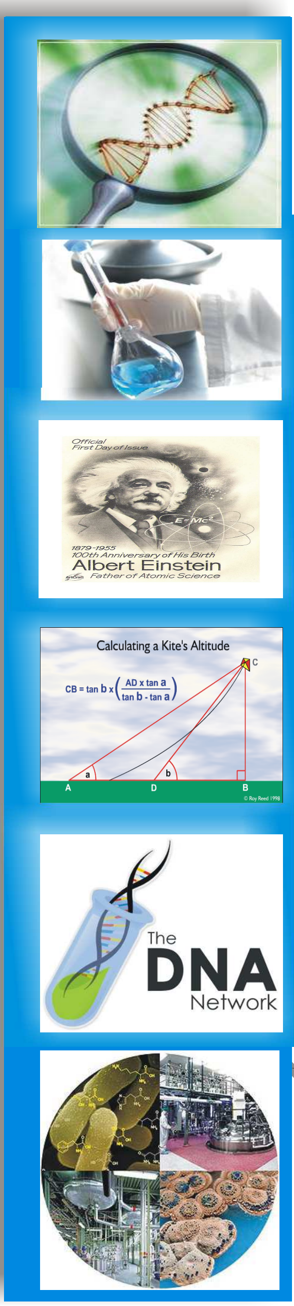

CSIR NET ENGINEERING SCIENCE
MOCK TEST PAPER

- *There are a total of 105 questions.*
- *PART - (A) Questions (1-15) will carry 2-marks each with 25% negative marking for each wrong answer.*
- *PART - (B) Questions (16-35) will carry 3.5-marks each with 25% negative marking for each wrong answer.*
- *PART - (C) Questions (36-105) will carry 5-marks each with 25% negative marking for each wrong answer.*
- **You are required to answer a maximum of 15, 20 and 20 questions each from part 'A' 'B' and 'C' respectively.**

- *Pattern of questions : MCQs*
- *Total marks : 200*
- *Duration of test : 3 Hours*

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PART - A (1 -15) (GENERAL APTITUDE)

Directions (1-4): Study the following table and answer the questions based on it. **Expenditures of a Company (in Lakh Rupees) Per Annum Over the given Years.**

Item of Expenditure				
Year	**Salary**	**Fuel and Transport**	**Bonus**	**Interest on Loans**
1998	288	98	3	23.4
1999	342	112	2.52	32.5
2000	324	101	3.84	41.6
2001	336	133	3.68	36.4
2002	420	142	3.96	49.4

1. The total amount of bonus paid by the company during the given period is approximately what percent of the total amount of salary paid during this period?

(1) 0.1%

(2) 0.5%

(3) 1%

(4) 1.25%

2. Total expenditure on all these items in 1998 was approximately what percent of the total expenditure in 2002?

(1) 62%

(2) 66%

(3) 69%

(4) 71%

3. The total expenditure of the company over these items during the year 2000 is?

(1) Rs. 544.44 lakhs

(2) Rs. 501.11 lakhs

(3) Rs. 446.46 lakhs

(4) Rs. 478.87 lakhs

4. The ratio between the total expenditure on Taxes for all the years and the total expenditure on Fuel and Transport for all the years respectively is approximately?

(1) 4:7

(2) 10:13

(3) 15:18

(4) 5:8

Directions (Ques 5 - 7) : In these questions, a statements of given, which is followed by various assumptions, Read the statements and the assumptions and decide which one of them are implicit.

Statement:

5. "Ensure freedom from thieves with this car locking system".

Assumptions:

I. This car locking system is the best.

II. It is desired to have freedom from thieves.

III. There are thieves everywhere.

(1) I and II are implicit

(2) II and III are implicit

(3) I and III are implicit

(4) Only II is implicit

6. "We deal in used cars. Contact us at phone no. XYZ, at the earliest possible." –an advertisement.

Assumptions:

I. Some people want to sell old cars.

II. The advertisement will be read by the needy people.

III. Used cars may not be totally useless

(1) Only I is implicit

(2) Only II and III are implicit

(3) Only I and III are implicit

(4) All I, II, III are implicit

Statement:

7. "Lalu Prasad is expected to announce several schemes for poor people in the budget". – a new reporter.

Assumptions:

I. The reporter has a fir reporting.

II. The news-reporter has genuine report sources.

III. Lalu Prasad is capable of announcing schemes.

(1) I and II are implicit.

(2) II and III are implicit

(3) Only III is implicit.

(4) All are implicit.

8. W % 9 3 G 6 H # 7 K $ L 2 * B M J © 4 5 E 8 @ Z

How many such symbols are there in the above arrangement each of which is immediately followed by a letter ?

(1) None

(2) One

(3) Two

(4) Three

9. What is the code for 'sky' in the code language ?

Statements:

I. In the code language, 'sky is clear' is written as 'de ra fa'.

II. In the same code language, 'make it clear' is written as 'de ga jo'.

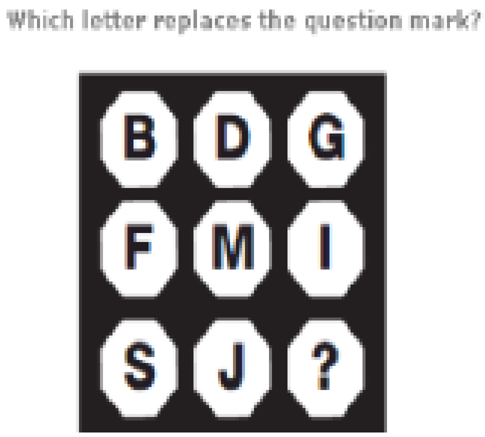
(1) I alone is sufficient while II alone is not sufficient

(2) II alone is sufficient while I alone is not sufficient

(3) Either I or II is sufficient

(4) Neither I nor II is sufficient

10. Which letter replaces the question mark?



(1) N

(2) O

(3) L

(4) K

Directions (Ques 11-12) : Compare Quantity A and Quantity B, using additional information centered above the two quantities if such information is given. Select one of the following four answer choices and fill in the corresponding circle to the right of the question.

(1) Quantity A is greater.

(2) Quantity B is greater.

(3) The two quantities are equal.

(4) The relationship cannot be determined from the information given.

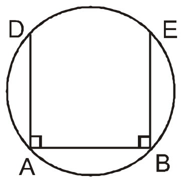
11.

Quantity A	Quantity B
0.717	0.71

12. 4 percent of s is equal to 3 percent of t, where s > 0 and t > 0.

Quantity A	**Quantity B**
s	t

13. Given a chord AB is a circle as shown. If two more chords AD and BE are drawn perpendicular to AB, then



(1) AD = BE

(2) AD = 2BE

(3) 2AD = BE

(4) None of these

14. Sunil walks towards the East from point A, turns right at point B and walks the same distance as he walked towards the East. He now turns left, walks and same distance again and finally makes a left turn and stops at point C after walking the same distance The distance between A and C is how many times as that of A and B ?

(1) Cannot be determined

(2) Two

(3) Three

(4) Four

15. Find out the next two numbers for the given number series.

44 41 38 35 32 29 26

(1) 24 21

(2) 22 19

(3) 23 20

(4) 29 32

PART (B) 16-35 (MATHEMATICS + ENGINEERING APTITUDE)

16. Moment of inertia of a uniform solid cylinder about its axis having length l and radius R is

(1) $\frac{1m}{2}\ell^2$

(2) $\frac{1}{2}mR^2$

(3) $\frac{1}{2}m\left(l^2 + R^2\right)$

(4) $\frac{1}{4}m\left(l^2 + 2R^2\right)$

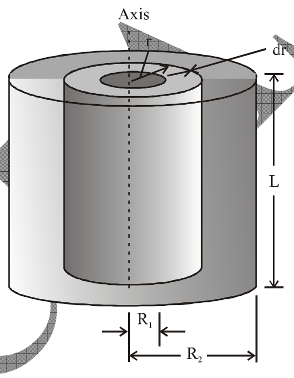
17. Figure shows a hollow, uniform cylinder with length L, inner radius R_1, and outer radius R_2, It might be a steel cylinder in a printing press or a sheet - steel rolling mill. The moment of inertia about the axis of symmetry of the cylinder is,

(1) $I = \frac{1}{4}M\left[R_1^2 + R_2^2\right]$

(2) $I = \frac{1}{2}M\left[R_1^2 + R_2^2\right]$

(3) $I = \frac{3}{2}M\left[R_1^2 + R_2^2\right]$

(4) $I = \frac{1}{2}M\left[R_1^2 + 2R_2^2\right]$



18. For cylindrical pipes, the Reynold's number corresponding to the critical speed is 2000 . Water (viscosity coefficient 10^{-3} N -s/m^2) flows through a pipe of diameter ·2 cm. What is the critical speed ?

(1) 4 cm/s

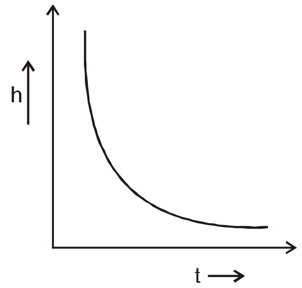
(2) 10 cm/s

(3) 12 cm /s

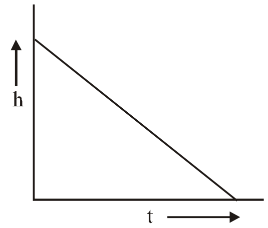
(4) 100 cm/s

19. Water in a vessel of uniform cross-section escapes through a narrow tube at the base of the vessel. Which graph given below represent the variation of the height h of the liquid with time t ?

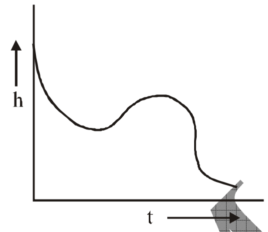
(1)



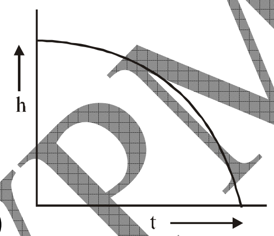
(2)



(3)



(4)



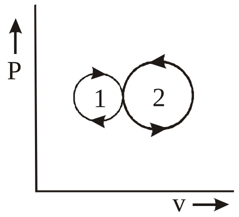
20. In the following indicator diagram, the net amount of work done will be

(1) positive

(2) negative

(3) zero

(4) infinity



21. Consider a reversible isothermal expansion of a photon gas. Determine the entropy S for this gas at temperature T and volume V

(1) $\sigma T^4 V$

(2) $\sigma T^3 V$

(3) $\frac{1}{3}\sigma T^3 V$

(4) $\frac{4}{3}\sigma T^3 V$

22. The maximum value of $\frac{1}{x^x}$ is

(1) e

(2) e^{-e}

(3) $e^{-1/e}$

(4) $e^{1/e}$

23. The greatest and the least value of $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 1$ in [0, 2] are

(1) 0, 8

(2) 0, –8

(3) 1, 8

(4) 1, –8

24. Cartesian form of green's theorem.

(1) $\iint_s \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right) dx\, dy = \int_c (Pdx + Qdy)$

(2) $\iint_s \left(\frac{\partial P}{\partial x} - \frac{\partial Q}{\partial y}\right) dx\, dy = \int_c (P + Q) dx$

(3) $\int_s \left(\frac{\partial P}{\partial x} - \frac{\partial Q}{\partial y}\right) dx = \iint_s (P + Q)\, dx\, dy$

(4) $\iint_s \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right) dx\, dy = \iint_s P dx\, dy$

25. Evaluate $\oint_c (x\, dy - y dx)$ around the circle $x^2 + y^2 = 1$

(1) π

(2) 2π

(3) 1

(4) 0

26. Let $f(x, y) = x^2 y^7 \cos^{-1}(y/x)$, then $x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y}$ equals

(1) 3

(2) 2

(3) 7

(4) 9

27. If $z = \sin^{-1}\left(\frac{x+y}{\sqrt{x}+\sqrt{y}}\right)$, then $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y}$ is equal to

(1) $\frac{1}{2}\sin z$

(2) $\frac{1}{2}\tan z$

(3) 0

(4) None of these

28. The value of y as , for an initial value of y(1) = 0, for the differential equation

$$\left(4t^2+1\right)\frac{dy}{dx}+8yt-t=0,\text{ is}$$

(1) 1

(2) 1/2

(3) 1/4

(4) 1/8

29. The differential equation $\frac{d^2y}{dx^2}+\sin x\frac{dy}{dx}+ye^x=\sinh x$

(1) first order and linear

(2) first order and non-linear

(3) second order and linear

(4) second order and non-linear

30. Consider the differential equation $(3x^2y^4 + 2xy)dx + (2x^3y^3 - x^2)dy = 0$. Then

(1) $1/x^2$ is an integrating factor

(2) $1/y^2$ is an integrating factor

(3) x^2 is an integrating factor

(4) y^2 is an integrating factor

31. The differential equation y dx - 2xdy = 0 represents

(1) A family of straight lines

(2) A family of parabolas

(3) A family of circles

(4) A family of catenaries

32. The series $1 + r + r^2 + \dots\dots\dots$ converges if

(1) $0 < r < 1$

(2) $r = 2$

(3) $r = 1$

(4) None of these

33. The series

$$\sum_{m=1}^{\infty}\frac{1}{2^m}=\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+...$$

(1) Diverges

(2) Oscillates

(3) Converges

(4) None of these

34. If f(x) = $\begin{vmatrix} 1 & x & x+1 \\ 2x & x(x-1) & (x+1)x \\ 3x(x-1) & x(x-1)(x-2) & (x+1)x(x-1) \end{vmatrix}$, then f(100) is equal to

(1) 0

(2) 1

(3) 100

(4) –100

35. Von Mises and Tresca criteria give different yield stress for

(1) Uni-axial stress

(2) Balanced bi-axial stress

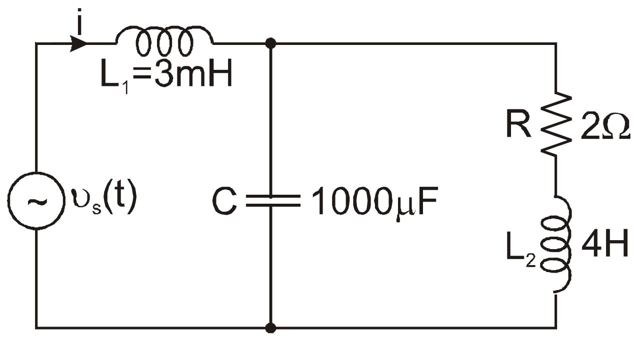
(3) Pure shear stress

(4) All

PART (C) – ELECTRICAL ENGINEERING

36. In the Circuit of fig. , the voltage across the capacitor is given by

υ_C (t) = 100 cos (500 t + 45°). Find υ_S (t) and i.



