PRODUCTION & INDUSTRIAL ENGINEERING _ MOCK - F __ Solutions

01. Ans: (B)

Sol: All quantitative techniques (Regression and moving average analysis) are well suited for the short range planning, whereas all qualitative techniques (Market survey, collective opinion and Delphi method) are suitable for medium and long range planning.

02. Ans: 13.09 (Range: 13.0 to 13.2)

Sol: The expression for torque being a function of 2θ, the cycle is repeated every 180° of the crank rotation.

$$T_{mean} = \frac{1}{\pi}\int_0^{\pi} T d\theta$$

$$= \frac{1}{\pi}\int_0^{\pi}(500 + 200\sin 2\theta - 300\cos 2\theta)d\theta$$

$$= \frac{1}{\pi}\left[500\theta - \frac{200}{2}\cos 2\theta - \frac{300}{2}\sin 2\theta\right]_0^{\pi}$$

$$= \frac{1}{\pi}[(500\pi - 0) - (0)] = 500 \text{ N.m}$$

$$P = T\omega$$

$$= 500 \times \frac{2\pi \times 250}{60}$$

= 13.089 W or 13.09 kW

03. Ans: (C)

Sol: The bulk mean temperature T_m at a given cross-section is defined on the basis of the thermal energy transported by the fluid stream which passes through that cross-section, as

$$T_m = \frac{\int_A \rho c_p u T dA}{\int_A \rho c_p u dA}$$

For flow through a circular pipe, the above expression reduces to

$$T_m = \frac{\int_0^R u(r)T(r)rdr}{\int_0^R u(r)rdr}$$

04. Ans: 53 NO RANGE

Sol: V (2x + 3y) = 2^2 V(x) + 3^2V(y)

= (4 × 2) + (9 × 5) = 53

05. Ans: (D)

Sol:

- Quick-Return mechanism is used to maintain cutting and reverse strokes. So, (A) is incorrect.

- Rack and pinion mechanism provides the bi-directional continuous feed which is not the requirement of intermittent table feed in shaping or planning. So, (B) is incorrect.
- Cam mechanism is not used because of its high cost relative to alternative mechanisms. So, (C) is incorrect.
- A Ratchet is a device that allows linear or rotary motion in only one direction. So, (D) is correct.

06. Ans: 74.94 (Range 74 to 76)

Sol: Given $T_E = 70, \quad \sigma^2 = 9$

$$\therefore \sigma = \sqrt{9} = 3, \quad Z = 1.647$$

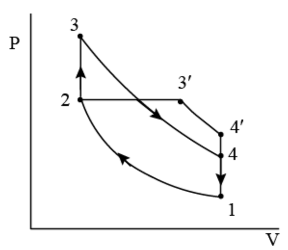
$$Z = \frac{T_S - T_E}{\sigma}$$

$$1.647 = \frac{T_S - 70}{3}$$

$$T_S = 74.94 \text{ weeks}$$

07. Ans: (D)

Sol:



Heat rejected in Otto = $c_V (T_4 - T_1)$

Heat rejected in diesel = $c_V (T_4' - T_1)$

Heat rejected in Otto is less where as heat supplied is same. Hence, efficiency is more for Otto than diesel.

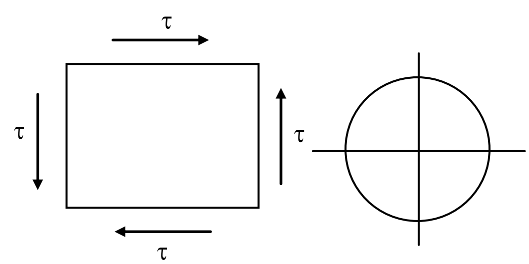
08. Ans: (B)

Sol: **Bottom gates:** In the case of bottom gates, usually favoured for large-sized casting, especially those of steel, *molten metal flows down the bottom of the mould cavity in the drag* and enters at the base of the casting.

These are used to keep the turbulence of metal at a minimum while pouring and to prevent mould erosion. Metal is allowed to rise gently in the mould but the filling takes place against gravity. So net head decreases while filling, so time required to fill is more.

09. Ans: (C)

Sol: For pure shear at the centroidal axis of the beam element is shown in figure below



The corresponding Mohr circle should be concentric with origin.

10. Ans: 509 MPa (Range 507 to 511)

Sol: The maximum torsion on the shaft

$$T = 100 \text{ N-m} = 100 \times 10^3 \text{ N. mm}$$

From Torsion equation $\frac{T}{J} = \frac{\tau}{r}$

$$\tau_{max} = \frac{T}{J} r_{max} = \frac{T}{Z_p} = \frac{100 \times 10^3}{\frac{\pi}{16}(10^3)}$$

$\therefore \tau_{max} = 509$ MPa

11. Ans: (C)

Sol: Initially when the steel rod is in the boat, it must be resulting in a water displacement such that weight of the water displaced equals the total weight. Since the density of the anchor material is several times than that of water, the volume of water displaced is several times more than the volume of the steel rod.

