 92.645$ kW

Stator copper losses $= 3\,I_1^2 \times R_1$

$= 3 \times (172.68)^2 \times 0.04$

$= 3.578$ kW

Air gap power = Input power – stator cu loss

$= 92.645 - 3.578 = 89.067$ kW

Power developed = $(1 - s)$ air gap power

$= (1 - 0.04)(89)$

$= 85.44$ kW

Ans: 85.2 to 85.8

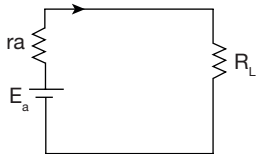
17. $\varepsilon_{b_1} = v + I_a R_a$

$$= 80 + \left(\frac{80}{15}\right) \times 0.4 = 82.13$$

$\varepsilon_b \; a \dfrac{N}{A}$

$$\frac{\varepsilon_{b_1}}{\varepsilon_{b_2}} = \frac{N_1}{N_2} \times \frac{A_2}{A_1}$$

$$\frac{82.13}{\varepsilon_{b_2}} = \frac{N_1}{2N_1} \times \frac{6}{2} \Rightarrow \varepsilon_{b_2} = 54.75\text{V}$$



terminal voltage in the second case

$\varepsilon_{b_2} = V_2 + Ia_2 R_{a(\text{lap})}$

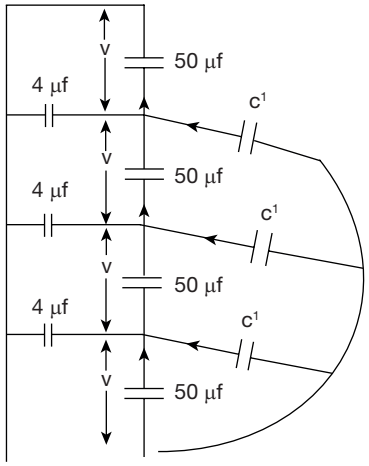
$$R_{a(\text{lap})} = R_{a(\text{wave})} \times \left(\frac{2}{6}\right)^2 = 0.44\Omega$$

$$54.75 = V_2 + \left(\frac{V_2}{15}\right) 0.44$$

$V_2 = 53.2$ volts Ans: 53 to 53.5

18. Choice (A)

19.



$I_C = I_4$

$3v(jwc^1) = v(jw4)$

$c^1 = \dfrac{4}{3} = 1.33$ μf Ans: 1.3 to 1.36

20. Load factor $= \dfrac{\text{average demand}}{\text{maximum demand}}$

Capacity factor $= \dfrac{\text{Average demand}}{\text{Installedcapacity}}$

Maximum demand = Capacity factor

$$\times \frac{\text{Installed capacity}}{\text{Load factor}}$$

$$= 0.8 \times \frac{500}{0.85} = 470.58 \text{ Mw}$$

Reserve capacity = 500 – 470.58 = 29.42 Mw

Choice (A)

21. $I_{a1} = \dfrac{E_a}{Z_1 + Z_2 + Z_0}$

$2 = \dfrac{1}{0.25 + 0.2 + Z_0}$

$0.45 + Z_0 = \dfrac{1}{2}$

$Z_0 = 5 - 0.45$

$Z_0 = 0.05$ Ans: 0.05

22. Total power $P = W_1 + W_2$

But $\dfrac{\omega_1}{\omega_2} = 3$

$\Phi = \tan^{-1}\left(\dfrac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right)$

$\Phi = \tan^{-1}\left[\dfrac{\sqrt{3}\left(\dfrac{W_1}{W_2} - 1\right)}{\dfrac{W_1}{W_2} + 1}\right]$

$\Phi = \tan^{-1}\left[\dfrac{\sqrt{3}(3-1)}{3+1}\right]$

$\Phi = \tan^{-1}\left(\dfrac{\sqrt{3}}{2}\right) = 40.893$

Power factor $\cos \Phi = 0.76$ Choice (C)

