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PRE GATE - 2018
Questions with Detailed Solutions

PRODUCTION & INDUSTRIAL ENGINEERING

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PRE GATE - 2018

Production and Industrial Engineering (PI)

The GA section consists of 10 questions. Questions 1 to 5 are of 1 mark each, and Questions 6 to 10 are of 2 marks each.

01. ***Choose the most appropriate word from the options given below to complete the following sentence:***

If I had known that you were coming, I _______________ you at the airport.

(A) would have met (B) shall have met (C) would meet (D) would have meeting

Ans: (A)

Exp: Conditional tense type three should be if clause (had+v3) and the main clause (would+have+v3)

02. ***In the following sentence certain parts are underlined and marked P, Q and R. One of the parts may contain error or may not be acceptable in standard written communication.***

Select the part containing an error. Choose D as your answer if there is no error.

They found (P) that five prisoners escaped (Q) the previous night. (R) No error (D)

(A) P (B) Q

(C) R (D) No error

Ans: (B)

Exp: In part 'Q' it should be 'prisoners had escaped' because the earlier action of the past should be in past perfect tense (had + v3).

03. ***The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.***

LAVA : VOLCANO ::

(A) ice : glass

(B) cascade : precipice

(C) steam : geyser

(D) avalanche : ice

Ans: (C)

Exp: (DEFINING CHARACTERISTIC) A volcano gives out lava (meaning molten rock); a geyser (meaning a natural hot spring) gives out steam.

04. If "JUICE" is coded as "19-41-17-5-9", then "TOY" will be coded as

(A) 39-29-49 (B) 41-31-51

(C) 13-23-3 (D) 15-25-5

Ans: **(A)**

Sol:

AS,

10	21	9	3	5
J	U	I	C	E
↓	↓	↓	↓	↓
10×2	21×2	9×2	3×2	5×2
↓ −1	↓ −1	↓ −1	↓ −1	↓ −1
19	41	17	5	9

Same as,

20	15	25
T	O	Y
↓	↓	↓
20×2	15×2	25×2
↓ −1	↓ −1	↓ −1
39	29	49

But in option (B)

20	15	25
T	O	Y
↓	↓	↓
20×2	15×2	25×2
↓ +1	↓ +1	↓ −1
41	31	51

It is not in that code

Option (C) and (D) are not correct

05. ***Fill in the blanks with an appropriate idiom***

Let us have your terms ____________

(A) through thick and thin

(B) in black and white

(C) ins and outs

(D) at cross-purposes

Ans: (B)

DLOA: through thick and thin means under all conditions

DLOB: correct answer - in black and white means in writing

DLOC: ins and outs means full details

DLOD: at cross-purposes means misunderstand each other

So the right option is 'B'

06. **Statement:** These apples are too expensive to be bad.

Which of the following can be logically inferred from the above statement?

I. The higher the selling price, the superior is the quality of the commodity.

II. when apples are in short supply, the prices go up.

(A) only I (B) only II

(C) I & II (D) None of the above

Ans: (A)

Exp: The second conclusion is irrelevant. The first is the meaning of the given statement. 'Too expensive to be bad' means that it can't be bad because it is expensive.

07. A postman walked 7 km north from the post office to reach Mr. Singh's house. He then took a left turn and walked 4 km to reach Mr. Kumar's house. He then took a right turn and walked 3 km to reach Mr. Sharma's house. The distance between Mr. Sharma's and Mr. Singh's house is ______

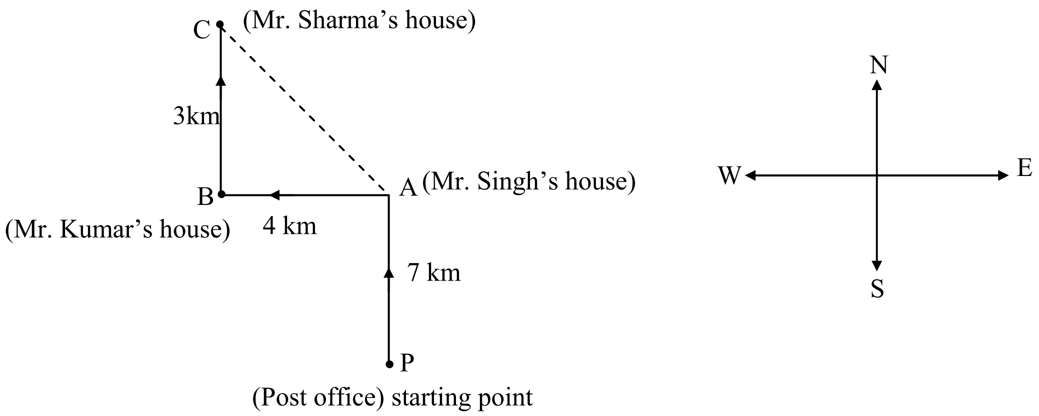
(A) 5 km (B) 6 km

(C) 4 km (D) 7 km

Ans: (A)

Sol:

Let the postman started from the point P which denote post office.



We have to find the distance between A and C so, applying Pythagoras theorem,

$AC^2 = AB^2 + BC^2 = 16 + 9$

$AC^2 = 25$

$AC = \sqrt{25} = 5$ cm

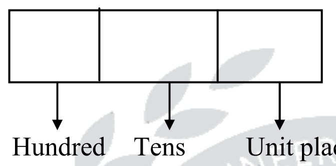
So, distance between Mr. Sharma's and Mr. Singh's house is 5 km.

08. How many 3-digit even number can be formed from the digits 1, 2, 3, 4, 5, 6, if the digits can be repeated?

(A) 216 (B) 108 (C) 96 (D) 54

Ans: (B)

Sol:



We know that, a number is called even, if its unit's place is occupied by an even digit (i.e) 2,4,6

So, for unit place, we have 3 options

For tens place, there are 6 options

For hundred place, there are 6 options

[repetition allowed]

$\therefore$ Total number of ways in which 3 digit even numbers can be formed = $3\times6\times6 = 108$

09. Examine the information given below

All the leaders are believable

Some believable persons are intelligent

Which of the following is a valid conclusion regarding the above arguments?

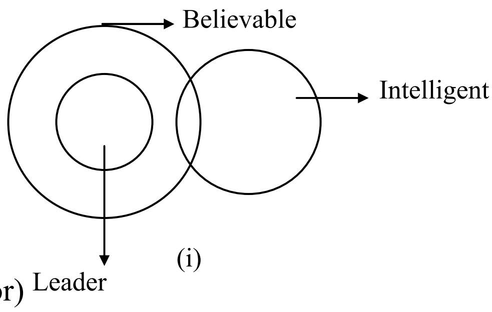
(A) All the leaders are intelligent (B) some leaders are believable

(C) All the intelligent persons are leaders (D) some believable persons are leaders

Ans: (D)

Sol: The given statements can be represented as

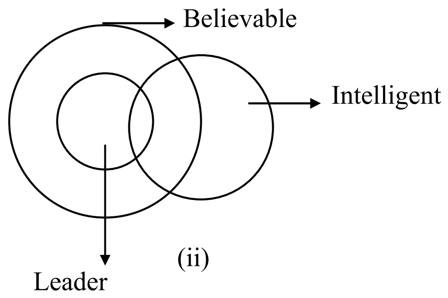
Case – I



(i)

(or)

Case – II



From above two diagrams

Hence, option (D) is correct

10. A shopkeeper sells note books at the rate of ₹457 each and earns a commission of 4%. He also sells pencil boxes at the rate of ₹80 each and earns a commission of 20%. How much amount of commission will he earn in two weeks, if he sells 10 note books and 6 pencil boxes a day?

(A) ₹1956 (B) ₹1586

(C) ₹1496 (D) None of these

Ans: (D)

Sol: S.P of the note book = ₹457

$\therefore$ Commission on one note book = ₹ $\frac{4\times 457}{100}$

and commission on 10 note books $= \frac{10\times 4\times 457}{100}$ = ₹ 182.80

and S.P of the pencil box = ₹80

$\therefore$ Commission on one pencil box = ₹ $\frac{80\times 20}{100}$

Commission on 6 pencil boxes = $\frac{80\times 20\times 6}{100}$ = ₹96

Hence, total commission of one day = (182.80+96) = ₹ 278.80

Thus, total commission of two weeks = 278.80× 14 = ₹3903.20

Option (A) is not correct

Option (B) is not correct

Option (C) is not correct

$\therefore$ None of these is the answer

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The subject specific section of PI consists of 55 questions, out of which question numbers 1 to 25 are of 1 mark each, while question numbers 26 to 55 are of 2 marks each

01. The standard alphanumeric codification of a grinding wheel is

51 – C – 36 – L – 7 – R – 23.

This specification of the wheel means a wheel of

(A) Cubic boron nitride and grit size number 36

(B) Silicon carbide and grit size number 3

(C) Cubic boron nitride and grit size number 7

(D) Silicon carbide and grit size number 36

01. Ans: (D)

Sol: Following is the de-codification of the grinding wheel

51 – Manufacturer's number

C – Abrasive as silicon carbide

36 – Grit size number / mesh number (Side of abrasive particle = 1/36 inches)

L – Grade of wheel (medium hardness)

7 – Structure (Dense)

R – Bonding material (Ruber)

DISTRACTOR LOGIC :

DLOA: 'C' can be easily misunderstood as 'cubic boron nitride' (Incorrect)

DLOB: '7' can be misunderstood as grain size number (Incorrect)

DLOC: 'C' can be misunderstood as cubic boron nitride and '7' as grit size (Incorrect)

DLOD: C = silicon carbide and grain size number = 36. (Correct)

02. In ultrasonic machining process, the material removal rate will be higher for materials with

(A) Higher toughness

(B) Higher ductility

(C) Lower toughness

(D) Higher fracture strain

02. Ans: (C)

Sol: Material removal rate will be higher for material with lower toughness because they have higher brittleness.