Now when the steel rod is thrown into the water, it would displace just the volume of water equals to its own volume and this is much less than before. Thus the level of water in the bath tub must go down.

12. Ans: 1 NO RANGE

Sol: Let $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{bmatrix}$

A is the upper triangular matrix eigen value is 1 only

Consider $(A - I) = \begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & 3 \\ 0 & 0 & 0 \end{bmatrix}$

Clearly earth of (A – I) = 2

Geometric multiplicity of eigen value 1 = No. of linearly independent eigen vectors

= n – r

= 3 – 2 = 1

13. Ans: 150 (Range: 150 to 150)

Sol: Given: 3V + I = 300

I = 300 – 3V

Power (P) = VI = V (300 – 3V)

$= 300V - 3V^2$

For optimum power

$$\frac{dP}{dV} = 0 \Rightarrow 300 - 6V = 0$$

V = 50 V

I = 300 – (3×50) = 150 Amp

14. Ans: (A)

Sol: Given data:

$S_{yt} = 420$ MPa, $S_e = 270$ MPa,

$\sigma_{max} = 100$ MPa, $\sigma_{min} = 40$ MPa

$$\sigma_a = \frac{100 - 40}{2} = 30 \text{ MPa}$$

$$\sigma_m = \frac{100 + 40}{2} = 70 \text{ MPa}$$

According to Soderberg's theory

$$\frac{\sigma_a}{S_e}+\frac{\sigma_m}{S_{yt}}=\frac{1}{FS}$$

$$\therefore \frac{30}{270}+\frac{70}{420}=\frac{1}{FS}$$

$$\therefore \frac{1}{9}+\frac{1}{6}=\frac{1}{FS}$$

$$\therefore FS=\frac{18}{5}=3.6$$

15. Ans: 96 NO RANGE

Sol: Characteristic equation is $|A-\lambda I|=0$

$$\begin{vmatrix}1-\lambda & 0 & 0\\ 0 & 2-\lambda & 1\\ 2 & 0 & 3-\lambda\end{vmatrix}=0$$

$\Rightarrow (1-\lambda)(2-\lambda)(3-\lambda)=0$

$\therefore \lambda = 1, 2, 3$ are eigen values

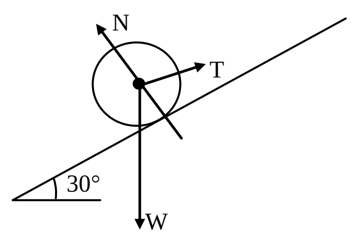
Eigen values of A	Eigen values of $A^2-3A+6I$
1	1 – 3 + 6 = 4
2	4 – 6 + 6 = 4
3	9 – 9 + 6 = 6

Determinate of $A^2 - 3A + 6I = 4\times 4\times 6$

$= 96$

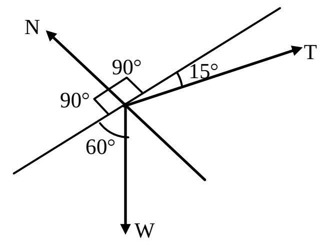
16. Ans: 10.35 (Range 10.1 to 10.5)

Sol: Free body diagram of Roller :



For equilibrium, all the forces should form concurrent force system.

Applying Lami's theorem,



$$\frac{T}{\sin 150^\circ}=\frac{W}{\sin 105^\circ}$$

T = 10.35 kN

17. Ans: 3.75 (Range: 3.50 to 4.00)

Sol: Given data: n = 0.4, T_c = 2.5 min

For maximum production rate

Optimum tool life (T) = $\frac{1-n}{n}\times T_c$

$$=\frac{1-0.4}{0.4}\times 2.5 = 3.75 \text{ min}$$

18. Ans: (D)

Sol:

Bag -1	**Bag- 2**
5 Red	4 Red
7 Green	8 Green

By total probability $=\frac{1}{2}\times\frac{7}{12}+\frac{1}{2}\times\frac{8}{12}$

$$=\frac{15}{24}$$

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19. Ans: (A)

Sol: *Tempering of Steel Martensite*: Martensite is not an equilibrium phase. This is why it does not appear on the $Fe\text{-}Fe_3C$ phase diagram. When martensite in a steel is heated below the eutectoid temperature, the thermodynamically stable α and Fe_3C phases precipitate. This process is called **tempering**. The decomposition of martensite in steels causes the strength and hardness of the steel to decrease while the ductility and impact properties are improved.