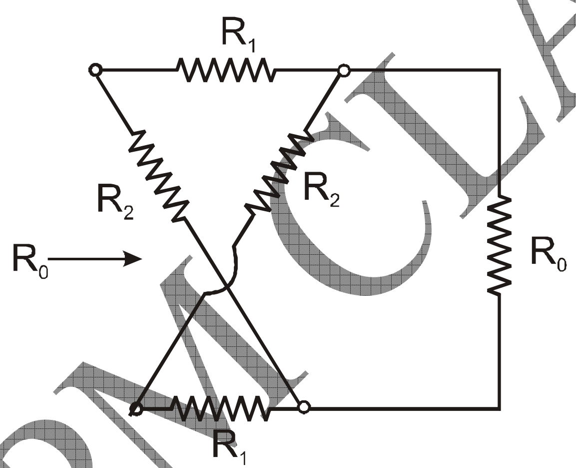
(1) 72.88 cos(500 t + 76°)V, 25 sin (500 t) A

(2) 65 cos(500 t + 76°)V,35.4 sin (500 t) A

(3) 72.88 cos(500 t + 70°)V,35.4 sin (500 t) A

(4) 72.88 cos(500 t + 76°)V,35.4 sin (500 t) A

37. For lattice type attenuator shown in the given figure, the characteristic impedance R_0 is



(1) $\frac{R_1 + R_2}{2}$

(2) $\frac{2R_1 + R_2}{R_1 + R_2}$

(3) $\sqrt{R_1 R_2}$

(4) $R_1 + \frac{R_2}{2}$

38. Two parallel plate capacitors are separated by a distance d. They are maintained at potential 0 and V1 respectively. The potential at any point between the plates is

(1) $-V_1\,dz$

(2) $\frac{V_1}{d}z$

(3) $-\frac{V_1}{d}z$

(4) $V_1\,dz$

39. Consider a 20 kVA, 2200/220 V, 50 Hz transformer. The OC/SC test results are as follows :

OC test : 220 V, 4.2 A, 148 W (LV side)

SC test : 86 V, 10.5 A, 360 W (HV side)

Determine the regulation at 0.8 pf lagging and at full load. What is the power factor on short - circuit ?

(1) 0.8 lag

(2) 0.4 lag

(3) 0.4 lead

(4) 0.5 lead

40. A 4 - pole DC motor is lap - wound with 400 conductors. The pole shoe is 20 cm long and average flux density over one - pole pitch is 0.4 T, the armature diameter being 30 cm. Find the torque and gross mechanical power developed when the motor is drawing 25 A and running at 1500 rpm

(1) 29.9 N - m, 4.0 kW

(2) 25.8 N - m, 3.8 kW

(3) 29.9 N -m , 4.7 kW

(4) 20.8 N -m, 2.5 kW

41. A number of alternators are working in parallel with their terminal voltage equal to the rated value. One of the machines, which has a synchronous reactance of 50% and a resistance of 1%, delivers a power output in kW equal to 70% of its rated kVA. If the emf of this unit equals 1.2 times the terminal voltage, find out the power factor at which the machine is operating.

(1) 0.900 lagging

(2) 0.989 lagging

(3) 0.900 leading

(4) 0.800 leading

42. Equation $e^x - 1 = 0$ is required to be solved using Newton's method with an initial guess $x_0 = -1$. Then, after one step of Newton's method, estimate x_1 of the solution will be given by

(1) 0.71828

(2) 0.36784

(3) 0.20587

(4) 0.00000

43. A is a m × n full rank matrix with m > n and I is an identity matrix. Let matrix $A^T = (A^T A)^{-1} A^T$. Then, which one of the following statements is FALSE ?

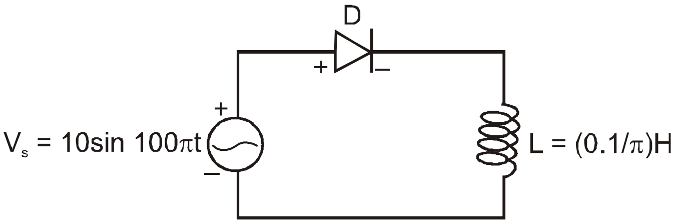
(1) $AA^T A = A$

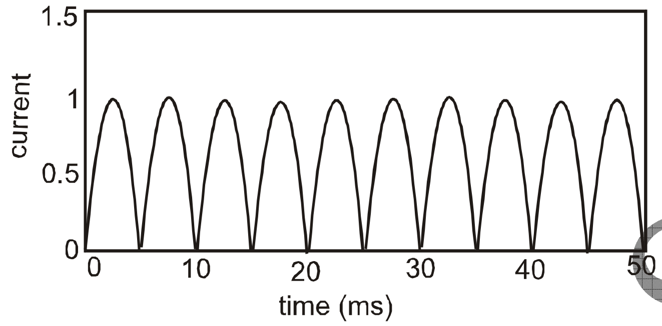
(2) $(AA^T)^2 = AA^T$

(3) $A^T A = I$

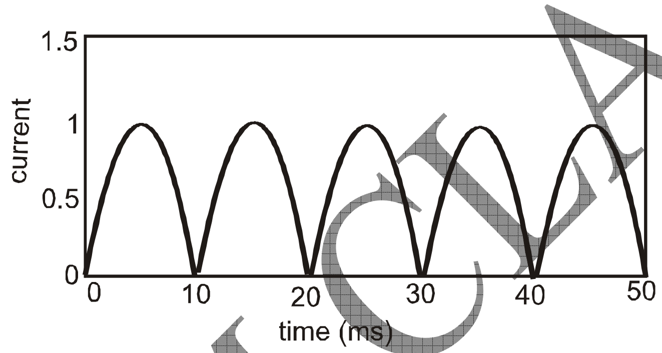
(4) $AA^T A = A^T$

44. The circuit shows an ideal connected to a connected inductor and is connected to a purely sinusoidal 50Hz voltage source. Under ideal conditions the current waveform through the inductor will look like

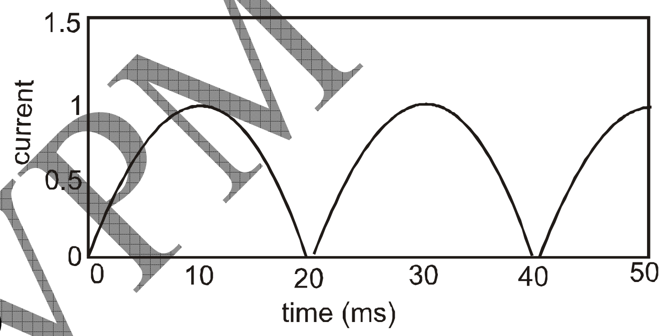

D
V_s = 10sin 100πt
L = (0.1/π)H


current
time (ms)

(1)

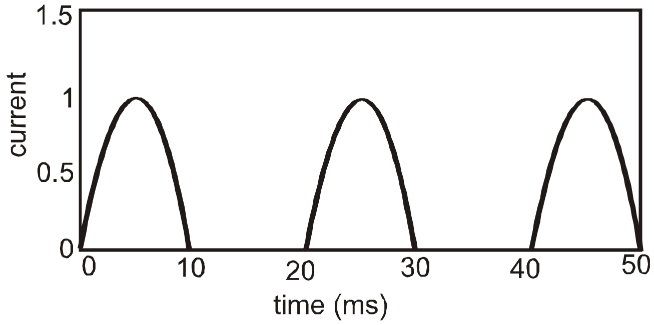

current
time (ms)

(2)

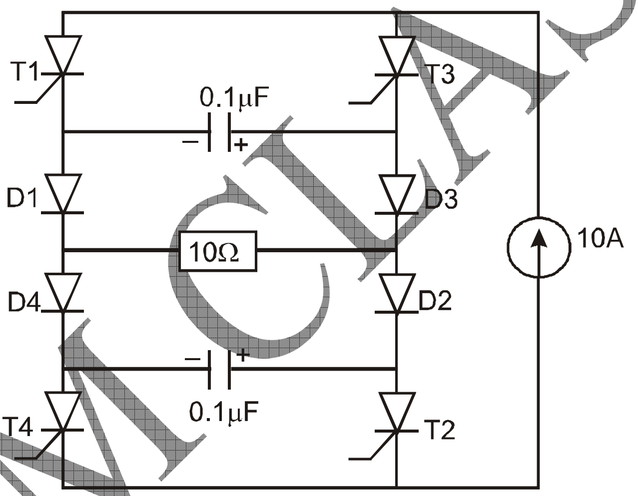

current
time (ms)

(3)

(4)



45. The current Source Inverter shown in figure is operated by alternately turning on thyristor pairs (T_1,T_2) and (T_3, T_4) . If the load is purely resistive, the theoretical maximum output frequency obtainable will be



(1) 125 kHz

(2) 250kHz

(3) 500 kHz

(4) 50 kHz

PART C - ELECTRONICS

46. Consider the following statements

1. Minimisation using Karnaugh map may not provide unique solution.

2. Redundant grouping in Karnaugh map may result in non-minimised solution.

3. Don't care states if used in Karnaugh map for minimisation, the minimal solution is not obtained.

Which of the statements given above are correct?

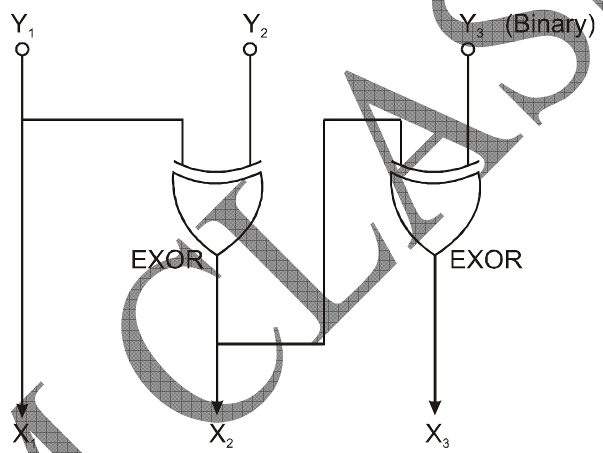
(1) 1, 2 and 3

(2) 2 and 3 only

(3) 1 and 3 only

(4) 1 and 2 only

47. In the circuit shown below, a gray code is converted to :



(1) Excess-3-code

(2) Binary code

(3) Decimal code

(4) BCD code

48. Consider the analog signal

$V = 2\cos(200\pi t)$

Determine he minimum required sampling rate to avoid aliasing. Determine the discrete time signal obtained by sampling the signal at a rate of 100 Hz. Determine the sampled signal when sampling rate is 45 Hz.

(1) $150\text{Hz},\ 2\sin(\pi n),\ 3\cos\left(\frac{9}{20}\pi n\right)$

(2) $200\text{Hz},\ 2\cos(\pi n),\ 2\cos\left(\frac{9}{20}\pi n\right)$

(3) $100\text{Hz},\ \frac{2}{5}\cos(\pi n),\ 2\cos\left(\frac{8}{20}\pi n\right)$

(4) $250\text{Hz},\ \frac{3}{7}\cos\cos\left(\frac{3}{5}\pi n\right),\ 3\cos\left(\frac{7}{20}\pi n\right)$

49. The system under consideration in an –RC low-pass filter (RC-LPF) with R = 1.0 kΩ and C = 1.0 μF.

Let H(f) denotes the frequency response of the RC-LPF. Let f_1 be the highest frequency such that $0 \le |f| \le f_1, \frac{|H(f_1)|}{H(0)} \ge 0.95$. Then f_1 (in Hz) is

(1) 327.8

(2) 163.9

(3) 52.2

(4) 104.4

50. An audio signal is to be transmitted digitally. Which is the system best suited for good fidelity?

(1) 8 bit PCM

(2) 13 bit PCM

(3) 32 bit PCM

(4) PCM system with non-uniform quantizer

51. Find the normalized average power in an angle -modulated signal with sinusoidal modulation.

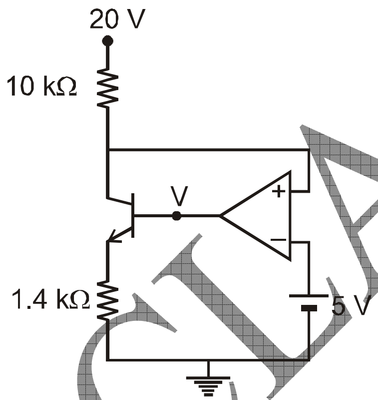
(1) 0

(2) A^2

(3) $\frac{1}{2}A^2$

(4) ∞

52. In the circuit shown below, the op-amp is ideal, the transistor has V_{BE} = 0.9 V and β = 150. Decide whether the feedback in the circuit is positive or negative and determine the voltage V at the output of the op-amp.



(1) Positive feedback, V = 0 V

(2) Positive feedback, V = 2 V

(3) Negative feedback, V = 3 V

(4) Negative feedback, V = 10 V

53. The output SNR is given by

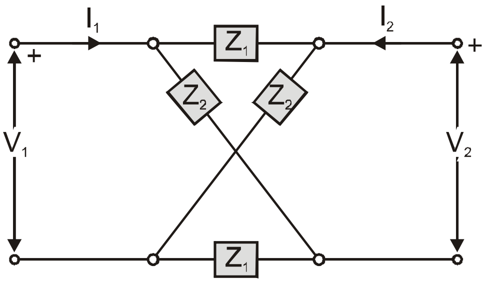
(1) 17 dB

(2) 12.8 dB

(3) 15.7 dB

(4) 20 dB.