23. To reduce the error, a low value resistance connected between standard and test resistance hence accuracy increases. Choice (C)

24. $V_o = 300\text{V}$

$V_o = \dfrac{V_s}{(1-\delta)} \Rightarrow 300 = \dfrac{150}{1-\delta}$

$1 - \delta = 0.5$

$\delta = 0.5$

$\dfrac{T_{ON}}{T_{OFF}} = \dfrac{\delta}{1-\delta} = 1$

$T_{ON} = T_{OFF}$

$T_{ON} = 40\ \mu\text{sec}$

Choice (D)

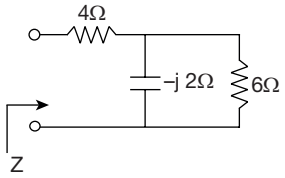
25. Maximum conduction obtained when minimum triggering angle is $\alpha = \sin^{-1}\left(\dfrac{E}{V_m}\right)$

$\alpha = \sin^{-1}\left(\dfrac{162-63}{230\sqrt{2}}\right) = 30^\circ$

Conduction angle $= 180 - \alpha = 150^\circ$

Choice (D)

26. Find the total impedance



$Z = 4 + \{6 \parallel -j2\}$

$Z = 4 + \dfrac{-j2 \times 6}{6 - j2}$

$Z = (4.6 - j1.8)\ \Omega$

$Z = 4.93\ \angle -21.37^\circ\ \Omega$

Power factor $p.f = \cos\theta = \cos(-21.37)$

$= 0.9312$ (Leading)

Average power supplied by the source is

$P = V_{\text{rms}}.I_{\text{rms}}.p.f = I_{rms}^2.R$

$I_{\text{rms}} = \dfrac{V_{rms}}{Z} = \dfrac{20}{4.93\angle -21.37} = 4.05\angle 21.37^o\ \text{Amp}$

$P = (4.05)^2 \times 4.6$

$= 75.7\ \text{W}$ Choice (B)

27. Convert Y to Δ

$Z_a = 2 + j3 - \dfrac{2 \times j3}{j2}$

$= 2 + j3 - 3 = (-1 + j3)\ \Omega$

$Z_b = 2 - j2 + \dfrac{2 \times (-j2)}{j3} = \left(\dfrac{2}{3} - j2\right)\Omega$

$Z_C = j3 - j2 + \dfrac{j3(-j2)}{2} = (3 + j1)\ \Omega$

$\left|\dfrac{Z_a}{Z_c}\right| = 1$ Ans: 0.9 to 1.1

28. $G(s)\,H(s) = \dfrac{K}{(s+3)(s^2 + 2s + 2)}$

$1 + G(s)\,H(s) = 0$

$(s + 3)(s^2 + 2s + 2) + K = 0.$

Closed loop poles nothing but roots of characteristic equation. So Sub $s = -4$

$(-1)(16 - 8 + 2) + K = 0.$

$K = 10.$

Choice (B)

29. Initial slope $\Rightarrow$ –40db/dec, so $P = 2$.

2nd Slope changing from –40db/dec to 0db/dec, so $Z = 2$.

Again slope changing from 0db/dec to + 20 db/dec, $Z = 1$

Next + 20db/dec to – 20db/dec ;so $P = 2$

$\therefore$ total $P = 2 + 2 = 4$.

$Z = 2 + 1 = 3$. Choice (B)

30. $X(z) = \dfrac{1}{1-z^{-3}} = z^{+3} + z^{+6} + z^{+9}\ldots\ldots$

So $x[-1] = 0$
$x[-3] = 1$ Choice (B)

31. Nyquist frequency for $x_1(t)$
$= 400\pi + 800\pi = 1200\pi$ (or) 600 Hz
Nyquist frequency for $x_2(t)$
$= 200\pi$ (or) 100 Hz

