

# **SESSION - 1**

I tcf wcwg'Cr vkwf g'Vguv'kp 'Gpi kp ggt kpi

Pqwvkpu'<

1. Options shown in green color and with ✓ icon are correct.
  2. Options shown in red color and with ✗ icon are incorrect.

S wgumqp'Rcr gt 'P co g<

O G<O GEJ CP KECN'GP I KP GGTKP I '53uv'Lcp"Uj kln4

Pwo dgt 'qh'S wgumkpiuk

87

VqwrO ctmk

322Ω

Wrong answer for MCQ will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks Questions.

## General Aptitude

P wo dgt "qh'S wgukqpu<

32

Ugev̄kqp'ōctm̄k

370

Q.1 to Q.5 carry 1 mark each & Q.6 to Q.10 carry 2 marks each.

S wgunkqp'P wo dgt '<3"S wgunkqp'V{ rg"<O ES

Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Dhoni, as well as the other team members of Indian team, present on the occasion.



Or w̥kpu'<

1. \* A
  2. ✓ B
  3. \* C
  4. \* D

S wgukqp'P wo dgt '24"S wgukqp'V{ rg"2O ES

Choose the word most similar in meaning to the given word:

### Awkward



Or w̄kpu'≤

- 1. ✓ A
  - 2. ✗ B
  - 3. ✗ C
  - 4. ✗ D

S w<sub>1</sub>W<sub>2</sub>W<sub>3</sub>'P wo dgt "≤5" S w<sub>1</sub>W<sub>2</sub>W<sub>3</sub>'V{ r g"≤Q E S

What is the adverb for the given word below?

Misogynous

- (A) Misogynousness    (B) Misogyny    (C) Misogynously    (D) Misogynous

Options :

1. ✘ A
2. ✘ B
3. ✓ C
4. ✘ D

Question Number : 4 Question Type : MCQ

An electric bus has onboard instruments that report the total electricity consumed since the start of the trip as well as the total distance covered. During a single day of operation, the bus travels on stretches M, N, O, and P, in that order. The cumulative distances travelled and the corresponding electricity consumption are shown in the Table below:

Stretch	Cumulative distance (km)	Electricity used (kWh)
M	20	12
N	45	25
O	75	45
P	100	57

The stretch where the electricity consumption per km is minimum is

- (A) M    (B) N    (C) O    (D) P

Options :

1. ✘ A
2. ✘ B
3. ✘ C
4. ✓ D

Question Number : 5 Question Type : MCQ

Ram and Ramesh appeared in an interview for two vacancies in the same department. The probability of Ram's selection is  $\frac{1}{6}$  and that of Ramesh is  $\frac{1}{8}$ . What is the probability that only one of them will be selected?

- (A)  $\frac{47}{48}$   
(B)  $\frac{1}{4}$   
(C)  $\frac{13}{48}$   
(D)  $\frac{35}{48}$

Options :

1. ✘ A
2. ✓ B
3. ✘ C
4. ✘ D

**Question Number : 6 Question Type : MCQ**

In the following sentence certain parts are underlined and marked P, Q, and R. One of the parts may contain certain 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.

The student corrected all the errors that the instructor marked on the answer book.

- |              |       |       |
|--------------|-------|-------|
| P            | Q     | R     |
| (A) P        | (B) Q | (C) R |
| (D) No Error |       |       |

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 7 Question Type : MCQ**

Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

**Statements:**

- I. All film stars are playback singers.
- II. All film directors are film stars.

**Conclusions:**

- I. All film directors are playback singers.
- II. Some film stars are film directors.

- (A) Only conclusion I follows.
- (B) Only conclusion II follows.
- (C) Neither conclusion I nor II follows.
- (D) Both conclusions I and II follow.

**Options :**

1. ✗ A
2. ✗ B
3. ✗ C
4. ✓ D

**Question Number : 8 Question Type : PCV**

A tiger is 50 leaps of its own behind a deer. The tiger takes 5 leaps per minute to the deer's 4. If the tiger and the deer cover 8 metre and 5metre per leap respectively, what distance in metres will the tiger have to run before it catches the deer?

**Eqt tgev'Cpuy gt :**

800

**Question Number : 9 Question Type : MCQ**

If  $a^2 + b^2 + c^2 = 1$ , then  $ab + bc + ac$  lies in the interval

- (A)  $[1, 2/3]$
- (B)  $[-1/2, 1]$
- (C)  $[-1, 1/2]$
- (D)  $[2, -4]$

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 10 Question Type : MCQ

Lamenting the gradual sidelining of the arts in school curricula, a group of prominent artists wrote to the Chief Minister last year, asking him to allocate more funds to support arts education in schools. However, no such increase has been announced in this year's Budget. The artists expressed their deep anguish at their request not being approved, but many of them remain optimistic about funding in the future.

Which of the statement(s) below is/are logically valid and can be inferred from the above statements?

- (i) The artists expected funding for the arts to increase this year.
- (ii) The Chief Minister was receptive to the idea of increasing funding for the arts.
- (iii) The Chief Minister is a prominent artist.
- (iv) Schools are giving less importance to arts education nowadays.

(A) (iii) and (iv)      (B) (i) and (iv)      (C) (i), (ii) and (iv)      (D) (i) and (iii)

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

### Mechanical Engineering

Number of Questions:	55
Section Marks:	85.0

Q.11 to Q.35 carry 1 mark each & Q.36 to Q.65 carry 2 marks each.

Question Number : 11 Question Type : MCQ

If any two columns of a determinant  $P = \begin{vmatrix} 4 & 7 & 8 \\ 3 & 1 & 5 \\ 9 & 6 & 2 \end{vmatrix}$  are interchanged, which one of the following statements regarding the value of the determinant is **CORRECT**?

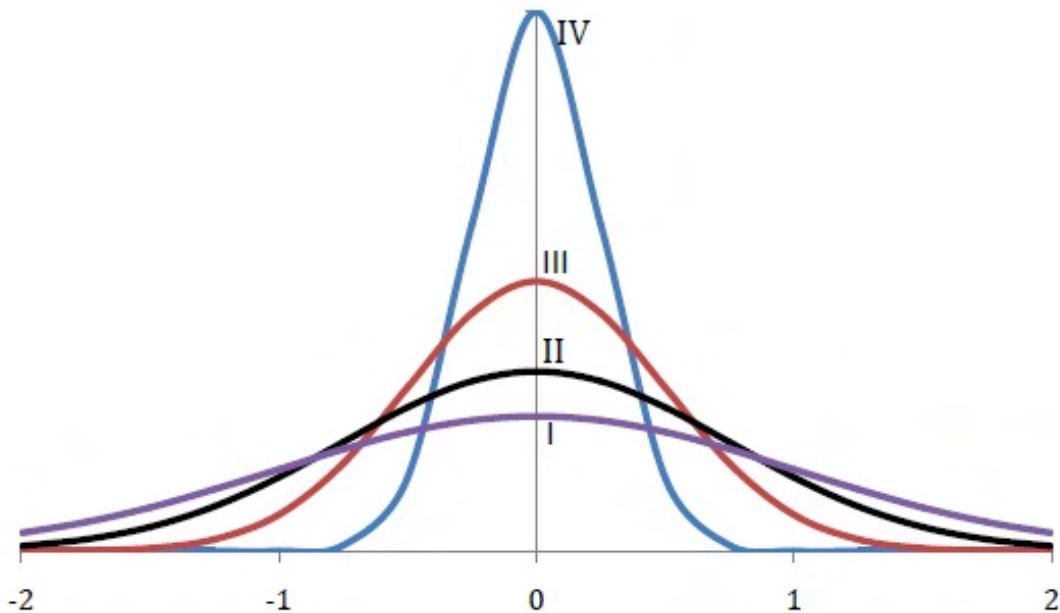
- (A) Absolute value remains unchanged but sign will change.
- (B) Both absolute value and sign will change.
- (C) Absolute value will change but sign will not change.
- (D) Both absolute value and sign will remain unchanged.