54. Given symemtrical lattice network shown in the figure below.



Matrix (Z) will be

(1) $\begin{bmatrix} \frac{(Z_1+Z_2)}{2} & \frac{(Z_2-Z_1)}{2} \\ \frac{(Z_2-Z_1)}{2} & \frac{(Z_1+Z_2)}{2} \end{bmatrix}$

(2) $\begin{bmatrix} \frac{(Z_1-Z_2)}{2} & \frac{(Z_2-Z_1)}{2} \\ \frac{(Z_2-Z_1)}{2} & \frac{(Z_1+Z_2)}{2} \end{bmatrix}$

(3) $\begin{bmatrix} \frac{(Z_1+Z_2)}{2} & \frac{(Z_2+Z_1)}{2} \\ \frac{(Z_2-Z_1)}{2} & \frac{(Z_1+Z_2)}{2} \end{bmatrix}$

(4) none of these

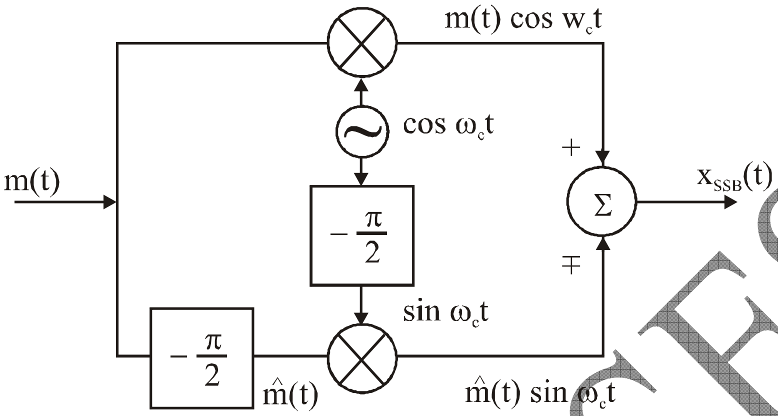
55. If the output of the phase–shift modulator as shown is an SSB signal. The difference of the signal at the summing function of the signal produces

(1) Lower side band SSB signal

(2) Upper-side band SSB signal

(3) Both upper & lower sideband SSB signal

(4) None of these



PART C - THERMODYNAMICS

56. In a thermoelectric thermometer for t° C temperature, the emf is given as:

$$E = 0.003 \cdot t - 5 \times 10^{-7} \cdot t^2 + 0.5 \times 10^{-3}, \text{ volts}$$

Thermometer is having reference junction at ice point and is calibrated at ice point and steam points. What temperature shall be shown by the thermometer for a substance at 30°C?

(1) 33.23°C

(2) 3.323°C

(3) 30.23°C

(4) 332.3°C

57. Estimate the % variation in temperature reading from a thermocouple having its test junction in gas and other reference junction at ice point. The temperature of gas using gas thermometer is found 50°C. Thermocouple is caliberated with emf varying linearly between ice point and steam point. When thermocouple's test junction is kept in gas at t°C and reference junction at ice point, the emf produced in millivolts is,

$$e = 0.18 \cdot t - 5.2 \times 10^{-4} \times t^2, \text{ millivolts}$$

(1) 28.32%

(2) 2.32%

(3) 25.82%

(4) 20.32%

58. An isolated system of total mass m is formed by mixing two equal masses of the same liquid initially at the temperatures T1 and T2. Eventually, the system attains an equilibrium state. Each mass is incompressible with constant specific heat C. Determine the value of S_{gen}.

(1) $mCLn\left[\frac{T_1 - T_2}{(T_1T_2)^{1/2}}\right]$

(2) $mCLn\left[\frac{T_1T_2}{2(T_1 + T_2)^{1/2}}\right]$

(3) $mCLn\left[\frac{T_1 + T_2}{2(T_1T_2)^{1/2}}\right]$

(4) $mCLn\left[\frac{T_1 - T_2}{2(T_1 + T_2)^{1/2}}\right]$

59. High pressure air at 1300 K flows into an aircraft gas turbine and undergoes a steady-state, steady-flow, adiabatic process to the turbine exit at 660 K. Calculate the work done per unit mass of air flowing through the turbine when temperature-dependent data are used.

(1) $725.5\frac{kJ}{kg}$

(2) $7.255\frac{kJ}{kg}$

(3) $7255\frac{kJ}{kg}$

(4) $72.55\frac{kJ}{kg}$

60. A heat pump uses a 5 hP compressor while extracting 500 Btu of energy from groundwater each minute. What is the COP if the purpose is to cool the groundwater ?

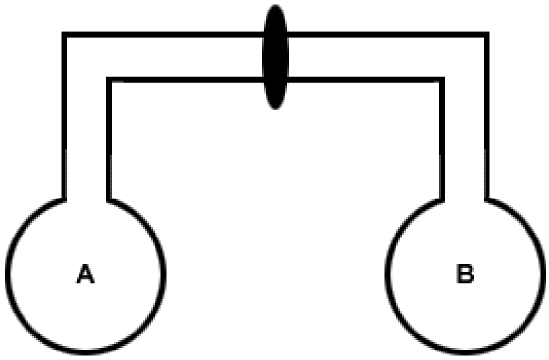
(1) 23.58

(2) 2.358

(3) 2.893

(4) .2586

61.



The volumes of containers A and B are kept separate by a stopcock. Both containers have a volume of 10^{-3} m^3 and are at a temperature of 273 K. The gas a in container A is at a pressure of 2.00×10^5 Pa. The gas b in container B is at a pressure of 1.00×10^5 Pa. What are the partial pressures of a and b after the stopcock has opened and the system has equilibrated?

(1) 1.0×10^6 Pa, 0.050×10^5 Pa

(2) 1.0×10^5 Pa, 0.50×10^5 Pa

(3) 0.1×10^5 Pa, 0.05×10^5 Pa

(4) 10×10^5 Pa, 50×10^5 Pa

62. A 19.5 L flask at 15 °C contains a mixture of three gases: N_2 (2.50 mol), He (0.38 mol), and Ne (1.34 mol). Calculate the partial pressure of neon gas in the mixture.

(1) 1.62 atm

(2) .162 atm

(3) 16.2 atm

(4) 1.22 atm

63. A Carnot Cycle operates between 200°C and 1200°C. Calculate its thermal efficiency if it operates as a power cycle.

(1) 66.7%

(2) 6.79%

(3) 67.9%

(4) 65 %

64. What is the density of carbon dioxide at 298 K and 1.0 atm?

(1) 1.8g/L

(2) 2.2g/L

(3) 1g/L

(4) 1.3g/L

65. Find the expression for ds in terms of dT and dp.

(1) $ds = c_p \frac{dT}{T} - \beta\upsilon dp$

(2) $ds = -c_p \frac{dT}{T} + \beta\upsilon dp$

(3) $ds = -c_p \frac{dT}{T} - \beta\upsilon dp$

(4) $ds = c_p \frac{dT}{T} + \beta\upsilon dp$

PART C - FLUID MECHANICS

66. For pipe flows, at constant diameter, head is proportional to

(1) flow

(2) $(\text{flow})^2$

(3) $(\text{flow})^3$

(4) $(\text{flow})^{-1}$

67. Unsteady uniform flow is flow through a/ an

(1) expanding tube at an increasing rate

(2) expanding tube at constant rate

(3) long pipe at decreasing rate

(4) long pipe at constant rate

68. A balloon lifting in air follows the

(1) law of gravitation

(2) Archimedes principle

(3) principle of buoyancy

(4) all of the above

69. Surface tension

(1) acts in the plane of interface normal to any line in the surface

(2) is also known as capillarity

(3) is a function of the curvature of the interface

(4) decreases with fall in temperature

70. Viscosity of water in comparison to mercury is

(1) higher

(2) lower

(3) same

(4) unpredictable

71. Hydraulic grade line as compared to the centre line of conduct

(1) should always be above

(2) should always be below

(3) should always be parallel

(4) may be above or below

72. A crude oil (s = 0.90) flows through a horizontal pipe 100 mm in diameter and 10m long and 1000 kg of oil is collected in 5 minutes. If the pressure difference at the two end is 14.715kN/m^2 then the viscosity of the oil is -

(1) 0.876 Ns/m^2

(2) 0.974 Ns/ m^2

(3) 0.389 Ns/m^2

(4) 0.389 Ns/m^2

73. A Wooden log of 0.6 m diameter and 5m length is floating in river water. Find the depth of the wooden log in water when the sp. gravity of the log is 0.7.

(1) 0.295 M

(2) 0.395 M

(3) 0.4 M

(4) 0.125 M

74. An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. Co-efficient of discharge for the orfice meter is given as 0.6. Find the discharge of water through pipe.

(1) 68.21 cm^3/s

(2) 68.21 litres/sec

(3) 68213.28 cm^3/s

(4) 68213.28 litres/sec

75. Find the density of a metallic body which floats at the interface of mercuryof sp. gr. 13.6 and water such that 40% fo its volumeis sub - merged in mercury and 60% In water.

(1) 6040.00 kg/ m^3

(2) 6000.40 kg/m^3

(3) 6040.40 kg/m^3

(4) 6000.00kg/m^3

PART C - MATERIAL SCIENCE

76. Main form of ceramic degradation is

(1) Corrosion

(2) Weathering

(3) Dissolution

(4) Swelling

77. High elastic modulus in materials arises from

(1) High strength of bonds

(2) Weak bonds

(3) combination of bonds

(4) None

78. How could you accurately measure the root radius of a charpy or Izod specimen?

(1) With a machine called shadowgraph

(2) With a rule

(3) With a vernier caliper

(4) With a densitometry

79. Electron sea exists in

(1) Polar bonds

(2) Ionic bond

(3) Covalent bond

(4) Metallic bond

80. High dielectric constant material is must for __________.

(1) Insulation of wires

(2) Generators

(3) Switch bases

(4) None of these

81. As a solid element melts, the atoms become __________ and they have __________ attraction for one another.

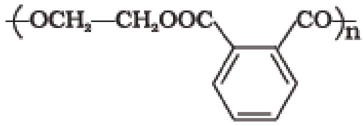
(1) more separated, more

(2) more separated, less

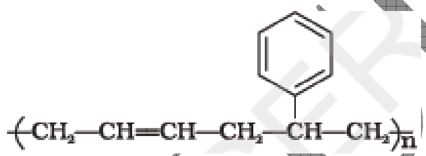
(3) closer together, more

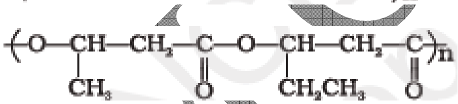
(4) closer together, less

82. In which of the following polymers ethylene glycol is one of the monomer units?

(1) 

(2) $-(CH_2-CH_2)_n-$

(3) 

(4) 

83. Which of the following statements is not true about low density polythene?

(1) Tough

(2) Hard

(3) Poor conductor of electricity

(4) Highly branched structure

84. Not a super conductive metallic element

(1) Fe

(2) Al

(3) Ti

(4) W

85. Which one is the wrong anode-cathode combination

(1) Zinc-Iron

(2) Nickel-Titanium

(3) Iron-Tin

(4) Silver-zinc

PART C - SOLID MECHANICS

86. Which of the following situations would produce the greatest acceleration?

(1) A 1.0-N force acting west and a 2.0-N force acting east on a 1.0-kg object.

(2) A 3.0-N force acting west and a 5.0-N force acting east on a 2.0-kg object.

(3) A 8.0-N force acting west and a 5.0-N force acting east on a 3.0-kg object.

(4) A 1.0-N force acting west and a 9.0-N force acting east on a 5.0-kg object.

87. A running man has the same kinetic energy as that of a boy of half the mass. The man speeds up by 2 ms^{-1} and the boy changes his speed by 'x' ms^{-1} so that the kinetic energies of the boy and the man are again equal. Then 'x' in ms^{-1} is

(1) $-2\sqrt{2}$

(2) $+2\sqrt{2}$

(3) $\sqrt{2}$

(4) 2

88. A car of mass 1000kg moves on a circular track of radius 20m. If the coefficient of friction is 0.64, then the maximum velocity with which the car can move is

(1) 15m/s

(2) 11.2m/s

(3) 20m/s

(4) 18m/s

89. In a structure comprising cations and anions, what is the coordination environment for cations which have a similar size to the anions (i.e., ratio of cation radius to anion radius >0.732)?

(1) Linear

(2) Octahedral

(3) Tetrahedral

(4) Cubic

90. Recoil is noticeable if we throw a heavy ball while standing on roller skates. If instead we go through the motions of throwing the ball but hold onto it, our net recoil will be

(1) zero.

(2) the same as before

(3) small, but noticeable

(4) larger then before

91. A bronze bar, 3m long with a c/s area of 320mm^2 is placed between two rigid walls. At –20°C, the gap between bar and wall is 2.5mm. Find temperature at which compressive stress in the bar will be 35MPa. Take

a =18×10^{-6}m/m/ºC and E= 80GPa.

(1) 50.6^{O}C

(2) 64^{o}C

(3) 40^{O}C

(4) 30^{O}C

92. State of stress at a point of a loaded component is given by σ_x = 30 MPa σ_y = 18 MPa and τ_{xy} = 8MPa

If the larger principal stress at the point is 34 MPa, what is the value of smaller principal stress?

(1) 12 MPa

(2) 14 MPa

(3) 16 MPa

(4) 18 MPa

93. A 10 cm long and 5 cm diameter steel rod fits sougly between two rigid walls 10 cm apart at room temperative. young's modulus of elasticity and coefficient of linear expansion of 12 × 10^{-6}/°C. respectively.

