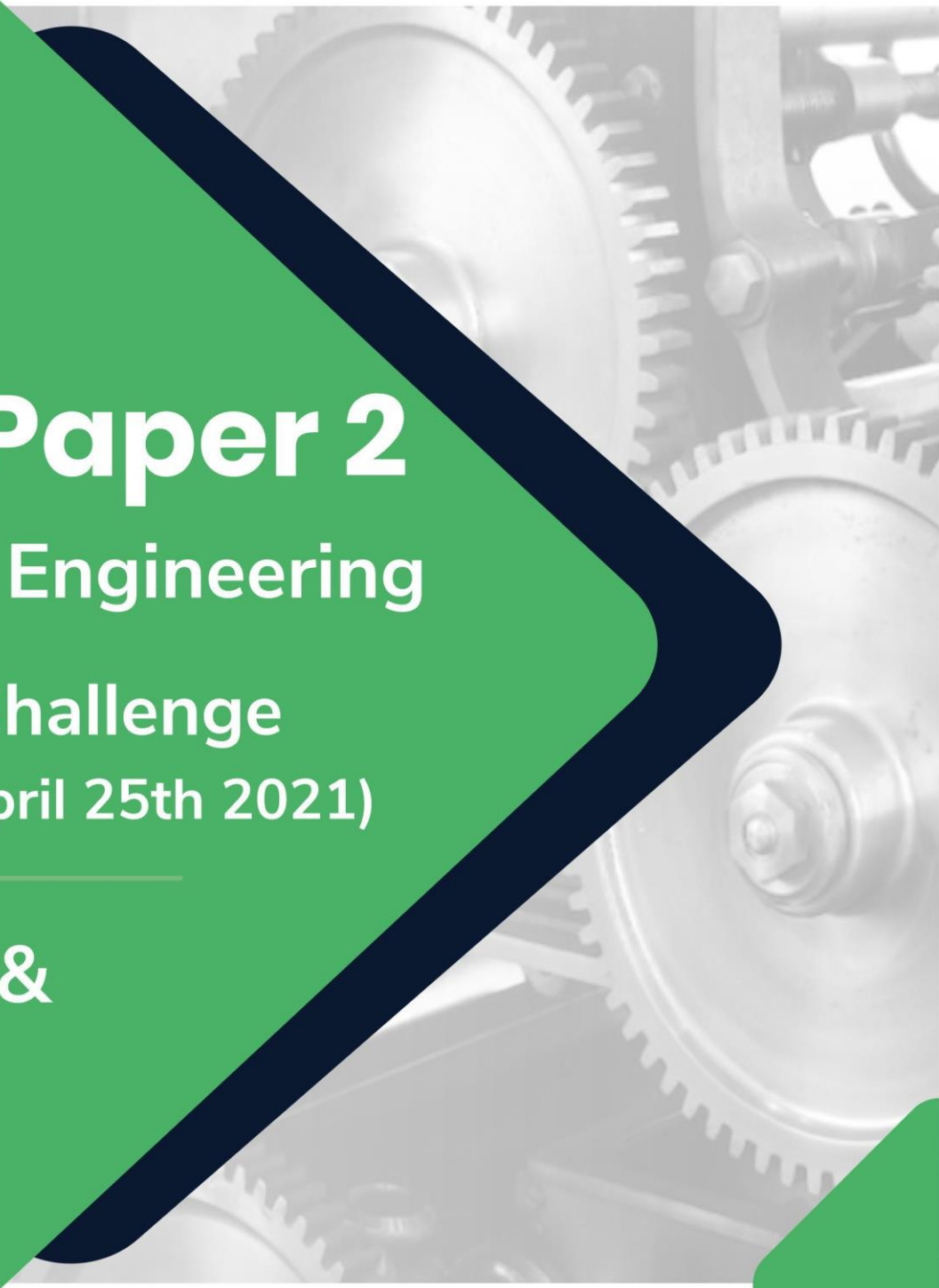
MEGA MOCK CHALLENGE

gradeup



ESE EE Paper 2

Mechanical Engineering

Mini Mock Challenge

(April 24th - April 25th 2021)

Questions & Solutions

1. Match List-I with List-II and select the correct answer using the codes given below the lists :

List-I

A- Pelton turbine

B. Francis turbine

C- Propeller turbine

D- Kaplan turbine

List-II

1- Specific speed from 300 to 1000 + axial flow with fixed runner vanes.

2- Specific speed from 10 to 50 + tangential flow

3- Specific speed from 60 to 300 + mixed flow

4- Specific speed from 300 to 1000 + axial flow with adjustable runner vanes.

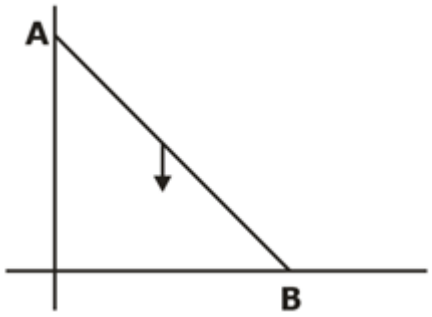
A. A-2, B-1, C-3, D-4 B. A-4, B-1, C-3, D-2

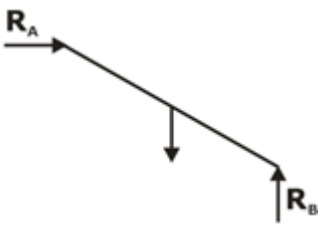
C. A-2, B-3, C-1, D-4 D. A-4, B-3, C-1, D-2

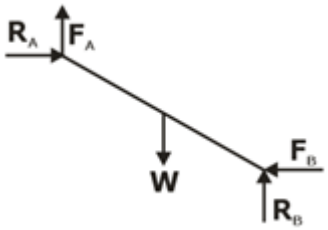
Ans. C

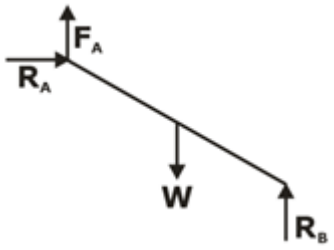
Sol. Pelton turbine- - Specific speed from 10 to 50 + tangential flow
Francis turbine – Specific speed from 60 to 300 + mixed flow
Propeller turbine – Specific speed from 300 to 1000 + axial flow with fixed runner vanes.
Kaplan turbine - Specific speed from 300 to 1000 + axial flow with adjustable runner vanes.

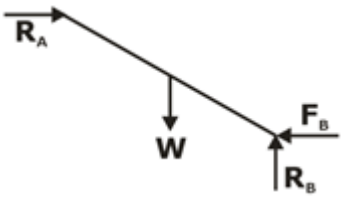
2. The correct free body diagram for the ladder shown in the figure is (both wall and floor rough)?



A. 

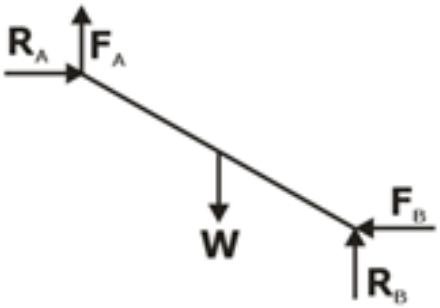
B. 

C. 

D. 

Ans. B

Sol.



Due to the weight of the ladder, a downward vertical force acts from the centre of gravity of the ladder (depicted by W).

Due to the contact from the wall of the ladder, Reaction forces R_A and R_B act normal to the surface. Since, the surfaces of contact are rough, a friction force acts in a direction so as to oppose the slipping of the ladder (depicted by F_A and F_B).