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 12 Question Type : MCQ

Among the four normal distributions with probability density functions as shown below, which one has the lowest variance?



(A) I

(B) II

(C) III

(D) IV

Options :

1. ✗ A
2. ✗ B
3. ✗ C
4. ✓ D

Question Number : 13 Question Type : PCV

Simpson's  $\frac{1}{3}$  rule is used to integrate the function  $f(x) = \frac{3}{5}x^2 + \frac{9}{5}$  between  $x = 0$  and  $x = 1$  using the least number of equal sub-intervals. The value of the integral is \_\_\_\_\_

**Eqt tgev' Cpu y gt :**

2

**Question Number : 14 Question Type : MCQ**

The value of  $\lim_{x \rightarrow 0} \frac{1 - \cos(x^2)}{2x^4}$  is



## **Options :**

1. ✗ A
  2. ✗ B
  3. ✓ C
  4. ✗ D

**Question Number : 15 Question Type : MCQ**

Given two complex numbers  $z_1 = 5 + (5\sqrt{3})i$  and  $z_2 = \frac{2}{\sqrt{3}} + 2i$ , the argument of  $\frac{z_1}{z_2}$  in degrees is



## Options :

1. ✓ A
  2. ✗ B
  3. ✗ C
  4. ✗ D

**Question Number : 16 Question Type : MCQ**

Consider fully developed flow in a circular pipe with negligible entrance length effects. Assuming the mass flow rate, density and friction factor to be constant, if the length of the pipe is doubled and the diameter is halved, the head loss due to friction will increase by a factor of



## **Options :**

1. ✘ A
  2. ✘ B
  3. ✘ C
  4. ✓ D

**Question Number : 17 Question Type : MCQ**

The Blasius equation related to boundary layer theory is a

- (A) third-order linear partial differential equation
- (B) third-order nonlinear partial differential equation
- (C) second-order nonlinear ordinary differential equation
- (D) third-order nonlinear ordinary differential equation

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✗ C
- 4. ✓ D

Question Number : 18 Question Type : MCQ

For flow of viscous fluid over a flat plate, if the fluid temperature is the same as the plate temperature, the thermal boundary layer is

- (A) thinner than the velocity boundary layer
- (B) thicker than the velocity boundary layer
- (C) of the same thickness as the velocity boundary layer
- (D) not formed at all

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✗ C
- 4. ✓ D

Question Number : 19 Question Type : MCQ

For an ideal gas with constant values of specific heats, for calculation of the specific enthalpy,

- (A) it is sufficient to know only the temperature
- (B) both temperature and pressure are required to be known
- (C) both temperature and volume are required to be known
- (D) both temperature and mass are required to be known

Options :

- 1. ✓ A
- 2. ✗ B
- 3. ✗ C
- 4. ✗ D

Question Number : 20 Question Type : PCV

A Carnot engine (CE-1) works between two temperature reservoirs A and B, where  $T_A = 900\text{ K}$  and  $T_B = 500\text{ K}$ . A second Carnot engine (CE-2) works between temperature reservoirs B and C, where  $T_C = 300\text{ K}$ . In each cycle of CE-1 and CE-2, all the heat rejected by CE-1 to reservoir B is used by CE-2. For one cycle of operation, if the net Q absorbed by CE-1 from reservoir A is 150 MJ, the net heat rejected to reservoir C by CE-2 (in MJ) is \_\_\_\_\_

EqttgevCpu gt :

50

Question Number : 21 Question Type : PCV

Air enters a diesel engine with a density of  $1.0 \text{ kg/m}^3$ . The compression ratio is 21. At steady state, the air intake is  $30 \times 10^{-3} \text{ kg/s}$  and the net work output is 15 kW. The mean effective pressure (in kPa) is \_\_\_\_\_

EqttgevCpu gt :

525

Question Number : 22 Question Type : PCV

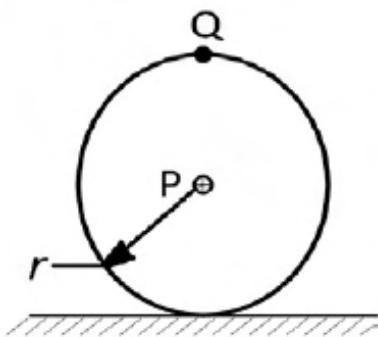
A stream of moist air (mass flow rate =  $10.1 \text{ kg/s}$ ) with humidity ratio of  $0.01 \frac{\text{kg}}{\text{kg dry air}}$  mixes with a second stream of superheated water vapour flowing at  $0.1 \text{ kg/s}$ . Assuming proper and uniform mixing with no condensation, the humidity ratio of the final stream (in  $\frac{\text{kg}}{\text{kg dry air}}$ ) is \_\_\_\_\_

EqttgevCpu gt :

0.02

Question Number : 23 Question Type : PCV

A wheel of radius  $r$  rolls without slipping on a horizontal surface shown below. If the velocity of point P is  $10 \text{ m/s}$  in the horizontal direction, the magnitude of velocity of point Q (in m/s) is \_\_\_\_\_



EqttgevCpu gt :

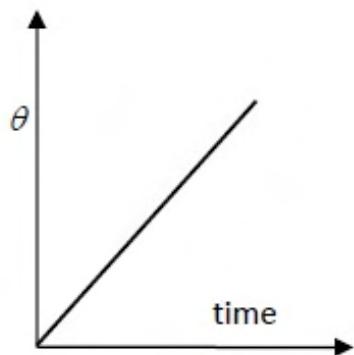
20

Question Number : 24 Question Type : MCQ

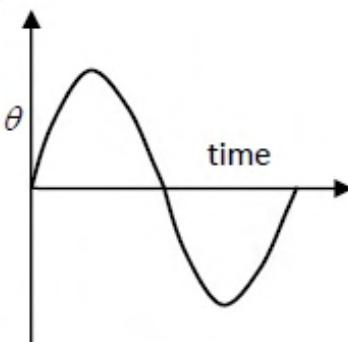
Consider a slider crank mechanism with nonzero masses and inertia. A constant torque  $\tau$  is applied on the crank as shown in the figure. Which of the following plots best resembles variation of crank angle,  $\theta$  versus time



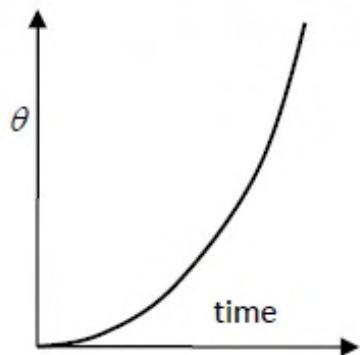
(A)



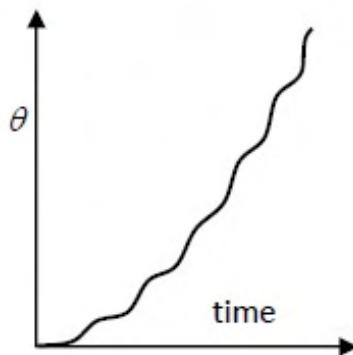
(B)