The stress developed in the rod due to, a 100°C rise in wall temperature will be – (in kgl/cm^2)

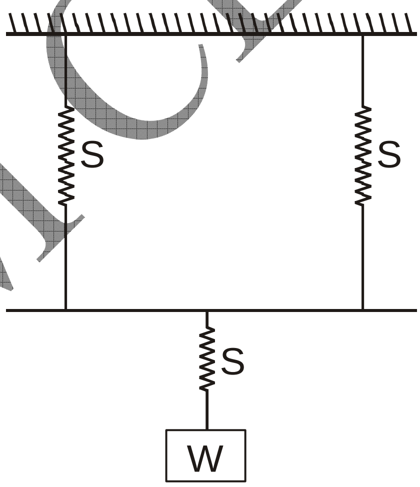
(1) 6 × 10^{-10}

(2) 6 × 10–9

(3) 204 × 103

(4) 2.4 × 104

94. If two identical helical springs are connected in parallel and to these two another identical spring is connected in series and the system in loaded by a weight w, as shown in the figure then the resulting deflection will be given by (S = deflection, S = stiffness, W = load)



(1) $\delta = \frac{3W}{2S}$

(2) $\delta = \frac{W}{2S}$

(3) $\delta = \frac{2W}{3S}$

(4) $\delta = \frac{W}{3S}$

95. At a point in body the normal stresses are $\sigma_x = \sigma$ and $\sigma_y = \sigma$ E is the young's Modulus and μ is the poisson's ratio of the material of the body. Assuming the material to be linearly elastic and isotropic. For place stress condition the ratio of σ_s and Ex is

(1) $\frac{E}{1-\mu}$

(2) E

(3) $\frac{E}{\mu}$

(4) $\frac{E}{1+\mu}$

PART C – COMPUTER SCIENCE

96. A hash table with 10 buckets with one slot per bucket is depicted in Fig. the symbols, S1 and S7 are initially entered using hashing function with linear probing. The maximum number of comparisons needed in searching an item that is not present is

0	S7
1	S1
2	
3	S4
4	S2
5	
6	S5
7	
8	S6
9	S3

(1) 4

(2) 5

(3) 6

(4) 3

97. Consider a schema R (A, B, C, D) and functional dependencies $A \rightarrow B$ and $C \rightarrow D$. Then the decomposition of R into R_1 (AB) and R_2 (CD) is

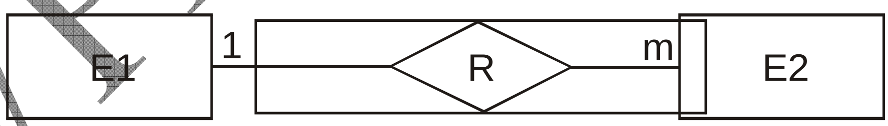
(1) dependency preserving and lossless join

(2) lossless join but not dependency preserving

(3) dependency preserving but not lossless join

(4) not dependency preserving and not lossless join

98. Consider the following entity relationship diagram (ERD), where two entities E1 and E2 have a relation R of cardinality 1:m.



The attributes of E1 are A11, A12 and A13 where A11 is key attribute. The attributes of E2 are A21, A22 and A23 where A21 is the key attribute and A23 is a multi-valued attribute. Relation R does not have any attribute. A relational database containing minimum number of tables with each table satisfying the requirements of the third normal form (3NF) is designed from the above ERD. The number of tables in the database is

(1) 2

(2) 3

(3) 5

(4) 4

99. Let T be a derivation tree in context free grammar G. If the length of the longest path in T is less than equal to K. then yield of T will be

(1) ≤ 2K-1

(2) ≥ 2K+2

(3) ≥ 2K+1

(4) ≥ 2K-1

100. Dijkstra banking algorithm in an operating system solves the problem of

(1) deadlock avoidance

(2) deadlock recovery

(3) mutual exclusion

(4) context switching

101. How many number of rows are affected in the output of the following query?

SQL Query SELECT count (*) FROM EMPLOYEE , DEPARTMENT WHERE DNAME = ' RESEARCH' AND D-No = 5 AND EMP. SUPERSSN = Dept. MGRSSN ?

Consider the following tables.

EMP

FNAME	SUPERSSN	DNO
JOHN	33445555	5
FRAKIN	8886665555	5
ALICIA	96765434	4

DEPT	DNAME	DNO	MGRSSN
	RESEARCH	5	33344555
	ADMIN	4	988754

(1) 5

(2) 2

(3) 3

(4) 1

102. While designing a kernel, an operating system designer must decide whether to support kernel-level or user-level threading. Which of the following statements is/are true?

1. Kernel-level threading may be preferable to user-level threading because storing information about user-level threads in the process control block would create a security risk.
2. User-level threading may be preferable to kernel-level threading because in user-level threading, if one thread blocks on I/O, the process can continue.

(1) 1 only

(2) 2 only

(3) 1 and 2 only

(4) none of these

103. Consider a popular sports news site. At a given moment , 20,000 concurrent users submit a request (a transaction, T) once every 2 minutes on average. Each transaction requires the WebApp to download a new article that averages 3K bytes in length. Therefore, throughput

(1) 4mb/s

(2) 3mbps

(3) 5mbps

(4) none of these

104. Consider the following program segment.

i = 6720; j = 4;

```
while ((i % j) = = 0)
  { i = i / j ;
  j = j + 1;
  }
```

On termination j will have the value

(1) 4

(2) 8

(3) 9

(4) 6720

105. If log (P) = $\left(\frac{1}{2}\right)$, log Q = $\left(\frac{1}{4}\right)$log R, log (p) = $\frac{1}{2}$log Q which of the following is True ?

(1) $P^2 = Q$

(2) $(Q^2)^2 = (PR)^2$

(3) $Q^2 = PR$

(4) $Q^2 = P^2$

Answer key

PART – A & B (1 -35)

Que	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	3	1	2	4	4	2	4	4	4	1	2	1	2	3
Que	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans	2	2	4	1	2	4	4	4	1	2	4	2	4	4	2
Que	31	32	33	34	35										
Ans	2	1	3	1	3										

PART (C) – ELECTRICAL ENGINEERING

Que	36	37	38	39	40	41	42	43	44	45
Ans	4	3	3	2	3	1	1	4	4	3

PART C – ELECTRONICS

Que	46	47	48	49	50	51	52	53	54	55
Ans	4	2	2	3	4	3	3	3	4	2

PART C – THERMODYNAMICS

Que	56	57	58	59	60	61	62	63	64	65
Ans	1	4	3	1	2	2	1	3	1	1

PART C - FLUID MECHANICS

Que	66	67	68	69	70	71	72	73	74	75
Ans	2	4	2	4	1	1	2	2	1	1

PART C - MATERIAL SCIENCE

Que	76	77	78	79	80	81	82	83	84	85
Ans	3	1	1	4	1	2	1	3	2	4

PART C - SOLID MECHANICS

Que	86	87	88	89	90	91	92	93	94	95
Ans	4	2	2	4	1	1	2	3	1	1

PART C – COMPUTER SCIENCE

Que	96	97	98	99	100	101	102	103	104	105
Ans	2	3	2	1	1	4	1	1	3	1

Hints and Solutions

1.(3) Required percentage = $\left[\frac{(3.00 + 2.52 + 3.84 + 3.68 + 3.96)}{(288 + 342 + 324 + 336 + 420)} \times 100\right]\%$

$= \left[\frac{17}{1710} \times 100\right]\% \approx 1\%$

2.(3) Required percentage = $\left[\frac{(288 + 98 + 3.00 + 23.4 + 83)}{420 + 142 + 3.96 + 49.4 + 98} \times 100\right]\%$

$= \left[\frac{495.4}{713.36} \times 100\right]\% \approx 69.45\%$

3.(1) Total expenditure of the Company during 2000

= Rs. (324 + 101 + 3.84 + 41.6 + 74) lakhs

= Rs. 544.44 lakhs.

4.(2) Required ratio = $\left[\frac{(83 + 108 + 74 + 88 + 98)}{(98 + 112 + 101 + 133 + 142)}\right] = \left[\frac{451}{586}\right] = \frac{1}{1.3} = \frac{10}{13}$

5.(4) There is no hint of use of 'best' and 'everywhere' terms.

6.(4) I and II are definitely implicit. Also an advertisement is meant to be read.

7.(2) Only II and III are implicit, we cannot say anything about I from the given statement.

8.(4) $ L, * B, @ Z.

9.(4) The only word common to I and II is 'clear' and as such, only the code for 'clear' can be ascertained from the given information.

10.(4) Working in columns, add together the numerical values of the first and second letters, and put the letter with the reverse alphabetical value of this sum in the bottom space.

11.(1) On number scale 0.717 comes after 0.71 and it is also more close to 0.72. Therefore quantity A > Quantity B

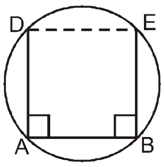
12.(2) 4%(s) = 3%(t)

4s = 3t

$s = \frac{3t}{4} = 0.75t$

$\Rightarrow \quad s < t$

13.(1)



Join DE

ABED form a cyclic quadrilateral

$\angle A = 90°$

$\angle B = 90°$

$\angle A + \angle B = 90°$

$\therefore$ AD || BE

Now in cyclic quadrilateral sum of opposite sides is 180°

$\therefore \quad \angle A + \angle E = 180°$

$\angle E = 90°$ $[\because \angle A = 90°]$

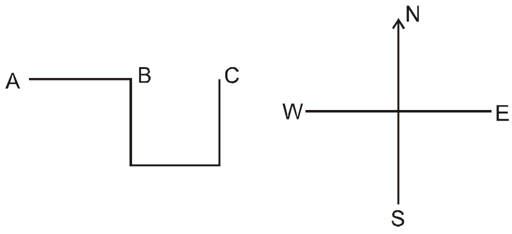
Similarly $\angle D = 90°$

$\therefore$ ABED form a rectangle

$\therefore$ AD = BE

(opposite sides of rectangle are equal)

14.(2)

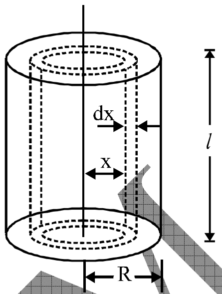


15.(3) This is a simple subtraction series, in which 3 is subtracted from each number to arrive at the next.

16.(2) Let M be the mass, l be the length and R be the radius of a solid cylinder as shown in fig. . We have to calculate moment of inertia of this solid cylinder about its axis.

Volume of the cylinder = $\pi R^2 l$ ...(i)

mass per unit volume of the cylinder $\rho = \frac{M}{\pi R^2 l}$,



Draw two cylindrical surface of radii x and (x + dx) coaxial with the given cylinder as shown in Fig. This part of the cylinder may be considered as a hollow cylinder of radius x and thickness dx

Area of cross section of the wall of this hollow cylinder = $2\pi x \cdot dx$.

Volume of material in this elementary hollow cylinder = $(2\pi x\, dx)\, l$

Mass of the elementary hollow cylinder

$$m = (2\pi x\, dx)\, l \times \rho = (2\pi x dx)\, l \times \frac{M}{\pi R^2 l}$$

$$m = \frac{2M}{R^2} x\,dx.$$

As radius of this cylinder is x, moment of inertia of the elementary cylinder about the given axis is

$$dI = mx^2 = \left(\frac{2M}{R^2} x\,dx\right) x^2 = \frac{2M}{R^2} x^3\,dx$$

∴ Moment of inertia of the solid cylinder about the given axis is

$$I = \int_{x=0}^{x=R} \frac{2M}{R^2} x^3\,dx = \frac{2M}{R^2}\left[\frac{x^4}{4}\right]_{x=0}^{x=R}$$

$$= \frac{2M}{4R^2}\left(R^4 - 0\right)$$

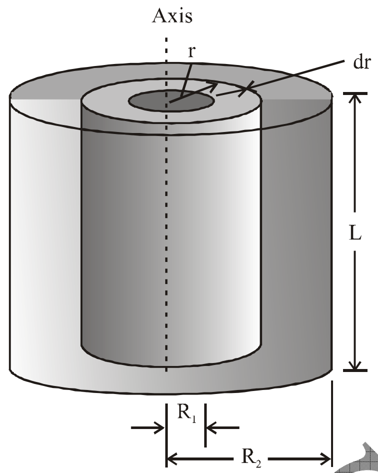
$$\boxed{I = \frac{1}{2} MR^2}$$

Note that this formula for I does not depend upon length of the cylinder.

17.(2) We choose as a volume element, a thin cylindrical shell of radius r, thickness dr, and length L. All parts of this element are at very nearly the same distance from the axis. The volume of the element is very nearly equal to that of a flat sheet with thickness dr, length L, and width $2\pi r$ (the circumference of the shell). Then

$$dm = \rho\,dV = \rho(\text{width x length x thickness})$$

$$= \rho(2\pi rL\,dr) \qquad ...(1)$$



The moment of inertia is given by

$$I = \int_{r=R_1}^{r=R_2} r^2 dm \int_{R_1}^{R_2} r^2 \rho(2\pi r L\, dr) \qquad \text{[use equation (1)]}$$

$$= 2\pi\rho L \int_{R_1}^{R_2} r^3\, dr$$

$$= 2\pi\rho L \left(\frac{r^4}{4}\right)_{R_1}^{R_2}$$

$$= \frac{2\pi\rho L}{4}\left(R_2^4 - R_1^4\right)$$

$$= \frac{\pi\rho L}{2}\left(R_2^2 - R_1^2\right)\left(R_2^2 + R_1^2\right) \quad [\because A^2 - B^2 = (A + B)(A - B)] \qquad ...(2)$$

If we express the moment of inertia in terms of the total mass M of the body. Then

$$\because \quad M = \rho V \qquad ...(3)$$

and the volume of the cylindrical shell is

$$V = \pi L\left(R_2^2 - R_1^2\right) \quad [\text{Volume of the cylinder } V = \pi R^2 h] \qquad ...(4)$$

From equation (3) and (4) we get

$$M = \pi L \rho\left(R_2^2 - R_1^2\right) \qquad ...(5)$$

using equation (5) in equation (2), we get

$$I = \frac{1}{2} M\left(R_2^2 + R_1^2\right)$$

18.(4) The critical speed is given as

$$v_c = \frac{k\eta}{\rho r}$$

where k = Reynold's number

η = Coefficient of viscosity

ρ = Liquid density

r = Radius of the pipe

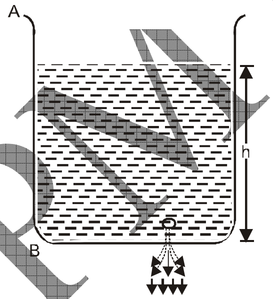
So, $$v_c = \frac{2000 \times 10^{-3}}{2 \times 10^{-3} \times 1000}$$

Since , k = 2000, η = 10^{-3}

r = 2 × 10^{-3} m, ρ = 1000

$v_c = 1 m/s$ = 100 cm/s

19.(1) Let AB be a vessel in which liquid is kept at height h. Let h be height at any instant t.