Now $\dfrac{N_1}{N_2} = \dfrac{600}{100} = 6$ Ans: 5.5 to 6.5

32. $I_C = \beta.I_B + (1+\beta).I_{CBO}$
$2.5 \times 10^{-3} = 100 \times 20 \times 10^{-6} + I_{CEO}$
$I_{CEO} = 0.5 \times 10^{-3} = 5 \times 10^{-4}$
$= 0.5$ mA Ans: 0.48 to 0.52

33. We know in general

$$g_m = g_{mo}\left[1 - \frac{V_{GS}}{V_P}\right]$$

$$1.5 \times 10^{-3} = 2 \times 10^{-3}\left[1 - \frac{V_{GS}}{-4}\right]$$

$0.75 = 1 + 0.25\ V_{GS}$
$V_{GS} = -1$V Ans: –1.1 to -0.9

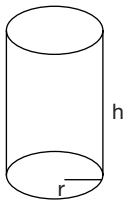
34. Given circuit is a ripple counter, $\overline{Q}_0$ is connected to rising edge Clk pulse, so it is UP counter.

Clk	Q_1	Q_0
0	0	0
1	0	1
2	1	0
3	1	1
4	0	0

Choice (A)

35. Field is propagating in x axis but polarized in y-axis because the polarization of wave in the orientation of E. Choice (B)

36.



Let r and h be the radius and height of the cylindrical cistern with surface = 108π sq. feet

$\therefore \quad 2\pi rh + \pi r^2 = 108\pi$

$\Rightarrow \quad 2rh = 108 - r^2$

$\Rightarrow \quad h = \dfrac{108 - r^2}{2r}$ $\rightarrow (1)$

Volume of the cylindrical cistern = $C = \pi r^2 h$

$$= \pi r^2\left(\frac{108 - r^2}{2r}\right)$$

$\therefore \quad V = \dfrac{\pi}{2}(108r - r^3)$ $\rightarrow (2)$

Let $f(r) = \dfrac{\pi}{2}(108r - r^3)$

$\therefore$ We have to find the maximum value of V.

$f'(r) = \dfrac{\pi}{2}(108 - 3r^2)$

$f'(r) = 0 \Rightarrow \dfrac{\pi}{2}(108 - 3r^2) = 0$

$\Rightarrow \quad 108 - 3r^2 = 0$

$\Rightarrow \quad r^2 = 36 \qquad \Rightarrow \quad r = 6$

And $f''(r) = -3\pi r < 0$ for $r = 6$

$\therefore$ $f(r)$ is maximum at $r = 6$

Hence the maximum volume of the cistern
$= V$ at $x = 6$

$= \dfrac{\pi}{2}(108 \times 6 - 6^3) = 216\pi$ cubic feet.

Choice (A)

37. Given –1, 2 and 5 are the eigenvalues of A.

$\therefore$ $-1 + 2$, $2 + 2$ and $5 + 2$ are the eigenvalues of $A + 2I_3$
i.e., 1, 4 and 7 are the eigenvalues of $A + 2I_3$

$\therefore$ Det $(A + 2I_3) = |A + 2I_3|$ = Product of the eigenvalues of $A + 2I_3 = 1 \times 4 \times 7 = 28$

$\Rightarrow$ Determinant of inverse of $A + 2I_3$

$= |(A + 2I_3)^{-1}| = \dfrac{1}{|A + 2I_3|} = \dfrac{1}{28}$ Choice (D)

38. Let B_1 and B_2 denote the events of selecting an engineering graduate and a science graduate respectively.
Let A be the event of selecting a youngster who is self employed.

