1. Ans. D

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

$$I.f=e^{\int\frac{8t}{4t^2+1}dt}$$
$$=4t^2+1$$

Solution is $y \times I.F=\int Q(t)I.F\,dt+c$

$$y \times (4t^2+1)=\int\frac{t}{4t^2+1}(4t^2+1)dt+c$$

$$y \times (4t^2+1)=\int t dt+c$$

$$y \times (4t^2+1)=\frac{t^2}{2}+c$$

As; y(1)=0 c= $-\frac{1}{2}$

$$y \times (4t^2+1)=\frac{t^2}{2}-\frac{1}{2}$$

$$y=\frac{(t^2-1)}{2(4t^2+1)}$$

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

$$y_{t=\infty}=\frac{(1-0)}{2(4+0)}$$

$$=\frac{1}{8}$$

2. Ans. A

At the highest point

$momentum\ before\ collision = momentum\ after\ collision$

$mv\cos\theta=-\frac{m}{2}v\cos\theta+\frac{m}{2}V$ (V is the velocity of other part after collision)

$$\frac{3}{2}mv\cos\theta=\frac{m}{2}V$$

$$V=3v\cos\theta$$

3. Ans. B

• Shear force changes sign at point of infexion and at that point bending moment is maximum

• When bending moment is maximum, the point is called point of contraflexure

4. Ans. D

As this system is under equilibrium so all the force must pass through point B. so Ry must be zero

$$T\sin\theta=mg$$

$$T\cos\theta=Rx$$

Dividing both eqn

$$\tan\theta=\frac{mg}{Rx}$$

$$R_x=mg\cot\theta$$

$$=35\times9.81\times\frac{275}{125}$$

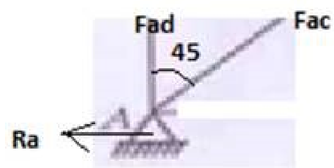
$$=755.4\,N$$

5. Ans. D

As only horizontal force is acting so all the reaction along veritical direction are zero. And Ra=1000Kn

At point B, no force is acting, so force in the member AB and BC is also zero.

Taking point A



angle A= 45 degree

$$Fac\ \sin45^\circ=Ra$$

$$Fac\ \sin45^\circ=1000$$

$$Fac\ =1414\,KN$$

6. Ans. D

We know that

$$R=\frac{\tau L}{G\theta}$$

$$R=\frac{1000\times120\times180}{0.8\times10^6\times\pi}$$

$$\frac{27}{\pi}$$

7. Ans. C

Taking a small differential area and find energy of both parts of the system

$$U = \int_0^l \frac{P^2x^2dx}{2EI} + \int_0^l \frac{P^2L^2dx}{2EI}$$
$$U = \frac{P^2L^3}{6EI} + \frac{P^2L^3}{2EI}$$
$$U = 4\frac{P^2L^3}{6EI}$$

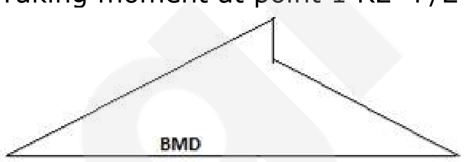
Now using castiglianos theorem,

$$\delta = \frac{\partial U}{\partial P}$$
$$= 8\frac{P^2L^3}{6EI}$$
$$= 4\frac{P^2L^3}{3EI}$$

8. Ans. A

$$\epsilon_h = \frac{Pd}{4tE}\left(2 - \frac{1}{m}\right)$$
$$\epsilon_l = \frac{Pd}{4tE}\left(1 - \frac{2}{m}\right)$$
$$\frac{\epsilon_l}{\epsilon_h} = \frac{\left(1 - \frac{2}{m}\right)}{\left(2 - \frac{1}{m}\right)}$$
$$= \frac{m-2}{2m-1}$$

9. Ans. C
R1+R2= P
Taking moment at point 1 R2=P/2+Pa/l



Hence bending moment is maximum at the middle left side,
M_x=(P/2-Pa/l)l/2
$M_x = \frac{Pl}{4}$+Pa/2

10. Ans. D
For buckling the euler critical load is given as

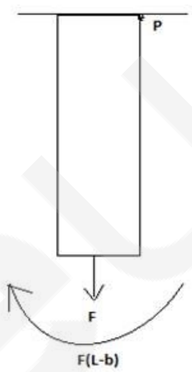
$$P_{euler} = \frac{\pi^2 EIminimum}{l^2}$$

So the buckling will begin at minimum moment of inertia.