3. A shaft with circular cross-sectional area is subjected to bending moment of 400 kNm and turning moment of 300kNM. On the basis of "Maximum principle stress theory" the direct stress is σ and according to "Maximum shear stress theory" the shear stress is τ , then find the ratio of τ/σ

A. 5/9 B. 9/5

C. 18/5 D. 5/18

Ans. A

Sol.

M = 400kNm T = 300kNm

Let, d=diameter of shaft

Equivalent Bending moment $M_e = \frac{1}{2}\left(M + \sqrt{M^2 + T^2}\right)$

Equivalent Turning moment $T_e = \sqrt{M^2 + T^2}$

According to Maximum principle stress theory; $M_e = \frac{1}{2}\left(M + \sqrt{M^2 + T^2}\right) = \frac{\pi}{32} d^{3\sigma}$

According to Maximum shear stress theory;

$$T_e = \sqrt{M^2 + T^2} = \frac{\pi}{16} d^3 \tau$$

Dividing both the equations;

$$\frac{\frac{1}{2}\left(M + \sqrt{M^2 + T^2}\right)}{\sqrt{M^2 + T^2}} = \frac{\sigma}{\tau \times 2}$$

Putting values of M and T

$$\frac{450}{500} = \frac{\sigma}{\tau \times 2}$$

$$\therefore \frac{\tau}{\sigma} = \frac{5}{9}$$

4. Calculate the range of wavelength for which earth surface is emitting maximum spectral emissive power if the earth temperature ranges from 250° K to 300°K.

A. $\lambda_M \in$ (0.58,0.66)μm B. $\lambda_M \in$ (5.56,9.63)μm

C. $\lambda_M \in$ (11.88,2.45)μm D. $\lambda_M \in$ (11.59,9.66)μm

Ans. D

Sol. According to Wein's displacement law:

$\lambda_{max}.T$ = 2898 μm

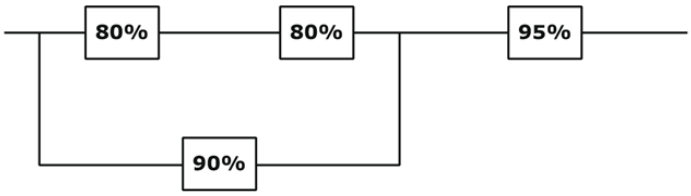
$\lambda_{m1}.250$ = 2898 μm $\Rightarrow \therefore \lambda_{m1}$ = 11.592 μm

$\lambda_{m2}.300$ = 2898 μm $\Rightarrow \therefore \lambda_{m1}$ = 9.66 μm

So the range of wavelength in which the earth will emit maximum spectral emissive power is

$\lambda_M \in$ (11.59,9.66)μm

5. The reliability of given system is:



A. 0.946 B. 0.9158

C. 0.5472 D. 0.3554

Ans. B

Sol.

Reliability in series = 0.8 × 0.8 = 0.64

Reliability in parallel = 1 – (1 R_1)(1 – R_2)

Reliability in parallel = 1 – (1 – R_1)(1 – R_2)

= 1 – (1 – 0.64) (1 – 0.9)

= 1 – 0.36 × 0.1

= 0.964

Total reliability = 0.964 × 0.95

6. The correct statement about motion programming method is_____.

A. This method is typically used with cartesian coordinate robot

B. Robotic type with rotational joint rely on interpolation process

C. This method overcomes the difficulties of lead through programming

D. All of the above

Ans. D

Sol.

- The motion programming method is typically used with cartesian coordinate robot. But robotic type with rotational joint rely on interpolation process.
- This method overcomes the difficulties of lead through programming.

7. The local heat transfer coefficient (in W/m^2K) at a point is given as h_x = 15.6x. The average heat transfer coefficient for a length of 8 m is :

A. 62.4 B. 78

C. 19.5 D. 10

Ans. A

Sol. The average heat transfer coefficient is given by :

$$h_{arg} = \frac{1}{L}\int_0^L hx\,dx$$

$$= \frac{1}{8}\int_0^8 15.6x dx$$

$$= \frac{15.6}{8} \times \frac{64}{2}$$

$h_{avg} = 62.4\ W/m^2K$

8. Find mean radius (in m) of flywheel which rotates at 10 rad/sec and has density and maximum stress of 1800 kg/m^3 and 100 MPa.

A. 11.78 B. 23.57

C. 47.14 D. 51.11

Ans. B

Sol. Given:

Angular velocity: ω = 10 rad/sec

Density: ρ = 1800 kg/m^3

$\sigma = \rho v^2 = \rho(r\omega)^2$

$$\therefore r^2 = \frac{\sigma}{\rho\omega^2} = \frac{100 \times 10^6}{1800 \times 10^2} = 555.55$$

$\boxed{r = 23.57\ m}$

9. Air flows over a flat plate (1 m long) at a velocity of 6 m/s Boundary layer thickness at middle of plate is_____ mm. Take Kinematic Viscosity of air as 0.15 stokes.

A. 5.6 B. 6.7

C. 3.4 D. 9.2

Ans. A

Sol.

Given,

Velocity of flow (V) = 6 m/s

Length of plate (L) = 1 m

kinematic viscosity (v) = 0.15 stokes

Reynolds Number is given by:

$$Re_{x=0.5} = \frac{6 \times 0.5}{0.15 \times 10^{-4}} = 2 \times 10^5$$

Which is less than 5×10^5, hence flow is laminar.

$$\delta = \frac{5x}{\sqrt{Re_x}} = \frac{5 \times 0.5}{\sqrt{2 \times 10^5}}$$

δ = 5.59 mm

10. Out of the following, which of all are/is the characteristics of renewable energy:

(1) continuous energy

(2) replenish-able energy

(3) clean energy

(4) brown energy

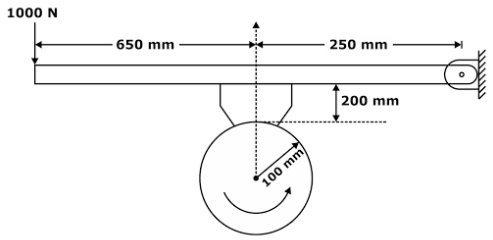
A. 2 & 3 B. 2, 3 & 4

C. 1, 3 & 4 D. 1, 2, 3 & 4

Ans. A

Sol. "Brown Energy" is a form of traditional fossil energy, example from coal/oil, which in-turn has a negative impact on environment. Hence, not a characteristic of renewable energy.

11. A brake drum (as shown in figure) is rotating in anticlockwise direction. Coefficient of friction between drum and shoe is 0.25 The braking torque for the shoe will be_____.

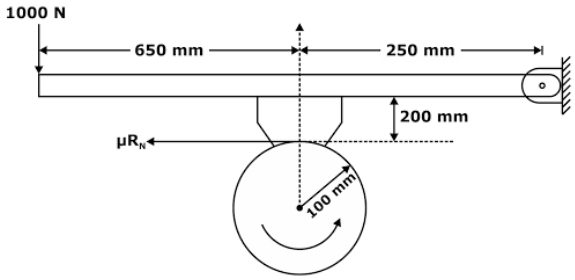


A. 50 N-m B. 75 N-m

C. 100 N-m D. 150 N-m

Ans. B

Sol.



Taking moment about hinge,

$\sum M_O = 0$

$1000 \times 900 = R_N \times 250 + F_f \times 200 \quad \{ F_f = \mu R_N = 0.25 R_N \}$

$1000 \times 900 = 300 R_N$

$R_N = 3000$ N

$T_R = F_f \times$ radius of brake drum

$T_R = \mu R_N \times R$

$T_R = 3000 \times 0.25 \times 100$

$= 75000$ N-mm

$= 75$ N-m

12. When the Degree of reaction is 50% is case of turbines, then the pressure drop is shared equally by the stator and the rotor. Then if the turbine has less than 50% reaction, the pressure drop_____ .