$\therefore \quad P(B_1) = \dfrac{60}{100} = 0.6,\ P(B_2) = \dfrac{40}{100} = 0.4$

$P(A/B_1) = \dfrac{45}{100} = 0.45$ and $P\left(\dfrac{A}{B_2}\right) = \dfrac{30}{100} = 0.3$

If the youngster selected is found to be self employed, then the probability that the person is a science graduate

$$= P(B_2/A) = \frac{P(B_2).P\left(\frac{A}{B_2}\right)}{P(B_1).P\left(\frac{A}{B_1}\right) + P(B_2).P\left(\frac{A}{B_2}\right)}$$

(By Baye's Theorem)

$$= \frac{0.4 \times 0.3}{(0.6 \times 0.45) + (0.4 \times 0.3)} = \frac{12}{39} = 0.3077$$

Ans: 0.29 to 0.31

39. Given $f(z) = u(x, y) + iv(x, y)$ is analytic and $u(x, y) = \cos x.\ \cos hy$.

$\therefore \quad \dfrac{\partial u}{\partial x} = u_x = -\sin x\ .\ \cos hy$

and $\dfrac{\partial u}{\partial y} = u_y = \cos x\ .\ \sin hy$

As $f(z)$ is analytic, $u(x, y)$ and $v(x, y)$ will satisfy Cauchy – Reimann equations.

i.e., $u_x = v_y$ and $v_x = -u_y$ $\rightarrow (1)$

we know that $dv = \dfrac{\partial v}{\partial x}dx + \dfrac{\partial v}{\partial y}dy$

$= v_x\,dx + v_y\,dy$

$= -u_y dx + u_x dy$ (From (1))

$= -(\cos x\ .\ \sin hy)\,dx + (-\sin x\ .\ \cos hy)\,dy$

$\therefore \quad dv = -\cos x\ .\ \sin hy\,dx - \sin x\ .\ \cos hy\,dy$

$= -d(\sin x\ .\ \sin hy)$

$\Rightarrow \quad v(x, y) = -\sin x\ .\ \sin hy$ Choice (C)

40. Given differential equation is

$\dfrac{dy}{dx} = \cos(x + y - 3)$ $\rightarrow (1)$

Put $x + y - 3 = u$

Differentiating w.r.t x on both sides,

$1 + \dfrac{dy}{dx} = \dfrac{du}{dx}$

$\Rightarrow \quad \dfrac{dy}{dx} = \dfrac{du}{dx} - 1$

$\therefore$ (1) becomes, $\dfrac{du}{dx} - 1 = \cos u \Rightarrow \dfrac{du}{dx} = 1 + \cos u$

$\dfrac{1}{(1+\cos u)}du = dx$

$\Rightarrow \quad \dfrac{1}{2\cos^2\left(\dfrac{u}{2}\right)}du = dx \Rightarrow \dfrac{1}{2}\sec^2(u/2)\,du = dx$

Integrating on both sides, $\dfrac{1}{2}\int \sec^2\left(\dfrac{u}{2}\right)du = \int dx$

$\Rightarrow \quad \dfrac{1}{2}\left(\dfrac{\tan\left(\dfrac{u}{2}\right)}{\dfrac{1}{2}}\right) = x + c$

$\Rightarrow \quad \tan\left(\dfrac{x+y-3}{2}\right) = x + c$

$\Rightarrow \quad \dfrac{x+y-3}{2} = \tan^{-1}(x + c)$

$\Rightarrow \quad x + y - 3 = 2\tan^{-1}(x + c)$

$\Rightarrow \quad y = (3 - x) + 2\tan^{-1}(x + c)$

$\therefore$ The general solution of (1) is

$y = (3 - x) + 2\tan^{-1}(x + c)$ Choice (A)

41. Starting current $I_s = 4$ p.u

Full load slip $S_f = 0.04$

Starting torque $= 16 \times 0.04 = 0.64$ p.u Choice (B)

42. Choice (B)

43. Voltage/phase $= \dfrac{3000}{\sqrt{3}} = 1732.05$V

Induced e.m.f = 1732.05V

Impedance drop $= 250 \times 4 = 1000$ V

R_a is negligible

$\Rightarrow \quad 1732.05^2 = 1732.05^2 + 1000^2 - 2 \times 1000 \times 1732.05 \cos(90 - \varphi)$