(C)



(D)

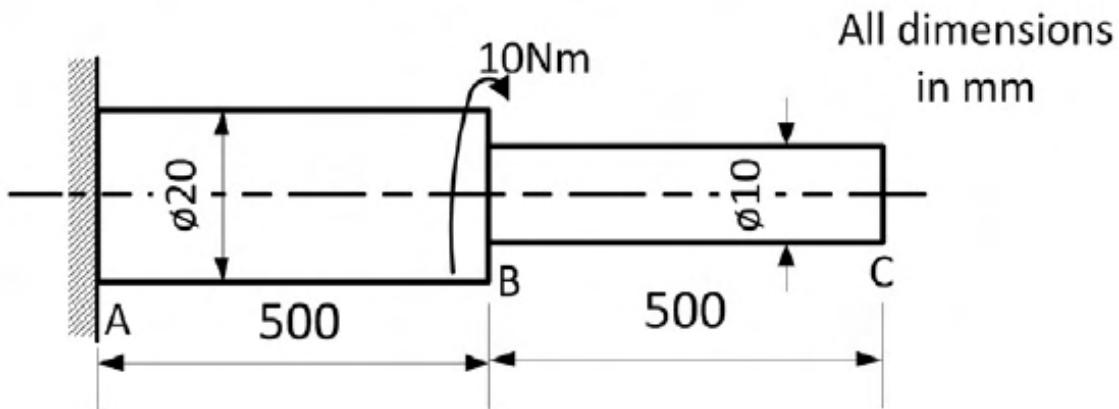


Options :

1. ✘ A
2. ✘ B
3. ✘ C
4. ✓ D

Question Number : 25 Question Type : PCV

Consider a stepped shaft subjected to a twisting moment applied at B as shown in the figure. Assume shear modulus,  $G = 77 \text{ GPa}$ . The angle of twist at C (in degrees) is \_\_\_\_\_

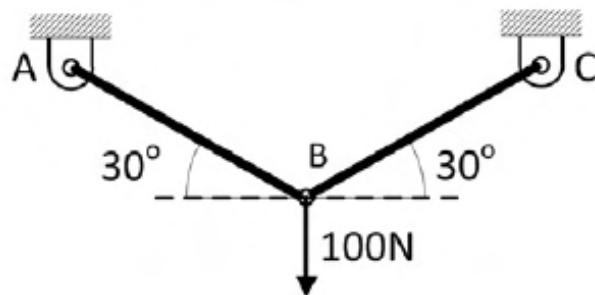


EqtgevCpu $\gamma$  gt:

0.22 to 0.25

Question Number : 26 Question Type : PCV

Two identical trusses support a load of 100 N as shown in the figure. The length of each truss is 1.0 m; cross-sectional area is  $200 \text{ mm}^2$ ; Young's modulus  $E = 200 \text{ GPa}$ . The force in the truss AB (in N) is \_\_\_\_\_



EqtgevCpu $\gamma$  gt:

100

Question Number : 27 Question Type : PCV

Consider a steel (Young's modulus  $E = 200 \text{ GPa}$ ) column hinged on both sides. Its height is 1.0 m and cross-section is 10 mm  $\times$  20 mm. The lowest Euler critical buckling load (in N) is \_\_\_\_\_

EqtgevCpu $\gamma$  gt:

3285 to 3295

Question Number : 28 Question Type : PCV

A swimmer can swim 10 km in 2 hours when swimming along the flow of a river. While swimming against the flow, she takes 5 hours for the same distance. Her speed in still water (in km/h) is \_\_\_\_\_

Eqttgev'Cpu y gt :

3.5

Question Number : 29 Question Type : MCQ

Which one of the following is the most conservative fatigue failure criterion?

- (A) Soderberg
- (B) Modified Goodman
- (C) ASME Elliptic
- (D) Gerber

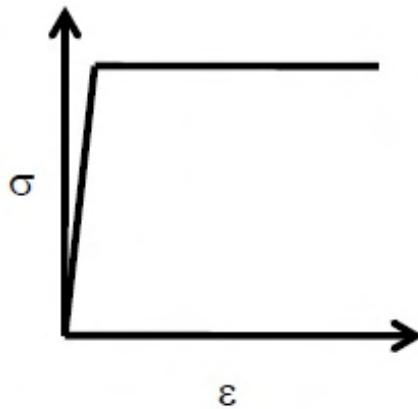
Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

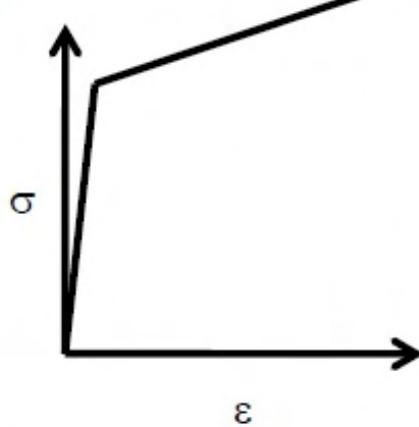
Question Number : 30 Question Type : MCQ

Which one of the following types of stress-strain relationship best describes the behaviour of brittle materials, such as ceramics and thermosetting plastics, ( $\sigma$  = stress and  $\varepsilon$  = strain)?

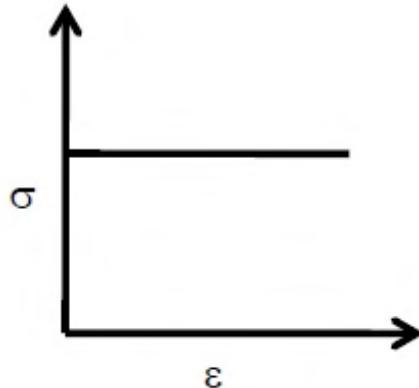
(A)



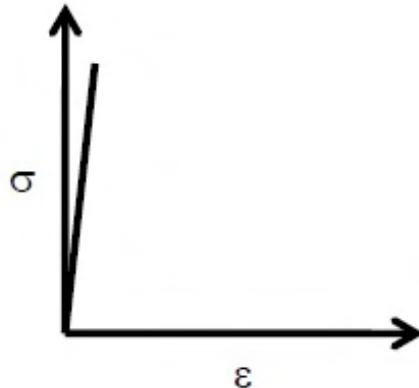
(B)



(C)



(D)



Options :

1. ✗ A
2. ✗ B
3. ✗ C
4. ✓ D

**Question Number : 31 Question Type : MCQ**

Match the following products with preferred manufacturing processes:

Product		Process	
P	Rails	1	Blow molding
Q	Engine crankshaft	2	Extrusion
R	Aluminium channels	3	Forging
S	PET water bottles	4	Rolling

- (A) P-4, Q-3, R-1, S-2
- (B) P-4, Q-3, R-2, S-1
- (C) P-2, Q-4, R-3, S-1
- (D) P-3, Q-4, R-2, S-1

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 32 Question Type : MCQ**

Holes of diameter  $25.0^{+0.040}_{-0.020}$  mm are assembled interchangeably with the pins of diameter  $25.0^{+0.005}_{-0.008}$  mm. The minimum clearance in the assembly will be

- (A) 0.048 mm
- (B) 0.015 mm
- (C) 0.005 mm
- (D) 0.008 mm

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 33 Question Type : PCV**

Under certain cutting conditions, doubling the cutting speed reduces the tool life to  $\left(\frac{1}{16}\right)^{th}$  of the original. Taylor's tool life index ( $n$ ) for this tool-workpiece combination will be \_\_\_\_\_

**Eqt tgev' Cpu y gt :**

0.25

**Question Number : 34 Question Type : MCQ**

In a linear arc welding process, the heat input per unit length is inversely proportional to

- (A) welding current
- (B) welding voltage
- (C) welding speed
- (D) duty cycle of the power source

**Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

**Question Number : 35 Question Type : MCQ**

The function of interpolator in a CNC machine controller is to

- (A) control spindle speed
- (B) coordinate feed rates of axes
- (C) control tool rapid approach speed
- (D) perform Miscellaneous (M) functions (tool change, coolant control etc.)