A. in the rotor is less than the pressure drop in the stator

B. in the rotor is more than the pressure drop in the stator

C. in the rotor is same as the pressure drop in the stator

D. across the rotor is zero.

Ans. A

Sol. Stages having 50% degree of reaction are used where the pressure drop is equally shared by the stator and the rotor for a turbine. Stage having reaction less than half that pressure drop in the rotor is less than the pressure drop in the stator. An impulse turbine has degree of reaction zero and we know that there is no pressure drop in the rotor.

13. A Thermal heat storage device contains R-11a which has a specific heat given by c_p = (0.05T + 0.2)KJ/kg-K. The rise in temperature in the liquid is from 20°C to 50°C. Determine the amount of thermal energy stored for the unit mass system.

A. 468 kJ B. 325 kJ

C. 257 kJ D. 98 kJ

Ans. A

Sol.

For Sensible Storage Device:

$$E_{storage} = m\int c_p dT$$

Here,

T_1 = 20°C = 293 K

T_2 = 50°C = 323 K

$$E_{storage} = m\int c_p dT$$

$$\therefore E_{storage} = 1.\int_{T_1}^{T_2} (0.05T + 0.2)dT$$

$$\therefore E_{storage} = \left[0.05\frac{T^2}{2} + 0.2T\right]_{293}^{323}$$

$\therefore E_{storage}$ = 468 kJ

14. The part of the automobile that allows the outer wheel to travel faster than the inner wheel during turns is

A. Universal Joint B. Differential

C. Tie Rod D. Control Arm

Ans. B

Sol. In automobiles and other wheeled vehicles, the differential allows the outer drive wheel to rotate faster than the inner drive wheel during a turn. This is necessary when the vehicle turns, making the wheel that is traveling around the outside of the turning curve roll farther and faster than the other.

15. Match the following:

List - I

P) Point of contraflexure

Q) Intensity of loading

List - II

i. Bending moment changes sign

ii. Shear force changes sign

iii. Rate of change of bending moment

iv. Change of shear force per unit length

A. P-i, Q-iv B. P-ii, Q-iv

C. P-i, Q-iii D. P-ii, Q-iii

Ans. A

Sol. In a bending moment diagram, point of contra flexure is the point at which the bending moment curve intersects with the zero line. In other words, the bending moment changes its sign from negative to positive or vice versa. Also, change of shear force per unit length is equal to Intensity of loading . Therefore, Option A is correct.

16. When the workpiece has fine grain structure, tool life will_____ (when compared to workpiece having comparatively larger grains).

A. increase B. remain the same

C. decrease D. none of these

Ans. C

Sol.

- When workpiece has fine grain structure ,it will be hard and strong and a larger cutting force will be needed by the cutting tool. Hence , tool life decreases. Whereas for a workpiece with larger grains, comparatively smaller cutting force will be needed as the workpiece will be a little softer.

17. A body "P" emits 4400 W/m^2 & body Q emits 1100 W/m^2 then what will be ratio of temperature of body Q to body P. (Assume both bodies as block body) _____.

A. 1.414 B. 4

C. 2 D. 0.707

Ans. D

Sol.

Given

$E_P = 4400\ W/m^2$

$E_Q = 1100\ W/m^2$

$E = \in A\sigma T^4$

For black body: $\in = 1$

$E \propto T^4$

$$\frac{E_P}{E_Q} = \left(\frac{T_P}{T_Q}\right)^4 \Rightarrow \frac{4400}{1100} = \left(\frac{T_P}{T_Q}\right)^4$$

$$\frac{T_P}{T_Q} = (4)^{\frac{1}{4}} = \sqrt{2}$$

$$\frac{T_Q}{T_P} = 0.707$$

18. In resistance welding, heat is generated due to the resistance between _____.

A. Electrode and welding flux
B. Asperities between touching part
C. Interatomic force
D. None of these

Ans. B

Sol.

- Resistance Welding is a thermo-electric process where heat is generated at the interface of the parts (especially at the asperities due to not being complete smooth) to be joined by passing an electrical current.
- It is precisely controlled in terms of time and pressure.

19. A pelton wheel is rotating at a speed of 200 rpm and developed 5200 kW when working under a head of 250m with an overall efficiency of 82%. The discharge when the turbine is working under a head of 150 m will be _____ m^3/s.

A. 2
B. 5
C. 7
D. 8

Ans. A

Sol. Given,

Speed of turbine (N) =200 rpm

Power developed (P) = 5200 kW

overall efficiency of 82% (η_o) = 82%

Head (H_1) = 250 m

Head (H_2) = 150 m

$$\eta_o = \frac{P}{\rho g H_1 Q_1}$$

$$0.82 = \frac{5200 \times 1000}{1000 \times 9.81 \times Q_1 \times 250}$$

$$Q_1 = 2.586$$

Now, we know that unit speed is given by:

$$\frac{Q_1}{\sqrt{H_1}} = \frac{Q_2}{\sqrt{H_2}}$$

$$\frac{2.586}{\sqrt{250}} = \frac{Q_2}{\sqrt{150}}$$

$$Q_2 = 2.0028$$

20. Consider the following statements regarding the Linear variable differential transformer (LVDT):

1) It is used to measure both the displacement and deflection of an object.

2) One of the disadvantages is that it has very high cost.

3) Its performance is independent of the vibration thus it is very accurate in measurement.

Which of the following statements is/are correct?

A. 1 only B. 1 and 2 only

C. 1 and 3 only D. 1, 2 and 3

Ans. A

Sol.

- LVDT can be used to measure the displacement, deflection, position and profile of a work piece.
- It has relatively low cost.
- The performance is likely affected by vibration etc.

21. Which of the following is a water tube boiler _____.

A. Lancashire boiler B. Cornish boiler

C. Babcock and Wilcox boiler D. Marine boiler

Ans. C

Sol.

- Babcock and Wilcox boiler is a horizontal straight water tube boiler.
- Fire tube boilers: Lancashire boiler, Cornish boiler, Marine boiler, Cochran boiler, etc.
- Cornish and Lancashire boilers are horizontal fire tube boilers.

22. The correct description of end effector – Interchangeable fingers is

A. It is a mechanical gripper with two gripping devices in one end effector

B. Mechanical gripper with an arrangement to have modular finger's to accommodate different size work part

C. Mechanical gripper as per the general anatomy of human hand.

D. Mechanical gripper with sensory feedback capabilities in fingers to Aid locating work part.

Ans. B

Sol.

- The description of end effector – Interchangeable fingers is Mechanical gripper with an arrangement to have modular finger's to accommodate different size work part .

23. A fluid flows through a horizontal pipe of 3 cm diameter. When the Reynold's number is 1500 and fluid velocity is 2m/s, the head loss over a length of 10m is

(Take g = 10m/s^2)

A. 2 .922m B. 0 .71m

C. 28m D. 10m

Ans. A

Sol.

$$\text{Head loss} = \frac{flv^2}{2gd}$$

f = Darcy's friction factor = 64/Re,

Re = 1500 (Flow is Laminar in nature)

$$f = \frac{64}{Re} = \frac{64}{1500} = 0.043$$

L = 10m

V = 2m/s

d = 3cm = 0.03m

Substituting the values,

$$\frac{0.043 \times 10 \times 2^2}{2 \times 9.81 \times 0.03} = 2.922$$

Head loss = 2.922 m

24. What is the atomic packing factor of BCC structure?

A. 0.64 B. 0.68

C. 0.74 D. 0.52

Ans. B

Sol.