20. Ans: (C)

Sol: Reliability (R) = $e^{-\lambda t}$

$$0.8 = e^{-\lambda \times 2000}$$

Taking log on both sides:

$$ln\,(0.8) = -2000\,\lambda \times ln(e)$$

$$\lambda = 1.1157 \times 10^{-4}\ /\ hr$$

$$MTBF = \frac{1}{\lambda} = 8962.84$$

$$Availability = \frac{MTBF}{MTBF + MTTR}$$

$$0.98 = \frac{8962.84}{8962.84 + MTTR}$$

MTTR = 182.915 hr $\approx$ 183 hr

21. Ans: –1 NO RANGE

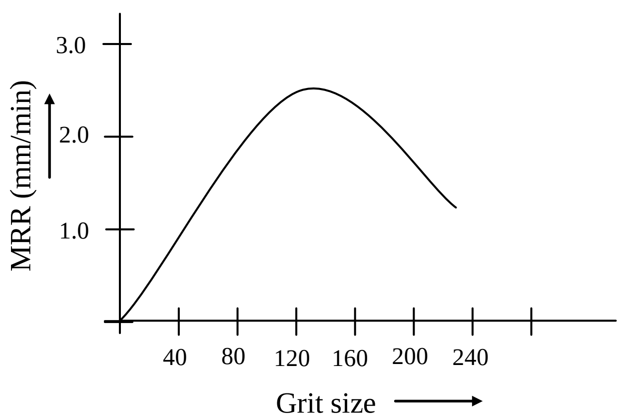
Sol: $$\underset{x\to 0}{Lt}\frac{\sin x}{x(x-1)} = \underset{x\to 0}{Lt}\frac{1}{x-1}.\underset{x\to 0}{Lt}\frac{\sin x}{x}$$

$$= -1 \times 1$$

$$= -1$$

22. Ans: (D)

Sol: The grit size of the abrasive affects both the machining rate and surface roughness of the machined surface. Increase in the grit size increases machining rate till the grit size be come nearly equal to amplitude of vibration. Beyond this, the increase in grit size decreases the machining rate. This is illustrated in figure below.



23. Ans: (C)

Sol:

Non-dimensional number	**Ratio of significance**
Froude number	Inertia force / Gravitational force
Euler number	Inertia force / Pressure force
Reynolds number	Inertia force / Viscous force
Mach number	Inertia force / Elastic force

24. Ans: (C)

Sol: *Computer Aided Design (CAD)* uses computers to produce and revise complex engineering drawings on the computer screen. This information produced in making the drawing can also be used to produce the CNC program used on the machine to produce the part. So option (A) is incorrect.

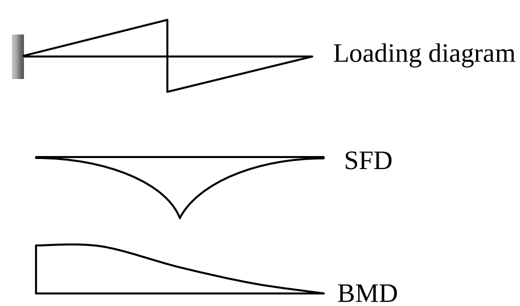
Computer Aided Manufacturing (CAM) uses the technologies of CAD and CAE (Computer aided engineering) to produce a computer model of a manufacturing process. It provides the codes required to control production machines, material handling equipment and control systems. So option (B) is incorrect.

Computer Integrated Manufacturing (CIM) uses a central host computer to control an entire network of computers involved in all phases of manufacturing. The ability of the CIM factory to oversee all aspects of the factory results in a new concept in inventory control and manufacturing scheduling called *Just In Time (JIT) manufacturing.* So option (C) is correct.

Direct Numerical Control (DNC) is used to upload and download CNC programs to one or more CNC machines from the large memory of the machine control unit. In some applications, the DNC system can be combined with part management system, where the CNC operator selects the latest version of a part from the central computer console located in the machine or manufacturing shop. So option (D) is incorrect.

25. Ans: (B)

Sol:

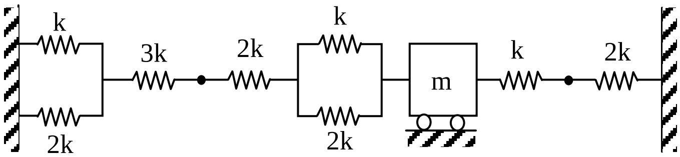


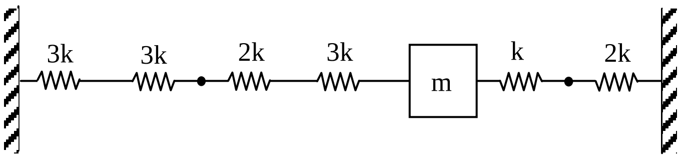
Slope of SFD = rate of loading and

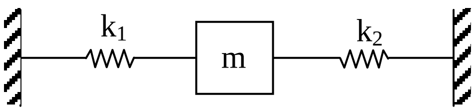
Slope of BMD = shear force value on the beam