$\cos(90 - \varphi) = 0.288 \Rightarrow \varphi = 16.78^\circ$

Power input $= \sqrt{3} \times 3000 \times 250 \times \cos(16.78)$

$= 1.24$ MW Ans: 1.23 to 1.25

44. Sustained short circuit current $= \dfrac{8000}{\sqrt{3} \times 11 \times 10^3}$

$= 0.419$ Ans: 0.418 to 0.42

45. $\Delta V = \dfrac{QX}{V_1}$

$X = \dfrac{0.4 \times 500 \times 500}{600} = 166.67\ \Omega$

For boosting of the voltage 5 kV

$5000 = \dfrac{Q \times 166.67}{500 \times 1000}$

$Q = 15$ MVAR injected Choice (C)

46. From the phasor diagram the capacitance is placed at the load side because capacitor current added to the receiving end current. Choice (C)

47. Self capacitance, $C_d = \dfrac{C_1 - n^2 C_2}{n^2 - 1}$

$= \dfrac{2700 - \left(\dfrac{9}{3}\right)^2 80}{\left(\dfrac{9}{3}\right)^2 - 1} = 247.5\,\text{PF}$ Choice (C)

48. $\dfrac{f_y}{f_x} = \dfrac{N_x}{N_y}$

$f_y = \dfrac{N_x}{N_y} \times f_x = \dfrac{6}{2} \times 5000 = 15000$ Hz Choice (C)

49. Dissipation factor $\tan\delta = WC_1r_1 = \omega C_4 R_4$

$\tan\delta = 314 \times (0.5 \times 10^{-6}) \times (400)$

$= 0.0628$ Choice (D)

50. Fundamental output voltage, $V_{01} = \dfrac{2V_s}{\pi}\sin\omega t$

RMS value of load current, $01r = \dfrac{\sqrt{2}\,V_s}{\pi R}$

Load power $= I_{01r}{}^2 = 405.28\text{W}$

Load power $= V_{01r} I_{01r} \cos\Phi$

Power factor $\cos\Phi = \dfrac{405.28}{405.28}$

$\cos\Phi = 1$ (resistive load) Choice (A)

51. Output voltage, $V_o = \dfrac{2V_m}{\pi}\cos\alpha - \dfrac{\omega L_s}{\pi} I_o$

$$150 = \frac{2\times 325}{\pi}\cos\left(30^o\right) - \frac{314\times L_s}{\pi}\times 10$$

$L_s = 29.2$ mH Choice (B)

52. at $\alpha = 0^o$, $V_o = \dfrac{3V_{mL}}{\pi}$

at $\alpha = 90^o$, $V_o = \dfrac{3V_{mL}}{\pi}\left[1+\cos\left(\alpha+\dfrac{\pi}{3}\right)\right]$

$V_o = 299(1 + \cos 150^o)$

$V_o = 40\text{V}$ Choice (B)

53. From the given circuit $Z = DE + F$

We need expression of Z in terms of A, B, C

$ABC = 101, 001$ combinations do not occur.

A	B	C	D	E	F	Z = DE + F
0	0	0	0	0	1	1
0	0	1	1	0	0	X
0	1	0	1	1	0	1
0	1	1	1	1	1	1
1	0	0	0	0	0	0
1	0	1	1	0	1	X
1	1	0	0	1	1	1
1	1	1	0	1	0	0

A \ BC	00	01	11	10
0	1	X	1	1
1		X		1

$Z(A, B, C) = \Sigma\, m(0, 2, 3, 6) + \phi(1, 5)$

$Z = \overline{A} + B\overline{C}$ Choice (C)

54. Active high preset, so when output of NOR gate is 1, then preset activated, and output becomes 1111 is next clk pulse (synchronous input)

Clk	Q_3	Q_2	Q_1	Q_0	Preset= $\overline{Q_3 + Q_2}$
0	1	1	1	1	0
1	1	1	1	0	0
2	1	1	0	1	0
10	0	1	0	1	0
11	0	1	0	0	0
12	0	0	1	1	1
13	1	1	1	1	0