DISTRACTOR LOGIC :

DLOA: Incorrect option (if wrongly assumed as higher toughness).

DLOB: Incorrect option (if misinterpreted as higher ductility).

DLOC: Correct option (As explained above).

DLOD: Incorrect option (if misinterpreted as higher fracture strain).

03. Principal stresses at a point in three dimensional loading are σ_1 = 80 MPa, σ_2 = 40 MPa and σ_3 = –40 MPa. The normal stress (in MPa) on maximum shear stress plane is _______

03. Ans: 20 [Range: 20 to 20]

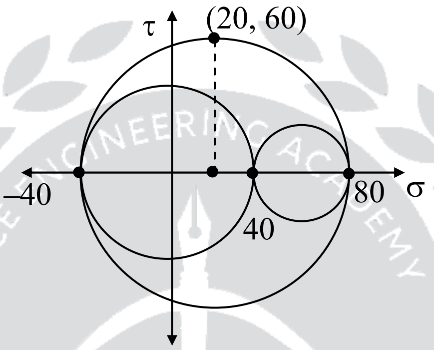
Sol:

Given data:

σ_1 = 80 MPa,

σ_2 = 40 MPa,

σ_3 = –40 MPa

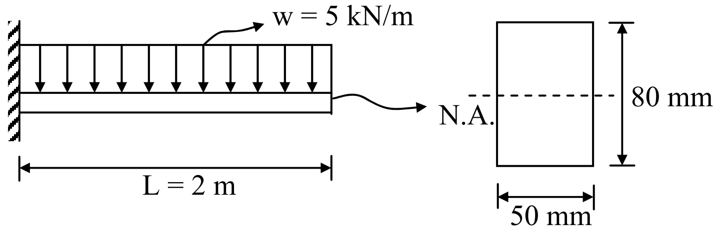


Largest Mohr's circle is considered to calculate maximum shear stress.

The normal stress on maximum shear stress plane is centre of the largest Mohr's circle.

i.e., $\frac{80+(-40)}{2}$ = 20 MPa

04. A cantilever beam of length 2 m and rectangular cross section 50 mm × 80 mm, carries uniformly distributed load of intensity 5 kN/m as shown in the diagram below. The maximum shear stress (in MPa) at neutral axis is_______.



Cross section

04. Ans: 3.75 [Range: 3.74 to 3.76]

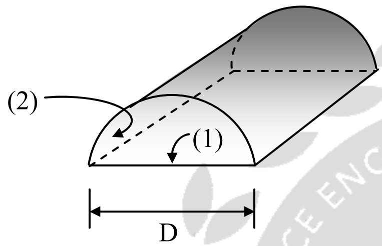
Sol: The transverse shear stress is present at neutral axis, its value is maximum at support where shear force is maximum

$$\left(\tau_{max}\right)_{N.A} = \frac{3}{2}\left(\tau_{avg}\right)$$

$$= \frac{3}{2} \times \frac{wL}{A}$$

$$= \frac{3}{2} \times \left[\frac{5\times10^3 \times 2}{0.05\times0.08}\right] = 3.75 \text{ MPa}$$

05. The view factor from curved surface to itself, for a very long duct of semi circular cross-section with its diameter 'D' as shown in figure, is ________ (neglect end effects and round the answer to two decimal places).



05. Ans: 0.36 [Range: 0.34 to 0.38]

Sol: $F_{1-2} = 1$ (from the geometry and neglecting end effects)

$F_{1\text{-outer}} = 0$ and $F_{2\text{-outer}} = 0$ (neglecting end effects)

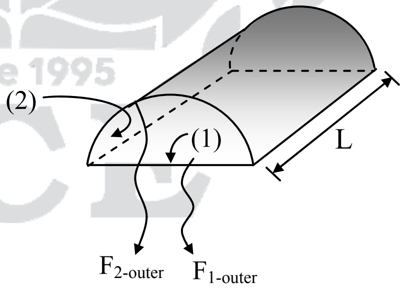
Using reciprocity theorem:

$A_1 F_{1-2} = A_2 F_{2-1}$

$$D \times L \times 1 = \left(\frac{\pi \times D \times L}{2}\right) \times F_{2-1}$$

(Assuming, length of the duct = L)

$$F_{2-1} = \frac{2}{\pi}$$



Using Summation rule:

$F_{2-1} + F_{2-2} = 1$

$$F_{2-2} = 1 - F_{2-1} = 1 - \frac{2}{\pi}$$

$F_{2-2} = 0.36$

06. The actual sales of a product for six consecutive months were given as 90, 130, 120, 125, 130, 145. The forecast for 7[th] month using five month moving average method is ________

06. Ans: 130 [Range: 130 to 130]

Sol: $F_7 = \dfrac{D_6 + D_5 + D_4 + D_3 + D_2}{5}$

$= \dfrac{145+130+125+120+130}{5} = 130$

07. In a single server queuing model, the mean arrival rate is 6/hour and arrival follows Poisson distribution. The mean service time is 5 minutes and it follows exponential distribution. The mean waiting time (in minutes) in the queue will be _________ .

07. Ans: 5 [Range: 5 to 5]

Sol: $\lambda = 6$ /hr ,

$\mu = \dfrac{1}{5} \times 60 = 12/\text{hr}$,

Traffic intensity, $\rho = \dfrac{\lambda}{\mu} = \dfrac{6}{12} = 0.5$

Average number of customer in the system, $L_s = \dfrac{\rho}{1-\rho} = \dfrac{0.5}{1-0.5} = 1$

Expected waiting time in the system, $W_s = \dfrac{L_s}{\lambda} = \dfrac{1}{6}$

Mean waiting time in the queue , $W_q = \rho . W_s$

$= 0.5 \times \dfrac{1}{6} = \dfrac{1}{12}\text{hr} = 5$ min

08. A particle travels in a circle of radius 20 cm at a speed that uniformly increases. If the speed changes from 5 m/s to 6 m/s in 2 sec, the angular acceleration (in rad/sec^2) is ______.

08. Ans: 2.5 [Range: 2.4 to 2.6]

Sol: The tangential acceleration is given by

$$a_t = \frac{dv}{dt} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{6-5}{2} = 0.5\,\text{m/s}^2$$

Thus, angular acceleration,

$$\alpha = \frac{a_t}{r} = \frac{0.5}{0.2} = 2.5\,\text{rad/sec}^2$$

09. A Pitot-static probe is placed in an air stream with velocity 10 m/s and density 1.2 kg/m^3. The U tube manometer attached with the probe has water as manometric fluid. Assuming probe factor to be '1', the reading indicated by the manometer (in mm, rounded upto 2 decimal places) is_________. (Assume g = 10 m/s^2).

09. Ans: 6 [Range: 5.9 to 6.1]

Sol: For static Pitot tube with manometer

$$V = C\sqrt{2g\left(\frac{\rho_m}{\rho}-1\right).x}$$

$$10 = 1\sqrt{2\times10\left(\frac{1000}{1.2}-1\right)x}$$

$\Rightarrow$ $x = 6.01\times10^{-3}$ m

$\Rightarrow$ x = 6 mm

10. The mean value of Rolle's theorem for the function $f(x)=\frac{\sin x}{e^x}$ in [0, π] is _______radian.

10. Ans: 0.785 [Range: 0.78 to 0.79]

Sol: By Rolle's theorem,

$$f'(c) = 0$$

$$e^{-c}(\cos c - \sin c) = 0$$

$$\Rightarrow \cos c - \sin c = 0$$

$$\Rightarrow \frac{\sin c}{\cos c} = 1$$

$$\Rightarrow \tan c = 1$$

$$\Rightarrow c = \frac{\pi}{4} \in (0, \pi)$$

$$\Rightarrow c = 0.785 \text{ radian}$$

11. Which of the following is correct dimension of term $\rho C_p\nabla^2T$ in MLTθ system. (Where ρ = density, C_p = specific heat capacity, T = temperature)

(A) $M^1L^{-3}T^{-2}\theta^1$
(B) $ML^{-2}T^{-2}\theta^1$
(C) $ML^{-3}T^{-2}\theta^0$
(D) None of the above

11. Ans: (C)

Sol: $\nabla^2 T = \dfrac{\partial^2 T}{\partial x^2} + \dfrac{\partial^2 T}{\partial y^2} + \dfrac{\partial^2 T}{\partial z^2}$

The dimension of each term for example can be calculated as

$$\frac{\partial^2 T}{\partial x^2} = \frac{\partial}{\partial x}\left(\frac{\partial T}{\partial x}\right)$$

$$= \frac{1}{L} \times \frac{\theta}{L} = L^{-2}\theta$$

$$\therefore \rho C_p \nabla^2 T = \left(\frac{kg}{m^3}\right) \times \left(\frac{J}{kg.K}\right) \times \left(\frac{K}{m^2}\right)$$

$$= \left(\frac{kg}{m^3}\right) \times \frac{\left(\frac{kg.m}{s^2}.m\right)}{kg.K} \times \frac{K}{m^2}$$

$$= \frac{kg}{m^3 s^2}$$

$$= M^1 L^{-3} T^{-2} \theta^0$$

DISTRACTOR LOGIC:

DLOA : If unit of $\dfrac{\partial^2 T}{\partial x^2}$ is taken as $\dfrac{K^2}{m^2}$, then option A is obtained

DLOB : If unit of $\dfrac{\partial^2 T}{\partial x^2}$ is taken as $\dfrac{K^2}{m}$, then option B is obtained

DLOC : Correct option

DLOD : If any other mistake is done then option D can be considered

12. For a laminar flow of a given liquid through circular pipe of a given length, if the discharge is increased to four times and the diameter is increased to twice then the head loss in the pipe becomes ‘x’ times of the original head loss. What is the value of ‘x’?