11. Ans. A
- Maximum principle stress theory is applied to brittle material
- All the rest theory in the options are applied to ductile material

12. Ans. C
According to D-Alembert's principle - A moving fluid mass may be brought to a static equilibrium position by applying an imaginary inertia force of the same magnitude as that of the accelerating force but in the opposite direction

13. Ans. D



Stress at the point P is given as

$$\sigma_p = \frac{F}{4b^2} + \frac{My}{I}$$
$$\sigma_p = \frac{F}{4b^2} + \frac{F(L-b)b}{\frac{(2b)^4}{12}}$$
$$\therefore\ \sigma_p = \frac{F(3L-2b)}{4b^3}$$

14. Ans. C
- For a floating body, it maintain its equilibrium at point where the line of buoyancy foce and the centre of gravity intersect and that point is called the centre of buoyancy
- Generally the metacentre of ships and other large vessels in sea are kept high to attain maximum stability.

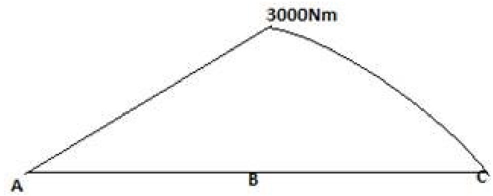
15. Ans. D
Bernoulli's equation to derive the discharge and velocity is applicable to all the above mentioned devices assuming the liquid in flow to be non-viscose and incompressible.

16. Ans. B
Range of Cc for a normal orifice is between 0.6 to 0.7 , so only option b is correct

17. Ans. A

$$Ra + Rc = 6000$$
$$Taking\ moment\ at\ A\ we\ get\ Rc = 4500\ N$$

So $Ra = 1500\ N$
Now BMD is



So maximum bending stress is

$$\sigma = \frac{My}{I}$$

$$\sigma = 3000\times1000\times50\times\frac{12}{30\times10^6}$$

$$= 60\ Mpa$$

18. Ans. C
● When a cylinder is rotated about an axis by applying energy from external source then such type of motion is known as vortex flow motion.

19. Ans. B
Power required is given by

$$P = \frac{\rho g Q h_f}{1000}\ kW$$

$$P = \frac{\rho g Q}{1000}\,\frac{flQ^2}{\times 12 d^5}\ kW$$

$$= \frac{\rho g}{1000}\,\frac{flQ^3}{\times 12 d^5}$$

$$= 1000\times9.81\times0.02\times1000\times\frac{0.07^3}{1000\times12\times0.2^5}$$

$$= 17.4\ Kw$$

20. Ans. B
● The velocity at which laminar flow stops is called lower critical velocity
● The velocity at which turbulent flow begin is called higher critical velocity
● Example for pipe flow lower critical velocity is 2300 and higher critical velocity is 4000

21. Ans. C

$$\frac{(T_{\infty i} - T_{\infty o})}{\frac{1}{h_i} + \frac{L_1}{k_1} + \frac{L_2}{K_2} + \frac{1}{h_o}} = \frac{(T_{\infty i} - T)}{\frac{1}{h_i} + \frac{L_1}{k_1}}$$

$$\frac{(20-(-2))}{\frac{1}{20} + \frac{0.3}{20} + \frac{0.15}{50} + \frac{1}{50}} = \frac{(20-T)}{\frac{1}{20} + \frac{0.3}{20}}$$

$$\frac{22}{0.088} = \frac{20-T}{0.065}$$

$$\therefore T = 3.75°C$$

22. Ans. C
● Product of eigen values of matrix must be determinant of matrix that is 15 so only option b and c are valid
● Also trace of matrix is 8 which should be sum of eigen values so only option c is correct