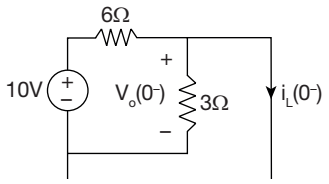
From the above table, we can understand that after 13 clk pulse the counter came to original state. So it is Mod 13 counter Choice (C)

55. **For $t < 0$:-**

Switch closed and the circuit is in *S.S*

$L \rightarrow S.C$

The equivalent circuit is shown in below

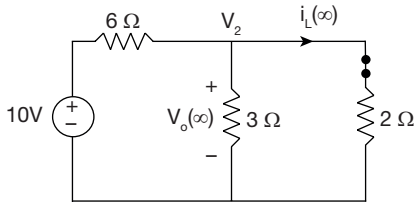


$i_L(0^-) = \dfrac{10}{6} = 5/3$ A

$V_o(0^-) = 0\text{V}$

$t \rightarrow \infty$

$i_L(\infty) = ?$



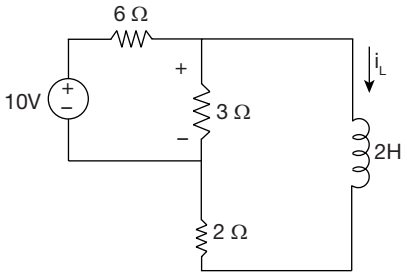
$$\frac{V_o(\infty)-10}{6} + \frac{V_o(\infty)}{3} + \frac{V_o(\infty)}{2} = 0$$

$V_o(\infty) - 10 + 2V_o(\infty) + 3V_o(\infty) = 0$

$6V_o(\infty) = 10$

$V_o(\infty) = \dfrac{5}{3}\text{V}$

For $t > 0$:-



$V_o(t) = V_0(\infty) + \{V_o(0^+) - V_0(\infty)\}.e^{-t/\tau}$

$\tau = \dfrac{L_{eq}}{R_{eq}}$

$R_{eq} = (6\|3) + 2$

$R_{eq} = 4\ \Omega$

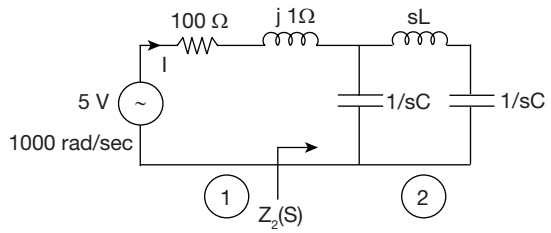
$L = 2$ H

$\tau = \dfrac{1}{2}$ sec

$\therefore \quad V_o(t) = \dfrac{5}{3}\{1 - e^{-2t}\}$ volts Choice (B)

56. Redraw the given circuit the *S*-domain

$Z_2(s) = \left(1/sC\right) \| \left(sL + 1/sC\right)$



$$Z_2(s) = \frac{\frac{1}{sC}\left\{\frac{s^2LC+1}{sC}\right\}}{\frac{1}{sC}+\frac{1}{sC}+sL}$$

But given I = 0

$I = 0$, only when $Z_2(s) = \infty$ [open circuit]

$$Z_2(s) = \frac{X}{2+s^2\,LC}$$

Let $2 + S^2\,LC = 0$

$S = j\omega$

$2 - \omega^2 LC = 0$

$$\omega = \sqrt{\frac{2}{LC}}$$

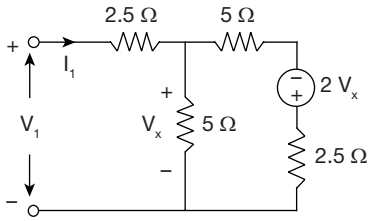
$$(1000)^2 = \frac{2}{LC}$$

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

$L = 0.2$ H Ans: 0.15 to 0.25

57. We know $Z_{11} = \left.\frac{V_1}{I_1}\right/_{I_2=0}$

Redraw the given circuit



From the circuit

$$V_1 - 2.5I_1 - V_x = 0 \text{ and } -I_1 + \frac{V_x}{5} + \frac{3V_x}{7.5} = 0$$