Unit cell	Effective number of atoms	Atomic packing fraction	Coordination number
Simple Cubic (SC)	1	0.52	6
Body centred Cubic (BCC)	2	0.68	8
Face centred cubic (FCC)	4	0.74	12
Hexagonal Close packed (HCP)	6	0.74	12

25. For a belt drive application, the difference between tensions on the slack & tight sides is 3000N. Determine the transmitted power in kW, if the belt speed is 15 m/s:

A. 45 B. 22.5

C. 90 D. 100

Ans. A

Sol.

Given, $T_1 - T_2 = 3000N$

where, T_1, T_2 are tension on tight & slack sides respectively.

v is belt speed = 15 m/sec

$\therefore$ Power = $(T_1 - T_2)v$

$\therefore$ Power = $3000 \times 15 = 45000$ watt = 45 kW

26. The demand and forecast in a Manufacturing plant for November are 17000 and 15500 orders respectively. By using simple exponential smoothing method, forecast for the month of December will be? Use smoothing coefficient= 0.26

A. 16890 B. 1589

C. 15890 D. 15690

Ans. C

Sol. Forecasting using exponential smoothing method is given by:

$F_{Dec} = F_{Nov} + \alpha(D_{Nov} - F_{Nov})$

$F_{Dec} = 15500 + 0.26 \times (17000 - 15500)$

$F_{Dec} = 15890$

27. Brinell hardness test is widely used for testing the hardness of engineering material however it make certain identaion which damage the material but still it used widely . Brinell Hardness number for load P, diamond ball diameter D mm and indentation diameter d mm is given as

A. $\dfrac{P}{\frac{\pi D}{2}\left(D-\sqrt{D^2-d^2}\right)}$ B. $\dfrac{2P}{\pi D\left(D+\sqrt{D^2-d^2}\right)}$

C. $\dfrac{2P}{D\left(D-\sqrt{D^2-d^2}\right)}$ D. $\dfrac{2P}{D\left(D+\sqrt{D^2-d^2}\right)}$

Ans. A

Sol. The Brinell hardness number is defined as

$$\frac{P}{\frac{\pi D}{2}\left(D-\sqrt{D^2-d^2}\right)}$$

Where P= load in kg

D= ball diameter in mm

d= indentation diameter in mm

28. A horizontal oil tank is in the shape of cylinder with hemispherical end and is exactly half full. What is the ratio of magnitude of vertical component of resultant hydrostatic thrust on one hemispherical end to that of horizontal component on the same end _____?

A. π B. π/2

C. 3/π D. π/3

Ans. B

Sol.

Horizontal component of pressure force is given by:

$$F_H = \rho g A_p \bar{x}$$

Where A_p = projected area of curved surface on vertical plane

$$F_H = \rho g \times \left(\frac{\pi r^2}{2}\right) \times \frac{4r}{3\pi} = \frac{2}{3}\rho g r^3$$

Now, vertical component is given by:

$$F_v = \rho g \times \text{Volume}$$

$$F_v = \rho g \times \frac{1}{4} \times \frac{4}{3}\pi r^3 = \frac{\rho g \pi r^3}{3}$$

Thus: $\frac{F_v}{F_H} = \frac{\rho g \pi r^3 \times 3}{3 \times 2\rho g r^3} = \frac{\pi}{2}$

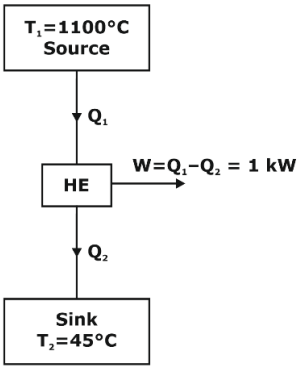
29. What will be the least rate of heat rejection per kW net output of a cyclic heat engine operating between a source temperature of 1100 °C and a sink temperature of 45 °C_____?

A. 0.326 kW B. 0.556 kW

C. 0.301 kW D. 0.406 kW

Ans. C

Sol.



Temperature of source: $T_1 = 1100 + 273 = 1373$ K

Temperature of sink: $T_2 = 45 + 273 = 318$ K

For Least rate of heat rejection per kW net output, engine must be reversible engine. Thus:

$$\eta_{max} = \eta_{rev} = 1 - \frac{T_2}{T_1} = 1 - \frac{318}{1373} = 0.768$$

Now,

$$\eta_{max} = \frac{W_{net}}{Q_1} = 0.768$$

Given, $W_{net} = 1$ kW

$$Q_1 = \frac{1}{0.768} = 1.301\,kW$$

Now, heat rejected: $Q_2 = Q_1 - W_{net} = 1.301 - 1 = 0.301$ kW

Hence, the least rate of heat rejection = 0.301 kW.

30. A submarine is rolling under seawater whose radius of gyration is 12 m and period of oscillation of rolling of ship is 22 seconds then nearest metacentric height in metres is _____

A. 1.7 B. 1.2

C. 2 D. 2.3

Ans. B

Sol. Given,

Time period of ship (T)= 22 sec

Radius of gyration (k) = 12 m

$$T = 2\pi\sqrt{\frac{k^2}{g \times GM}}$$

$$22 = 2\pi\sqrt{\frac{12^2}{9.81 \times GM}}$$

GM = 1.197 m

≈ 1.2 m

31. Match the equivalent length of the column for their respective end conditions:

Column 1

A) Both end hinged

B) One end fixed and other free

C) Both ends fixed

D) One end fixed and other hinged

Column 2

P) 2L

Q) $\frac{L}{\sqrt{2}}$

R) $\frac{L}{2}$

S) L

A. A-S, B-R, C-P, D-Q

B. A-R, B-S, C-Q, D-P

C. A-R, B-Q, C-S, D-P

D. A-S, B-P, C-R, D-Q

Ans. D

Sol. The equivalent length of the column for the respective end conditions are

Both ends hinged → L

One end fixed and other free → 2L

Both ends fixed → $\frac{L}{2}$

One end fixed and other hinged → $\frac{L}{\sqrt{2}}$

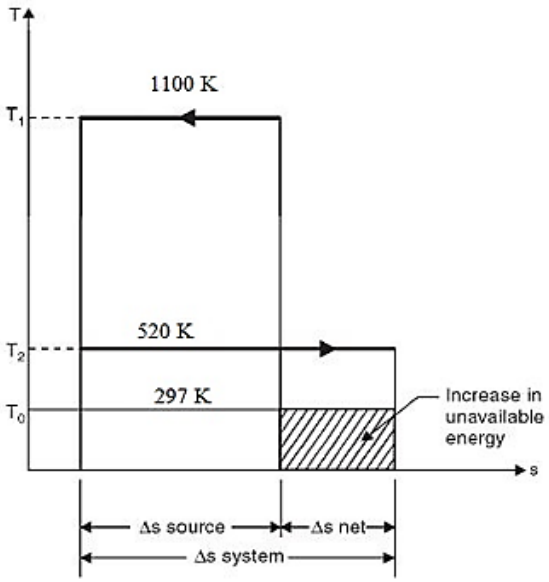
32. Estimate the entropy(kJ/min-K) produced during heat transfer for a system at 520 K receives 7500 kJ/min from a source at 1100 K. The temperature of atmosphere is 297 K. Assuming that the temperatures of system and source remain constant during heat transfer

A. 9.60 B. 8.60

C. 7.90 D. 7.60

Ans. D

Sol.



Temperature of source, T_1 = 1100 K

Temperature of system, T_2 = 520 K

Temperature of atmosphere, T_0 = 297 K

Heat received by the system, Q = 7500 kJ/min.

Net change of entropy:

Change in entropy of the source during heat transfer

$= \frac{-Q}{T_1} = \frac{-7500}{1100}$ = - 6.82 kJ/min-K

Change in entropy of the system during heat transfer

$\frac{Q}{T_2} = \frac{7500}{520} = 14.42$ kJ/min-K

The net change of entropy, ΔS = – 6.82 + 14.42

= 7.60 kJ/min-K. (Ans.)