By Bernoulli's theorem we have, the total energy per unit mass of the liquid at the surface

= KE + PE + pressure energy

= O + gh + O

= gh ...(1)

and total energy per unit mass of the liquid at the orifice

$$= \frac{1}{2}V^2 + O + O$$

$$= \frac{1}{2}V^2 \qquad ...(2)$$

From equation (1) and (2), we get

$$\frac{1}{2}V^2 = gh \Rightarrow V^2 = 2gh$$

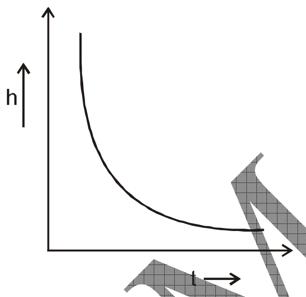
$$\left(\frac{h}{t}\right)^2 = 2gh$$

$$h^2 = 2ght^2$$

$$h = 2gt^2$$

$$h \propto t^2$$

So curve between height h and time t is given by



20.(2) The cyclic process 1 is clockwise and the process 2 is anti clockwise. Therefore W_1, will be positive and W_2 will be negative, area 2 > area 1, Hence the net work will be negative.

21.(4) The energy density of a photon gas is

$$U = \sigma T^4$$

Thus the energy is

$$E = \int U d^2r = \sigma V T^4$$

Now use the first law of thermodynamics

$$dE = dQ - dW$$

$$dQ = dE + dW = dE + pdV$$

$$= \sigma T^4 dV + \frac{1}{3}\sigma T^4 dV = \frac{4}{3}\sigma T^4 dV$$

$$dS = \frac{dQ}{T} = \frac{4}{3}\sigma T^3 dV$$

$$S = \int dS = \frac{4}{3}\sigma T^3 V$$

22.(4) $y = \frac{1}{x^x} = x^{-x}$

Taking logarithms, we get

$\log y = -x \log x$

Diff. $\frac{1}{y} = -\left(x\frac{1}{x} + \log x\right)$

$\therefore \quad \frac{dy}{dx} = -y(1 + \log x)$

$$\frac{dy}{dx} = -\frac{1}{x^x}(1 + \log x)$$

$$\frac{d^2y}{dx^2} = -\left[\frac{y}{x} + (1+\log x)(-y(1+\log x))\right] = \frac{1}{x^x}\left[(1+\log x)^2 - \frac{1}{x}\right]$$

For maxima and minima.

$$\frac{dy}{dx} = 0$$

$\Rightarrow \quad -\frac{1}{x^x}(1 + \log x) = 0$

$\Rightarrow \quad x = e^{-1}$

$$\left(\frac{d^2y}{dx^2}\right)_{x=1/e} = \frac{1}{\left(\frac{1}{e}\right)^{1/e}}\left[(0)^2 - \frac{1}{\left(\frac{1}{e}\right)}\right] = e^{1/e}(-e) < 0$$

$\therefore$ $y = \frac{1}{x^x}$ is maximum at $x = \frac{1}{e}$.

$\therefore$ Maximum value $= \frac{1}{\left(\frac{1}{e}\right)^{1/e}} = e^{1/e}$

23.(4). $f(x) = x^4 - 8x^3 + 22x^2 - 24x + 1$

$f(0) = 1,$

$f(2) = 2^4 - 8.2^3 + 22.2^2 - 24.2 + 1 = -7$

Now, $f'(x) = 4x^3 - 24x^2 + 44x - 24$

For maximum and minimum

$f'(x) = 0$

$\Rightarrow$ $4x^3 - 24x^2 + 44x - 24 = 0$

$\Rightarrow$ $4(x-1)(x-2)(x-3) = 0$

$\Rightarrow$ $x = 1, 2, 3$

Since $x = 3$ does not lie in [0, 2]

$\therefore$ Therefore, consider only $x = 1$ and $x = 2$ $f''(1) > 0$

$\therefore$ At $x = 1$, $f(x)$ is minimum

We have $f(1) = 1^4 - 8.1^3 + 22.1^2 + 22.1^2 - 24.1 + 1 = -8$

Greatest of f(x) = largest of (1, –7) = 1

Least of f(x) = smallest of (1, –7, –8) = –8

24.(1) $\iint_s \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right) dx\,dy = \int_c (Pdx + Qdy)$

25.(2) $\oint_c (x\,dy - y\,dx) = \int_0^{2\pi}\left(x\frac{dy}{dt} - y\frac{dx}{dt}\right)dt$

c denotes $x^2 + y^2 = 1$

$\therefore$ x = cost and y = sin t be the parametric equation of this circle.

So $\oint_c (x\,dy - y\,dx) = \int_0^{2\pi} \cos t(\cos t) - \sin t(-\sin t)\,dt$

$= \int_0^{2\pi} \cos^2 t + \sin^2 t\,dt$

$= \int_0^{2\pi} dt$

$= 2\pi$

26.(4) Since f(x, y) is a homogeneous function of degree 9, then by Euler's theorem of homogeneous function we know that $x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y} = nf$ (Here n is the degree of the function)

i.e,. $x\frac{\partial f}{\partial x} + y\frac{\partial f}{\partial y} =$ 9f [degree of function is 9]

27.(2) sin z is homogeneous in x, y of degree 1/2.

$\therefore \quad x\frac{\partial}{\partial x}(\sin z) + y\frac{\partial}{\partial y}(\sin z) = \frac{1}{2}\sin z$

$\Rightarrow \quad x\cos z\frac{\partial z}{\partial x} + y\cos z\frac{\partial z}{\partial y} = \frac{1}{2}\sin z$

$\Rightarrow \quad x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = \frac{1}{2}\tan z.$

28. (4) Given

$\left(4t^2+1\right)\frac{dy}{dx} + 8yt - t = 0,$

$\Rightarrow \quad \frac{dy}{dt} + \frac{8t}{4t^2+1}y = \frac{1}{4t^2+1}$

$\text{I.F.} = e^{\int .8t/\left(4t^2+1\right)}dt = \left(4t^2+1\right)$

Hence solution of equation (i) is ,

$$y\left(4t^2+1\right)=\int \frac{t}{\left(4t^2+1\right)} K.\left(4t^2+1\right) dt + C = \frac{t^2}{2}+C$$

$\Rightarrow$ $$y=\frac{t^2}{2\left(4t^2+1\right)}+\frac{C}{\left(4t^2+1\right)}$$

But, y(1) = 0, therefore $0=\frac{1}{10}+\frac{C}{5}, \Rightarrow C=-\frac{1}{2}$

From equation (ii), we have $y=\frac{t^2}{2\left(4t^2+1\right)}-\frac{1}{2\left(4t^2+1\right)}$

From equation (ii), we have $y=\frac{t^2}{2\left(4t^2+1\right)}-\frac{1}{2\left(4t^2+1\right)}$

$\therefore$ $$y\big|_{t\to\infty}=\underset{t\to\infty}{Lt}\frac{1}{2\left(4+1/t^2\right)}-\frac{1}{2\left(4t^2+1\right)}=\frac{1}{2(4+0)}-0=\frac{1}{8}$$

29.(4) Given : $\frac{d^2y}{dx^2}+\sin x\frac{dy}{dx}+ye^x=\sinh x$

The above equation is second order and non linear. Hence (4)is the correct answer.

30.(2) Given differential equation is

$$(3x^2y^4+2xy)dx+(2x^3y^3-x^2)dy=0$$

then $\frac{\partial M}{\partial y}=12x^2y^3+2x$

$\frac{\partial N}{\partial x}=6x^2y^3-2x$

Now

$$\frac{\frac{\partial M}{\partial y}-\frac{\partial N}{\partial x}}{M}=\frac{6x^2y^3+4x}{3x^2y^4+2xy}=\frac{2}{y}$$

Thus, $I.F.=e^{-\int g(y)dy}=e^{-\int 2/y\,dy}=e^{-2\log y}=\frac{1}{y^2}$

31. (2) The given equation is $\frac{dx}{x} - \frac{2dy}{y} = 0$

$\Rightarrow$ log x - 2 log y = log C $\Rightarrow$ $\log \frac{x}{y^2} = \log C \Rightarrow x = Cy^2 \Rightarrow y^2 = c'x\left[c' = \frac{1}{c}\right]$

This represents parabola.

32.(1) $0 < r < 1$

33.(3) The sequence

$S_n = \frac{1}{2} + \frac{1}{4} + ... + \frac{1}{2^n}$ and $\lim_{n\to\infty} S_n = 1$, the series has the value 1. Hence the given series converges.

34.(1) Given determinant

$$= \begin{vmatrix} 1 & x & x+1 \\ 2x & x(x-1) & (x+1)x \\ 3x(x-1) & x(x-1)(x-2) & (x+1)x(x-1) \end{vmatrix} = \begin{vmatrix} 1 & 1 & 1 \\ 2x & x-1 & x \\ 3x(x-1) & (x-1)(x-2) & x(x-1) \end{vmatrix} x(x+1)$$

$$= x(x+1)(x-1) \begin{vmatrix} 1 & 1 & 1 \\ 2x & x-1 & x \\ 3x & x-2 & x \end{vmatrix}$$

Applying $C_1 \to C_1 - C_3$ and $C_2 \to C_2 - C_3$

$$x(x+1)(x-1) = \begin{vmatrix} 0 & 0 & 1 \\ x & -1 & x \\ 2x & -2 & x \end{vmatrix} (x+1)(x-1)[-2x+2x] = 0$$

$\therefore$ $f(x) = 0 \Rightarrow f(100) = 0$

35.(3) Von Mises and Tresca criteria give different yield stress for Pure shear stress.

36.(4) $X_{L_1} = j\omega L_1 = j500\left(3\times10^{-3}\right) = j1.5\Omega$

$X_{L_2} = j\omega L_2 = j500\left(4\times10^{-3}\right) = j2\Omega$

$$X_c = \frac{1}{j\,\omega C} = -j\frac{1}{500\times10^{-3}} = j\,2\Omega$$

Thus, the admittance of R – L_2 circuit branch is given by

$$Y_{R-L_2} = \frac{1}{2+j2} = 0.354\angle-45°$$

= (0.25 – j 0.25)mho

Again Y_C being $\frac{1}{X_C} = j\,0.5$, the equivalent admittance of Y_C and Y_{R-L_2} is given by

$Y = Y_C + Y_{R-L_2}$

= j 0.5 + 0.25 – j 0.25 = 0.25 + j 0.25

= 0.354 $\angle 45°$ mho

From this

$$I = YV_C = 0.354\angle45° \times \frac{100}{\sqrt{2}}\angle45°$$

= 25∠90°V

Then, $i = 25\sqrt{2}\cos(500t + 90°)$

= -35.4 sin (500 t) A

Now, drop across L_1 is obtained as

$$V_{drop(L_1)} = IX_L = 25\angle90° \times 1.5\angle90°$$

= 37.5∠180°V

Finally, the supply voltage is obtained as

$$V_S = IX_{L_1} + V_C = 37.5\angle180° + \frac{100}{\sqrt{2}}\angle45°$$

$$= 37.5 + j0 + 70.72 \times \frac{1}{\sqrt{2}} + j70.72 \times \frac{1}{\sqrt{2}}$$

= 37.5 + 50 + j 50 = 12.5 + j 50

= 51.54 ∠76°V

This gives

$$\upsilon_S(t) = \sqrt{2} \times 51.54 \cos(500t + 76°)$$

= 72.88 cos(500 t + 76°)V.

37.(3) $R_0 = \sqrt{R_{sc} R_{oc}}$

Since $R_{sc} = \frac{2R_1R_2}{R_1 + R_2}$ and $R_{oc} = \frac{R_1R_2}{2}$

∴ $R_0 = \sqrt{R_1R_2}$

38.(3) The voltage between the plates is the function of z only.

the Laplace's equation is

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

Since, $\frac{\partial V}{\partial x} = \frac{\partial V}{\partial y} = 0 \text{ i.e } \frac{\partial^2 V}{\partial z^2} = 0$

Integrating above equation twice,

$$\frac{\partial V}{\partial z} = A \text{ and } v = Az + B$$

Applying boundary conditions,

i.e. V = 0 at Z = 0

and $V = V_1$ at z = d gives

$$B = 0 \quad \text{and} \quad A = \frac{V_1}{d}$$

$$\therefore \quad V = \frac{V_1}{d} z$$

39.(2) It may be noted that OC data is not required in this question for finding the regulation, Since, during SC test instruments have been placed on the HV side i.e. primary side.

$$\therefore \quad Z_{01} = 86/10.5 = 8.19\Omega; R_{01} = 360/10.5^2 = 3.26\Omega$$

$$X_{01} = \sqrt{(8.19)^2 - (3.26)^2} = 7.5\Omega$$

Full load primary current I_1 = 20000/2200 = 9.09 A

Total voltage drop as referred to primary

$$= I_1 (R_{01} \cos\phi + X_{01} \sin\phi)$$

Drop = 9.09 (3.26×0.8+7.5×0.6) = 64.4 V

Percentage regulation = 64.6 × 100/2200 = 2.9 %

Power factor on short - Circuit

= R_{01}/Z_{01} = 3.26/8.19 = 0.4 lag

40.(3) Flux/ pole = $B_{av} \tau_p \ell$

$$\tau_p = \text{Pole pitch} = \frac{2\pi r}{P} = \frac{\pi D}{P}$$

$$\text{Flux/ pole} = \frac{\pi \times 30 \times 10^{-2}}{4} \times 20 \times 10^{-2} \times 0.4 = 0.0188 \text{Wb}$$

$$\text{Induced emf} = \frac{\Phi N Z}{60} \left(\frac{P}{A} \right)$$

$$= \frac{0.0188 \times 1500 \times 400}{60} \times \left(\frac{4}{4} \right) = 188\text{V}$$

Gross mechanical power developed = $E_a I_a$

$$= \frac{188 \times 25}{1000} = 4.7\text{kW}$$

Torque developed = $\dfrac{4.7 \times 1000}{\left(\dfrac{2\pi \times 1500}{60}\right)} = 29.9\text{N} - \text{m}$

41.(1) It is given that $\dfrac{I_a r_a}{V_t} = 1\% = 0.01$ and $\dfrac{I_a X_s}{V_t} = 50\% = 0.50$

$$E_f^2 = (V_t \cos\theta + I_a r_a)^2 + (V_t \sin\theta + I_a X_s)^2$$

$$= V_t^2 \left[\left(\cos\theta + \frac{I_a r_a}{V_t}\right)^2 + \left(\sin\theta + \frac{I_a X_s}{V_t}\right)^2\right]$$

Here $I_a = 0.7\ I_{rated}$.