$15I_1 = 3V_x + 6V_x$

$9V_x = 15\,I_1$

Sub $V_x = \frac{5}{3} I_1$

$$V_1 - 2.5\,I_1 - \frac{5}{3} I_1 = 0$$

$$\frac{V_1}{I_1} = Z_{11} = 4.166\ \Omega$$

Ans: 4.1 to 4.2

58. Characteristic equation $1 + G.H = 0$.

$s\,(1 + as) + k = 0 \Rightarrow as^2 + s + k = 0$

$$s^2 + \frac{1}{a}s + \frac{k}{a} = 0$$

$$\xi\omega_n = \frac{1}{a}\ ;\ \omega_n = \sqrt{\frac{k}{a}}$$

$$M_p = e^{-\xi\pi/\sqrt{1-\xi^2}} \times 100$$

$$0.5 = e^{-\xi\pi/\sqrt{1-\xi^2}}$$

$$-0.693 = -\frac{\xi\pi}{\sqrt{1-\xi^2}}$$

$0.048\,(1-\xi^2) = \xi^2$

$0.048 = 1.0486\xi^2$

$\xi = 0.2154$

$$\frac{1}{2\sqrt{ka}} = 0.2154$$

$$\sqrt{ka} = 2.32$$

$ka = 5.3814$ Choice (B)

59. The routh array is

s^3		1	3K
s^2		K + 2	20
s^1		$3k - \frac{20}{K+2}$	
s^0		20	

If the system is stable only when

$K + 2 > 0$ and

$$3K - \frac{20}{K+2} > 0.$$

$3K^2 + 6K - 20 > 0$

$K > 1.76$ and $K > -3.768$

From the above conditions, the system is stable for $k > 1.76$

If $K = 1.76$, the system is marginally stable

$(K + 2)\,S^2 + 20 = 0$

sub $K = 1.76$

$-3.76(\omega^2) + 20 = 0$

$\omega^2 = 5.319$

$\omega_o = 2.3$ rad/sec Ans: 2.2 to 2.4

60. $\frac{Y(s)}{X(s)} = T(s) = C.\,(SI - A)^{-1}.\,B + D$

$$A = \begin{bmatrix} -1 & 1 \\ 2 & 0 \end{bmatrix}$$

$$(SI - A) = \begin{bmatrix} s+1 & -1 \\ -2 & s \end{bmatrix}$$

$$(sI - A)^{-1} = \frac{adj\,(sI - A)}{|sI - A|} = \frac{1}{s(s+1)-2}\begin{bmatrix} s & 1 \\ 2 & s+1 \end{bmatrix}$$

$$\therefore \quad T(s) = \begin{bmatrix} -1 & 2 \end{bmatrix} \begin{bmatrix} s & 1 \\ 2 & s+1 \end{bmatrix} \begin{bmatrix} 2 \\ 3 \end{bmatrix} \frac{1}{s^2+s-2}$$

$$T(S) = \frac{-2s-3+2(3s+7)}{s^2+s-2}$$

$$T(A) = \frac{6s-2s-3+14}{s^2+s-2} = \frac{(4s+11)}{s^2+s-2}$$ Choice (C)

61. $P_n = P_{no}.\exp\left\{\frac{V_f}{V_T}\right\}$

$$P_{no} = \frac{n_i^2}{N_D} = \frac{\left(1.5\times10^{10}\right)^2}{2.5\times10^{16}} = 9 \times 10^3$$

$$P_n = 9 \times 10^3 \exp\left\{\frac{0.4}{0.026}\right\}$$

$P_n = 4.32 \times 10^{10}$ cm^{-3} Choice (A)