26. Ans: (B)

Sol:







$$\Rightarrow \frac{1}{k_1} = \frac{1}{3k} + \frac{1}{3k} + \frac{1}{2k} + \frac{1}{3k} = \frac{1}{k}\left[\frac{2+2+3+2}{6}\right] = \frac{9}{6k}$$

$$\therefore\ k_1 = \frac{2k}{3}$$

$$\Rightarrow \frac{1}{k_2} = \frac{1}{k} + \frac{1}{2k} = \frac{3}{2k}$$

$$\therefore\ k_2 = \frac{2k}{3}$$

$$k_{eq} = k_1 + k_2 = \frac{2k}{3} + \frac{2k}{3} = \frac{4k}{3}$$

$$k_{eq} = \frac{4 \times 6000}{3} = 8000\ \ N/m$$

27. Ans: (A)

Sol: The amount of spring back is the property of the material which depends on the modulus of elasticity. So statement (I) is correct. Higher the modulus of elasticity, lower would be the spring back. So given statement (II) is incorrect. Hence, option (a) is correct.

28. Ans: (A)

Sol: Given f(D)y = Q(x) …………(1)

where $f(D) = D^2 + 4D + 4$

& $Q(x) = x^4\, e^{-2x} = e^{-2x}.x^4 = e^x \,.\, V(x)$

$$\text{Now, } y_P = \frac{1}{f(D)}\left[e^{-2x}\, x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{f(D-2)}x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{(D-2)^2 + 4(D-2) + 4}x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1(x^4)}{D^2}\right]$$

$$\therefore y_p = e^{-2x}.\frac{x^6}{30}$$

29. Ans: 1.066 (Range: 0.9 to 1.2)

Sol: Data given:

F_c = 1600 N, F_t = 500 N,

t_1 = d = 0.3 mm,

b = w = 5 mm, r = 0.42,

α = 10°, V_c = 35 m/min

Rate of energy dissipated / per unit volume,

$$= \frac{F_c \times V_c}{t_1 \times b \times V_c}$$

$$= \frac{1600}{0.3\times5\times1000}\left(\frac{J}{mm^3}\right) = 1.066\ J/mm^3$$

30. Ans: (D)

Sol: Hobbing: It is the most accurate of the roughing processes since no repositioning of tool or blank is required and each tooth is cut by multiple hob-teeth, averaging out any tool errors. Excellent surface finish is achieved by this method and is widely used for production of gears.

31. Ans: 884.1 (Range: 882.00 to 886.00)

Sol: Given, σ = 1100 MPa, n = 0.35

h_1 = 58 mm,

$$\varepsilon = \ell n\left(\frac{h_o}{h_1}\right)$$

$$\varepsilon = \ell n\left(\frac{75}{58}\right) = ln\ (1.293) = 0.257$$

Flow stress (Y_f) = $\sigma\ \varepsilon^n$

$Y_f = 1100(0.257)^{0.35}$ = 683.7 MPa

Starting volume

V = 75(1000) = 75,000 mm^3

At h = 58 mm,

A = V/L = 75,000/58 = 1293.1 mm^2

The force required to achieve this compression (F) = 683.7×1293.1

= 884,095 N $\cong$ 884.1 kN.

32. Ans 4.48

Sol: Wall shear stress:

$$\tau_o = -\frac{dP}{dx}\frac{R}{2}$$

In laminar flow through a pipe, the velocity distribution is,

$$u = 1.4\left[1-\left(\frac{r}{R}\right)^2\right]$$

$$u = U_{max}\left[1-\left(\frac{r}{R}\right)^2\right]$$

and,

$$U_{max} = \frac{R^2}{4\mu}\left(\frac{-dP}{dx}\right)$$

$$\frac{-dP}{dx} = \frac{4\mu U_{max}}{R^2}$$

$$\tau_o = \frac{4\mu U_{max}}{R^2}\times\frac{R}{2} = \frac{2\mu U_{max}}{R}$$

$$= \frac{2\times0.08\times1.4}{50\times10^{-3}}$$

$$\tau_o = 4.48\ N/m^2$$

33. Ans: (C)

Sol: Given

$$f(x) = \frac{\pi^2}{3} - 4\left(\frac{\cos x}{1^2} - \frac{\cos 2x}{2^2} + ...\right)$$

clearly f(x) is continuous at x = 0

($\because \underset{x\to0}{Lt}$ f(x) = 0) the four series converges

to f(0)

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{1}{1^2} + \frac{1}{2^2} - \frac{1}{3^2} + ... = \frac{\pi^2}{12}$$

34. Ans: (B)

Sol: *Single Action Presses*. A single action press has one reciprocation slide that carries the tool for the metal forming operation. The press has a fixed bed. It is the most widely used press for operations like blanking, coining, embossing, and drawing. Hence given options (A) and (D) are incorrect.