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 36 Question Type : PCV**

Consider a spatial curve in three-dimensional space given in parametric form by

$$x(t) = \cos t, \quad y(t) = \sin t, \quad z(t) = \frac{2}{\pi}t, \quad 0 \leq t \leq \frac{\pi}{2}.$$

The length of the curve is \_\_\_\_\_

**Eqt tgevCpu y gt :**

1.85 to 1.87

**Question Number : 37 Question Type : PCV**

Consider an ant crawling along the curve  $(x - 2)^2 + y^2 = 4$ , where  $x$  and  $y$  are in meters. The ant starts at the point  $(4, 0)$  and moves counter-clockwise with a speed of 1.57 meters per second. The time taken by the ant to reach the point  $(2, 2)$  is (in seconds) \_\_\_\_\_

**Eqtgev' Cpu y gt :**

1.9 to 2.1

**Question Number : 38 Question Type : MCQ**

Find the solution of  $\frac{d^2y}{dx^2} = y$  which passes through the origin and the point  $(\ln 2, \frac{3}{4})$ .

- (A)  $y = \frac{1}{2}e^x - e^{-x}$
- (B)  $y = \frac{1}{2}(e^x + e^{-x})$
- (C)  $y = \frac{1}{2}(e^x - e^{-x})$
- (D)  $y = \frac{1}{2}e^x + e^{-x}$

**Options :**

- 1. ✗ A
- 2. ✗ B
- 3. ✓ C
- 4. ✗ D

**Question Number : 39 Question Type : MCQ**

The probability of obtaining at least two “SIX” in throwing a fair dice 4 times is

- (A) 425/432
- (B) 19/144
- (C) 13/144
- (D) 125/432

**Options :**

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

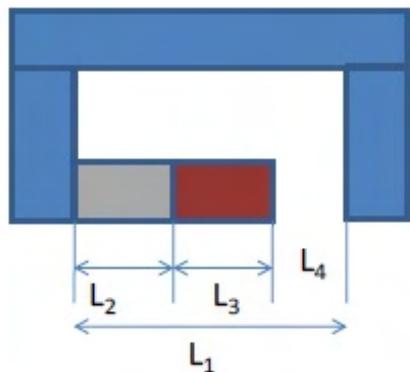
**Question Number : 40 Question Type : MCQ**

In the assembly shown below, the part dimensions are:

$$L_1 = 22.0 \pm 0.01 \text{ mm}$$

$$L_2 = L_3 = 10.0 \pm 0.005 \text{ mm}$$

Assuming the normal distribution of part dimensions, the dimension  $L_4$  in mm for assembly condition would be:



- (A)  $2.0 \pm 0.008$
- (B)  $2.0 \pm 0.012$
- (C)  $2.0 \pm 0.016$
- (D)  $2.0 \pm 0.020$

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 41 Question Type : PCV

A DC welding power source has a linear voltage-current ( $V-I$ ) characteristic with open circuit voltage of 80 V and a short circuit current of 300 A. For maximum arc power, the current (in Amperes) should be set as \_\_\_\_\_

EqtgevCpu ygt:

149 to 151

Question Number : 42 Question Type : MCQ

A triangular facet in a CAD model has vertices: P1(0,0,0); P2(1,1,0) and P3(1,1,1). The area of the facet is

- (A) 0.500
- (B) 0.707
- (C) 1.414
- (D) 1.732

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 43 Question Type : MCQ

Following data refers to the activities of a project, where, node 1 refers to the start and node 5 refers to the end of the project.

Activity	Duration (days)
1-2	2
2-3	1
4-3	3
1-4	3
2-5	3
3-5	2
4-5	4

The critical path (CP) in the network is

- (A) 1-2-3-5
- (B) 1-4-3-5
- (C) 1-2-3-4-5
- (D) 1-4-5

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 44 Question Type : PCV

For a canteen, the actual demand for disposable cups was 500 units in January and 600 units in February. The forecast for the month of January was 400 units. The forecast for the month of March considering smoothing coefficient as 0.75 is \_\_\_\_\_

Eqt tgev'Cpuy gt:

568 to 570

Question Number : 45 Question Type : PCV

An orthogonal turning operation is carried out under the following conditions: rake angle =  $5^\circ$ ; spindle rotational speed = 400 rpm; axial feed = 0.4 m/min and radial depth of cut = 5 mm. The chip thickness,  $t_c$ , is found to be 3 mm. The shear angle (in degrees) in this turning process is \_\_\_\_\_

EqtgevCpuy gt :

18.5 to 19.0

Question Number : 46 Question Type : MCQ

The solidification time of a casting is proportional to  $\left(\frac{V}{A}\right)^2$ , where  $V$  is the volume of the casting and  $A$  is the total casting surface area losing heat. Two cubes of same material and size are cast using sand casting process. The top face of one of the cubes is completely insulated. The ratio of the solidification time for the cube with top face insulated to that of the other cube is

- (A)  $\frac{25}{36}$       (B)  $\frac{36}{25}$       (C) 1      (D)  $\frac{6}{5}$

Options :

1. ✘ A
2. ✓ B
3. ✘ C
4. ✘ D

Question Number : 47 Question Type : PCV

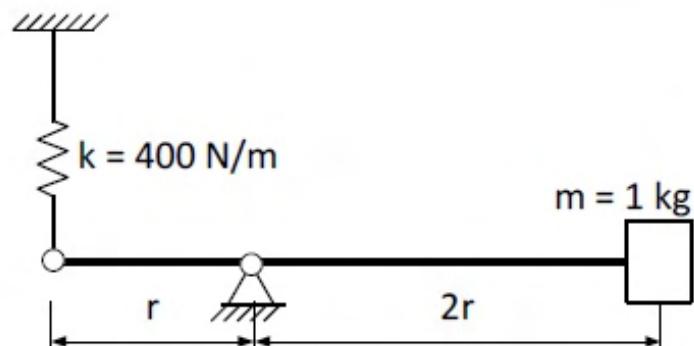
In a slab rolling operation, the maximum thickness reduction ( $\Delta h_{max}$ ) is given by  $\Delta h_{max} = \mu^2 R$ , where  $R$  is the radius of the roll and  $\mu$  is the coefficient of friction between the roll and the sheet. If  $\mu = 0.1$ , the maximum angle subtended by the deformation zone at the centre of the roll (bite angle in degrees) is \_\_\_\_\_

EqtgevCpuy gt :

5.6 to 5.8

Question Number : 48 Question Type : MCQ

Considering massless rigid rod and small oscillations, the natural frequency (in rad/s) of vibration of the system shown in the figure is



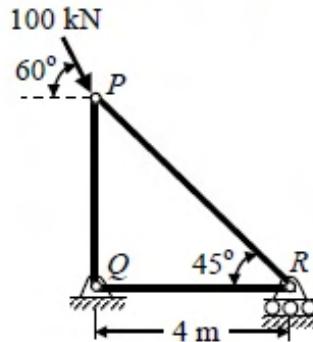
- (A)  $\sqrt{\frac{400}{1}}$       (B)  $\sqrt{\frac{400}{2}}$       (C)  $\sqrt{\frac{400}{3}}$       (D)  $\sqrt{\frac{400}{4}}$