(A) $\dfrac{1}{4}$ (B) $\dfrac{1}{2}$ (C) 1 (D) 8

12. Ans: (A)

Sol: For laminar flow through circular pipe,

$$h_f = \frac{\Delta P}{\rho g} = \frac{\left(\frac{32\mu V L}{D^2}\right)}{\rho g} = \frac{32\mu\left(\frac{Q}{\frac{\pi}{4}D^2}\right).L}{\rho g D^2} = \frac{128\mu QL}{\rho g \pi D^4}$$

$$\therefore \frac{h_{f2}}{h_{f1}} = \left(\frac{Q_2}{Q_1}\right)\times\left(\frac{D_1}{D_2}\right)^4 = \left(\frac{4}{1}\right)\left(\frac{1}{2}\right)^4 = \frac{1}{4}$$

DISTRACTOR LOGIC :

DLOA : Correct answer

DLOB : If $h_f = \frac{fLQ^2}{12.1\times D^5}$ is used instead of $h_f = \frac{128\mu QL}{\rho g \pi D^4}$ then option 'B' is obtained

DLOC : If velocity is not substituted in terms of discharge and $h_f = \frac{32\mu VL}{\rho g D^2}$ is used then option 'C' is obtained

DLOD : If velocity is not substituted in terms of discharge and $h_f = \frac{fLV^2}{2gD}$ is used then option 'D' is obtained

Note: For laminar flow, if $h_f = \frac{fLQ^2}{12.1D^5}$ is used then $f = \frac{64}{Re}$ must be used. In this case again correct answer is obtained.

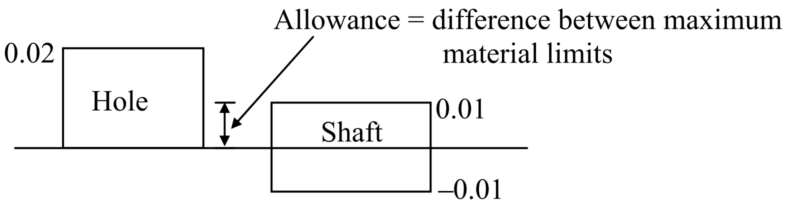
13. Consider a hole – shaft interchangeable assembly as $40\ H^{+0.02}_{0.000}\ j^{+0.01}_{-0.01}$.

The allowance (in microns) in the assembly is

(A) 0.01 (B) 90 (C) 18 (D) 10

13. Ans: (D)

Sol: As clearly seen in the figure,



Allowance = difference between MML of hole and shaft

$= (\text{upper limit})_{\text{shaft}} - (\text{lower limit})_{\text{hole}}$

$= 0.01 - 0.00 = 0.01\text{mm} = 10\ \mu\text{m}$

DISTRACTOR LOGIC :

DLOA : Incorrect, (mistakes in unit)

DLOB : Incorrect (Upper limit)$_{shaft}$ – (Lower limit)$_{shaft}$

DLOC : Incorrect: (Upper limit)$_{hole}$ – (Upper limit)$_{shaft}$

DLOD : Correct (Explained above)

14. Being the other parameters same, in which one of the following gating systems the metal enters into the cavity with the least velocity?

(A) 1: 2:1 (B) 1:2:3 (C) 1:2:2 (D) 1:4:2

14. Ans: (B)

Sol: Maximum velocity occurs in the gating system where the ratio of cross sectional areas of ingate to sprue is maximum. i.e. area and velocity are inversely proportional.

DISTRACTOR LOGIC :

DLOA : If the ratio is (1/1), Incorrect option

DLOB : Correct (Explained above)

DLOC : If the ratio is (2/1), Incorrect option

DLOD : If the ratio is (2/1), Incorrect option

15. In point to point type of Numerical Control system

(A) Control of position and velocity of the tool are essential.

(B) Control of only position of the tool is sufficient.

(C) Control of only velocity of the tool is sufficient.

(D) Neither position nor velocity need to be control.

15. Ans: (B)

Sol: In point to point system control positioning, the locations are specified for the tool head, irrespective of the path and velocity.

DISTRACTOR LOGIC :

DLOA: Incorrect option (If wrongly assumed as control of position and velocity of the tool are essential).

DLOB: Correct option (As explained above).

DLOC: Incorrect option (If misinterpreted as control of only velocity of the tool is sufficient).

DLOD: Incorrect option (If wrongly interpretation).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17 CS Heven Patel
17 IN
17 PI Guruprasath
18 CE
18 EC Akhilesh Kumar
18 IN
18 PI
18 PI Venkatesh
19 CE Ashish
19 EE Sachin Kumar
20 EE Monika Tiwari
20 EC
20 CS
20 IN Suraj Kumar
20 IN Saurabh Pandey
... and many more

16. Principle of motion economy which relates to arrangement of work place is

(A) Rhythm (B) Drop deliveries

(C) Combination of tools (D) Ballistic movements

16. Ans: (B)

Sol: Rhythm and ballistic movements refer to "use of human body", combination of tools refer to design of tools and equipment.

17. Choose the CORRECT statement :

(A) Characteristic dimension for a duct in forced convection is $\frac{4A}{P}$ where as, it is $\frac{A}{P}$ for horizontal rectangular plate in free convection.

(B) Characteristic dimension for a duct in forced convection is $\frac{A}{P}$ where as, it is $\frac{4A}{P}$ for horizontal rectangular plate in free convection.

(C) Characteristic dimension, for a duct in forced convection and for a horizontal rectangular plate in free convection, is $\frac{4A}{P}$.

(D) Characteristic dimension, for a duct in forced convection and for a horizontal rectangular plate in free convection, is $\frac{A}{P}$.

Where, A = Cross-sectional area in forced convection and surface area in free convection, P = Perimeter

17. Ans: (A)

Sol:

- Characteristic dimension for a duct in forced convection = $\frac{4A}{P}$
- Characteristic dimension for a horizontal rectangular plate in free convection = $\frac{A}{P}$

<u>DISTRACTOR LOGIC :</u>

DLOA : Correct option.

DLOB : If the characteristic dimensions are interchanged.

DLOC : If both dimensions are considered as $\frac{4A}{P}$.

DLOD : If both the dimensions are considered as $\frac{A}{P}$.

18. The tangential load acting on a spur gear is 200 N with pressure angle 20°. The normal load acting on it is

(A) 72.8 N (B) 212.8 N (C) 584.8 N (D) 549.5 N

18. Ans: (B)

Sol: Normal load (F_n) = $\dfrac{F_T}{\cos\phi} = \dfrac{200}{\cos 20^o}$

$F_n = 212.8$ N

DISTRACTOR LOGIC :

DLOA : Radial load (F_r) = $F_t \tan\phi$

$F_r = 200 \times \tan 20° = 72.8$ N

DLOB : Correct Answer.

DLOC : $F_n = \dfrac{F_t}{\sin\phi} = \dfrac{200}{\sin 20^o} = 584.8\text{N}$

DLOD : $F_n = \dfrac{F_t}{\tan\phi} = \dfrac{F_t}{\tan 20°} = 549.5\text{N}$

19. For an out of control process, if consumer risk and producer risk are 50 % and 5 % respectively. The Average Run Length (ARL) is ______units.

19. Ans: 2 [Range 2 to 2]

Sol: Average Run Length (ARL) = $\dfrac{1}{1-\beta} = \dfrac{1}{P_d}$

[Where, P_d = observation plotting outside control limits]

$\dfrac{1}{P_d} = \dfrac{1}{1-0.5} = 2$

For an out of control process it is desirable to have small ARL.

20. The depth of cut and cutting speed in an orthogonal cutting operation are 0.6 mm and 6 m/s respectively. If thickness of the chip is 0.90 mm, the chip velocity is

(A) 9 m/s (B) 6 m/s (C) 4 m/s (D) 8 m/s

20. Ans: (C)

Sol: Given: Orthogonal cutting is specified in the problem

Depth of cut (d) = Uncut chip thickness (t_1) = 0.6 mm (d = t_1 in orthogonal cutting)

Cutting velocity, $V = 6$ m/s

Chip thickness, $t_2 = 0.90$ mm

Chip velocity, $V_c = ?$

$\Rightarrow$ Chip thickness ratio, $r = \frac{t_1}{t_2} = \frac{0.60}{0.90} = \frac{2}{3}$

$$V_c = rV = \frac{2}{3} \times 6$$

$$V_c = 4 \text{ m/s}$$

DISTRACTOR LOGIC :

DLOA : If 'r' is wrongly taken as, $r = \frac{t_2}{t_1} = 1.5$, Then, $V_c = 9$ m/s

DLOB : Relationship between chip velocity and cutting velocity is wrongly expressed as $V = rV_c$, then V = 6 m/s

DLOC : Correct option

DLOD : Wrong data interpretation.

21. In the iron-iron carbon diagram, on cooling, a solid transforms into two other solid phases at the same time. The reaction is called

(A) Eutectic reaction (B) Eutectoid reaction

(C) Peritetic reaction (D) Perieutectic reaction

21. Ans: (B)

Sol: Eutectoid reaction :

$$\text{solid}(\gamma) \xrightarrow{-\Delta h} \text{solid}(\alpha) + \text{solid}(Fe_3C)$$

γ = austenite , α = Ferrite , Fe_3C = Cementite , $\alpha + Fe_3C$ = Pearlite

DISTRACTOR LOGIC :

DLOA : Eutectic reaction: $\text{Liquid}(L) \xrightarrow{-\Delta h} \text{solid}(\gamma) + \text{solid}(Fe_3C)$

DLOB : Correct option .