33. Which language is used commonly for programming the PLC _____?

A. Ladder diagram
B. English
C. Assembly level
D. Machine

Ans. A

Sol.

• The programming language allows the user to communicate with PLC via programming device. The ladder diagram (LAD) is most common programmable controller language.

• LAD consists of a set of set of instruction that will perform the most basic type of control functions relay-type logic, timing and counting and basic math operations.

34. Consider following statement:

A) At Economic order quantity (EOQ) ordering cost is equal to Holding cost.

B) At EOQ Holding cost is minimum.

C) At EOQ ordering cost is minimum.

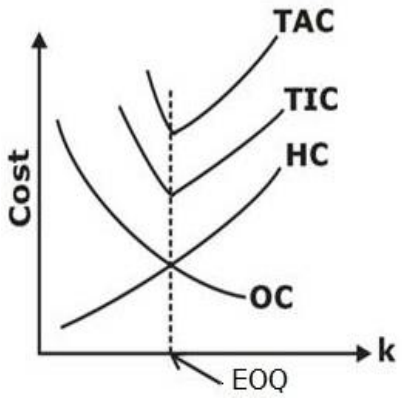
D) At EOQ total annual cost in equal to total inventory cost.

Which of the above statement are correct.

A. 1, 2 and 3 only
B. 1, 2 and 4 only
C. 1 and 4 only
D. 2 and 3 only

Ans. C

Sol.



TAC – Total annual cost

TIC – Total inventory cost

HC – Holding cost

OC – Ordering cost

35. The pressure inside the soap bubble of 50 mm diameter is 2.5 N/m^2 above the atmosphere. Estimate the surface tension of the soap film _____.

A. 0.0456N/m
B. 0.080 N/m
C. 0.01562 N/m
D. 0.189 N/m

Ans. C

Sol. For a soap bubble, the pressure in excess of outside pressure is given by:

$$P_i - P_o = \frac{8\sigma}{d}$$

Given: $P_i - P_o = 2.5$ N/m^2

d = 50 mm = 0.05 m

$$2.5 = \frac{8\sigma}{50\times10^{-3}}$$

$$\sigma = \frac{2.5\times50\times10^{-3}}{8} = 0.01562\ \text{N/m}$$

36. Consider the following statements regarding CISC:

1) It stands for Complex Instruction Set Computer.

2) It does not support array.

3) The stack is being used for procedure arguments and return addresses with CISC.

Which of the following statements is/are correct _____?

A. 1 and 2 Only
B. 1 and 3 Only
C. 1 Only
D. 1, 2 and 3

Ans. B

Sol.

* CISC stands for Complex Instruction Set Computer.

* CISC support array while RISC does not support array.

* The Stack is being used for procedure arguments and return addresses with CISC while Registers are being used for procedure arguments and return addresses with RISC.

37. In a single server queuing system with arrival rate of 'λ' and mean service time of 'μ' the expected waiting time per customer in the system is $\frac{1}{(\mu-\lambda)}$.

What is the expected number of customers in system?

A. $\frac{\lambda^2}{(\mu-\lambda)}$

B. μ-λ

C. $\frac{\lambda}{(\mu-\lambda)}$

D. $\left(\frac{\mu-\lambda}{\lambda}\right)$

Ans. C

Sol. Expected number of customer in the system = $L_s = W_s \times \lambda$

$$= \left(\frac{1}{\mu-\lambda}\right)\lambda = \left(\frac{\lambda}{\mu-\lambda}\right)$$

38. For an engine operating on diesel cycle, if frictional power loss is 20% of the indicated power. Find mechanical efficiency (%) _____.

A. 60

B. 50

C. 80

D. 65

Ans. C

Sol. Given,

FP=0.2×IP

and we know that FP + BP = IP

Therefore BP = IP - FP = IP - 0.2×IP = 0.8IP

$$\eta_{mech} = \frac{BP}{IP} = \frac{0.8IP}{IP} = 80\%$$

(where BP is brake power, IP is indicated power and FP is friction power)

39. Enthalpy is calculated as the

A. sum of internal energy and the product of pressure and volume of the system

B. sum of internal energy and the product of pressure and density of the system

C. difference between the internal energy and the product of pressure and

density of the system

D. difference between the internal energy and the product of pressure and volume of the system

Ans. A

Sol. Hess's Law states that the heat transferred, or change in enthalpy (H), in a reaction is the same regardless whether the reaction occurs in a single step or in several steps. The method of calculating the enthalpy of reaction developed by Hess is called Hess's Law of Heat Summation.

Enthalpy (H) - The sum of the internal energy of the system plus the product of the pressure of the gas in the system and its volume: $H_{sys} = E_{sys} + PV$

After a series of rearrangements, and if pressure if kept constant, we can arrive at the following equation:

$$\Delta H = q\ (at\ constant\ pressure)$$

Where ΔH is the H_{final} minus $H_{initial}$ and q is the heat.

40. A single-stage impulse turbine with a diameter of 220 cm runs at 6000 rpm. If the blade speed ratio is 0.42 then, the inlet velocity of steam will be

A. 79 m/s

B. 188m/s

C. 1645.59 m/s

D. 900 m/s

Ans. C

Sol. Given,

diameter (D) = 220 cm =2.2 m

speed of turbine (N) = 6000 rpm

blade speed ratio(k) = 0.42

Blade speed ratio = (blade velocity /velocity of steam at entry)

$$\text{Blade velocity } (V_b) = \frac{\pi DN}{60} = \frac{\pi \times 6000 \times 2.2}{60} = 691.15\ m/s$$

$$\text{Inlet velocity of steam} = \frac{V_b}{k} = \frac{691.15}{0.42} = 1645.596\ m/s$$

41. Stretch forming is a process in which _____.

A. All deformations occur in the direction of stretch

B. All forces are applied in the direction of stretch

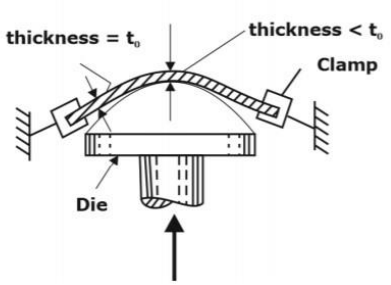
C. Advantage is taken of plastic state indicated due to stretch

D. no dies are used

Ans. A

Sol.

- Stretch forming is a metal forming process in which a piece of sheet metal is stretched and bent simultaneously over a die in order to form large contoured parts.



- As the form die is driven into the sheet, which is gripped tightly at its edges, the tensile forces increase and the sheet plastically deforms into a new shape. The method can only create surfaces with radii in one direction.

42. Consider the following statements about SCARA Robot:

1. DOF is Six.

2. DOF is Four.

3. These good for vertical assembly operations, such as inserting pins in holes without binding.

Which of the following statements is/are correct _____?

A. 1 only

B. 2 only

C. 1 and 3 only

D. 2 and 3 only

Ans. D

Sol. • SCARA robot has 4 degree of freedom. Its full for is "Selective compliance Assembly Robot Arm". Its similar in construction to the jointed arm robot except the shoulder and elbow axes are vertical.

• SCARAs and six-axis robots typically mount on a pedestal and move in the X, Y, and Z planes like Cartesians, but incorporate a θ-axis at the end of the Z plane to rotate the end-of-arm tooling. Thus, SCARAs good for vertical assembly operations, such as inserting pins in holes without binding.