23. Ans. A

$$\frac{d^2y}{dx^2} = 3x - 2$$

By Successive Integration twice we get
$dy/dx = 3x^2/2 - 2x + C_1$
$y = 3x^3/6 - 2x^2/2 + C_1x + C_2$
or, $y = x^3/2 - x^2 + C_1x + C_2$ ___________(1)
by putting y(0)=2 and y(1)=-3 we get in equation (1)
$2 = C_2$
& $-3 = 1/2 - 1 + C_1 + C_2$
where $C_2 = 2$
Hence C_1 =
Hence the final equation
$y = x^3/2 - x^2 + 2x - 9/2$

24. Ans. B
We know that

$$\delta = \frac{\partial U}{\partial P} = \frac{PL^3}{3EI}$$

On integration we get

$$\therefore U = \frac{P^2L^3}{6EI}$$

25. Ans. A
For matrix to be singular

$$\begin{pmatrix} 8 & x & 0 \\ 4 & 0 & 2 \\ 12 & 6 & 0 \end{pmatrix} = 0$$

$$or;\ 8(0-12) - x(0-24) = 0$$

$$or;\ x = \frac{96}{24}$$

$$\therefore x = 4$$

26. Ans. B
At the surface of the plate
$heat\ conducted = heat\ convected$

$$-k\left(\frac{dT}{dy}\right)_{y=0} = h(T - T_\infty)$$

$$-k(-70e^{-y})_{y=0} = h(100 - 30)$$

$$-1(-70) = h(100-30)$$

$$h = 1\ W/m^2K$$

27. Ans. A

$$\alpha = \frac{K}{\rho C_p} = 1.2\times10^{-5}$$

$$\frac{43.6}{\rho C_p} = 1.2\times10^{-5}$$

$$\rho C_p = 36.33\times10^5$$

From the figure the area of cross section is

Ac= $\frac{1}{2}\times2\times3tan30\times3 = 3\sqrt{3}$

$$heat\ utlised = heat\ given\ by\ power\ source$$

$$\rho Ac\times l\times C_p(T_m - T_a) = KVA\times1000\times time\ factor\times t$$

$$\rho Ac\times\frac{l}{t}\times C_p(T_m - T_a) = KVA\times1000\times time\ factor$$

$$36.33\times10^5\times3\sqrt{3}\times10^{-6}\times V\times(1530-30) = 2.5\times1000\times0.85$$

$V = 0.075\ m/s$ (nearest answer is a)

28. Ans. B

For SC $8\times\frac{1}{8} = 1$

For BCC $8\times\frac{1}{8} + 1 = 2$

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

29. Ans. D

• A thermosetting plastic is one which when heated form condensate and have very high molecular mass and have no long range crystalline lattice structure

30. Ans. C

• Silicon steel are magnetized steel which is manufactured in such a way to minimize hysteresis loss and minimize the loss of heat in electrical device

• hence option c is correct

31. Ans. C

$$\frac{(T_{\infty i} - T_{\infty o})}{\frac{L_1}{k_1} + \frac{L_2}{K_2}} = \frac{(T_{\infty i} - T)}{\frac{L_1}{k_1}}$$

$$\frac{(1000-120)}{\frac{0.3}{3} + \frac{0.3}{0.3}} = \frac{(1000-T)}{\frac{0.3}{3}}$$

$$\therefore T = 920\ °C$$

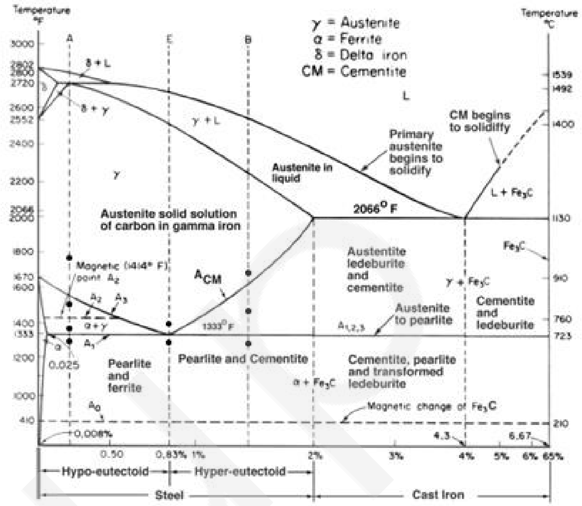
32. Ans. A

• Among all the above bond silicate is the most soft material and hence the most soft