DLOC : Peritetic reaction: $\text{Liquid}(L) + \text{solid}(\delta) \xrightarrow{-\Delta h} \text{solid}(\gamma)$

DLOD : Perieutectic reaction: No such reaction exits in iron-carbon diagram

22. If $A = \begin{bmatrix} -3 & 1 \\ 2 & +3 \end{bmatrix}$ then $A^{100} = ?$

(A) $11^{50}\ I$ (B) $11^{100}\ I$ (C) $11^{50}\ A$ (D) $11^{100}\ A$

22. Ans: (A)

Sol: The characteristic equation is

$$|A - \lambda I| = \lambda^2 - 0.\lambda - 11 = 0$$

$$\Rightarrow \lambda^2 - 11 = 0$$

By Cayley-Hamilton theorem

$$A^2 - (11)I = 0$$

$$A^2 = (11)I$$

$$A^{100} = (A^2)^{50} = (11\ I)^{50} = 11^{50}\ I$$

23. The value of the integral $\int_c \frac{\cos z}{(z-\pi)} dz$ where c is $|z-1| = 3$ is

(A) $-2\pi i$ (B) $2\pi i$ (C) πi (D) $-\pi i$

23. Ans: (A)

Sol: The singular point $z = \pi = 3.14$ lies inside the circle C: $|z-1| = 3$

$$\int_c \frac{\cos z}{(z-\pi)} dz = 2\pi i f(\pi) \quad \text{where } f(z) = \cos z$$

$$= 2\pi i \cos(\pi)$$

$$= -2\pi i$$

24. Suppose 'X' is a Poisson random variable and $E(X^2) = 6$ then $P(X \le 1.2)$ is

(A) $2e^{-2}$ (B) $3e^{-3}$ (C) $3e^{-2}$ (D) $2e^{-3}$

24. Ans: (C)

Sol: $V(X) = E(X^2) - (E(X))^2$

$\Rightarrow \lambda = 6 - \lambda^2$ [where λ is the mean of Poisson distribution]

$\Rightarrow \lambda^2 + \lambda - 6 = 0$

$\Rightarrow \lambda = 2$

Thus $P(X \le 1.2) = P(X = 0) + P(X=1) = e^{-2} + 2e^{-2} = 3e^{-2}$

25. The solution of the differential equation $e^{x-y}\,dx + e^{y-x}\,dy = 0$ is

(A) $e^{x} + e^{-y} = c$ (B) $e^{2x} + e^{-2y} = c$

(C) $e^{2x} + e^{2y} = c$ (D) $e^{-2x} + e^{-2y} = c$

25. Ans: (C)

Sol: $e^{x-y}dx + e^{y-x}dy = 0$

$$\frac{e^{x}}{e^{y}}dx + \frac{e^{y}}{e^{x}}dy = 0$$

$$\int e^{2x}\,dx + \int e^{2y}\,dy = k$$

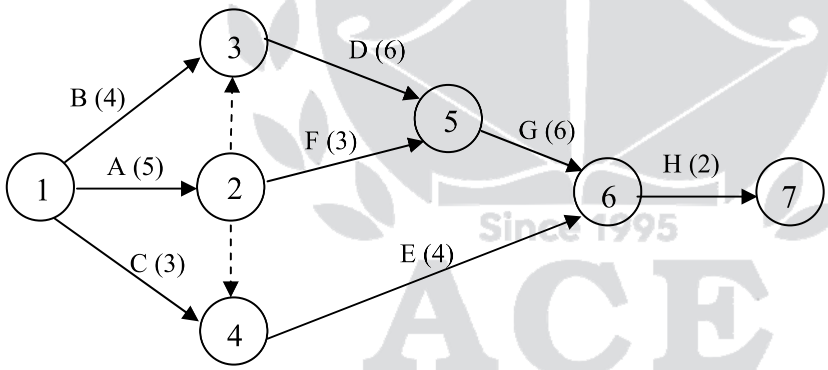
$$\frac{e^{2x}}{2} + \frac{e^{2y}}{2} = k$$

$$e^{2x} + e^{2y} = 2k$$

$$e^{2x} + e^{2y} = c$$

(Here c, k are constants)

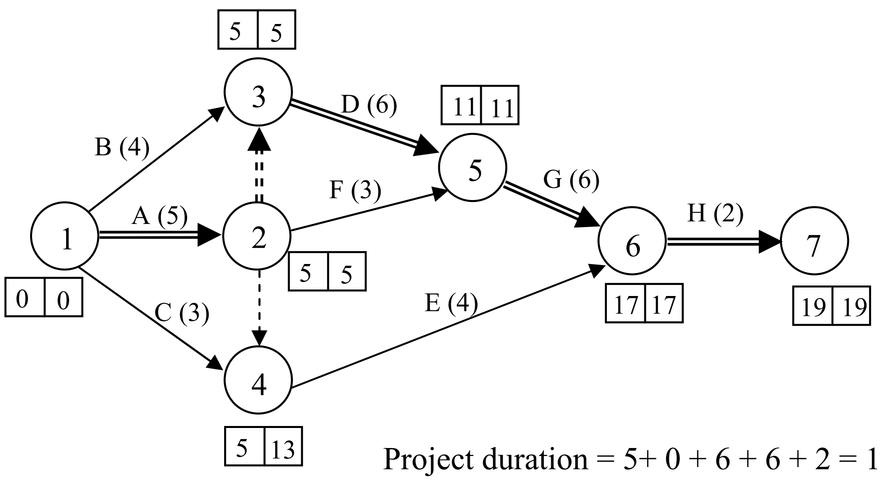
26. Consider the following network as shown in figure below.



The project duration for the network is __________

26. Ans: 19 [Range: 19 to 19]

Sol:



Project duration = 5+ 0 + 6 + 6 + 2 = 19

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28 E&T Mukesh Khakhar
28 EE Abhinav Kumar
28 ME Suhas M
28 ME
29 EE
30 E&T
30 EE Ginige naveen
31 ME Umakanth
32 E&T
32 EE Ajita Mohanty
33 CE
34 E&T Satpal
34 EE
35 EE Vishal Bajaj
36 EE Prasanth shekar
37 CE Ajay Jiarwal
37 E&T Ramjeet Kumar
38 E&T Rajesh Kumar
38 EE M Raquib Anjum
39 E&T
39 EE
39 ME Amit
40 ME Ujjwal
TOTAL SELECTIONS 188
CE 82
ME 42
EE 35
E&T 29

27. Consider the following Linear Programming (LP) model.

Maximize , $Z = 600\,x_1 + 700\,x_2$

Subjected to

$6x_1 + 10x_2 \leq 60$

$6x_1 + 8x_2 \leq 48$

$7x_1 + 12x_2 \leq 84$

$x_1 \geq 0$, $x_2 \geq 0$

The optimal value of the solution is ______

27. Ans: 4800 [Range: 4799 to 4801]

Sol: Maximize , $Z = 600\,x_1 + 700\,x_2$

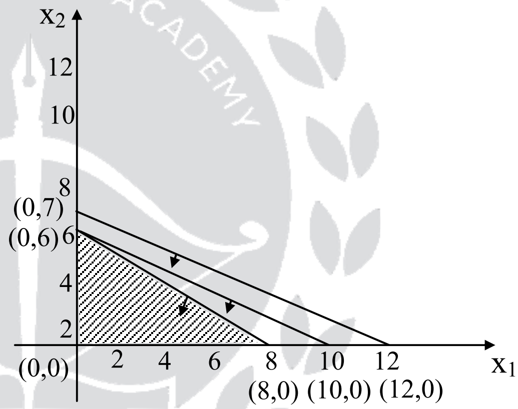
Subject to

$6x_1 + 10x_2 \leq 60 \Rightarrow \frac{x_1}{10} + \frac{x_2}{6} \leq 1$

$6x_1 + 8x_2 \leq 48 \Rightarrow \frac{x_1}{8} + \frac{x_2}{6} \leq 1$

$7x_1 + 12x_2 \leq 84 \Rightarrow \frac{x_1}{12} + \frac{x_2}{7} \leq 1$

$x_1 \geq 0$, $x_2 \geq 0$



$Z(0,0) = 600(0) + 700(0) = 0$

$Z(0,6) = 600(0) + 700(6) = 4200$

$Z(8,0) = 600(8) + 700(0) = 4800$

$\therefore\ Z_{max} = 4800$

28. In an orthogonal machining operation, when the chip thickness ratio increases, what is the correct effect on shear plane angle and shear velocity respectively?

(A) Both increase

(B) Shear angle increases but shear velocity decreases

(C) Both decrease

(D) Shear angle decreases but shear velocity increases

28. Ans: (A)

Sol: $\tan\phi = \dfrac{r\cos\alpha}{1 - r\sin\alpha}$

Where, r = chip thickness ratio,

α = back rake angle

ϕ = shear plane angle

If 'r' increases, 'ϕ' increases

Now, $V_s = \dfrac{V\cos\alpha}{\cos(\phi - \alpha)}$

Where, V_s = shear velocity,

V = cutting velocity

α = back rake angle

If 'r' increases, then 'ϕ' increases

$\therefore$ $\cos(\phi - \alpha)$ decreases and 'V_s' increases

<u>DISTRACTOR LOGIC :</u>

DLOA: Correct, Explained above

DLOB: Incorrect, Shear velocity can be wrongly expressed as

$V_s = \dfrac{V\cos(\phi - \alpha)}{V\cos\alpha}$

DLOC: Incorrect

Shear plane angle can be wrongly related as

$\tan\phi = \dfrac{r\sin\alpha}{1 - r\cos\alpha}$ and $V_s = \dfrac{v\cos(\phi - \alpha)}{V\cos\alpha}$

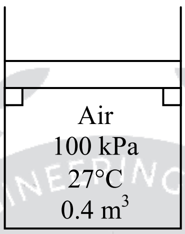
DLOD: Incorrect

$\tan\phi = \dfrac{r\sin\alpha}{1 - r\cos\alpha}$

29. Air is contained in a cylinder device fitted with a piston-cylinder. The piston initially rests on a set of stops, and a pressure of 300 kPa is required to move the piston. Initially, the air is at 100 kPa and 27°C and occupies a volume of 0.4 m^3. The heat is transferred to the air, which increases its temperature to 1200 K. Assume air has constant specific heats evaluated at 300 K. The magnitude of heat transferred (in kJ) to the air is ___________.

29. Ans: 340 [Range: 339 to 341]

Sol: Intially the pressure of air is 100 kPa. When the heat is supplied to it the pressure goes on increasing, till it reaches 300 kPa. Once piston leaves the stops the pressure become cosntant. Let the temperature at this state be T_2.