Options :

1. ✘ A
2. ✘ B
3. ✘ C
4. ✓ D

Question Number : 49 Question Type : MCQ

For the truss shown in figure, the magnitude of the force in member  $PR$  and the support reaction at  $R$  are respectively



(A) 122.47 kN and 50 kN

(C) 70.71 kN and 50 kN

(B) 70.71 kN and 100 kN

(D) 81.65 kN and 100 kN

Options :

1. ✘ A
2. ✘ B
3. ✓ C
4. ✘ D

Question Number : 50 Question Type : PCV

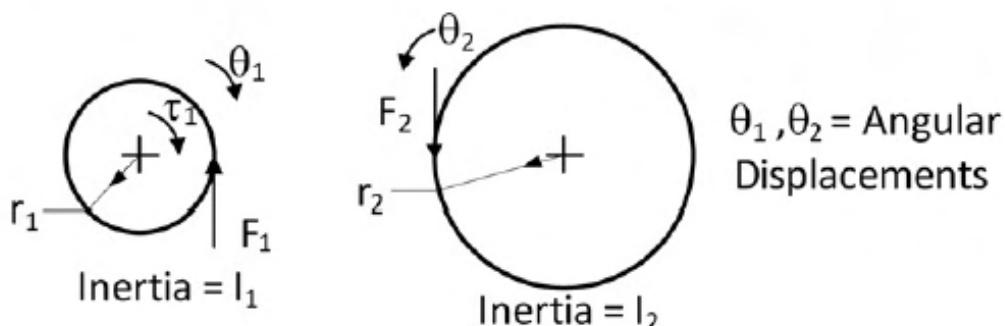
A ball of mass 0.1 kg, initially at rest, is dropped from height of 1 m. Ball hits the ground and bounces off the ground. Upon impact with the ground, the velocity reduces by 20%. The height (in m) to which the ball will rise is \_\_\_\_\_

Eqt tgev' Cpu y gt:

0.64

Question Number : 51 Question Type : MCQ

A pinion with radius  $r_1$ , and inertia  $I_1$  is driving a gear with radius  $r_2$  and inertia  $I_2$ . Torque  $\tau_1$  is applied on pinion. The following are free body diagrams of pinion and gear showing important forces ( $F_1$  and  $F_2$ ) of interaction. Which of the following relations hold true?



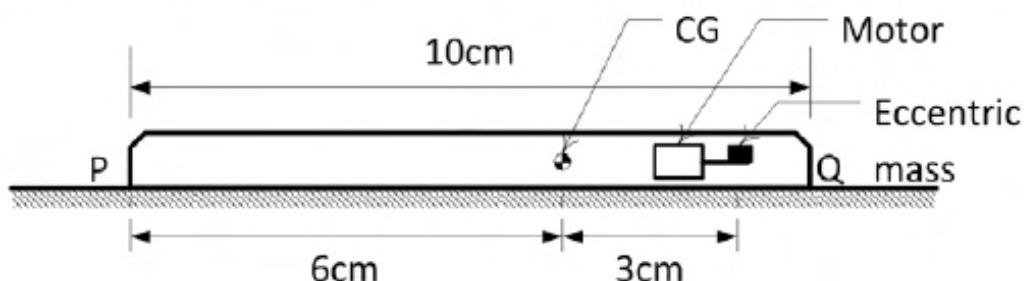
- (A)  $F_1 \neq F_2; \tau_1 = I_1 \ddot{\theta}_1; F_2 = I_2 \frac{r_1}{r_2^2} \ddot{\theta}_1$
- (B)  $F_1 = F_2; \tau_1 = \left[ I_1 + I_2 \left( \frac{r_1}{r_2} \right)^2 \right] \ddot{\theta}_1; F_2 = I_2 \frac{r_1}{r_2^2} \ddot{\theta}_1$
- (C)  $F_1 = F_2; \tau_1 = I_1 \ddot{\theta}_1; F_2 = I_2 \frac{1}{r_2} \ddot{\theta}_2$
- (D)  $F_1 \neq F_2; \tau_1 = \left[ I_1 + I_2 \left( \frac{r_1}{r_2} \right)^2 \right] \ddot{\theta}_1; F_2 = I_2 \frac{1}{r_2} \ddot{\theta}_2$

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 52 Question Type : MCQ

A mobile phone has a small motor with an eccentric mass used for vibrator mode. The location of the eccentric mass on motor with respect to center of gravity (CG) of the mobile and the rest of the dimensions of the mobile phone are shown. The mobile is kept on a flat horizontal surface.



Given in addition that the eccentric mass = 2 grams, eccentricity = 2.19 mm, mass of the mobile = 90 grams,  $g = 9.81 \text{ m/s}^2$ . Uniform speed of the motor in RPM for which the mobile will get just lifted off the ground at the end Q is approximately

- (A) 3000
- (B) 3500
- (C) 4000
- (D) 4500

Options :

1. ✗ A
2. ✓ B
3. ✗ C

4. \* D

**Question Number : 53 Question Type : MCQ**

A machine element is subjected to the following bi-axial state of stress:  $\sigma_x = 80$  MPa;  $\sigma_y = 20$  MPa;  $\tau_{xy} = 40$  MPa. If the shear strength of the material is 100 MPa, the factor of safety as per Tresca's maximum shear stress theory is

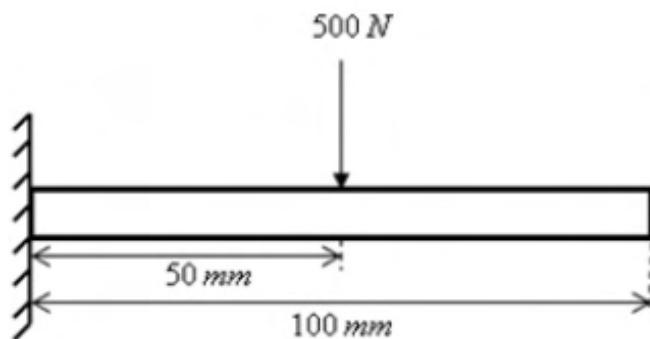


## Options :

1. \* A
  2. ✓ B
  3. \* C
  4. \* D

**Question Number : 54 Question Type : PCV**

A cantilever beam with flexural rigidity of  $200 \text{ N.m}^2$  is loaded as shown in the figure. The deflection (in mm) at the tip of the beam is \_\_\_\_\_.