• vitrified bond bond are hard bond are used in industry

33. Ans. A

• from the iron iron carbide phase diagram



• at eutectoid composition 100% pearlite is obtained

34. Ans. C

$$MRR = depth\ of\ cut\times width\times feed$$

$$= 50\times5\times\frac{10}{60}$$

$$= 41.7\ \mathrm{mm3/s}$$

35. Ans. D

German silver contain 60% cu, 20% zn and 20% Ni

So it does not contain silver

36. Ans. B

• Coal dust improves surface finish

• Sand flour or flour dust improves strength and collapsibility

37. Ans. A

• for making hollow components with the use of core slush casting is used

• it is widely used to make jewels

38. Ans. B

As surface area are equal $4\pi r^2 = 6a^2$

$$\frac{r^3}{a^3} = \left(\frac{6}{4\pi}\right)^{\frac{3}{2}}$$

Now $\frac{t_{sphere}}{t_{cube}} = \left(\frac{V_s}{V_c}\right)^2$

$$= \left(\frac{4\pi r^3}{3a^3}\right)^2$$

$$= \left(\frac{4\pi}{3}\left(\frac{6}{4\pi}\right)^{\frac{3}{2}}\right)^2$$

$$= \frac{6}{\pi}$$

39. Ans. B
• a plug guage is used to check cylindrical bore
• a ring guage is used to measure shaft size

40. Ans. A

$$we\ know\ that\ ;\ heat\ generated = I^2Rt$$

$$= 15000^2 \times 0.0001 \times 0.25$$

$$5625\ W - sec$$

41. Ans. C
• To make the steel softer quenching is done
• To remove oil grease etc air blasting is done
• To prevent cold crank preheating is done
• To prevent plate distortion plate adjustment is done.
So option (c)

42. Ans. C
• Velocity of chip along tool is chip velocity
• Velocity at which shearing occur along the crack is called shear velocity
• Velocity along the face of tool is called cutting velocity

43. Ans. A
Z=no. of tooth

$$table\ feed\ per\ min = Z \times feed\ per\ tooth \times rpm$$

$$= 8 \times 0.1 \times 150$$

$$= 120\ mm/min$$

44. Ans. C
As the spring are parallel
so $K_{eq} = k_1 + k_2 = 20 + 20 = 40\frac{KN}{m}$

$$f = \frac{1}{2\pi}\sqrt{\frac{k_{eq}}{m}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{40 \times 1000}{100}}$$

$$= \frac{10}{\pi}$$

45. Ans. C
In ultrasonic machining as the distance between tip of the tool increases the value of force acted upon plate increases and hence the material removal rate increases, but as the distance gap increases further the force decreases and hence the material removal rate start decreasing. So it first increases and then decreases

46. Ans. B
In taylor tool life equation Time is in minute and velocity is in m/min

$$VT^n = Constant$$

$$63(10 \times 60)^n = 257.35$$

$$n = 0.22$$

Now

$$\left(\frac{T_2}{T_1}\right)^n = \frac{V_1}{V_2}$$

$$\left(\frac{T_2}{10}\right)^{0.22} = \frac{V}{2V}$$

T_2=25.79 min

47. Ans. A
• 3-2-1 is a method of fixture/ clamping where 3 pins are attached at one plane to a machine parts and remaining 2 pins and 1 pins are attached at two other perpendicular planes.
• As a result of these attachments the body is rigidly fixed and there is no motion possible in any direction. So the degree of freedom restricted is 6