Double Action Presses. A double action press has two slides moving in the same direction against a fixed bed. It is more suitable for drawing operations, especially deep drawing, than single action press. For this reason, its two slides are generally referred to as outer blank holder slide and the inner draw slide. The blank holder slide is a hollow rectangle, while the inner slide is a solid rectangle that reciprocates within the blank holder.

The blank holder slide has a shorter stroke and dwells at the bottom end of its stroke, before the punch mounted on the inner slide touches the workpiece. In this way, practically the complete capacity of the press is available for drawing operation.

Another advantage of double action press is that the four corners of the blank holder are individually adjustable. This permits the application of non uniform forces on the work if needed.

A double action press is widely used for deep drawing operations and irregular shaped stampings. So given option (B) is correct.

Triple Action Presses. A triple action press has three moving slides. Two slides (the blank holder and the inner slide) move in the same direction as in a double – action press and the third or lower slide moves upward through the fixed bed in a direction opposite to that of the other two slides. This action allows reverse – drawing, forming or bending operations against the inner slide while both upper actions are dwelling.

Cycle time for a triple – action press is longer than for a double – action press because of the time required for the third action. Hence given option (C) is incorrect.

35. Ans: 87.72 (Range 86.5 to 88.3)

Sol: Stroke length = 400 mm,

$$n = \frac{\ell}{r} = 4.5$$

$$\omega_{crank} = \frac{2\pi \times 200}{60} = 20.94\,\text{rad/s}$$

a_{crank} = ?

2r = 400 mm

⇒ r = 200 mm

$a_{crank} = r\,\omega^2 = 87.72\ \text{m/s}^2$

36. Ans: (D)

Sol: Initial volume = 0.033 × 2 = 0.066 m^3

Finally pressure becomes 500 kPa

Final volume = 0.042 × 1 = 0.042 m^3

It is constant pressure process

So,

Work done = 500 × [0.066 – 0.042] = 12 kJ

37. Ans: (B)

Sol: Given f(D) y = Q(x) ....(1)

where f(D) = D^2+3D+2

and Q(x) = cos(x)

C.F: Consider A.E, f(m) = 0

$\Rightarrow m^2+3m+2=0$

⇒ m = –1, –2

$\therefore\ y_c = c_1e^{-x} + c_2e^{-2x}$

P.I: Here, Q(x) = cos(x) = cos(ax+b)

and $f(D) = \phi(D^2) = \phi(-a^2) = \phi(-1)$

$= (-1) + 3D + 2 = 1 + 3D \neq 0$

Now,

$$y_p = \frac{1}{1+3D} \times \frac{1-3D}{1-3D}\cos(x) = \frac{1-3D}{1-9D^2}\cos(x)$$

$$\Rightarrow y_p = (1-3D)\left[\frac{1}{1-9(-1)}\cos x\right] = (1-3D)\left(\frac{1}{10}\cos(x)\right)$$

$$\therefore\ y_p = \frac{\text{cox}(x)}{10} + \frac{3}{10}\sin x$$

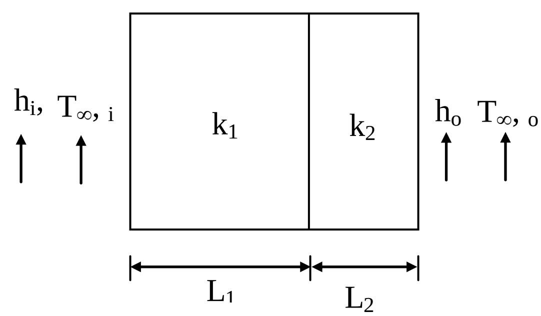
Hence, the general solution of (1) is

$$y = y_c + y_p$$

$$\text{i.e., } y = c_1e^{-x} + c_2e^{-2x} + \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

38. Ans: 13.40 (Range: 13.1 to 13.7)

Sol:



Let the interface temperature (in °C) of the two sections be T.