43. Efficiency of superheat Rankine cycle is more as compared to normal Rankine cycle as:

A. enthalpy of main steam is more in case of superheat cycle

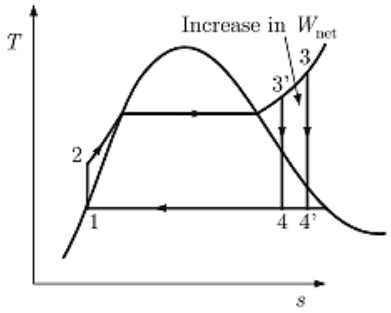
B. mean temperature of heat addition is more for superheat cycle

C. temperature of steam is more in condenser

D. quality of steam is less in condenser

Ans. B

Sol.



In the Rankine cycle, average temperature with which heat gets transferred to steam will increase without increasing boiler pressure on superheating steam at high temperatures. Effect of superheating on working of vapour power cycle on T-S diagram shows total area under process cycle . As network and heat input increase, superheating of steam at higher temperature will cause a in rise in thermal efficiency as it increases mean temperature of heat addition temperature.

44. Solidity is defined as _____.

A. $\frac{\text{Blede area}}{\text{Swept area}}$

B. $\frac{\text{Average power output}}{\text{Rated power output}}$

C. Blade area × circumference of rotor

D. Average power outputs blade area

Ans. D

Sol.

Solidity is defined as the ratio of blade area to swept area:

$$\sigma = \frac{\text{Ratio of blade area}}{\text{Circumference of rotor}}$$

Solidity: $\sigma = \frac{Nb}{2\pi R}$

Where:

N = Number of blades

b = width of blade

R = Blade radius

45. A truss is said to be perfect when it satisfies the following conditions: (Where m is number of members and j is number of joints)

A. m = 2j + 3 B. m = 3j - 2

C. m = 2j - 3 D. m = 3j + 2

Ans. C

Sol.

For stability of truss

m = 2j - 3

Where m is number of members and j is number of joints, 3 means number of support reactions.

46. The bob of a simple pendulum of length 1m has mass 100g and a speed of 1.4m/s at the lowest point in its path. Find the tension in the string at this instant. Take g=10 m/s^2

A. zero B. 0.196 N

C. 1 N D. 1.196 N

Ans. D

Sol.

Given,

length of pendulum (r) = 1m

mass of bob (m) = 100 g = 0.1 kg

velocity at lowest point (v) = 1.4 m/s

$$\text{tension} = mg + \frac{mv^2}{r} = 0.1\times10 + \frac{0.1\times1.4^2}{1} = 1.196$$

Tension = 1.196 N

47. If volume of moist air with 40% relative humidity is isothermally reduced to half of its original volume than relative humidity will be

A. 0.50 B. 0.65

C. 0.25 D. 0.80

Ans. D

Sol. Given,

Relative humidity = 0.4

$$\phi = \frac{P_V}{P_{VS}}$$

$$0.4 = \frac{P_V}{P_{VS}}$$

On isothermally compressing to half of the inital volume, we have:

$$v_2 = \frac{v_1}{2}$$

$$P_{v2} = 2\times P_{v1}$$

$$\phi = 2\times\frac{P_V}{P_{VS}} = 2\times0.4 = 0.8 = 80\%$$

48. Heat flow through an evaporator is analyzed. The walls are assumed to be plane, and following are the parameters found : Rate of heat transfer = 64 kW, heat transfer coefficient for hot and cold fluids are 115 W/m^{2}K and 95 W/m^{2}K respectively, thermal conductivity of wall is 200 W/mK. If the thickness of the wall is 10mm. What will be the Overall heat transfer coefficient ?

A. 51.88 W/m^{2}K B. 60.7151 W/m^{2}K

C. 200.4512 W/m^{2}K D. 367.149 W/m^{2}K

Ans. A

Sol.

Given :

Q = 64 kW

h_i = 115 W/m^{2}K

h_o = 95 W/m^{2}K

k = 200 W/mK

δ = 10 mm

For a plane wall,

Overall heat transfer coefficient,

$$\frac{1}{U} = \frac{1}{h_i} + \frac{1}{h_o} + \frac{\delta}{k}$$

$$\frac{1}{U} = \frac{1}{115} + \frac{1}{95} + \frac{0.01}{200}$$

U = 51.88 W/m^{2}K

49. Consider the following statements regarding the actuators:

1) Hydraulic actuators produces much larger forces than the pneumatic actuators.

2) Pneumatic actuators are capable of working at greater speeds than hydraulic actuators.

3) One of the applications of the hydraulic actuator is the aircraft landing gear.

Which of the following statements is/are correct _____?

A. 1 and 2 only
B. 1 and 3 only
C. 1 only
D. 1, 2 and 3

Ans. D

Sol.

• Hydraulic actuators use incompressible fluid thus they are capable to produce much larger forces than the pneumatic actuators.

• Pneumatic actuators are capable of working at greater speeds than hydraulic actuators.

• Application of hydraulic actuators:

Automobile power steering, brakes, aircraft landing gear, lift trucks, front end loaders.

50. An elevator weighing 500 kg is to be lifted up at a constant velocity of 0.20 m/s. What would be the minimum horsepower of the motor to be used?

A. 9.8 hp
B. 98 hp
C. 980 hp
D. 1.313 hp

Ans. D

Sol. as elevator is going up with a uniform velocity, the work done by the motor is equal to the work done against force of gravity

$P = Fv = mgv = 500 \times 9.81 \times 0.2 = 980$ W

P in horse power = 980/746 = 1.313 hp

51. In a NC machine to drive the work table by a distance of 300 mm, the total angular movement (in degrees) of a lead screw with a pitch of 6 mm is?

A. 15000
B. 18000
C. 20000
D. 22000

Ans. B

Sol. Given:

Pitch = 6mm

Since pitch is distance travelled in one revolution = 6 mm

Thus, No. of revolution to travel a distance of 300 mm = 300/6 =50 revolution

1 revolution = 360 degrees

Thus, 50 revolution = 360 × 50 = 18000 degrees

52. A 50 mm thick metal sheet is rolled with 100 mm diameter rolls to reduce thickness without any change in its width. The coefficient of friction at the work roll interface is 0.1. What is the minimum possible thickness of the sheet that can be produced in a single pass?

A. 1.5 mm
B. 29.5 mm
C. 49.5 mm
D. 39.5 mm

Ans. C

Sol.

Given,

initial thickness of plate (h_1)= 50 mm

Radius of rolls = 50 mm

Coefficient of friction (μ) = 0.1

$\Delta h=\mu^2 R$

$h_1-h_2= \mu^2 R$

$h_2=h_1- \mu^2 R = 50-0.1^2 \times 50 = 49.5$

53. A joint described as U-joint in Robotics is called

A. Linear joint
B. Twisting joint
C. Orthogonal joint
D. Rotational joint

Ans. C

Sol.

Linear joint → L-joint

Orthogonal joint → U-joint

Rotational Joint → R-joint

Twisting joint → T-joint

54. Select the best options from below, which correctly matches the List A with the List B:

List A	List B
A1: Square Thread	B1: widely used in Vice
A2: ACME Thread	B2: mostly used in lead screw
A3: Buttress Thread	B3: Screw Jack
A4: Trapezoidal Thread	B4: For transmitting power in Machine tool

A. A1 - B1, A2 - B3, A3 - B4, A4 - B2.

B. A1 - B1, A2 - B2, A3 - B3, A4 - B4.

C. A1 - B2, A2 - B3, A3 - B4, A4 - B1.

D. A1 - B3, A2 - B2, A3 - B1, A4 - B4.

Ans. D

Sol.

List A	List B
A1: Square Thread	B3: Screw Jack
A2: ACME Thread	B2: mostly used in lead screw
A3: Buttress Thread	B1: widely used in Vice
A4: Trapezoidal Thread	B4: For transmitting power in Machine tool

55. A 0.5m diameter pipe bifurcates at a Y-section into two branches 20cm and 40cm in diameter. If the rate of flow in the main pipe is 0.6 m^3/sec and through the smaller diameter pipe is 0.25 m^3/sec. Determine the velocity of flow in 40cm pipe.