48. Ans. A

$$\eta = \tan^{-1} u = \tan^{-1} 0.5 = 26.56°$$

We know that $2\beta + \eta - \gamma = 90°$

$$2\beta + 26.56 - 5 = 90°$$

$$\beta = 34.22°$$

Now shear force $F_s = \tau_s \times A_s = \tau_s \times (t_o b)/sin\beta$

$$= 350 \times 0.25 \times 4/sin34.22$$

$$= 622.36\ N$$

$$now\ \frac{F_c}{\cos(\eta - \gamma)} = \frac{F_s}{\cos(\beta + \eta - \gamma)}$$

$$\frac{F_c}{\cos 21.56} = \frac{622.36_s}{\cos 55.78}$$

$$F_c = 1029.23\ N$$

Similarly

$$\frac{F_c}{\cos(\eta-\gamma)} = \frac{F_t}{\sin(\eta-\gamma)}$$

$$\frac{1029.23}{\cos 21.56} = \frac{F_t}{\sin(21.56)}$$

$$F_t = 406\ N$$

49. Ans. D
Probability that no test happen on a day =
$1-\frac{1}{5}=\frac{4}{5}$
Probability that the student did not miss any test $=\frac{4}{5}\times\frac{4}{5}=\frac{16}{25}$
So the probability that student misses atleast one test is $=1-\frac{16}{25}=\frac{9}{25}$

50. Ans. B
For a real gas **cp-cv= ZR**. The answer depends on the value of compressibility factor Z.
And for ideal and perfect gas the value of Z=1
So **cp-cv= R**
Hence only for perfect gas it is posible

51. Ans. C
• Isothermal is a process where temperature is constant
• Isentropic is a process where both heat transfer and entropy change is zero
• Hyperbolic is similar name of isothermal process
So only polytropic process is the right answer

52. Ans. C
• Carnot cycle have the maximum efficiency when reversible engine because no loss is there due to transfer of heat between reservoir. And also any engine working between two fixed reservoir temperature have same efficiency and this is maximum when the engine is reversible.

53. Ans. A
Writing the SFEE for the turbine
$$\dot{m}\left(h_1+\frac{V_1^2}{2}+gz_1\right)+\dot{Q}=\dot{m}\left(h_2+\frac{V_2^2}{2}+gz_2\right)+\dot{W}$$
$$20\left(3200+\frac{160^\wedge 2}{2000}+\frac{9.81x10}{1000}\right)+0=20\left(2600+\frac{100^2}{2000}+9.81\times\frac{6}{1000}\right)+\dot{W}$$
$$\dot{W}=121257\ KW=12.157\ MW$$

54. Ans. C
For a engine which is not a carnot engine
$$\eta_{engine}=1-\frac{Q_{rejected}}{Q_{supplied}}$$
$$=1-\frac{70}{80}$$
$$=0.125$$
$$=12.5\%$$

55. Ans. B
Tl=250k and TH=300 K
For a carnot refrigerator
$$COP_R=\frac{T_L}{T_H-T_L}$$
$$COP_R=\frac{250}{300-250}$$
$$COP_R=5$$

56. Ans. A
N=2000rpm
$\dot{v}=25\ litre=0.025\ m3$
We know that
$B.P=bmep\times swept\ volume\ flow\ rate\ in\ m3\ per\ sec$
$$B.P=bmep\times\dot{v}\times\frac{N}{2\times60}$$
$$=0.6\times1000\times0.025\times\frac{2000}{2\times60}$$
$$=250Kw$$

57. Ans. B
When
$\mu=0\ (\ the\ gas\ is\ ideal\ gas)$
when
$\mu>0\ the\ gas\ cools\ when\ throttled$
$\mu<0\ the\ gas\ gets\ heated\ when\ throttled$

58. Ans. D
According to kinetic theory of gasses the kinetic energy of a gas is given by
$E=\frac{3}{2}KT\ (\ where\ K\ is\ boltzman\ constant)$
$As\ KT\propto P$
$$E=\frac{3}{2}P$$
$$P=\frac{2}{3}E$$

59. Ans. D
• Traceability is the process of copying a defined product from the history of design available.
• Interchangeability is the method of making standard product such such two mating parts brought from different shops can be fit properly
• Here selective assembly should be the answer, as it means dividing the tolerance of work material into several groups such that each group have more precise dimension.

60. Ans. D
• Here The finger stick to the ice tray due to the phenomenon of regelation, As the tray is brought outside of refrigerator so inside temperature has no role here.similarly humidity is the amount of water vapour in air so it also doesn't effect the phenomenon.
• The heat capacity define the amount of heat transfer between two bodies.
• Thermal conductivity is the property by

which conduction heat transfer occur between bodies and the two bodies behave as solid between contact region and stick together. so option d is most appropriate answer

61. Ans. B
When the temperature is below freezing point (sub zero weather), the water present in the cloths first become ice and then these ice sublimates into water vapour through the process of sublimation.
Hence option b is the right answer.