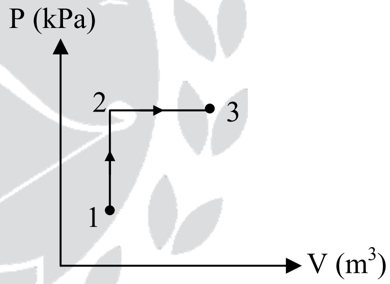
$P_1 = 100$ kPa,

$T_1 = 300$ K,

$V_1 = V_2 = 0.4\ m^3$

Process 1-2 :

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$



$$\Rightarrow T_2 = \frac{P_2}{P_1} \times T_1 = \frac{300}{100} \times 300 = 900\,K$$

$$\Rightarrow m = \frac{P_1V_1}{RT_1} = \frac{100 \times 0.4}{0.287 \times 300} = 0.464\,kg$$

Total heat supplied = $m\,c_v\,(T_2 - T_1) + m\,c_p\,(T_3 - T_2)$

$= 0.464 \times 0.717 \times (900 - 300) + 0.464 \times 1.005 \times (1200 - 900)$

$= 340$ kJ

30. In a Numerical Control machining operation, the tool has to be moved from point (5, 4) to point (7, 2) along a circular path with center at (5, 2). Before starting the operation, the tool is at (5, 4). The correct G and M code for this motion is

(A) N 010 G 03 X 7.0 Y 2.0 L_F

(B) N 010 G 02 X 7.0 Y 2.0 L_F

(C) N 010 G 01 X 7.0 Y 2.0 L_F

(D) N 010 G 00 X 7.0 Y 2.0 L_F

30. Ans: (B)

Sol: Based on the above, to produce arc from (5, 4) to (7, 2) with center (5, 2) the tool has to move in the clockwise direction. Hence G02 is used.

DISTRACTOR LOGIC :

DLOA: Incorrect option (If G03 is used).

DLOB: Correct option (As explained above).

DLOC: Incorrect option (If G01 is used).

DLOD: Incorrect option (If G00 is used).

31. In powder metallurgy over mixing of different metal powders should be avoided because:

(A) It increases green strength and apparent density

(B) It decreases green strength and increases apparent density

(C) It decreases green strength and apparent density

(D) It increases green density and decreases apparent density

31. Ans: (B)

Sol: In powder metallurgy over mixing of different metal powders should be avoided, as it will increase the apparent density of the mixture. Also, over mixing usually reduces the green strength of the PM manufactured component due to smoothening of the powdered particle surface. There by reducing the interlocking capability of the particle. This will also reduce the sintered strength.

DISTRACTOR LOGIC :

DLOA: Incorrect wrongly expressed as it increases green strength and apparent density.

DLOB: Correct option (As explained above).

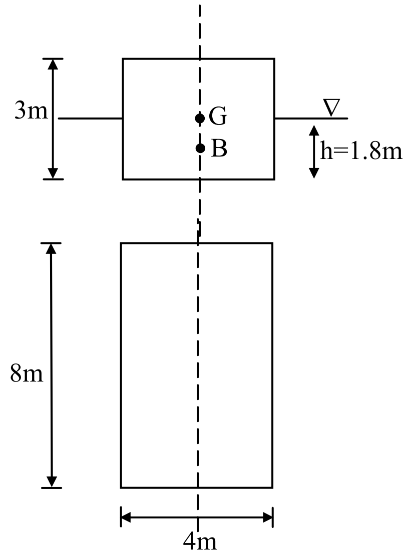
DLOC: Incorrect Wrong interpretation

DLOD: It increases green density and decreases apparent density can be easily misunderstood (Incorrect).

32. A wooden block of 3m × 4m × 8m size and 0.6 specific gravity is floating in a fresh water such that its largest face is parallel to the free surface. The metacentric height of the block in meters is_____.

32. Ans: 0.141 [Range: 0.135 to 0.145]

Sol:



Let, h = submerged depth of the block as the block is floating

Weight = buoyancy force

$\Rightarrow \rho_s V_s g = \rho \forall g$

$\Rightarrow 600\times(3\times4\times8) = 1000\times(4\times8\times h)$

$\Rightarrow h = 0.6\times3 = 1.8\text{m}$

$$GM = \frac{I_{min}}{\forall} - BG = \frac{\left(8\times\frac{4^3}{12}\right)}{(8\times4\times1.8)} - \left(\frac{3}{2}-\frac{1.8}{2}\right) = 0.141\text{m}$$

33. Which of the following are NOT thermosetting materials?

(A) Phenolics, Melamines

(B) Silicones, Unsaturated Polyesters.

(C) Acrylic, Polyamide

(D) Urethanes and Ureas

33. Ans: (C)

Sol: Thermoplastic materials are Polyethylene, Polypropylene, Polystyrene, PVC, ABC, Acrylic, Poly amide (Nylon), Polyamides, Acetals, Cellulosics, Polycarbonate.

Thermosetting materials are phenolics, unsaturated polyesters, Ureas, Silicons Urethanes, Melamines.

<u>DISTRACTOR LOGIC :</u>

DLOA: Phenolics / Melamines can be easily misunderstood as'Thermoplastic materials' (Incorrect). or Wrong interpretation.

DLOB: Silicones and Unsaturated Polyesters can be easily misunderstood as 'Thermoplastic materials' (Incorrect).

DLOC: Correct option (As explained above).

DLOD: Urethanes / Ureas can be easily misunderstood as 'Thermoplastic materials' (Incorrect).

34. A metallic strip 250 mm wide and 10 mm thick is to be rolled using two steel rolls, each of 600 mm diameter. It is required to achieve 30 % reduction in cross-sectional area of the strip after rolling. If the plane strain flow stress of the strip material in the roll gap is 400 MPa, the roll separating force (in MN) is _______ (Rounded up to two decimal places).

34. Ans: 3.76 [Range: 3.00 to 4.00]

Sol: Given,

Initial thickness, $H_o = 10$ mm,

$H_1 = (1 - 0.3)\, H_0 = 7$ mm,

$\Delta H = 10 - 7 = 3$ mm

Width of strip, $b = 250$ mm,

Roll radius, $R = 300$ mm, $\sigma_y = 400$ MPa

$\therefore$ Length of deformation zone, $L = \sqrt{R\,\Delta H} = \sqrt{300 \times 3} = 30$ mm

Assuming maximum reduction per pass

Coefficient of friction $= \mu = \text{Tan}(\beta) = \sqrt{\dfrac{\Delta H}{R}} = \sqrt{\dfrac{3}{300}} = 0.1$

$$\text{Roll separating force } = \frac{2}{\sqrt{3}}\sigma_y\,(bL)\left[1+\frac{\mu L}{4H}\right]$$

$$= \frac{2}{\sqrt{3}}400(250\times30)\left[1+\frac{0.1\times30}{4\times8.5}\right] = 3.76 \text{ MN}$$

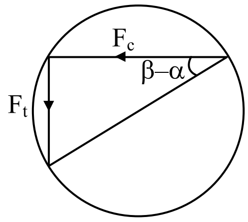
35. In an orthogonal machining operation, the cutting tool used has 5 degrees rake angle and friction angle at the secondary zone is 32°. If the thrust force measured by two – component dynamometer is 750 N, the cutting force (in N) is ________ (Rounded upto two decimal places).

35. Ans: 1471.95 [Range: 1467.00 to 1477.00]

Sol: Constructing the merchant circle diagram

As clear from the diagram

$$\tan(\beta - \alpha) = \frac{F_t}{F_c}$$



$$\Rightarrow \tan(32 - 5) = \frac{750}{F_c}$$

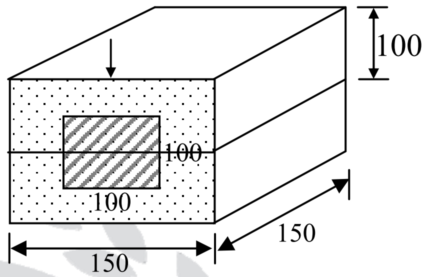
$$\Rightarrow F_c = \frac{750}{\tan 27} = 1471.95$$

36. A cubical cavity of 100 mm side is made such a way that half of the cavity is in drag box. Height of the cope box is 100 mm and its area is 150 mm × 150 mm. If the densities of the sand and the metal poured in the cavity are 1600 kg/m^3 and 8000 kg/m^3 respectively, the minimum weight required to be placed on the cope box (in N) to prevent the lifting of cope box by molten metal is ________ (Rounded upto two decimals only).

36. Ans: 11.77 [Range: 11.00 to 12.30]

Sol: Given data:

A cubical casting cavity,



Side (a) = 100 mm

Density of sand = 1600 kg/m^3

Density of metal = 8000 kg/m^3

Weight of cope = volume of cope × density × g

$$= [(0.15\times0.15\times0.1) - (0.1\times0.1\times0.05)]\times1600\times9.81 = 27.468\text{ N}$$

Metallostatic force of liquid metal on cope

$$= \text{projected area of cubical cavity} \times \text{Pressure}$$

$$= 0.1\times0.1\times0.05\times(8000\times9.81) = 39.24\text{ N}$$

$$\text{Net B.F.} = (39.24 - 27.468) = 11.772\text{ N}$$

The minimum weight required to be placed on the cope box (in N) to prevent the lifting of cope box by molten metal is 11.77 N

37. In a spot welding process, the secondary voltage of the transformer is set as 5V and the timer for current passage is set as 0.2 sec. If the contact resistance between the sheets is 200 micro ohms and the total resistance of the circuit other than the interface resistance between the sheets is 100 micro ohms, the heat generated at the interface (in kJ) is ______ (Rounded up to one decimal only).