Eqt tgev' Cpu y gt :

0.24 to 0.28

**Question Number : 55 Question Type : PCV**

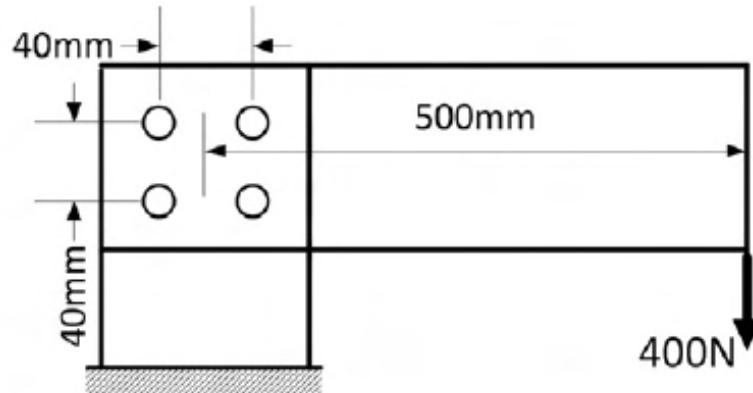
A precision instrument package ( $m = 1 \text{ kg}$ ) needs to be mounted on a surface vibrating at 60 Hz. It is desired that only 5% of the base surface vibration amplitude be transmitted to the instrument. Assume that the isolation is designed with its natural frequency significantly lesser than 60 Hz, so that the effect of damping may be ignored. The stiffness (in N/m) of the required mounting pad is

Eqt tgev' Cpu y gt :

6750 to 7150

**Question Number : 56 Question Type : P C V**

A horizontal plate has been joined to a vertical post using four rivets arranged as shown in the figure. The magnitude of the load on the worst loaded rivet (in N) is \_\_\_\_\_



Eq t gev' Cpu y gt :

1835 to 1845

Question Number : 57 Question Type : MCQ

For flow through a pipe of radius  $R$ , the velocity and temperature distribution are as follows:

$$u(r, x) = C_1, \text{ and } T(r, x) = C_2 \left[ 1 - \left( \frac{r}{R} \right)^3 \right], \text{ where } C_1 \text{ and } C_2 \text{ are constants.}$$

The bulk mean temperature is given by  $T_m = \frac{2}{U_m R^2} \int_0^R u(r, x) T(r, x) r dr$ , with  $U_m$  being the mean velocity of flow. The value of  $T_m$  is

(A)  $\frac{0.5C_2}{U_m}$

(B)  $0.5C_2$

(C)  $0.6C_2$

(D)  $\frac{0.6C_2}{U_m}$

Options :

1. ✗ A

2. ✗ B

3. ✓ C

4. ✗ D

Question Number : 58 Question Type : MCQ

Match the following pairs:

Equation		Physical Interpretation	
P	$\nabla \times \vec{V} = 0$	I	Incompressible continuity equation
Q	$\nabla \cdot \vec{V} = 0$	II	Steady flow
R	$\frac{D\vec{V}}{Dt} = 0$	III	Irrotational flow
S	$\frac{\partial \vec{V}}{\partial t} = 0$	IV	Zero acceleration of fluid particle

- (A) P-IV, Q-I, R-II, S-III  
(B) P-IV, Q-III, R-I, S-II  
(C) P-III, Q-I, R-IV, S-II  
(D) P-III, Q-I, R-II, S-IV

Options :

1. ✘ A  
2. ✘ B  
3. ✓ C  
4. ✘ D

Question Number : 59 Question Type : NAT

The velocity field of an incompressible flow is given by

$\vec{V} = (a_1x + a_2y + a_3z)\mathbf{i} + (b_1x + b_2y + b_3z)\mathbf{j} + (c_1x + c_2y + c_3z)\mathbf{k}$ , where  $a_1 = 2$  and  $c_3 = -4$ . The value of  $b_2$  is \_\_\_\_\_

Correct Answer :

1.9 to 2.1

Question Number : 60 Question Type : MCQ

A 10 mm diameter electrical conductor is covered by an insulation of 2 mm thickness. The conductivity of the insulation is 0.08 W/m-K and the convection coefficient at the insulation surface is 10 W/m<sup>2</sup>-K. Addition of further insulation of the same material will

- (A) increase heat loss continuously
- (B) decrease heat loss continuously
- (C) increase heat loss to a maximum and then decrease heat loss
- (D) decrease heat loss to a minimum and then increase heat loss

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✓ C
- 4. ✗ D

Question Number : 61 Question Type : NAT

Temperature of nitrogen in a vessel of volume 2 m<sup>3</sup> is 288 K. A U-tube manometer connected to the vessel shows a reading of 70 cm of mercury (level higher in the end open to atmosphere). The universal gas constant is 8314 J/kmol-K, atmospheric pressure is 1.01325 bar, acceleration due to gravity is 9.81 m/s<sup>2</sup> and density of mercury is 13600 kg/m<sup>3</sup>. The mass of nitrogen (in kg) in the vessel is \_\_\_\_\_

Correct Answer :

4.4 to 4.6

Question Number : 62 Question Type : NAT

Air ( $\rho = 1.2 \text{ kg/m}^3$  and kinematic viscosity,  $\nu = 2 \times 10^{-5} \text{ m}^2/\text{s}$ ) with a velocity of 2 m/s flows over the top surface of a flat plate of length 2.5 m. If the average value of friction coefficient is  $C_f = \frac{1.328}{\sqrt{Re_x}}$ , the total drag force (in N) per unit width of the plate is \_\_\_\_\_

Correct Answer :

0.0158 to 0.0162

Question Number : 63 Question Type : NAT

Water ( $\rho = 1000 \text{ kg/m}^3$ ) flows through a venturimeter with inlet diameter 80 mm and throat diameter 40 mm. The inlet and throat gauge pressures are measured to be 400 kPa and 130 kPa respectively. Assuming the venturimeter to be horizontal and neglecting friction, the inlet velocity (in m/s) is \_\_\_\_\_

Correct Answer :

**Question Number : 64 Question Type : NAT**

A well insulated rigid container of volume  $1 \text{ m}^3$  contains  $1.0 \text{ kg}$  of an ideal gas [ $C_p = 1000 \text{ J/(kg.K)}$  and  $C_v = 800 \text{ J/(kg.K)}$ ] at a pressure of  $10^5 \text{ Pa}$ . A stirrer is rotated at constant rpm in the container for 1000 rotations and the applied torque is  $100 \text{ N-m}$ . The final temperature of the gas (in K) is \_\_\_\_\_

**Correct Answer :**

1283.4 to 1287.4

**Question Number : 65 Question Type : NAT**

Steam enters a well insulated turbine and expands isentropically throughout. At an intermediate pressure, 20 percent of the mass is extracted for process heating and the remaining steam expands isentropically to  $9 \text{ kPa}$ .

Inlet to turbine:  $P = 14 \text{ MPa}$ ,  $T = 560^\circ\text{C}$ ,  $h = 3486 \text{ kJ/kg}$ ,  $s = 6.6 \text{ kJ/(kg.K)}$

Intermediate stage:  $h = 2776 \text{ kJ/kg}$

Exit of turbine:  $P = 9 \text{ kPa}$ ,  $h_f = 174 \text{ kJ/kg}$ ,  $h_g = 2574 \text{ kJ/kg}$ ,  $s_f = 0.6 \text{ kJ/(kg.K)}$ ,  $s_g = 8.1 \text{ kJ/(kg.K)}$

If the flow rate of steam entering the turbine is  $100 \text{ kg/s}$ , then the work output (in MW) is \_\_\_\_\_

**Correct Answer :**

123.56 to 127.56

# **SESSION - 2**

## **Graduate Aptitude Test in Engineering**

## Notations :

1. Options shown in green color and with ✓ icon are correct.
  2. Options shown in red color and with ✗ icon are incorrect.

**Question Paper Name:** ME : MECHANICAL ENGINEERING 1st Feb Shift1  
**Number of Questions:** 65  
**Total Marks:** 100.0

Wrong answer for MCQ will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks Questions.

## General Aptitude

Number of Questions: 10  
Section Marks: 15.0

**Q.1 to Q.5 carry 1 mark each & Q.6 to Q.10 carry 2 marks each.**

**Question Number : 1 Question Type : MCQ**

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

If the athlete had wanted to come first in the race, he \_\_\_\_\_ several hours every day.