A. 6.36 m/s B. 1.452 m/s

C. 2.785 m/s D. 2.425 m/s

Ans. C

Sol. Let the main pipe be considered to be divided into two pipes 1 and 2.

Given : diameter of pipe 1 (d_1)= 0.2 m

diameter of pipe 2 (d_2)= 0.4 m

discharge through the main pipe (Q)= 0.5 m^3/s

discharge through pipe 1 (Q_1)= 0.2 m^3/s

By continuity equation;

$Q = Q_1 + Q_2$

$Q_2 = 0.6 - 0.25$

$Q_2 = 0.35\ m^3/sec$

We know,

$Q_2 = A_2V_2$

$0.35 = \frac{\pi}{4} \times 0.4^2 \times V_2$

$V_2 = 2.785$ m/s

56. Out of the following statements pertaining to robotics, which of them is/are correct:

(1) All Rotational transformation matrix are by default orthogonal matrix

(2) For any rotational transformation matrix → ($R^{-1} = R^T$)

(3) For any rotational transformation matrix → ($RR^T = 1$)

(4) Scale factor σ > 1 is used for enlarging, σ < 1 is used for reducing.

A. 1 & 2

B. 1, 2 & 3

C. 2, 3 & 4

D. 1, 2, 3 & 4

Ans. B

Sol. Following statements are correct:

1. All Rotational transformation matrix are by default orthogonal matrix
2. For any rotational transformation matrix → ($R^{-1} = R^T$)
3. For any rotational transformation matrix → ($RR^T = 1$)
4. Scale factor σ > 1 is used for reducing, σ < 1 is used for enlarging.

57. A machine part of mass 2 kg vibrates in viscous medium, angular frequency at resonance condition is found to be 10π rad/s. If a harmonic exciting force of 25 N produces 1.25 cm. Find the stiffness of the system (in N/m).

A. 2566 B. 1973

C. 2363 D. 2236

Ans. B

Sol.

Given,

mass(m) = 2 kg

angular frequency at resonance condition (ω_n) = 10π rad/s

At resonance condition the resonance frequency is the natural frequency.

$$\omega_n = \sqrt{\frac{k}{m}}$$

$$10\pi = \sqrt{\frac{k}{2}}$$

$$\therefore k = 1973\ N/m$$

58. Using the table given below, calculate the six week moving average forecast for the 16th week.

Week	10	11	12	13	14	15
Demand (units)	105	115	120	140	135	116

A. 122 B. 134

C. 120 D. 118

Ans. A

Sol.

6 week moving average forecast for 16th week

$$= \frac{1}{6}[105 + 115 + 120 + 140 + 135 + 116]$$

F_6 = 121.83 units.

59. The process in which martensitic steel is reheated to reduce its brittleness without losing any significant portion of its hardness is called _____.

A. Annealing B. Normalizing

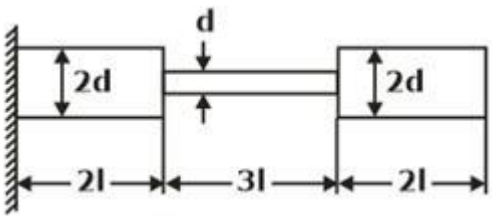
C. Quenching D. Tempering

Ans. D

Sol.

- Tempering is a process of heat treating, which is used to increase the toughness of iron-based alloys.
- Tempering is performed by elevating the steel to a set point below its lower critical temperature, typically following a hardening operation.
- Tempering is most commonly used following a quenching operation and it can restore some of its ductility lost while quenching.

60. Three shafts of different lengths and x-S/C are arranged as shown below:



A torque 'T' is applied at the free end of the shaft. If, G = Modulus of rigidity of shaft material, what will be the twist produced at the free end?

A. $\frac{52Tl}{G\pi d^4}$

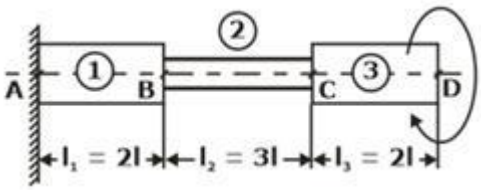
B. $\frac{104Tl}{G\pi d^4}$

C. $\frac{28Tl}{\pi Gd^3}$

D. $\frac{168Tl}{\pi Gd^3}$

Ans. B

Sol.



$d_1=2d$, $d_2=d$, $d_3=2d$

as all three shafts are arranged in series,

∴ Torque on each shaft will be same.

i.e., $T_1 = T_2 = T_3 = T$

and for series connection, deflection At end 'D',

$\theta = \theta_1 + \theta_2 + \theta_3$ …(1)

$$\theta = \frac{32T}{G\pi}\left[2\times\frac{2l}{(2d)^4}+\frac{3l}{(d)^4}\right]$$

$$= \frac{32Tl}{G\pi d^4}\left[\frac{4}{(2)^4}+\frac{3}{(1)^4}\right]$$

$$= \frac{32Tl}{G\pi d^4}\left(\frac{52}{16}\right)$$

$$= \frac{104Tl}{G\pi d^4}$$

61. A prismatic bar of length 4m is subjected to an uniaxial pull of 100kN then the magnitude of product of change in diameter to its diameter will be (in μm) take E = 200 GPA, μ = 0.3

A. 0.763

B. 0.567

C. 0.190

D. Can not be determine

Ans. A

Sol. Given, L = 4m, P = 100 kN, E = 200 GPa

μ = 0.3

as we know that,

$$\Delta L = \frac{PL}{AE} = \frac{PL}{\frac{\pi}{4}d^2 E} \Rightarrow \Delta L = \frac{4PL}{\pi d^2 E}$$

$$\frac{\Delta d}{d} = -\mu \frac{\Delta L}{L}$$

$$\frac{\Delta d}{d} = -\mu \frac{4PL}{\pi d^2 E}$$

$$\Rightarrow (d \times \Delta d) = -\frac{\mu \times 4PL}{\pi E} = -\frac{0.3 \times 4 \times 100 \times 10^3 \times 4}{\pi \times 200 \times 10^9}$$

$(d \times \Delta d) = -0.7639 \times 10^{-6}$m

$(d \times \Delta d) = -0.7639\mu m$

$|d \times \Delta d| = 0.763\ \mu m$

62. Consider the following statements regarding the Open Feed control systems:

1) It uses stepper motor.

2) Number of pulse rate decides the specific movement.

3) A feedback signal controls the movement.

Which of the following statements is/are correct _____?

A. 1 only B. 2 Only

C. 1 and 2 only D. 1, 2 and 3

Ans. C

Sol.

- Stepper motors are inherently open-loop devices. They don't require feedback because each pulse of current delivered by the drive equals one step of the motor.
- Stepper motors are controlled by a driver, which sends the pulses into the motor causing it to turn.

63. For a steady flow process in a turbine from state 1 to state 2, h_1= 450 kJ/kg, h_2= 150 kJ/kg and entropy changes from s_1 = 1.2 kJ/kgK to s_2 = 0.8 kJ/kgK. Ambient temperature is 300 K. Find the change in availability (kJ) _____.

A. 175 B. 180

C. 186 D. 182

Ans. B

Sol. Given:

h_1= 450kJ/kg

h_2= 150kJ/kg

s_1= 1.2 kJ/kgK and s_2= 0.8 kJ/kgK

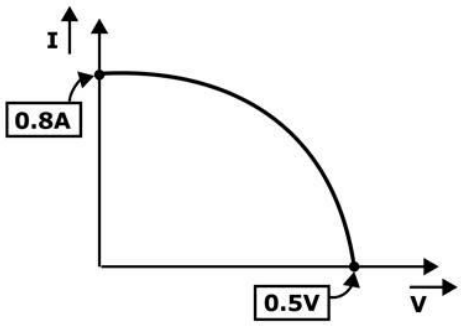
T_o= 300K

Since turbine is open system.