$\therefore$ $(1.2V_t)^2 = V_t^2\ [(\cos\theta + 0.01 \times 0.7)^2 + (\sin\theta + 0.5 \times 0.7)^2]$

$1.44 = 0.014 \cos\theta + 0.7 \sin\theta + 1.12255$

or $0.014 \cos\theta + 0.7 \sin\theta = 1.44 - 1.12255 = 0.31745$ ....(i)

It is known that $(A \cos\theta + B \sin\theta) = \sqrt{A^2 + B^2} \sin\left(\theta + \tan^{-1}\dfrac{A}{B}\right)$

$\therefore$ Eq (i) can be written as

$0.70014 \sin(\theta + 1.14577°) = 0.31745$

or $\sin(\theta + 1.14577°) = 0.4535$

or $\theta = 25.824°$

$\therefore$ Power factor $= \cos 25.824° = 0.900$ lagging

42.(1) $f(x) = e^x - 1 = 0$ At $x_0 = -1$

Let $x_1 = x_0 + h$ $\qquad f(x_0) = f(-1) = e^{-1} - 1 = \frac{1-e}{e}$

here, $h = \frac{f(x_0)}{f'(x_0)} = \frac{-\frac{1-e}{e}}{1/e}$ $\qquad f'(x) = e^x - 0 = ex$

$= e - 1 \quad f'(x_0) = f'(-1) = e^{-1} =$

$\therefore \quad x_1 = X_0 + h$

$= -1 + (e - 1)$

$= e - 2$

$\therefore \quad x_1 = 0.71828$

43.(4) $A^T = (A^T A) = A^{-1} (A^T)^{-1} A^T$

$\Rightarrow \quad A^+ = A^{-1} I = A^{-1}$

From options

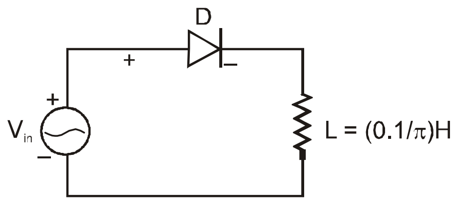
(1) $AA^T A = AA^{-1} A = A$ True

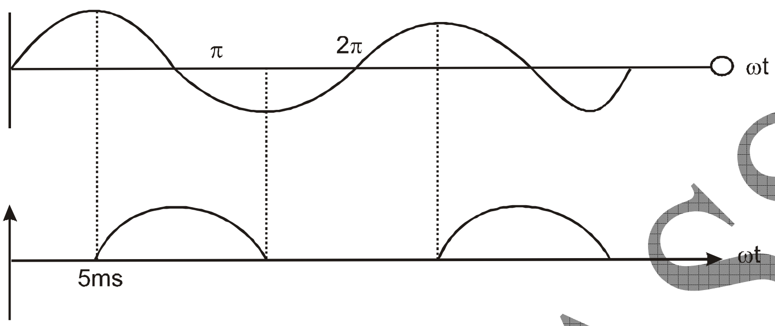
(2) $\left(AA^T\right)^2 = \left(AA^{-12}\right) = I^2 = I$
$AA^T = AA^{-1} = I$

(3) $A^T A = A^{-1} A = I$ True

(4) $AA^T A = AA^{-1} A = A \; A^T$ $\qquad$ False

44.(4)





$$\upsilon_L = L\frac{di}{dt}$$

$$i = \frac{1}{2}\int \upsilon dt$$

For $0 < \omega t < \pi, \upsilon_L = \upsilon_{in} = 10\sin\omega t = \frac{di}{dt}$

$\therefore \quad i = \frac{1}{L}\int \upsilon dt = \frac{\pi}{0.1}\int 10\sin 100\pi t\, dt$

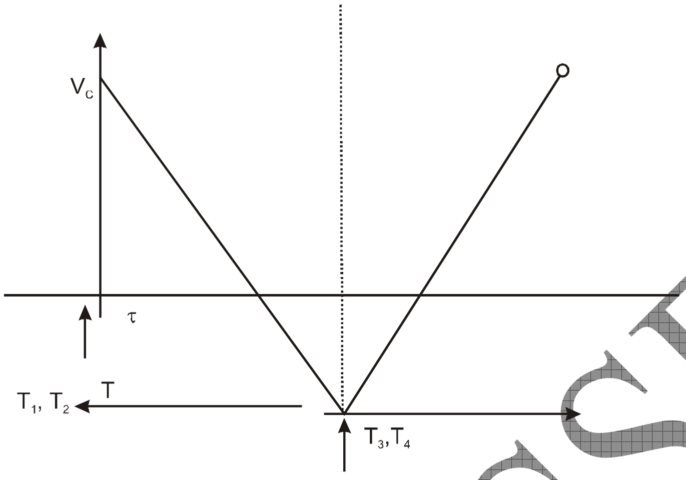
$\Rightarrow \quad$ At $100\pi t = \frac{\pi}{2}, i = 0, \Rightarrow c = 0$

$\therefore \quad i = -\cos 100\pi t$

$\therefore \quad i_{peak} = 1A$

For $\pi < \omega t, \quad \upsilon_L = \upsilon_{in} = 0$

45.(3) Let T_3 and T_4 already conducting at t = 0



Now, trigger T_1 and T_2, so T_3, T_4 force commutated.

Now capacitor start to discharge, Becomes zero.

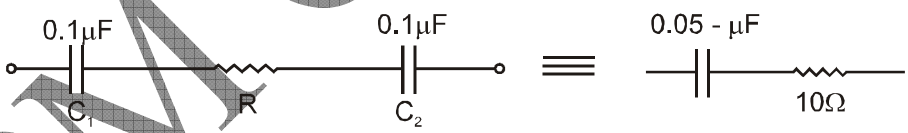
Now charge with opposite polarity

At $t = \frac{T}{2}$, trigger T_3, T_4

So T_2 T_1 force commutated.

Now capacitor start to discharge , becomes zero and now charge with positive polarity

This completes one cycle



Time constant, = τ = RC = 0.5μ s

$\therefore$ Total $\tau = 4 \times \tau = 4 \times 0.5\mu$ s = 2μ s

$\therefore$ $f = \frac{1}{T} = \frac{1}{2 \times 10^{-6}} = 500\text{kHz}$

46.(4) Minimisation using Karnaugh map may not provide unique solution. Redundant grouping in Karnaugh map may result in non-minimised solution. So correct option is (4).

47.(2) This circuit represents gray to binary code converter where binary bits are given by

$X_1 = Y_1$

$X_2 = Y_1 \oplus Y_2$

$X_3 = Y_2 \oplus Y_3 = (Y_1 \oplus Y_2) \oplus Y_3$

48.(2) Sampling rate = $2f_M$

$f_M = 100$

$f_S = 200$ Hz

Discrete signal frequency for 100 Hz

$$f = \frac{100}{200} = \frac{1}{2}\text{Hz}$$

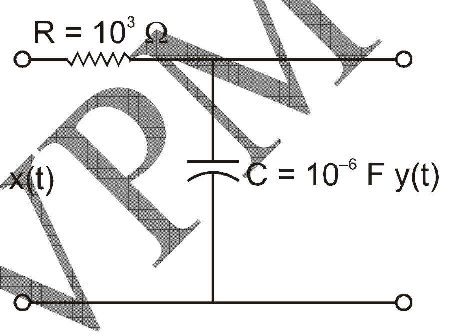
$V[n] = 2\cos(2\pi f_n) = 2\cos(\pi n)$

Discrete signal frequency for 45Hz

$$f = \frac{45}{200} = \frac{9}{40}$$

$$V[n] = 2\cos(2\pi f_n) = 2\cos\left(\frac{9}{20}\pi n\right)$$

49.(3)



$$H(\omega) = \frac{\frac{1}{j\omega C}}{R + \left(\frac{1}{j\omega C}\right)} = \frac{1}{1 + j\omega RC}$$

$$H(f) = \frac{1}{1 + j2\pi fRC}$$

$$|H(f)| = \frac{1}{\sqrt{1 + 4\pi^2 f^2 R^2 C^2}}$$

$$|H(f_1)| = \frac{1}{\sqrt{1 + 4\pi^2 f_1^2 R^2 C^2}}$$

H(0) = 1

Given, $\frac{|H(f_1)|}{H(0)} \geq 0.95$

$$1 + 4\pi^2 f_1^2 R^2 C^2 \leq 1.108$$

Simplifying,

$$f_1 \leq \frac{0.329}{2\pi RC}$$

$f_1 \leq 52.2$ Hz

$f_{1\,max} = 52.2$ Hz

50.(4) As speech signal has mainly low frequency content and varies non-uniform. The non-uniform quantization technique employs μ-law or A-law compounding technique and hence provided good fidelity.

51.(3) An angle-modulated signal with a single-tone modulation can be expressed as

$$x_c(t) = \sum_{n=-\infty}^{\infty} AJ_n(\beta)\ \cos(\omega_c + n\omega_m)t$$

The normalized average power in $x_c(t)$ is given by

$$P = \sum_{n=-\infty}^{\infty} \frac{1}{2} A^2 J_n^2(\beta) = \frac{1}{2} A^2 \sum_{n=-\infty}^{\infty} J_n^2(\beta) = \frac{1}{2} A^2$$

since $$\sum_{n=-\infty}^{\infty} J_n^2(\beta) = 1-$$

52.(3) Negative feedback, v = 3v

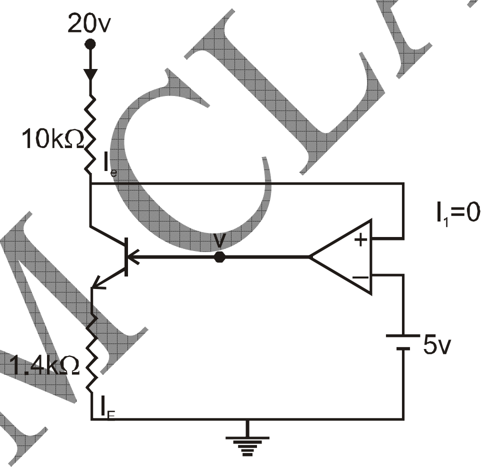
For ideal op-amp, voltage at non inverting point is equal to inverting point (negative feedback) so current from 5kΩ resistor

$$\frac{20-5}{10} = 1.5\text{mA}$$

Ideal op-amp has no current in input,

V_0 = 1.4 × 1.5 MA + 0.9

= 3 volts



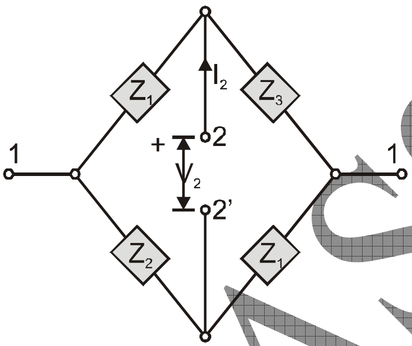
53.(3) Consider an FM broadcast system with parameter Δf = 75 kHz and B = 15 kHz. Assuming $S_X = \frac{1}{2}$, find the output SNR and calculate the improvement (in dB) over the baseband system.

Substituting the given parameters info Eq. we obtain

$$\left(\frac{S}{N}\right)_0 = 3\left(\frac{75(10^3)}{15(10^3)}\right)^2\left(\frac{1}{2}\right)\gamma\ 37.5\gamma$$

Now $10\log 37.5 = 15.7$ dB

54.(4) The network is rearranged as shown in the figure below :



z - parameter equations are

$$V_1 = z_{11} \cdot I_1 + z_{12} \cdot I_2$$

$$V_2 = z_{21} \cdot I_1 + z_{22} \cdot I_2$$

$$z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{1}{2}(Z_1 + Z_2)$$

$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} = \frac{1}{2}(Z_2 + Z_1)$$

$$z_{12} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = \frac{1}{2}(Z_2 - Z_1)$$

$$z_{22} = \left.\frac{V_2}{I_2}\right|_{I_2=0} = \frac{1}{2}(Z_1 + Z_2)$$

$$[Z] = \frac{1}{2}\begin{bmatrix}(Z_1+Z_2) & (Z_2-Z_1)\\(Z_2+Z_1) & (Z_1+Z_2)\end{bmatrix}$$

55.(2) Upper sideband SSB signal

Let m(t) $\leftrightarrow M(\omega)\hat{m}(t)$ and $\leftrightarrow \hat{M}(\omega)$

By applying the modulation theorem or the frequency-shifting property of the Fourier transform, we have $m(t)\cos\omega_c t \leftrightarrow \frac{1}{2}M(\omega-\omega_c)+\frac{1}{2}M(\omega+\omega_c)$

and $\hat{m}(t)\sin\omega_c t \leftrightarrow \frac{1}{2j}\hat{M}(\omega-\omega_c) - \frac{1}{2j}\hat{M}(\omega+\omega_c)$

Taking the Fourier transform of Eq. we have

$$\hat{M}(\omega-\omega_c) = -j\,\text{sgn}(\omega-\omega_c)\,M(\omega-\omega_c)$$

and $\hat{M}(\omega+\omega_c) = -j\,\text{sgn}(\omega-\omega_c)\,M(\omega-\omega_c)$

Thus, $$X_c(\omega) = \frac{1}{2}M(\omega-\omega_c) + \frac{1}{2}M(\omega+\omega_c)$$

$$-\left[-\frac{1}{2}\text{sgn}(\omega-\omega_c)\,M(\omega-\omega_c)+\frac{1}{2}\text{sgn}(\omega+\omega_c)M(\omega+\omega_c)\right]$$

$$= \frac{1}{2}M(\omega-\omega_c)\left[1+\text{sgn}(\omega-\omega_c)\right]+\frac{1}{2}M(\omega+\omega_c)\left[1-\text{sgn}(\omega+\omega_c)\right]$$

Since $$1+\text{sgn}(\omega-\omega_c) = \begin{cases} 2 & \omega>\omega_c \\ 0 & \omega<\omega_c \end{cases}$$

and $$1-\text{sgn}(\omega-\omega_c) = \begin{cases} 2 & \omega<-\omega_c \\ 0 & \omega>-\omega_c \end{cases}$$

we have $$X_c(\omega) = \begin{cases} 0 & |\omega|<\omega_c \\ M(\omega+\omega_c) & \omega<-\omega_c \\ M(\omega-\omega_c) & \omega>\omega_c \end{cases}$$

We see that $X_c(t)$ is an upper-sideband SSB signal.