## Options :

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

**Question Number : 2 Question Type : MCQ**

Choose the most suitable one word substitute for the following expression:

Connotation of a road or way

- (A) Pertinacious      (B) Viaticum      (C) Clandestine      (D) Ravenous

## Options :

1. \* A
  2. ✓ B
  3. \* C
  4. \* D

**Question Number : 3 Question Type : MCQ**

Choose the correct verb to fill in the blank below:

Let us \_\_\_\_\_.

- (A) introvert      (B) alternate      (C) atheist      (D) altruist

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 4 Question Type : MCQ

Find the missing sequence in the letter series below:

A, CD, GHI, ?, UVWXYZ

- (A) LMN      (B) MNO      (C) MNOP      (D) NOPQ

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 5 Question Type : MCQ

If  $x > y > 1$ , which of the following must be true?

- i.  $\ln x > \ln y$       ii.  $e^x > e^y$       iii.  $y^x > x^y$       iv.  $\cos x > \cos y$

- (A) (i) and (ii)      (B) (i) and (iii)  
(C) (iii) and (iv)      (D) (ii) and (iv)

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 6 Question Type : MCQ

Ram and Shyam shared a secret and promised to each other that it would remain between them. Ram expressed himself in one of the following ways as given in the choices below. Identify the correct way as per standard English.

- (A) It would remain between you and me.  
(B) It would remain between I and you.  
(C) It would remain between you and I.  
(D) It would remain with me.

Options :

1. ✓ A

2. ✗ B
3. ✗ C
4. ✗ D

**Question Number : 7 Question Type : MCQ**

In the following question, the first and the last sentence of the passage are in order and numbered 1 and 6. The rest of the passage is split into 4 parts and numbered as 2, 3, 4, and 5. These 4 parts are not arranged in proper order. Read the sentences and arrange them in a logical sequence to make a passage and choose the correct sequence from the given options.

1. On Diwali, the family rises early in the morning.
2. The whole family, including the young and the old enjoy doing this.
3. Children let off fireworks later in the night with their friends.
4. At sunset, the lamps are lit and the family performs various rituals.
5. Father, mother, and children visit relatives and exchange gifts and sweets.
6. Houses look so pretty with lighted lamps all around.

(A) 2,5,3,4      (B) 5,2,4,3      (C) 3,5,4,2      (D) 4,5,2,3

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 8 Question Type : NAT**

From a circular sheet of paper of radius 30 cm, a sector of 10% area is removed. If the remaining part is used to make a conical surface, then the ratio of the radius and height of the cone is \_\_\_\_\_.

**Correct Answer :**

1.9 to 2.2

**Question Number : 9 Question Type : MCQ**

$\log \tan 1^\circ + \log \tan 2^\circ + \dots + \log \tan 89^\circ$  is....

(A) 1      (B)  $1/\sqrt{2}$       (C) 0      (D) -1

**Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

**Question Number : 10 Question Type : MCQ**

Ms. X will be in Bagdogra from 01/05/2014 to 20/05/2014 and from 22/05/2014 to 31/05/2014. On the morning of 21/05/2014, she will reach Kochi via Mumbai.

Which one of the statements below is logically valid and can be inferred from the above sentences?

- (A) Ms. X will be in Kochi for one day, only in May.
- (B) Ms. X will be in Kochi for only one day in May.
- (C) Ms. X will be only in Kochi for one day in May.
- (D) Only Ms. X will be in Kochi for one day in May.

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

### Mechanical Engineering

Number of Questions: 55  
Section Marks: 85.0

Q.11 to Q.35 carry 1 mark each & Q.36 to Q.65 carry 2 marks each.

**Question Number : 11 Question Type : MCQ**

At least one eigenvalue of a singular matrix is

- (A) positive
- (B) zero
- (C) negative
- (D) imaginary

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

**Question Number : 12 Question Type : MCQ**

At  $x = 0$ , the function  $f(x) = |x|$  has

- (A) a minimum
- (B) a maximum
- (C) a point of inflexion
- (D) neither a maximum nor minimum

Options :

- 1. ✓ A
- 2. ✗ B
- 3. ✗ C
- 4. ✗ D

**Question Number : 13 Question Type : MCQ**

Curl of vector  $\mathbf{V}(x, y, z) = 2x^2 \mathbf{i} + 3z^2 \mathbf{j} + y^3 \mathbf{k}$  at  $x = y = z = 1$  is

- (A)  $-3\mathbf{i}$       (B)  $3\mathbf{i}$       (C)  $3\mathbf{i} - 4\mathbf{j}$       (D)  $3\mathbf{i} - 6\mathbf{k}$

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 14 Question Type : MCQ

The Laplace transform of  $e^{i5t}$  where  $i = \sqrt{-1}$ , is

- (A)  $\frac{s - 5i}{s^2 - 25}$       (B)  $\frac{s + 5i}{s^2 + 25}$       (C)  $\frac{s + 5i}{s^2 - 25}$       (D)  $\frac{s - 5i}{s^2 + 25}$

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 15 Question Type : NAT

Three vendors were asked to supply a very high precision component. The respective probabilities of their meeting the strict design specifications are 0.8, 0.7 and 0.5. Each vendor supplies one component. The probability that out of total three components supplied by the vendors, at least one will meet the design specification is \_\_\_\_\_

Correct answer :

0.96 to 0.98

Question Number : 16 Question Type : NAT

A small ball of mass 1 kg moving with a velocity of 12 m/s undergoes a direct central impact with a stationary ball of mass 2 kg. The impact is perfectly elastic. The speed (in m/s) of 2 kg mass ball after the impact will be \_\_\_\_\_

Correct Answer :

7.8 to 8.2

Question Number : 17 Question Type : NAT

A rod is subjected to a uni-axial load within linear elastic limit. When the change in the stress is 200 MPa, the change in the strain is 0.001. If the Poisson's ratio of the rod is 0.3, the modulus of rigidity (in GPa) is \_\_\_\_\_.

**Correct Answer :**

76 to 78

**Question Number : 18 Question Type : MCQ**

A gas is stored in a cylindrical tank of inner radius 7 m and wall thickness 50 mm. The gage pressure of the gas is 2 MPa. The maximum shear stress (in MPa) in the wall is

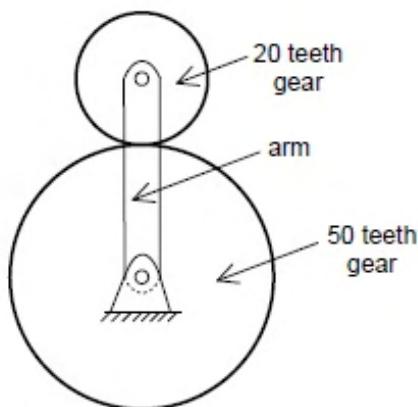


### Options :

1. ✘ A
  2. ✘ B
  3. ✓ C
  4. ✘ D

**Question Number : 19 Question Type : MCQ**

The number of degrees of freedom of the planetary gear train shown in the figure is






## **Options :**

1. ✘ A
  2. ✘ B
  3. ✓ C
  4. ✘ D

**Question Number : 20 Question Type : NAT**

In a spring-mass system, the mass is  $m$  and the spring constant is  $k$ . The critical damping coefficient of the system is  $0.1 \text{ kg/s}$ . In another spring-mass system, the mass is  $2m$  and the spring constant is  $8k$ . The critical damping coefficient (in  $\text{kg/s}$ ) of this system is \_\_\_\_\_

**Correct Answer :**

0.38 to 0.42

**Question Number : 21 Question Type : NAT**

The uniaxial yield stress of a material is  $300 \text{ MPa}$ . According to von Mises criterion, the shear yield stress (in  $\text{MPa}$ ) of the material is \_\_\_\_\_

**Correct Answer :**

171 to 175

**Question Number : 22 Question Type : MCQ**

If the fluid velocity for a potential flow is given by  $\mathbf{V}(x, y) = u(x, y)\mathbf{i} + v(x, y)\mathbf{j}$  with usual notations, then the slope of the potential line at  $(x, y)$  is

- (A)  $\frac{v}{u}$       (B)  $-\frac{u}{v}$       (C)  $\frac{v^2}{u^2}$       (D)  $\frac{u}{v}$

**Options :**

1. ✘ A
2. ✓ B
3. ✘ C
4. ✘ D

**Question Number : 23 Question Type : MCQ**

Which of the following statements regarding a Rankine cycle with reheating are **TRUE**?