37. Ans: 11.1 [Range: 10.8 to 11.4]

Sol: Given data:

$V = 5V$

$T = 0.2$ Sec

$R_{contact} = 200\times10^{-6}\ \Omega$

R_{circut} (other than contact resistance) $= 100\times10^{-6}\ \Omega$

$R_{total} = (100 + 200)\times10^{-6} = 300\times10^{-6}\ \Omega$

The heat generated at the interface (H) = $I^2 R\,\tau$

$$I = \frac{V}{R_{total}} = \frac{5}{300\times10^{-6}} = \frac{50000}{3} = 16{,}666.7A$$

$H = I^2 \times R_{contact} \times \tau$

$= (16{,}666.7)^2 \times 200 \times 10^{-6}\times0.2$

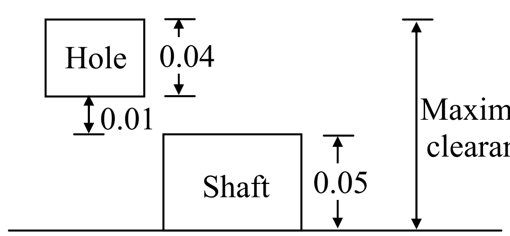
$= 11111.15$ J $= 11.1$ kJ

38. A shaft is specified as $50^{0.050}_{0.000}$ mm. The mating hole has clearance fit with minimum clearance of 0.01 mm. The tolerance on the hole is 0.04mm. The maximum clearance in mm between the hole and the shaft is

(A) 0.05 mm (B) 0.01 mm (C) 0.5 mm (D) 0.1 mm

38. Ans: (D)

Sol:



As clearly seen in the figure,

Maximum clearance = $(\text{Upper limit})_{hole} - (\text{lower limit})_{shaft}$

$= (0.05 + 0.01 + 0.04) - 0 = 0.1$ mm

(OR)

Minimum clearance = diff. between maximum material limits

= L-hole – H-shaft

L-hole = min. clearance + H-shaft = 0.01 + 50.05 = 50.06mm

Hole Tol. = H-hole – L-hole

H-hole = L-hole + Hole Tol. = 50.06 + 0.04 = 50.10mm

Maximum clearance = diff. between minimum material limits

= H-hole – L-shaft = 50.10 – 50.00 = 0.1 mm

DISTRACTOR LOGIC :

DLOA: Maximum clearance = Min. clearance+ tolerance of hole

= 0.01 + 0.04 = 0.05 (Incorrect).

DLOB: Maximum clearance = $(\text{Upper limit})_{hole}$ – $(\text{lower limit})_{shaft}$

= (0.05 + 0.01 + 0.04) = 0.01 mm. Calculation mistake, Incorrect).

DLOC: Maximum clearance = Min. clearance+ tolerance of hole

= 0.01 + 0.04 = 0. 5 (Calculation mistake, Incorrect).

DLOD: Correct option (As explained above).

39. A monopolistic firm produced two goods whose demand functions are

$P_1 = 12 - x_1$, $P_2 = 36 - 5x_2$

Where x_1 and x_2 are the quantities of two goods produced and P_1 and P_2 are the prices of a unit of each good knowing the cost function $c(x_1, x_2) = 2x_1x_2 + 15$. The maximum profit is ______units.

39. Ans: 57 [Range: 56 to 58]

Sol: Sales = $P_1x_1 + P_2x_2 = (12 - x_1)x_1 + (36 - 5x_2)x_2$

Cost = $c(x_1 x_2) = 2x_1x_2 + 15$

Profit = P = Sales – Cost

$\Rightarrow 12x_1 - x_1^2 + 36x_2 - 5x_2^2 - 2x_1x_2 - 15$

$\frac{dP}{dx_1} = 12 - 2x_1 - 2x_2 = 0$; $x_1 + x_2 = 6$ ------ (i)

$\frac{dP}{dx_2} = 36 - 10x_2 - 2x_1 = 0$; $x_1 + 5x_2 = 18$ ---- (ii)

eq.(i) – eq.(ii)

$\Rightarrow -4x_2 = -12$

$\therefore x_2 = 3$

$x_1 + x_2 = 6$

$x_1 + 3 = 6$

$\Rightarrow x_1 = 3$; $x_2 = 3$

$$\text{Profit} = 12x_1 - x_1^2 + 36x_2 - 5x_2^2 - 2x_1x_2 - 15$$
$$= 12 \times 3 - 3^2 + 36\times3 - 5\times3^2 - 2\times3\times3 - 15$$
$$= 36 - 9 + 108 - 45 - 18 - 15$$
$$= 57$$

40. In a bolted joint two flanges of combined stiffness 400 kN/mm are bolted by a bolt of stiffness 100 kN/mm. The pitch of the bolt is 2 mm. If the bolt is tightened by two revolutions, the tensile force (in kN) generated in the bolt is _______ .

40. Ans: 320 [Range: 320 to 320]

Sol: Let δ_P and δ_b be the compression in plate and elongation in bolt respectively.

The sum of deformation in the bolt and plate must be equal to distance traveled by the nut.

$$\delta_p + \delta_b = \delta$$

$$\frac{P}{k_p} + \frac{P}{k_b} = \delta$$

$$P = \frac{k_p k_b}{k_p + k_b} \times \delta = \frac{400 \times 100}{400 + 100} \times 4 = 320 \text{ kN}$$

41. In a plate clutch the coefficient of friction and maximum pressure intensity are 0.25 and 0.825 MPa respectively. The inner and outer diameters of the contact area are 225 mm and 300 mm respectively. The clamping force applied by the spring to hold the plates together for uniform wear theory is _______kN.

41. Ans: 21.9 [Range: 21 to 23]

Sol: $F = \int P\,dA$

$$= \int \frac{c}{r} \times 2\pi r\,dr \quad [\because P \propto \frac{1}{r} \text{ for uniform wear}]$$

$$= 2\pi c\,(R_o - R_i)$$

$$= 2\pi\,(P_{max}\,R_i)\,(R_o - R_i) \quad [\because \text{ maximum pressure is present at inner radius}]$$

$$= 2\pi\,(0.825 \times 112.5) \times (150 - 112.5) = 21.9 \text{ kN}$$

42. For a transformer having linear power source characteristics, maximum power is obtained at 40 V and 150 A. The open circuit voltage and short circuit current are _____ and _____ respectively.

(A) 40 V and 150 A (B) 80 V and 150 A

(C) 40 V and 300 A (D) 80 V and 300 A

42. Ans: (D)

Sol: According to V-I characteristics of power source

$$V = V_0 - \frac{V_0}{I_S} I \Rightarrow \frac{V_0}{I_S} I = V_0 - V \Rightarrow \frac{I}{I_S} V_0 = V_0 (1 - \frac{V}{V_0})$$

$$\Rightarrow \frac{I}{I_S} = (1 - \frac{V}{V_0}) \Rightarrow \frac{I}{I_S} + \frac{V}{V_0} = 1 \text{ ---- (i)}$$

(Where, V_0 = Open Circuit Voltage, I_S = Short Circuit Current)

$$P = VI = V_0 \left(1 - \frac{I}{I_S}\right) \times I$$

$$P = V_0 \left(I - \frac{I^2}{I_S}\right)$$

For $P = P_{max}$; $\frac{\partial P}{\partial I} = 0$

$$\frac{\partial P}{\partial I} = V_0 \left(1 - \frac{2I}{I_S}\right) = 0$$

$$I = \frac{I_s}{2} = 150\,A$$

I = 300 A

By substituting I_S value in equation (i), we get

$\Rightarrow V_0 = 80$ V

(***Shortcut method:*** V_0 should be greater than V and I_S should be greater than I, both are satisfied in D).

<u>DISTRACTOR LOGIC :</u>

DLOA : Incorrect option, if wrongly assumed/ calculated as

$$\frac{I}{I_S} + \frac{V}{V_0} = 1$$

$$\frac{150}{300} + \frac{40}{V_0} = 1$$

$$V_0 = 80V$$

$$I = \frac{I_S}{2} = 150A$$

DLOB : Incorrect option, if misinterpreted as

$V = V_0$

$I = I_s$.

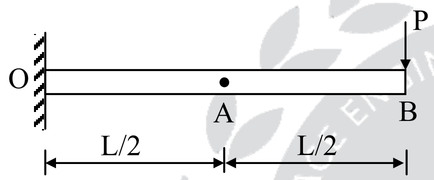
DLOC : Incorrect option, if misinterpreted as

$V = V_s$

$2I = I_s = 2 \times 150 = 300$ Amp

DLOD : Correct option (As explained above).

43. The cantilever beam of length 'L' and flexural rigidity EI carries a point load 'P' at its free end as shown in the figure below.

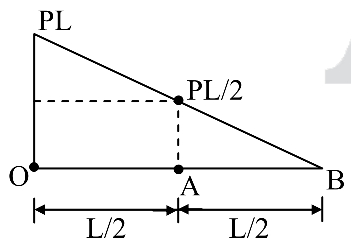


The deflection at point 'A' on the beam is

(A) $\frac{PL^3}{6\,EI}$ (B) $\frac{5\,PL^3}{24\,EI}$ (C) $\frac{5\,PL^3}{48\,EI}$ (D) $\frac{5\,PL^3}{6EI}$

43. Ans: (C)

Sol: The deflection at point 'A' can be found from moment area method as given below.



$$\delta_{A/O} = \frac{1}{EI}\text{(Moment of area of BMD between O and A about A)}$$

$$= \frac{1}{EI}\left[\left(\frac{PL}{2}\times\frac{L}{2}\right)\times\left(\frac{L}{4}\right)+\left(\frac{1}{2}\times\frac{PL}{2}\times\frac{L}{2}\right)\times\left(\frac{2}{3}\times\frac{L}{2}\right)\right]$$

$$= \frac{PL^3}{EI}\left(\frac{1}{16}+\frac{1}{24}\right) = \frac{5PL^3}{48EI}$$

DISTRACTOR LOGIC :

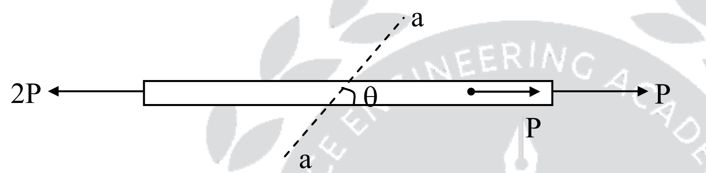
DLOA : If deflection of 'A' is considered as half of that of 'B' then option 'A' is obtained.