62. Ans. D
$Heat\ loss\ by\ hotter\ body = Heat\ gain\ by\ colder\ body$

$$10\times0.8\times(100-T) = 40\times4(T-20)$$

$$16.8\,T = 400$$

$$T = 23.8\,°C$$

63. Ans. D
Given r=10 mm
For heat transfer to be maximum, the radius of insultion is cricital radius and is given by

$$As\ r_c = \frac{K_{insulation}}{h_{outside}}$$

$$= \frac{0.5}{20}\times1000\ mm$$

$$= 25\ mm$$

$\therefore Thickness\ of\ insulation = r_c - r = 25 - 10 = 15\ mm$

64. Ans. A
specific heat of water can be taken as 4.18 kJ/Kg K
$Heat\ loss\ by\ hotter\ body = Heat\ gain\ by\ colder\ body$

$$1\times0.4\times(60-T) = 1\times4.18(T-20)$$

$$4.58\,T = 107.6$$

$$T = 23.5\,°$$

65. Ans. B
Given r=1/2 =0.5 mm
The critical thickness of insulation is given as

$$r_c = \frac{0.1}{100}\times1000\ mm = 1\ mm$$

$$\therefore Thickness\ of\ insulation = r_c - r$$

$$= 1 - 0.5$$

$$= 0.5\ mm$$

66. Ans. D
● In fuel fired large power boiler, the temperature of the bed is very large due to this the radiation effect is predominant.
● As Stefan boltzman constant is of order 10^-8 so any temperature term(T^4) lesser than 10^8 will have no effect of radiation

67. Ans. B
For constant heat flow through a slab where cross section and thickness are constant

$$Q = \frac{\Delta T(KA)}{L}$$

$$\Delta T \propto \frac{1}{K}$$

$\text{so the ratio of temperature difference is} = \frac{1}{k1}:\frac{1}{k2}:\frac{1}{k3}$

$$= \frac{1}{1}:\frac{1}{2}:\frac{1}{4}$$

68. Ans. A

● As seen from the above figure for basic size of the hole
● The lower deviation is zero. This type of system is known as hole basis system

69. Ans. C
The value of standard tolerance is given by value of i
It must be noted here that the value of i in this formula is in micro meter
And it is given as
i= 0.45$\sqrt[3]{D}$ +0.001 D micro meter

70. Ans. B
● Suppose you draw a circle in a plane paper. If you look at the circle by tilting the paper at some other angle rather than 90 degree you will see an ellipse. So answer would be option b

71. Ans. A
● In hydrostatic friction there is no contact between shaft and journal bearing, so the starting friction is minimum in this case.

72. Ans. A
● ACME thread is a type of trapezoidal thread with thread angle 29 degree, while trapezoidal thread has thread angle 30 degree.
● Buttress thread has thread angle 45 degree and is used in heavy load condition in one direction motion only

73. Ans. B

$$\frac{d}{p} = 0.25$$

For a rivet under tangential load the efficiency is given as

$$\eta = 1 - \frac{d}{p}$$
$$= 1 - 0.25$$
$$= 0.75$$
$$= 75\%$$

74. Ans. C

$$As\text{ , }life\ of\ ball\ bearing = \left(\frac{C}{P}\right)^3$$
$$\frac{L_2}{L_1} = \left(\frac{P_1}{P_2}\right)^3$$
$$\frac{L_2}{8000} = \left(\frac{10}{20}\right)^3$$
$$L_2 = 1000\ hrs$$

75. Ans. C
- Answer here is assembly drawing, in this type of drawing, parts are drawn after assembly and shown in three orthogonal planes to show relationship among different parts
- Layout drawing is the first overall drawing of a plan from which assembly and part drawings and fabrication drawing are prepared.

76. Ans. C
Only in the case of friction drawing no heat is supplied from external source and no melting of workpiece occurs in bulk, in rest of the options work material is melted by application of heat.

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