Change in availability of open system = $h_1 - h_2 - T_o (s_1 - s_2)$

Change in availability of open system = 450–150–300(1.2–0.8) = 180 kJ

64. A Photo-voltaic (PV) cell which is operating at cell temperature of 40°C, it's performance curve is given below. Determine the Maximum power from the solar cell if the Fill Factor(FF) is equal to 0.8.



A. 64 W B. 32 W

C. 37.55 W D. None of the above

Ans. D

Sol.

From the performance curve given above, we can infer:

I_{SC} = 0.8A

V_{OC} = 0.32W

By definition of Fill Factor:

$$Fill\ Factor = \frac{\text{Actual Max}^{m}\text{ obtainable power}}{\text{Product (Open Circuit Voltage, Short Circuit Current)}}$$

$$\therefore FF = \frac{P_{MAX}}{(V_{OC} \cdot I_{SC})}$$

$\therefore P_{MAX} = FF.(V_{OC} \,.\, I_{SC})$

$\therefore P_{MAX} = 0.8 \times 0.5 \times 0.8 = 0.32$ W

65. The amount of heat flow through a body by conduction is _____.

A. directly proportional to the area of the body

B. directly proportional to the temperature difference on the two faces of the body

C. dependent upon the material of the body

D. All options are correct

Ans. D

Sol. $Q/t = KA\,(T_2 - T_1)/d$

Q/t = amount of heat flow

A = area

d = distance between two area

T_2 and T_1 temperature of two surface

K (Coefficient of thermal conductivity) depends upon material

66. In a reverted gear train two gears A and B are meshing, B-C is a compound gear and C and D are meshing. The modules of A and C are 2 mm and 3 mm respectively. The number of teeth in A, B and D are 10, 20 and 12 respectively. Find the number of teeth in C.

A. 14 B. 12

C. 6 D. 8

Ans. D

Sol. We have $m_A=2=m_B=m$

Similarly $m_C=m_D=3=$ m' (for meshing gear module remains constant)

We know in reverted gear ;

$R_A+R_B=R_C+R_D$ .....(1)

But module,

$$m = \frac{D}{T} = \frac{2R}{T}$$

$$R = \frac{mT}{2}$$

from equation(1)

$$m(T_A + T_B) = m'(T_C + T_D)$$

$$2(10 + 20) = 3(T_C + 12)$$

$$T_C = 8$$

67. The mechanism of material removal in ECM process is _____.

A. Ionic dissolution
B. Melting and evaporation
C. Erosion and cavitations
D. Melting and corrosion

Ans. A

Sol.

- The mechanism used in ECM for material removal is ionic dissolution.
- Sometimes it is referred as reverse electroplating since it removes material instead of depositing it.
- ECM use is limited to electrically conductive materials.

68. The structure of Fe_3C in iron carbon diagram is

A. FCC
B. BCC
C. tetragonal
D. orthorhombic

Ans. D

Sol. Cementite or iron carbide, is very hard, brittle intermetallic compound of iron & carbon, as Fe_3C, contains 6.67 % C. It is the hardest structure that appears on the iron carbon diagram. Its crystal structure is orthorhombic.

69. The following is/are scheduled maintenance____.

A. Overhauling of machine
B. Cleaning of tank
C. Whitewashing of building
D. All of the above

Ans. D

Sol. **Scheduled maintenance:** Scheduled maintenance includes inspections, adjustments, regular service, and planned shutdowns.

(i) Overhauling of machine,

(ii) Cleaning of tank,

(iii) Whitewashing of building

70. Calculate the fuel injection velocity V_{inj} (in m/s) if fuel is injected at a rate 0.3 kg/s with pressure of 180 bar. The fuel has 45 °API. The pressure in combustion chamber is 20 bar and coefficient of velocity is 0.90. The specific gravity of fuel is given by $S.G. = \frac{140}{130 + °API}$.

A. 180 B. 200

C. 162 D. 222.22

Ans. A

Sol.

Since velocity of injection is given by:

$$V_{inj} = C_v\sqrt{\frac{2(P_{inj} - P_{cy})}{\rho_f}}$$

Given: $C_v = 0.90$

$P_{inj} = 180 \text{ bar} = 20 \times 10^5 \text{ bar}$

$P_{cyl} = 20 \text{ bar} = 20 \times 10^5 \text{ bar}$

Now $S.G. = \frac{140}{130 + °API} = \frac{140}{130 + 45}$

$S.G. = 0.8$

Thus, $\rho_f = 800 \text{ kg/m}^3$

$$V_{inj} = 0.90 \times \sqrt{\frac{2 \times (180 - 20) \times 10^5}{800}} = 180 \text{ m/s}$$

71. Young's modulus of elasticity and Poisson's ratio of a material are 2×10^5 MPa and 0.34 respectively. The modulus of rigidity of the material is_____.

A. 0.4025×10^5 Mpa B. 0.4664×10^5 Mpa

C. 0.8375×10^5 MPa D. 0.7462×10^5 MPa

Ans. D

Sol. Given,

$E=2 \times 10^5$

$\mu=0.34$,

$E = 2G(1+\mu)$

$2 \times 10^5 = 2G(1 + 0.34)$

$G = 0.7462 \times 10^5$ MPa

72. The internal energy of a certain system is a function of temperature alone and is given by formula E = 25 + 0.25 *t* kJ (where t is the temperature). If this system executes a process for which the work done by it per degree temperature increase is 0.75 kN-m, the heat-interaction per degree temperature increase is _____ kJ.

A. 0.25 B. 0.75

C. 1.00 D. 1.25

Ans. C

Sol. Given,

$E= 25 + 0.25t$

Now, $\frac{dE}{dT} = 0.25$ and $\frac{dW}{dt} = 0.75$ (given)

According to first law of thermodynamics,

$$\frac{dQ}{dt} = \frac{dE}{dt} + \frac{dW}{dt}$$

$=0.25+0.75 = 1$ kJ

73. Which of the following methods of casting is best suited for casting of hollow pipes and tubes?

A. Investment casting B. Permanent mould casting

C. Die casting D. Centrifugal casting

Ans. D

Sol. Specifically, true centrifugal casting is generally used for the making of hollow pipes and tubes, which are axi-symmetric with a concentric hole. Molten metal is accumulated at the inward surface of the mould by the rotation of the mould and then the solidification of a melt is taking place.

74. A spring mass system has natural frequency 80 rad/s. What is the damping ratio required if it is desired to reduce this frequency to 40rad/s by adding damper to it?

A. 0.433 B. 0.5

C. 0.717 D. 0.866

Ans. D

Sol. Given,

natural frequency(ω) = 80 rad/s

damped frequency (ω_d)=40rad/s

$$\omega_d = \omega\sqrt{(1-\xi^2)}$$

$$40 = 80\sqrt{\left(1-\xi^2\right)}$$

$$\xi = \frac{\sqrt{3}}{2} = 0.866$$

75. The COP of a Carnot refrigerator is 6. The ratio of its lower and higher absolute temperature is :

A. 7/8 B. 1/7

C. 1/6 D. 6/7

Ans. D

Sol. The COP of a Carnot refrigerator is given by :

$$COP = \frac{T_L}{T_H - T_L}$$

$$6 = \frac{T_L}{T_H - T_L}$$

$$6T_H - 6T_L = T_L$$

$$7T_L = 6T_H$$

$$\frac{T_L}{T_H} = \frac{6}{7}$$

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