For steady state one-dimensional heat conduction, the rate of heat flux is given by

$$q = \frac{T_{\infty,i} - T_{\infty,o}}{\frac{1}{h_i} + \frac{L_1}{k_1} + \frac{L_2}{k_2} + \frac{1}{h_o}} = \frac{T_{\infty,i} - T}{\frac{1}{h_i} + \frac{L_1}{k_1}}$$

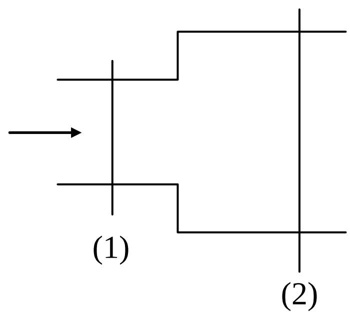
Substituting the respective values, we get

$$\frac{40-4}{\frac{1}{20}+\frac{0.3}{20}+\frac{0.15}{50}+\frac{1}{50}}=\frac{40-T}{\frac{1}{20}+\frac{0.3}{20}}$$

$\Rightarrow$ T = 13.40°C

39. Ans: 30 (Range 29 to 31)

Sol:



$$\frac{P_1}{\gamma}+\frac{V_1^2}{2g}=\frac{P_2}{\gamma}+\frac{V_2^2}{2g}+h_{Le}$$

$$\Rightarrow \frac{P_2}{\gamma}-\frac{P_1}{\gamma}=\frac{V_1^2-V_2^2}{2g}-h_{Le}$$

$\frac{P_2-P_1}{\gamma}$ represents rise in HGL (as $Z_1 = Z_2$)

$$\Rightarrow 0.02=\frac{V_1^2-V_2^2}{2g}-\frac{(V_1-V_2)^2}{2g}$$

By continuity equation $V_1 = 4V_2$

$$\Rightarrow 0.02=\frac{16V_2^2-V_2^2}{2g}-\frac{9V_2^2}{2g}$$

$$\Rightarrow 0.02=\frac{6V_2^2}{2g}$$

$$\Rightarrow \frac{V_2^2}{2g}=\frac{0.02}{6}$$

Since, $h_{Le}=\frac{9V^2}{2g}=\frac{9\times 0.02}{6}$ = 0.03 m

$\therefore$ Energy grade line drops down by 30 mm

40. Ans: 26.72 (Range 25 to 27)

Sol: Given data:

Cutting Stroke time (t_c) = 3 s,

Return stroke time (t_r) = 2 s,

Length of work piece (L) = original length = 200 mm,

Approach length (L_A) = 60 mm,

Cutting velocity (N) = 50 double stroke/min,

Cutting speed (V_a) = ?

Return cutting ratio (k)

$$=\frac{\text{Re turn stroke Time}}{\text{Cutting stroke time}}$$

$$=\frac{2}{3}=0.67$$

The return-cutting ratio (k) = 0.67

The stroke length is the sum of the original length and two times the approach length.

$L_s = L + 2\,L_A$

$L_A = 200 + (2\times60) = 320$ mm

The stroke length (Ls) = 320 mm.

Average cutting speed

(v_a) = N L_s (1 + k)

= 50 × 320 (1 + 0.67)

= 26,720 mm/min

= 26.7 m/min

The cutting speed of the shaper

= 26.7 m/min.

41. Ans: 0.026 (Range : 0.026 to 0.026)

Sol: Allowance = difference between maximum material limits

= higher limit shaft – lower limit of hole

= [(41.996 + 0.015) – (42.000 – 0.015)]

= 42.011 – 41.985

= 0.026 mm

42. Ans: (A)

Sol: K = 1.33, t = 2 mm, w = 8t

L = 1 m, σ_u = 500 MPa,

Force required for bending = $\frac{KLt^2\sigma_u}{w}$

$$= \frac{1.33\times1000\times2^2\times500}{8\times2}$$

= 166.25 kN

43. Ans: (A)

Sol: Casting size = 100 mm × 100 mm × 50 mm

Riser, D = H

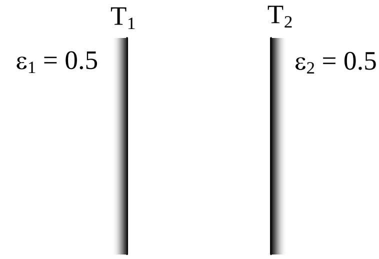
$$\left(\frac{V}{A_s}\right)_c = \frac{100\times100\times50}{2(50\times100+50\times100)} = 25$$

$$\left(\frac{V}{A_s}\right)_r = \frac{D}{6}$$

Freezing ratio = $\frac{(V/A_s)_r}{(V/A_s)_c} = \frac{D/6}{25} = \frac{D}{150}$

44. Ans: (C)

Sol:



Net heat exchange

$$(Q_1) = \frac{\sigma(T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{\varepsilon_1 A} + \frac{1}{AF_{1-2}} + \frac{1-\varepsilon_2}{\varepsilon_2 A}}$$

$$= \frac{\sigma A(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1} \quad \text{(as } F_{12} = 1\text{)}$$