56.(1) At ice point, t = 0°C, $E_0 = 0.5 \times 10^{-3}$, volts

At steam point, t = 100°C, $E_{100} = 0.0265$, volts

When t = 30°C

$$E_{30} = 9.14 \times 10^{-3} \text{ volts}$$

Thus temperature shown by this thermometer,

$$t = \left(\frac{E_{30} - E_0}{E_{100} - E_0}\right) \times (T_{100} - T_0)$$

$$= \left(\frac{9.14 \times 10^{-3} - 0.5 \times 10^{-3}}{0.0265 - 0.5 \times 10^{-3}}\right) \times 100$$

= 33.23°C

57.(4). As ice point and steam points are two reference points, so

at ice point having t = 0°C, e.m.f. = 0

at steam point having t = 100°C, e.m.f. = 12.8 mV

at gas temperature of 50°C, emf = 7.7 mV

Since emf variation is linear so, temperature at emf of 7.7 mV;

$$= \frac{(100 - 0) \times 7.7}{(12.8 - 0)}$$

= 60.16°C

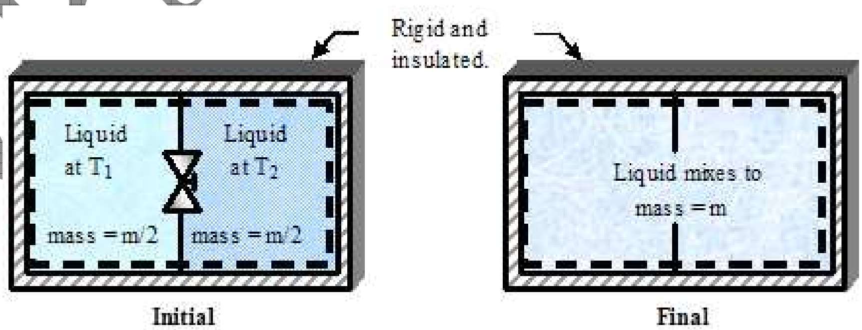
Temperature of gas using thermocouple = 60.16°C

% variation in temperature reading with respect to gas thermometer reading of 50°C

$$= \frac{60.16 - 50}{50} \times 100$$

= 20.32%

58.(3)



Let's begin with the defintion of entropy generation:

$$\Delta S = \int\left(\frac{\delta Q}{T}\right) + S_{gen} \qquad ...2$$

We can solve Eqn 2for S_{gen} :

$$S_{gen} = \Delta S - \int\left(\frac{\delta Q}{T}\right) \qquad ...3$$

Since the system is isolated, there is no heat transferred:

$$\int\left(\frac{\delta Q}{T}\right) = 0 \qquad ...4$$

We can use Eqn 4 to simplify Eqn 3, yielding :

$$S_{gen} = \Delta S \qquad ...5$$

The change in the entropy of the system is :

$$\Delta S = m\hat{S}_{final} - m\hat{S}_{init} \qquad ...6$$

$$\Delta S = m\hat{S}_{final} - \left[\frac{m}{2}\hat{S}_1 + \frac{m}{2}\hat{S}_2\right] \qquad ...7$$

We can rearrange this equation to show that the total change in entropy for the system is the sum of the changes in entropy of each of the two fluids.

$$\Delta S = \frac{m}{2}\left[\left(\hat{S}_{final} - \hat{S}_1\right) + \left(\hat{S}_{final} - \hat{S}_2\right)\right] \qquad ...8$$

The entropy change for an incompressible fluid depends only on temperature.

$$\Delta \hat{S} = \int_{T_{limiy}}^{T_{final}} \frac{\hat{C}}{T} dT \qquad ... 9$$

Because the heat capacity in this problem is a constant, it is relatively easy to integrate Eqn 9 to get:

$$\Delta\hat{S} = \hat{C}_{avg} Ln\left|\frac{T_{final}}{T_{init}}\right| \qquad ...10$$

Next, apply Eqn 10 to determine the entropy change of each fluid in this process and substitute the result into Eqn 8 :

$$\Delta\hat{S} = \frac{m}{2}\hat{C}\left|Ln\frac{T_{final}}{T_1} + Ln\frac{T_{final}}{T_2}\right| \qquad ...11$$

Properties of logarithms let us rearrange Eqn 11 to :

$$\Delta\hat{S} = \frac{m}{2}\hat{C}Ln\left[\frac{T_{final}^2}{T_1T_2}\right] \qquad ...12$$

Combining Eqn 12 with Eqn 5 gives us :

$$S_{gen} = \frac{m}{2}\hat{C}Ln\left[\frac{T_{final}^2}{T_1T_2}\right] \qquad ...13$$

To complete this derivation, we must elimnate T_{final} from Eqn 13. We can determine Tfinal in terms of T_1 and T_2 by applying the 1st Law to this process.

$$\Delta U = Q - W \qquad ...14$$

No work or heat crosses the sytem boundary, so Eqn 14 becomes :

$$\Delta U = 0 \qquad ...15$$

Now, use the constant specific heat of the incompressible fluid to determine ΔU :

$$\frac{m}{2}\left[\left(\hat{U}_{final} - \hat{U}_1\right) + \left(\hat{U}_{final} - \hat{U}_2\right)\right] = 0 \qquad ...16$$

$$\frac{m}{2}\hat{C}[(T_{final} - T_1) + (T_{final} - T_2)] = 0 \qquad ...17$$

Now, solve Eqn 17 for T_{final} :

$$T_{final} = \frac{T_1 + T_2}{2} \qquad ...18$$

Now, we can use Eqn 18 to eliminate Tfinal from Eqn 13 :

$$S_{gen} = \frac{m}{2}\hat{C}Ln\left[\frac{1}{T_1T_2}\left(\frac{T_1+T_2}{2}\right)^2\right] \quad ...19$$

Simplify Eqn 19 algebraically :

$$S_{gen} = \frac{m}{2}\hat{C}Ln\left[2\cdot Ln\left[\frac{1}{(T_1T_2)^{1/2}}\left(\frac{T_1+T_2}{2}\right)\right]\right] \quad ...20$$

Finally :

$$S_{gen} = m\hat{C}Ln\left[\frac{T_1+T_2}{2(T_1T_2)^{1/2}}\right]$$

59.(1) **Control Volume:** The turbine.

Property Relation: Assume air is an ideal gas and use ideal gas relations.

Process: Steady-state, steady-flow, adiabatic process

Conservation Principles:

Conservation of mass:

$$\sum \dot{m}_{in} = \sum \dot{m}_{out}$$

$$\dot{m}_1 = \dot{m}_2 = \dot{m}$$

Conservation of energy:

$$\dot{Q}_{in} + \underbrace{\sum \dot{m}_i\left(h_i + \frac{\vec{V}_i^2}{2} + gz_i\right)}_{\text{for each inlet}} = \dot{W}_{out} + \underbrace{\sum \dot{m}_e\left(h_e + \frac{\vec{V}_e^2}{2} + gz_e\right)}_{\text{for each exit}}$$

According to the sketched control volume, mass and work cross the control surface. Neglecting kinetic and potential energies and noting the process is adiabatic, we have

$$0 + \dot{m}_1 h_1 = \dot{W}_{out} + \dot{m}_2 h_2$$

$$\dot{W}_{out} = \dot{m}(h_1 - h_2)$$

The work done by the air per unit mass flow is

$$w_{out} = \frac{\dot{W}_{out}}{\dot{m}} = h_1 - h_2$$

Notice that the work done by a fluid flowing through a turbine is equal to the enthalpy decrease of the fluid

Using the air tables, Table

at T_1 = 1300 K, h_1 = 1395.97 kJ/kg

at T_2 = 660 K, h_2 = 670.47 kJ/kg

$$w_{out} = h_1 - h_2$$

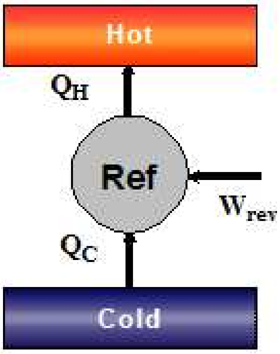
$$= (1395.97 - 670.47)\frac{kJ}{kg}$$

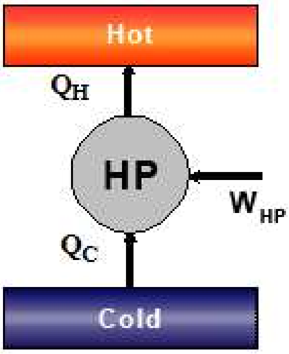
$$= 725.5\frac{kJ}{kg}$$

60.(2) Read : Here we must apply the definition of COP for both refrigerators and heat pumps.

Given : W 5hP

Find : COPR ???





If the purpose is to cool the groundwater, then the device is a refrigerator.

So, let's begin with the definition of the coefficient of performance for a refrigerator.

$$COP_R = \frac{Q_C}{W_{Ref}} \quad ....(1)$$

We are given the values of both QC and W, so all we need to do is make the units consistent and then plug values into Eqn 1.

Conversion Factors :	1 hP = 2545 Btu/h	W	12725	Btu/h
		QC	30000	Btu/h
		COPR	2.358	

61.(2). You could approach this problem by calculating the number of moles of gas using PV = nRT , then resolving for the pressures. However, you can take a tremendous shortcut if you remember Dalton's law: the pressure a gas exerts in a mixture is the same as the pressure it would exert if alone. Since we know the final and initial volumes of the system and the initial pressure of each gas, we can use Boyle's law to calculate the final pressure contribution of each gas. For gas a, rearrange Boyle's law to solve for the final pressure P_{a2} :

$$P_{a2} = \frac{P_{a1}V_1}{V_2} = \frac{P_{a1}}{2}$$

$$\frac{2.00 \times 10^5 \text{ Pa}}{2}$$

$= 1.0\times10^5$ Pa

= 1/2 for both gases. A similar calculation for gas B gives $P_{b2} = 0.50\times10^5$ Pa.

62.(1) Total moles of gas:

2.50 + 0.38 + 1.34 = 4.22 moles

PV = nRT:

(x) (19.5 atm) = (4.22 mol) (0.08206) (288 K)

x = 5.115 atm

The partial pressure for neon:

5.115 x (1.34/4.22) = 1.62 atm

63.(3) Given : T_H 1200 °C T_C 200 °C

T_H 1473.15K T_C 473.15K

Find : η ???

The thermal efficiency of a Carnot Cycle depends only on the temperatures of the reservoirs with which it interacts. The equation that defines this relationship is :

$$\eta = 1 - \frac{T_C}{T_H} \quad \text{....(1)}$$

Just be sure to use absolute temperature in Eqn 1 ! In this case, convert to Kelvin. Temperatures in Rankine will work also.

η 67.9%

64.(1) Use the equation for gas density:

$$d = \frac{n\mu}{V} = \frac{P\mu}{RT}$$

$\mu = 44.0\ \frac{g}{mol}$. If we use the value of R 0.0821 $\frac{L\ atm}{mol\ K}$ we can stick with the original units. Plugging in these values, we find that the density d of CO_2 is 1.8 g/L.

65.(1) Let $s = f(T, p)$

Then $$ds = \left(\frac{\partial s}{\partial T}\right)_p .dT + \left(\frac{\partial s}{\partial p}\right)_T dp$$

As per maxwell relation

$$\left(\frac{\partial s}{\partial p}\right)_T = -\left(\frac{\partial s}{\partial T}\right)_p$$

Substituting this in the above equation, we get

$$ds = \left(\frac{\partial s}{\partial T}\right)_p dT - \left(\frac{\partial \upsilon}{\partial T}\right)_p .dp \qquad ....(1)$$

The enthalpy is given by

$dh = c_p dT = Tds + \upsilon dp.$

Dividing by dT at constant pressure

$$\left(\frac{\partial h}{\partial T}\right)_p = c_p = T\left(\frac{\partial s}{\partial T}\right)_p + 0$$ (as dp = 0 when pressure is constant)

Now, substituting this in Eqn. (i), we get

$$ds = c_p \frac{dT}{T} - \left(\frac{\partial s}{\partial T}\right)_p .dp. \qquad ...(2)$$

But $$\beta = \frac{1}{\upsilon}\left(\frac{\partial \upsilon}{\partial T}\right)_p .$$

Substituting this in Eqn. (ii), we get

$$\boxed{ds = c_p \frac{dT}{T} - \beta\upsilon dp.}$$

66.(2) For pipe flows, at constant diameter, head is proportional to $(\text{flow})^2$

67.(4) Unsteady uniform flow is flow through a long pipe at constant rate

68.(2) A balloon lifting in air follows the Archimedes principle

69.(4) Surface tension decreases with fall in temperature

70.(1) Viscosity of water in comparison to mercury is higher

71.(1) Hydraulic grade line as compared to the centre line of conduct should always be above

72.(2) 0.974 Ns/m^2

$$V = \frac{Q}{A} = \frac{1000/900 \times 1/(60\times 5)}{\frac{\pi}{4}\times 0.1 \times 0.1}$$

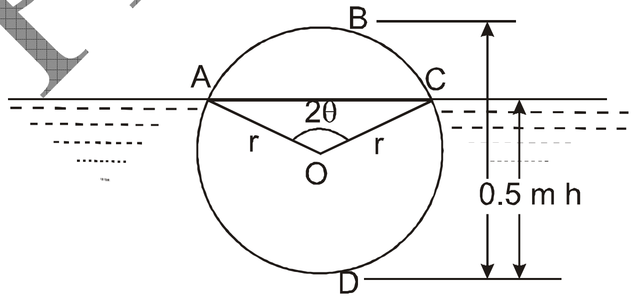
$$= \frac{4\times 1}{0.9\times 3\times \pi} = 0.472 m/sec$$

We know $\mu = \frac{(P_1 - P_2)D^2}{32VL}$

$$= \frac{14.715\times 10^3 \times 0.1 \times 0.1}{32\times 0.472\times 10}$$

$\mu = 0.974\ N - s/m^2$.

73.(2)



Given

Dia. of log = 0.6 m

Length L = 5 m

Sp. gr., S = 0.7

∴ Density of log, = 0.7 × 1000 = 700 kg/m^3

∴ Weight density of log, w= ρ × g

= 700 × 9.81 N/m^3

Find depth of immersion or h

Weight of wooden log= Weight density × Volume of log

$$= 700 \times 9.81 \times \frac{\pi}{4}(D)^2 \times L$$

$$= 700 \times 9.81 \times \frac{\pi}{4}(.6)^2 \times 5N = 989.6 \times 9.81\,N$$

For equilibrium.