DLOB : If lengths $\frac{L}{2}$ and $\frac{2L}{3}$ are considered while calculating C.G. of rectangle and triangle instead of $\frac{L}{4}$ and $\frac{2}{3}\left(\frac{L}{2}\right)$ then option 'B' is obtained.

DLOC : Correct option.

DLOD : If total length of beam is considered (2L) instead of 'L' then option 'D' is obtained.

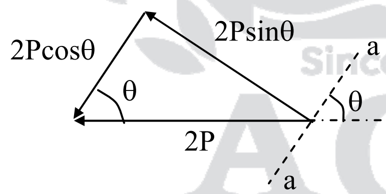
44. A bar of uniform cross-section 'A' carries concentrated loads as shown in the diagram below. The normal stress on the inclined plane a-a is



(A) $\frac{P}{A}\sin^2\theta$ (B) $\frac{2P}{A}\sin^2\theta$ (C) $\frac{P}{A}\sin 2\theta$ (D) $\frac{2P}{A}\cos^2\theta$

44. Ans: (B)

Sol: The force in section a-a is 2P which can be resolved into normal and tangential components as,



The resisting area along a-a is $\frac{A}{\sin\theta}$.

$$\sigma_n = \frac{\text{Normal force}}{\text{Resisting area}} = \frac{(2P\sin\theta)}{(A/\sin\theta)} = \frac{2P}{A}\sin^2\theta$$

DISTRACTOR LOGIC :

DLOA : If force 'P' is considered instead of '2P' then option 'A' is obtained.

DLOB : Correct option

DLOC : If force 'P' is considered instead of '2P' and tangential component is calculated instead of normal component then option 'C' is obtained.

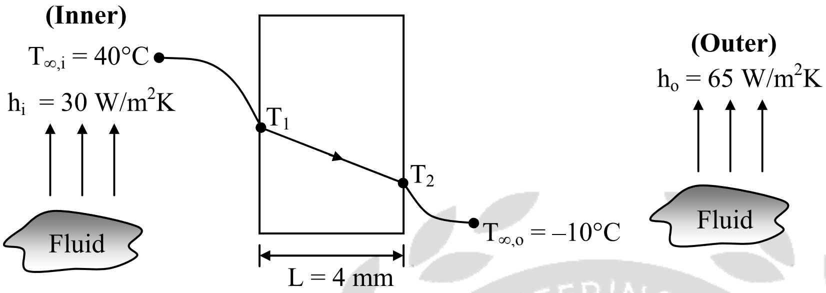
DLOD : If tangential component is considered or angle '90 – θ' is considered instead of θ then option 'D' is obtained.

45. The rear window of an automobile is defogged by passing warm air over its inner surface. The warm air is at $T_{\infty,i}$ = 40°C and the corresponding convection coefficient is h_i = 30 W/m^2-K. The outside ambient air temperature is $T_{\infty,o}$ = –10°C and the associated convection coefficient is h_o = 65 W/m^2-K. The outer surface temperature of 4 mm thick window glass (k = 1.2 W/m-K) is

(A) 4.77°C (B) 18.87°C (C) 7.94°C (D) 20.76°C

45. Ans: (A)

Sol:



$$\text{Heat transfer rate} = \frac{T_{\infty,i} - T_{\infty,o}}{\frac{1}{h_i A} + \frac{L}{k.A} + \frac{1}{h_o A}} = \frac{T_2 - T_{\infty,o}}{\frac{1}{h_o.A}} \text{ -----------(1)}$$

$$\Rightarrow \quad \frac{40-(-10)}{\frac{1}{30} + \frac{0.004}{1.2} + \frac{1}{65}} = \frac{T_2 - (-10)}{\frac{1}{65}}$$

$$\frac{50}{0.052} = (T_2 + 10) \times 65$$

$$T_2 = 4.77°C$$

DISTRACTOR LOGIC:

DLOA : Correct option

DLOB : Incorrectly taken $T_{\infty,o}$ = 10°C instead of –10°C in equation (1)

DLOC : Inner surface temperature is calculated instead of outer surface.

DLOD : Inner surface temperature is calculated instead of outer surface by using $T_{\infty,o}$ = 10°C instead of -10°C.

46. A project has a gain in NPV of Rs. 12632 when a discount rate of 12 % is used. The same project has loss in NPV of Rs. 6935 when discount rate of 22% is used. Actual internal rate of return for the project is

(A) 6.5 % (B) 28.5 % (C) 16.5 % (D) 18.5 %

46. Ans: (D)

Sol:

NPV		DISCOUNT RATE
12, 632	—	12
		←– r
(–) 63935	—	22

ΔNPV = 19567 , Δr = –10 %

ΔNPV_1 = 12632 , Δr_1 = ?

$$\Delta r_1 = \frac{\Delta NPV_1}{\Delta NPV} \times \Delta r = \frac{12632}{19567} \times (-10) = -6.46\ \%$$

$\Rightarrow \Delta r_1 = 12 - r$

$\Rightarrow$ r = 12 + 6.46 = 18.46 %

NPV has to be zero for internal rate of return by interpolation we have r as 18.5 %

47. The failure rate of each component is 0.004/hour. Three such components are in parallel redundancy if it is converted to one basic component and two stand by components. The increase in mean time to failure (MTTF) of system is

(A) 127 hours (B) 292 hours (C) 153 hours (D) 243 hours

47. Ans: (B)

Sol: Parallel redundancy

$$MTTF = \frac{1}{\lambda}\left(1 + \frac{1}{2} + \frac{1}{3}\right)$$

$$= \frac{1}{0.004}\left(1 + \frac{1}{2} + \frac{1}{3}\right) = 458.33 \text{ hours}$$

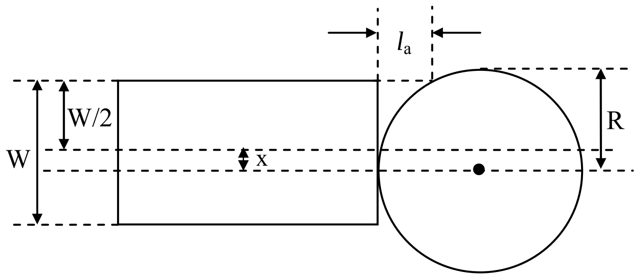
Stand by redundancy

$$MTTF = \frac{n+1}{\lambda}$$

$$= \frac{2+1}{0.004} = 750 \text{ hours}$$

Increase MTTF = 750 – 458.33 = 291.67 hours

48. A schematic diagram of face milling operation is shown in the figure.



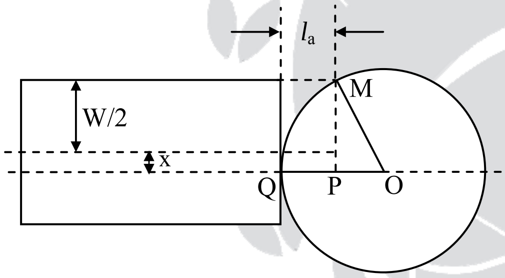
If R is the cutter radius, 'W' is the width of the workpiece and 'x' is the offset, then the length of approach (ℓ_a) is expressed as

(A) $R-\sqrt{R^2+\left(\frac{W}{2}+x\right)^2}$ (B) $R-\sqrt{R^2-\left(\frac{W}{2}+x\right)^2}$

(C) $R-\sqrt{R^2-\left(\frac{W}{2}-x\right)^2}$ (D) $R+\sqrt{R^2-\left(\frac{W}{2}-x\right)^2}$

48. Ans: (B)

Sol:



$\ell_a = PQ = OQ - OP$

$= R-\sqrt{OM^2-MP^2}$ (Applying Pythagoras theorem)

$\ell_a = R-\sqrt{R^2-\left(\frac{W}{2}+x\right)^2}$

DISTRACTOR LOGIC :

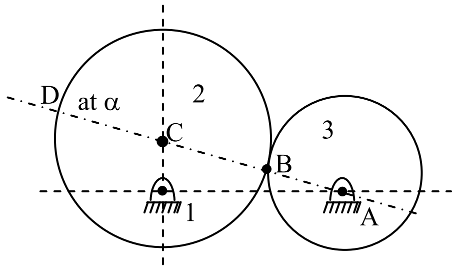
DLOA : Applying Pythagoras theorem incorrectly.

DLOB : Correct.

DLOC : Offset 'x' can be wrongly subtracted from half – width.

DLOD : Wrong identification of approach length ℓ_a

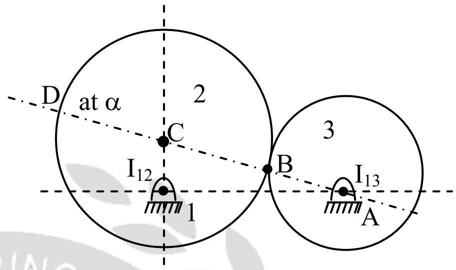
49. Two circular discs are connected as shown in figure. The instantaneous centre between the discs 2 and 3 is located at



(A) A (B) B
(C) Either A or B (D) cannot be predicted

49. Ans: (A)

Sol:



Disc ‘1’ does not rotate about its C.G.

The motion at ‘B’ is rolling as well as Sliding.

Common normal is locus of I_{23} and it is line joining both the disc centres.

By Kennedy’s Theorem I_{23} is located on line joining I_{12} and I_{13}.

Both the above mentioned lines intersect at the centre of disc 3 i.e at A.

DISTRACTOR LOGIC :

DLOA : Correct option

DLOB : When we assume both the discs running about centre of mass then B is instantaneous centre of mass for system.