Considering new emissivity of second plate $(\varepsilon_2') = 0.25$

$$Q_2 = \frac{\sigma A(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2'} - 1}$$

$$\frac{Q_2}{Q_1} = \frac{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2'} - 1} = \frac{\frac{1}{0.5} + \frac{1}{0.5} - 1}{\frac{1}{0.5} + \frac{1}{0.25} - 1}$$

$$= \frac{2+2-1}{2+4-1} = \frac{3}{5} = 0.6$$

Percentage decrease in heat exchange

$$= \frac{Q_1 - Q_2}{Q_1} \times 100\%$$

$$= \left(1 - \frac{Q_2}{Q_1}\right) \times 100\%$$

$$= (1-0.6)\times100\% = 40\ \%$$

45. Ans: 300 (Range 300 to 300)

Sol: FC = Rs. 15000, SP = Rs. 90/unit,

VC = Rs. 30/unit, Profit = Rs. 3000

Profit = Total revenue – Total cost

$\Rightarrow 3000 = q\times SP - (FC + q\times VC)$

$$\Rightarrow q = \frac{18000}{60} = 300 \text{ units}$$

46. Ans: (A)

Sol: $$AOQ(\%) = \left(\frac{(P_d \times P_a)\times N - n}{N}\right)\times 100$$

$$= \left(\frac{0.01\times 0.9397\times(10000-89)}{10000}\right)\times 100$$

= 0.931 %

47. Ans: 3 (Range 2.8 to 3.2)

Sol: N_g = 300 rpm,

$$\omega_g = \frac{2\pi\times 300}{60} = 31.4 \text{ rad/s}$$

$V_{s\,max}$ = 1260 mm/s

Path of recess = 8.06 mm and

Path of approach = 10.03 mm

Maximum velocity of sliding

$= (\omega_p + \omega_g)\times$maximum path

$$1260 = \omega_g\left(\frac{\omega_p}{\omega_g}+1\right)\times 10.03$$

1260 = 31.4(G + 1)×10.03

$\therefore$ G = 3

48. Ans: (B)

Sol: Shear force throughout the beam will be 10 kN and it is constant.

Bending Moment: (*Sign convention : Hogging moment is taken negative*)

$(BM)_C = 0$

$(BM)_{B_{Right}} = -10\times 1 = -10$ kN.m

$(BM)_{B_{Left}} = -10$ kN.m – 10 kN.m

= –20 kN.m

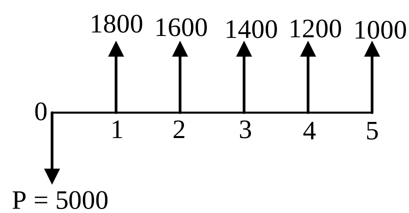
$(BM)_A = -10\times 2 - 10 = -30$ kN.m

Thus, $|SF_{max}|$ = 10 kN

and $|BM_{max}|$ = 30 kN.m

49. Ans: 450 (Range 445 to 455)

Sol:



Rate of return (i) = 10 %

NPV

$$= -5000 + \frac{1800}{(1+0.1)^1} + \frac{1600}{(1+0.1)^2} + \frac{1400}{(1+0.1)^3} + \frac{1200}{(1+0.1)^4} + \frac{1000}{(1+0.1)^5}$$

= –5000 + 1800 × 0.909 + 1600 × 0.826 + 1400 × 0.751 + 1200 ×0.682 + 1000 × 0.620

= – 5000 + 1636.2 + 1321.6 + 1051.4 + 818.4 + 620

= 447.6 ≈ ₹ 450

50. Ans: (B)

Sol: $$\int_{-\infty}^{\infty} x\, e^{-x^2}\, dx$$

Let $f(x) = xe^{-x^2}$

$$f(-x) = -xe^{-x^2} = -f(x)$$

$\therefore$ f(x) is odd function

$\therefore$ The value of given integral is zero.

51. Ans: 5 (Range 5 to 5)

Sol:

	2	3
A	$+\theta$	$10-\theta$
B	$5-\theta$	$15+\theta$

θ = minimum value of $(5-\theta, 10-\theta) = 0$

θ = 5 units

The maximum quantity that can be shifted to A-2 cell without changing the supply and demand constraint is 5 units.

52. Ans: (B)

Sol: $$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$\Rightarrow \quad P_1 = \rho\frac{V_2^2 - V_1^2}{2} = \frac{15\rho V^2}{2}$$

Just inside the pitot tube

$P_{stag} = \rho\,(4V)^2/2 = 8\rho V^2$

$P_1 + \gamma_{Hg}.h = P_{stag} + \gamma_{water}.h$

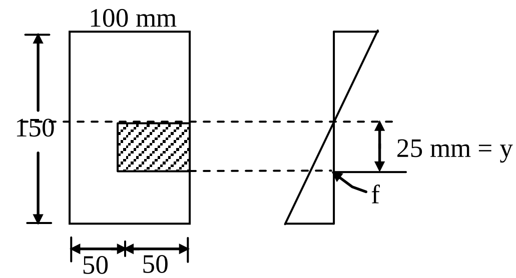
$$\Rightarrow \frac{1}{2}\rho V^2 = h(\gamma_{Hg} - \gamma)$$

$$\Rightarrow \quad V = \sqrt{\frac{2\times(0.2\times 9810)}{1000}(13.6-1)}$$

$= 7.03$ m/s

53. Ans: (C)

Sol:



From bending equation

$$f = \frac{M}{I}.y = \frac{16\times 10^6}{\left(\frac{100\times 150^3}{12}\right)}(25)$$

$= 14.22$ MPa

Force on hatched surface = average stress on the hatched area × hatched area

$$= \left(\frac{0+14.22}{2}\right)(25\times 50) = 8.9\,\text{kN}$$

54. Ans: (A)

Sol: Put $x^3 = t \Rightarrow 3x^2\, dx = dt$

$$\Rightarrow x^2\, dx = \frac{dt}{3}$$

$x = 0 \Rightarrow t = 0$

$x = 2 \Rightarrow t = 8$

$$\therefore \int_0^2 x^2[x^3]dx = \int_0^8 [t]\frac{dt}{3}$$

$$= \frac{1}{3}\int_0^8 [t]dt$$

$$= \frac{1}{3}\frac{8(8-1)}{2} = \frac{28}{3}$$

55. Ans: (B)

Sol: V = 20 V,

I = 200 A,

Speed = 5 mm/s

$A_w = 20\ mm^2$,

H.R/mm^3 = 10 J/mm^3

$\eta_{H.T} = 0.85$

Melting rate of weld bead = $A_w \times$ Speed

= 20 × 5 = 100 mm^3/s

Rate of H.R for melting

= melting rate × H.R/mm^3

= 100 × 10 = 1000 J/sec

Heat generated = V × I

= 20 × 200 = 4000 J/s

Rate of Heat input = 0.85 × 4000 = 3400 J/s

$$\eta_{melting} = \frac{1000}{3400} = 0.2941 = 29.41\ \%$$

56. Ans: (D)

Sol: 'Cut out for' means designed to be so. 'Cut up' means 'to be emotionally upset'. 'Cut down' means 'to kill somebody' or 'to make something fall down by cutting it at the base'. 'Cut off' means 'separated from the rest of the world'.

57. Ans: (C)

58. Ans: (A)

59. Ans: (D)

Sol: Let principle be 1. then amount after 10 years = 3 × 1 = 3

∴ Simple interest = 3 - 1 = 2

$$\therefore \text{Rate of interest} = \frac{2\times 100}{1\times 10} = 20\%$$

60. Ans: (C)

Sol:

20=2*2*5
25=5*5
35=1*5*7
40=2*2*2*5

Note that 20 – 14 = 6; 25 – 19 = 6;
35 – 29 = 6; 40 – 34 = 6.

Required number

= L.C.M. of (20, 25, 35 and 40) – 6

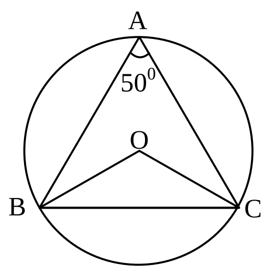
= (2 × 2 × 2 × 5 × 5 × 7) – 6

= 1400 – 6 = 1394

61. Ans: (C)

Sol: The angle subtended by an arc at the centre of the circle is twice the angle subtended by the arc at any point on the remaining part of the circle.

$\therefore \angle BOC = 2\angle BAC = 2 \times 50° = 100°$



Now in ΔBOC

OB = OC [radii of circumcentre]

$\therefore \angle OBC = \angle OCB = x$ (let)

$\therefore x + x + 100° = 180°$

$\Rightarrow 2x = 80°$

$\Rightarrow x = 40°$

62. Ans: (A)

Sol: At 4:10 the hour hand is a head of minute hand

Given that n = 4 and x = 10

Then according to the formula required angle

$$= \left\{30\left(n - \frac{x}{5}\right) + \frac{x}{2}\right\}^0$$

$$= \left\{30\left(4 - \frac{10}{5}\right) + \frac{10}{2}\right\}^0$$

$$= \{(30 \times 2) + 5\}^0 = (60 + 5)^0 = 65^0$$

63. Ans: (B)

Sol: Total cost (in Rs) of journey to Town A

= 4300 + 3100 + 4000 + 6000

= 17400

Average cost = $\frac{17400}{4}$ = Rs. 4350

64. Ans: (A)

Sol: Maximum cost (in Rs) of journey from Delhi to town A = By Train 4 = Rs. 6000

Similarly, for town B = Rs. 6300

Town C = Rs. 5600 and

Town D = Rs. 5700

$\Rightarrow$ Maximum cost = 6000 + 6300 + 5600

= Rs. 23600

65. Ans: (D)