Weight of wooden log = Weight of water displaced

= Weight density of water × Volume of water displaced

$$\therefore \text{ Volume of water displaced} = \frac{989.6 \times 9.81}{1000 \times 9.81} = 0.9896 m^3$$

(∴ Weight density of water = 1000 × 9.81 N/m^2)

Let h is the depth of immersion

∴ Volume of log inside water = Area of ADCA × Length

= Area of ADCA × 5.0

But volume of log inside water = Volume of water displaced = 0.9896 m^3

∴ 0.9896 = Area of ADCA × 5.0

$$\therefore \text{ Area of ADCA} = \frac{0.9896}{5.0} = 0.1979 m^2$$

But area of ADCA = Area of curved surface ADCOA + Area of ΔAOC

$$= \pi r^2\left[\frac{360° - 2\theta}{360°}\right] + \frac{1}{2} r\cos\theta \times 2r\sin\theta$$

$$= \pi r^2\left[1 - \frac{\theta}{180°}\right] + r^2\cos\theta\sin\theta$$

$\therefore$ $$0.1979 = \pi\,(3)^2\left[1 - \frac{\theta}{180°}\right] + (.3)^2\cos\theta\sin\theta$$

0.1979 = .2827 – .00157 θ + 0.9 cos θ sin θ

$$\theta - \frac{.09}{.00157}\cos\theta\sin\theta = \frac{.0848}{.00157}$$

or θ – 57.32 cos θ sin θ = 54.01.

For θ = 60°, 60 – 57.32 × 0.5 × .866 – 54.01 = 60 – 24.81 – 54.01

For θ = 70° 70– 57.32 × .342 × 0.9396 – 54.01 = 70 – 18.4 – 54.01 =

For θ = 72° 71 – 57.32 × .309 × .95 – 51.01 = 72 –16.84 – 54.01

For θ = 71° 71 – 57.32 × .325 × .9455 – 54.01 = 71 – 17.61 – 54

$\therefore$ θ = 71.5 ° 71.5 – 57.32 × .3173 × .948 – 54.01 = 71.5 – 71.5 – 17

Then h = r + r cos 71.5°

= 0.3 + 0.3 × 0.3173 = 0.395 m.

74.(1) Given :

Dia. of orifice, d_0 = 10 cm

$\therefore$ Area, $a_0 = \frac{\pi}{4}(10)^2 = 78.54\ \text{cm}^2$

Dia. of pipe, d_1 = 20 cm

$\therefore$ Area, $a_1 = \frac{\pi}{4}(20)^2 = 314.16\ \text{cm}^2$

$p_1 = 19.62 \text{ N/cm}^2 = 19.62 \times 10^4 \text{ N/m}^2$

$\therefore \quad \frac{p_1}{\rho g} = \frac{19.62 \times 10^4}{1000 \times 9.81}$ = 20 m of water

Similarly $\frac{p_2}{\rho g} = \frac{9.81 \times 10^4}{1000 \times 9.81}$ = 10 m of water

$\therefore \quad h = \frac{p_1}{\rho g} - \frac{p_2}{\rho g}$ = 20.0 – 10.0 = 10 m of water = 1000 cm of

$C_d = 0.6$

The discharge, Q is given by equation (6.13)

$$Q = C_d \frac{a_0 a_1}{\sqrt{a_1^2 - a_0^2}} \times \sqrt{2gh}$$

$$= 0.6 \times \frac{78.54 \times 314.16}{\sqrt{(314.16)^2 - (78.54)^2}} \times \sqrt{2 \times 981 \times 1000}$$

$$= \frac{20736838.09}{304} = 68213.28 \text{ cm}^3/\text{s} = \mathbf{68.21\ litres/s.}$$

75.(1) Let the volume of the body $= V \text{ m}^3$

Then volumeof body sub - merged in mercury

$$= \frac{40}{100} V = 0.4 V \text{ m}^3$$

Volume of body sub - merged in water

$$= \frac{60}{100} \times V = 0.6V\ m^3$$

For the equilibrium of the body

Total buoyant force (upward force) = Weight of the body

But total buoyant force = Force of buoyancy due to water + Force fo buoyancy due to mercury.

Force fo buoyancy due to water = Weight of water displaced by body

= Density of water × g × Volume of water displaced

= 1000 × g × Volume of body in water

= 1000 × g × 0.6 × V N

and Force of buoyancy due to mercury

= Weight of mercury displaced by body

= g × Density of mercury × Volume of mercury displaced

= g × 13.6 × 1000 × Volume of body in mercury

= g × 13.6 × 1000 × 0.4 V N

Weight of the body = Density × g × Volume of body = ρ × g × V

Where ρ is the density of the body

∴ For equilibrium, we have

Total buoyant force

1000 × g × 0.6 × V + 13.6 × 1000 × g × .4 V = ρ × g ×V

or ρ = 600 + 13600 + .4 = 600 + 54400 = 6040.00 kg/m^3

Density of the body = 6040.00 kg/m^3.

76.(3) Main form of ceramic degradation is Dissolution.

77.(1) High elastic modulus in materials arises from high strength of bonds.

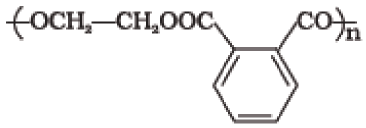
78.(1) To accurately measure the root radius of a charpy or Izod specimen, we use a machine called shadowgraph.

79.(4) Electron sea exists in metallic bond.

80.(1) High dielectric constant material is must for Insulation of wires.

81.(2) As a solid element melts, the atoms become more separated and they have less attraction for one another.

82.(1) Ethylene glycol is one of the monomer units in



83.(3)

84.(2)

85.(4)

86.(4) A 1.0-N force acting west and a 9.0-N force acting east on a 5.0-kg object would produce the greatest acceleration.

87.(2) If the mass of the man is 'm', the mass of the boy is m/2. If v_1 and v_2 are the initial velocities of the man and boy respectively, we have

$\frac{1}{2} mv_1^2 = \frac{1}{2} (m/2)v_2^2$

Therefore, $v_2 = v_1 . \sqrt{2}$

On changing the speeds, we have

$\frac{1}{2} m(v_1+2)^2 = \frac{1}{2} (m/2)(v_2+x)^2$

On substituting for v_2 $(=v_1\sqrt{2})$, the above equation simplifies to

$(v_1+2)^2 = \frac{1}{2} (v_1\sqrt{2} +x)^2$ from which $x = 2\sqrt{2}$ ms^{-1}.

88.(2) As the frictional force supplies the centripetal force required for the circular motion, we have

$\mu mg = mv^2/r$ so that $v = \sqrt{(\mu rg)} = \sqrt{(0.64\times20\times9.8)} = 11.2$m/s

89.(4) The coordination environment for cations is Cubic.

90.(1) If instead we go through the motions of throwing the ball but hold onto it, our net recoil will be zero.

91.(1) Strain corresponding to 35MPa stress $= \frac{35}{80x10^3} = 4.375x10^{-4}$

Elongation due to above strain = 4.375 x 10^{-4} x 3000 = 1.3125mm

To generate above compressive stress, total elongation to be compensated by thermal rise will be

= (1.3125 + 2.5) mm = 3.8125mm and let the final temperature be T ^oC .

Now, $3\times10^3 \times18\times10^{-6} \times (T + 20) = 3.8125$

T = 50.6ºC.

92.(2) $$\sigma_2 = \left(\frac{\sigma_x + \sigma_4}{2}\right) = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + z_{xy}^2}$$

$$\sigma_2 = \left(\frac{30+18}{2}\right) = \sqrt{\left(\frac{30-18}{2}\right)^2 + 8^2}$$

$\sigma_2 = 24 - \sqrt{36+64}$ = 24 – 10

σ_2 = 14 MPa Ans.

93.(3) ℓ = 10 cm d = 5 cm.

ΔT = 100°C

Strain is prevented so stress will be induced in the steel rod.

Equation of compatibility for this case (Statically intermidiate)

$$L\alpha T = \frac{PL}{AE}$$

α = Ea ΔT

$= 12 \times 10^{-6} \times 2 \times 10^{6} \times 100$

$= 2.4 \times 10^3$ kgf/cm^2 Ans.

94.(1) $\text{Seq} = \dfrac{2S \times S}{2S + S} = \dfrac{2S}{3}$

$\therefore \quad \delta = \dfrac{W}{\text{Seq}} = \dfrac{3W}{2S}$ Ans.

95.(1) $\varepsilon_x = \dfrac{\sigma_x}{E} - \dfrac{\mu\sigma_y}{E}$

$\sigma_x = \sigma$ and $\sigma_y = \sigma$

$\therefore \ \varepsilon_x = \dfrac{\sigma_x}{E} - \dfrac{\mu\sigma_y}{E}$

$\varepsilon_x = \dfrac{\sigma}{E}(1 - \mu)$

$\Rightarrow \dfrac{\sigma}{\varepsilon_x} = \dfrac{E}{1-\mu}$ **Ans.**

96.(2) It will be one more than the size of the biggest cluster (which is 4) in this case. This is because, assume a search key hashing onto bin 8. By linear probing the next location for searching is bin 9. Then 0, then 1. If all these resulted in a miss, we try at bin 2 and stop as it is vacant. This logic may not work if deletion is done before the search.

97.(3) In the relation R, FD set is $A \to B$ and $C \to D$ when we decompose R in R_1 and R_2

	A	B	C	D
AB	a	a	b	b
CD	b	b	a	a

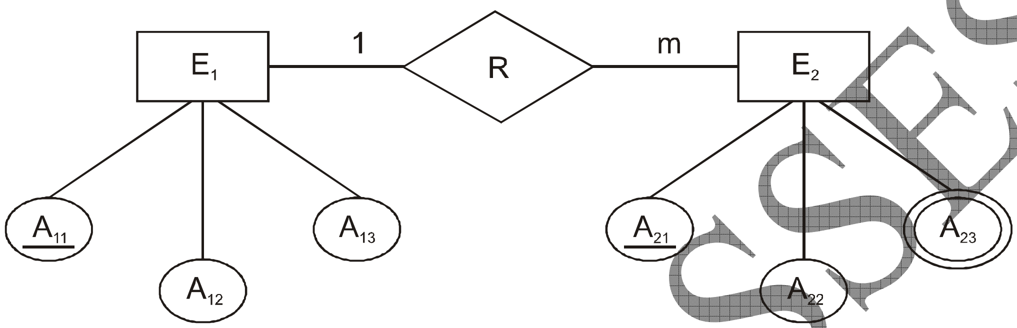
Since R_1 contains $A \to B$ and R_2 contains $C \to D$ and there is no common attribute among R_1 and R_2 hence the decomposition of R is lossy.

Also, R_1 contains $A \rightarrow B$

R_2 contains $C \rightarrow D$

Hence all the dependencies are preserved

98.(2) .



Since each talbe is to in 3rd Normal form for each multi-valued attribute individual table is to be created. Hence, total number of tables in the database is 3.

1 for entity set E_1, 2 for entity set E_2 and 3 for attributes A_{23}.

Hence(2) is the correct option.

99.(1) $\leq 2^{K-1}$

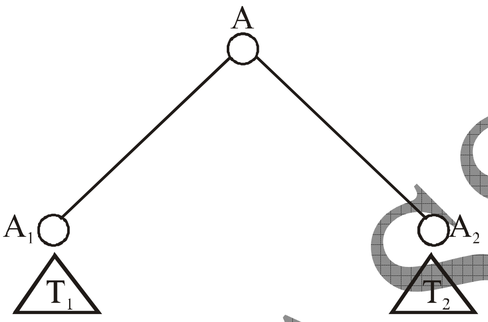
We prove the result by induction on k, the length of the longest path for all A-trees (Recall an A-tree is a derivation tree whose root has label A).

When the longest path in an A-tree is of length 1, the root has only one son whose label is a terminal (when the root has two sons, the labels are variables).

So the yield is of length 1. Thus, there is basis for induction.

Assume the result for k – 1 (k > 1). Let T be an A-tree with a longest path of length less than or equal to k. As k > 1, the root of T has exactly two sons with labels A_1 and A_2 . The two subtrees with the two sons as roots have the longest paths of length less than or equal to k – 1 (see Fig.)

If w_1 and w_2 are their yields, then by induction hypothesis, $|w_1| \le 2^{k-2}$, $|w_2| \le 2^{k-2}$. So the yield of T = w_1w_2 ., $|w_1w_2| \le 2^{k-2} + 2^{k-2} = 2^{k-1}$. By the principle of induction, the result is true for all A-trees, and hence for all derivation trees.



Tree T with subtrees T_1 and T_2

100.(1) deadlock avoidance

This algorithm is commonly known as the banker's algorithm. The name was chosen because the algorithm could be used in a banking system to ensure that the bank never allocated its available cash in such a way that it could no longer satisfy the needs of all its customers.

101.(4) **EMP DEPT Table**

EMP NAME	D NO	SuPERSSN
JOHN	5	33344555

1 row is affected.

102.(1) Kernel level threading may be preferrable to user level threading because storing information about user level thread in a PCB would create a security risk i.e. with each access to the non-critical services. We are going to the domain where both critical and non-critical services are residing. Any harm in this domain may creates problems to the critical services. Hence Kernel level threading is preferable.

103.(1) P = [20,000 × 0.5 × 3kb] / 60 = 500 kbytes / sec

= 4 megabits per second

104.(3) Step-1

i = 6720; j = 4; i % j = 0

$$i = \frac{6720}{4} = 1680$$

j = 5

Step-2

i = 1680; j = 5 i % j = 0

i = 336; j = 6

Step-3

i = 336; j = 6 i % j = 0

i = 56; j = 7

Step-4

i = 56; j = y

105.(1) $\log P = \frac{1}{2} \log Q$

$$= \frac{1}{2}\left(\frac{1}{4}\right) \log R$$

$$\frac{1}{2} = \frac{1}{8} \log R$$

$$\frac{1}{4} = \log R$$

$$\log Q = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$\log Q = \frac{1}{4} \log R$$

$\boxed{Q^4 = R}$

$\boxed{P^2 = Q}$