DLOC : Lines intersect at disc centre 3 i.e., A . So, wrong option

DLOD : Wrong option

50. It is desired to give 97.72 % confidence in an estimate of weight in a population of cereal boxes, if standard deviation is estimated to be 0.8 ounce and an accuracy of ± 0.1 ounce. The required number of observations for the sample should be ______

50. Ans: 64 [Range: 64 to 64]

Sol: For 97.72 % confidence level, z = 2

Standard deviation = s = 0.8 ounce

Error = e = 0.1 ounce

$$n = \left(\frac{zs}{e}\right)^2 = \left(\frac{2\times 0.8}{0.1}\right)^2 = 64 \text{ observations}$$

51. If 20 kJ of heat is added to Carnot cycle at temperature of 100°P (where °P is an arbitrary unit of temperature) and 14.6 kJ is rejected at 0°P, the location of absolute zero on the scale is [Assume linear relation between temperature in Kelvin (K) and the arbitrary unit (°P)].

(A) –273.15 (B) –273.16 (C) –270.37 (D) +273.15

51. Ans: (C)

Sol: Consider an absolute thermodynamic temperature T.

Such that for Carnot cycle

$\Rightarrow \dfrac{Q_1}{Q_2} = \dfrac{T_1}{T_2}$ [where $Q_1 = 20$ kJ, $Q_2 = 14.6$]

$\Rightarrow \dfrac{20}{14.6} = \dfrac{T_1}{T_2}$

$\because$ T = (at + b)

Let, $T_1 = (at_1 + b)$, $T_2 = at_2 + b$

$\therefore$ $T_1 = at_1 + b$, $T_2 = at_2 + b$

$\therefore$ $T_1 = a \times 100 + b$, $T_2 = a \times 0 + b = b$

$\Rightarrow \dfrac{20}{14.6} = \left(\dfrac{100a + b}{b}\right)$

$20b = 14.6 \times 100a + 14.6b$

$\therefore$ b = 270.37a

At absolute zero, T = 0

$\therefore$ 0 = at + b

$\therefore$ 0 =at + 270.37a

$\therefore$ t = –270.37°P

DISTRACTOR LOGIC :

DLOA : Absolute zero in Kelvin scale is equivalent to –273.15°P in celsius scale. This option is given to confuse the student.

DLOB : This option is incorrect and is given to confuse the student. –273.16

In Kelvin scale absolute zero is equal to –273.16°P in celcius scale. So option B is also wrong.

DLOC : Explained in the above solution.

DLOD : This option is given to confuse the student. Absolute zero in Celsius scale cannot be 273.15°P, it must be below 0°P.

52. The system of linear equations

$$x_1 - 3x_2 + 2x_3 = 5$$
$$x_1 - x_3 = -1$$
$$x_1 - 2x_2 + x_3 = 5 \text{ has}$$

(A) exactly two solutions (B) no solution

(C) a unique solution (D) many solutions

52. Ans: (B)

Sol: Consider the augmented matrix of the given system

$$[A|B] = \left[\begin{array}{ccc|c} 1 & -3 & 2 & 5 \\ 1 & 0 & -1 & -1 \\ 1 & -2 & 1 & 5 \end{array}\right]$$

$$R_2 \to R_2 - R_1, \quad R_3 \to R_3 - R_1 \quad \sim \left[\begin{array}{ccc|c} 1 & -3 & 2 & 5 \\ 0 & 3 & -3 & -6 \\ 0 & 1 & -1 & 0 \end{array}\right]$$

$$R_3 \to 3R_3 - R_2 \quad \sim \left[\begin{array}{ccc|c} 1 & -3 & 2 & 5 \\ 0 & 3 & -3 & -6 \\ 0 & 0 & 0 & 6 \end{array}\right]$$

Here, $\rho(A) = 2$ and $\rho(A|B) = 3$

$\therefore$ The given system is inconsistent and has no solution

53. The directional derivative of $\phi(x, y, z) = xy^2z + 4yz^2$ at the point P(1, 2, –1) along $\bar{i} - 2\bar{j} + \bar{k}$ is ___.

(A) –16 (B) $\frac{1}{\sqrt{6}}$ (C) $\frac{-16}{\sqrt{6}}$ (D) $\frac{16}{\sqrt{7}}$

53. Ans: (C)

Sol: Given that $\phi(x, y, z) = xy^2z + 4yz^2$

Let $\bar{a} = \bar{i} - 2\bar{j} + \bar{k}$ & P = (1, 2, –1)

Now $\nabla\phi = \text{grad } \phi = \bar{i}\frac{\partial\phi}{\partial x} + \bar{j}\frac{\partial\phi}{\partial y} + \bar{k}\frac{\partial\phi}{\partial x}$

$\Rightarrow \nabla\phi = \bar{i}\left(y^2z\right) + \bar{j}\left(2xyz + 4z^2\right) + \bar{k}\left(xy^2 + 8yz\right)$

$\Rightarrow (\nabla\phi)_P = (-4)\ \bar{i} + (0)\ \bar{j} + (-12)\ \bar{k}$

Now the directional derivative of the function $\phi(x, y, z)$ in the direction of a vector $\bar{a}$ at the point P

$= (\nabla\phi)_P \cdot \frac{\bar{a}}{|\bar{a}|}$

$= \left((-4)\bar{i} + (0)\bar{j} + (-12)\bar{k}\right) \cdot \frac{\left(\bar{i} - 2\bar{j} + \bar{k}\right)}{\sqrt{(1)^2 + (-2)^2 + (1)^2}}$

$= \frac{(-4)(1) + (0)(-2) + (-12)(1)}{\sqrt{1+4+1}}$

$= \frac{-16}{\sqrt{6}}$

54. The particular integral of $2x^2 \frac{d^2y}{dx^2} + 3x\frac{dy}{dx} - 3y = x^3$ is ________.

(A) $\frac{x^3}{6}$ (B) $\frac{x^3}{12}$ (C) $\frac{x^3}{16}$ (D) $\frac{x^3}{18}$

54. Ans: (D)

Sol: The given Euler-Cauchy's form can be converted to

$2D(D-1)y + 3Dy - 3y = e^{3z}$ (where $D = \frac{d}{dz}$, $x = e^z$ & $z = \log x$)

$(2D^2 + D - 3)y = e^{3z}$

$\therefore\ y_p = \frac{e^{3z}}{(2D^2 + D - 3)}$

$= \frac{e^{3z}}{(2D+3)(D-1)} = \frac{e^{3z}}{(6+3)(3-1)} = \frac{e^{3z}}{18} = \frac{x^3}{18}$

55. A person goes to office either by car, scooter, bus or train, the probability of which being $\frac{1}{7}, \frac{3}{7}, \frac{2}{7}$ and $\frac{1}{7}$ respectively. Probability that he reaches office late, if he takes car, scooter, bus or train are $\frac{2}{9}, \frac{1}{9}, \frac{4}{9}$ and $\frac{1}{9}$ respectively. Given that he reached office in time, then the probability that he travelled by car is

(A) $\frac{1}{5}$ (B) $\frac{1}{6}$ (C) $\frac{1}{7}$ (D) $\frac{1}{8}$

55. Ans: (C)

Sol: $P(C) = \frac{1}{7}$, $P(S) = \frac{3}{7}$, $P(B) = \frac{2}{7}$, $P(T) = \frac{1}{7}$

Let E be the event that he reaches office in time.

$$P(E\,|\,C) = \frac{7}{9}, P(E\,|\,S) = \frac{8}{9}$$

$$P(E\,|\,B) = \frac{5}{9}; P(E\,|\,T) = \frac{8}{9}$$

$$P(C\,|\,E) = \frac{\frac{1}{7}\times\frac{7}{9}}{\left(\frac{1}{7}\times\frac{7}{9}\right)+\left(\frac{3}{7}\times\frac{8}{9}\right)+\left(\frac{2}{7}\times\frac{5}{9}\right)+\left(\frac{1}{7}\times\frac{8}{9}\right)} = \frac{1}{7}$$

NEW BATCHES - 2019
ADMISSIONS OPEN

CENTER	COURSE	BATCH TYPE	DATE
HYDERABAD - Abids	GATE + PSUs – 2019	Morning Batch	20th January 2018
HYDERABAD - Abids	GATE + PSUs – 2019	Weekend Batch	20th January 2018
HYDERABAD - Abids	ESE + GATE + PSUs – 2019	Morning Batch	20th January 2018
HYDERABAD - DSNR	GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - DSNR	GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - DSNR	ESE + GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - DSNR	ESE + GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - Kukatpally	GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - Kukatpally	GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - Kukatpally	ESE + GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - Kukatpally	ESE + GATE + PSUs – 2019	Evening Batch	19th January 2018
Delhi	GATE + PSUs – 2019	Weekend Batch	13th & 27th January 2018
Delhi	GATE + PSUs – 2019	Regular Batch (Evening)	24th February 2018
Delhi	ESE + GATE + PSUs – 2019	Weekend Batch	13th & 27th January 2018
Delhi	ESE + GATE + PSUs – 2019	Regular Batch (Evening)	24th February 2018
Bhopal	GATE + PSUs – 2019	Morning & EveningBatch	29th January 2018
Bhopal	GATE + PSUs – 2020	Morning & EveningBatch	29th January 2018
Bhopal	ESE+GATE + PSUs – 2019	Morning & Evening Batch	29th January 2018
Bhopal	ESE+GATE + PSUs – 2020	Morning & Evening Batch	29th January 2018
Pune	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Pune	GATE + PSUs – 2019	Evening Batch	22nd January 2018
Pune	ESE+GATE + PSUs – 2020	Weekend Batch	20th January 2018
Bengaluru	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Vijayawada	GATE + PSUs – 2019&20	Weekend Batch	21st January 2018
Kolkata	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Kolkata	GATE + PSUs – 2020	Weekend Batch	20th January 2018