62. $I_C = I_{CO}.\, e^{\left[V_{BE}/V_T\right]}.\left[1+\frac{V_{CE}}{V_A}\right]$

Given V_{BE} = constant

$$\Delta IC = ICO.\, e^{\left[V_{BE}/V_T\right]}.\left[\frac{\Delta V_{CE}}{V_A}\right]$$

$$\frac{\Delta I_C}{I_C} = \frac{\Delta V_{CE}}{V_A + V_{CE}}$$

Given $\frac{\Delta I_C}{i_c} \le 4\%$

$$\therefore \frac{\Delta V_{CE}}{V_A + V_{CE}} \le \frac{1}{25}$$

$25(\Delta V_{CE}) \le V_A + V_{CE}$
$\Delta V_{CE} = 3 - 1.5 = 1.5$ V
$V_{CE\,\min} = 1.5$ V
$25 \times 1.5 \le V_A + 1.5$
$V_A \ge 36$ V Choice (A)

63. $I_D = \frac{V_{DD}}{1k\Omega + R_{Ch}}$

$R_{Ch}\ \alpha\ \frac{1}{t_{Ch}}$

$$\frac{R_{Ch_1}}{R_{Ch_2}} = \frac{t_{Ch_2}}{t_{Ch_1}}$$

When $V_{GG} = 0$ $t_{Ch_1} = 10$ μm

When $V_{GG} = 3$ volt $t_{Ch_2} = 10\ \mu m - 2W_2$

$W\ \alpha\ \sqrt{V_{GS} + V_{bi}}$

$$\frac{W_1}{W_2} = \sqrt{\frac{V_{GS1}+V_{bi}}{V_{GS2}+V_{bi}}}$$

$$\frac{1}{W_2} = \sqrt{\frac{0-1}{-3-1}} \Rightarrow W_2 = 2\ \mu m$$

$t_{Ch_2} = 10\,\mu m - 2\times2\,\mu m = 6\ \mu m$

$$R_{Ch_2} = \frac{R_{Ch_1} \times t_{Ch_1}}{t_{Ch_2}}$$

$$= \frac{600\times10}{6}$$

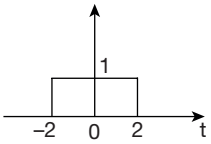
$R_{Ch_2} = 1000\Omega$

$$I_D = \frac{10}{1k\Omega + 1k\Omega} = 5\,mA$$ Choice (B)

64. q ROC is entire S-plane

Choice (A)

65. $x(t) = rect\left(\frac{t}{\tau}\right) = rect\left(\frac{t}{4}\right)$



$$\therefore rect\left(\frac{t}{\tau}\right) = \tau Sa\left(\frac{\omega\tau}{2}\right)$$

$$rect\left(\frac{t}{4}\right) = 4\ Sa\left(\frac{\omega.4}{2}\right) = 4Sa(2\ \omega)$$

By using scaling property of fourier transform $F\{x(3t)\}$

$$= F\left[rect\left(\frac{3t}{4}\right)\right] = 4 \times \frac{1}{3} Sa\left(\frac{2\omega}{3}\right)$$

Similarly $F\left(x\left(\frac{t}{3}\right)\right) = F\left(rect\left(\frac{t}{12}\right)\right)$

$= 4.3Sa(2\ \omega.3) = 12\ Sa\ (6\ \omega)$

$$F(y(t)) = F[x(3t)]\ .\ F\left[x\left(\frac{t}{3}\right)\right]$$

$$= \frac{4}{3}.12\,Sa\left(\frac{2\omega}{3}\right).sa(6\omega)$$

$$= \frac{16}{\frac{2\omega}{3}.6\omega}\sin\left(\frac{2\omega}{3}\right).\sin(6\omega)$$

$$= \frac{4}{\omega^2}\sin\left(\frac{2\omega}{3}\right)\sin(6\omega)$$ Choice (C)