- (i) increase in average temperature of heat addition
- (ii) reduction in thermal efficiency
- (iii) drier steam at the turbine exit

- (A) only (i) and (ii) are correct  
(B) only (ii) and (iii) are correct  
(C) only (i) and (iii) are correct  
(D) (i), (ii) and (iii) are correct

**Options :**

1. ✘ A
2. ✘ B
3. ✓ C
4. ✘ D

**Question Number : 24 Question Type : MCQ**

Within a boundary layer for a steady incompressible flow, the Bernoulli equation

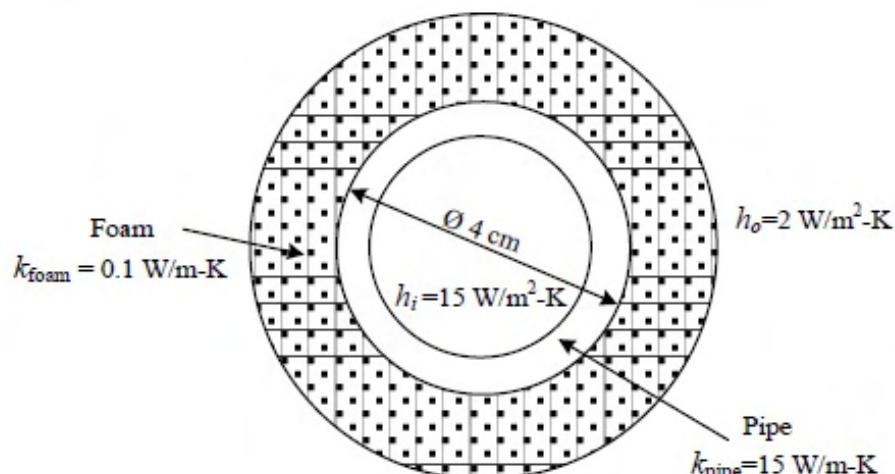
- (A) holds because the flow is steady
- (B) holds because the flow is incompressible
- (C) holds because the flow is transitional
- (D) does not hold because the flow is frictional

**Options :**

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

**Question Number : 25 Question Type : NAT**

If a foam insulation is added to a 4 cm outer diameter pipe as shown in the figure, the critical radius of insulation (in cm) is \_\_\_\_\_



**Correct Answer :**

4.9 to 5.1

**Question Number : 26 Question Type : MCQ**

In the laminar flow of air ( $Pr = 0.7$ ) over a heated plate, if  $\delta$  and  $\delta_T$  denote, respectively, the hydrodynamic and thermal boundary layer thicknesses, then

- (A)  $\delta = \delta_T$
- (B)  $\delta > \delta_T$
- (C)  $\delta < \delta_T$
- (D)  $\delta = 0$  but  $\delta_T \neq 0$

**Options :**

1.  A
2.  B
3.  C

4. \* D

**Question Number : 27 Question Type : NAT**

The COP of a Carnot heat pump operating between 6 °C and 37 °C is \_\_\_\_\_

**Correct Answer :**

9.8 to 10.2

**Question Number : 28 Question Type : MCQ**

The Van der Waals equation of state is  $\left(p + \frac{a}{v^2}\right)(v - b) = RT$ , where  $p$  is pressure,  $v$  is specific volume,  $T$  is temperature and  $R$  is characteristic gas constant. The SI unit of  $a$  is



## **Options :**

1. ✘ A
  2. ✘ B
  3. ✓ C
  4. ✘ D

**Question Number : 29 Question Type : NAT**

A rope-brake dynamometer attached to the crank shaft of an I.C. engine measures a brake power of 10 kW when the speed of rotation of the shaft is 400 rad/s. The shaft torque (in N-m) sensed by the dynamometer is

**Correct Answer :**

24 to 26

**Question Number : 30 Question Type : SA**

The atomic packing factor for a material with body centered cubic structure is

**Correct Answer :**

0.66 to 0.69

**Question Number : 31 Question Type : MCQ**

The primary mechanism of material removal in electrochemical machining (ECM) is

- (A) chemical corrosion
- (B) etching
- (C) ionic dissolution
- (D) spark erosion

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✓ C
- 4. ✗ D

Question Number : 32 Question Type : MCQ

Which one of the following statements is TRUE?

- (A) The 'GO' gage controls the upper limit of a hole
- (B) The 'NO GO' gage controls the lower limit of a shaft
- (C) The 'GO' gage controls the lower limit of a hole
- (D) The 'NO GO' gage controls the lower limit of a hole

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✓ C
- 4. ✗ D

Question Number : 33 Question Type : MCQ

During the development of a product, an entirely new process plan is made based on design logic, examination of geometry and tolerance information. This type of process planning is known as

- (A) retrieval
- (B) generative
- (C) variant
- (D) group technology based

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 34 Question Type : NAT

Annual demand of a product is 50000 units and the ordering cost is Rs. 7000 per order. Considering the basic economic order quantity model, the economic order quantity is 10000 units. When the annual inventory cost is minimized, the annual inventory holding cost (in Rs.) is \_\_\_\_\_

**Correct Answer :**

34000 to 36000

**Question Number : 35 Question Type : MCQ**

Sales data of a product is given in the following table:

Month	January	February	March	April	May
Number of units sold	10	11	16	19	25

Regarding forecast for the month of June, which one of the following statements is **TRUE**?

- (A) Moving average will forecast a higher value compared to regression.  
(B) Higher the value of order  $N$ , the greater will be the forecast value by moving average.  
(C) Exponential smoothing will forecast a higher value compared to regression.  
(D) Regression will forecast a higher value compared to moving average.

1. ✘ A  
2. ✘ B  
3. ✘ C  
4. ✓ D

**Question Number : 36 Question Type : MCQ**

The chance of a student passing an exam is 20%. The chance of a student passing the exam and getting above 90% marks in it is 5%. GIVEN that a student passes the examination, the probability that the student gets above 90% marks is

- (A)  $\frac{1}{18}$       (B)  $\frac{1}{4}$       (C)  $\frac{2}{9}$       (D)  $\frac{5}{18}$

**Options :**

1. ✘ A  
2. ✓ B  
3. ✘ C  
4. ✘ D

**Question Number : 37 Question Type : NAT**

The surface integral  $\iint_S \frac{1}{\pi} (9x\mathbf{i} - 3y\mathbf{j}) \cdot \mathbf{n} dS$  over the sphere given by  $x^2 + y^2 + z^2 = 9$  is \_\_\_\_\_

**Correct Answer :**

214 to 218

**Question Number : 38 Question Type : MCQ**

Consider the following differential equation:

$$\frac{dy}{dt} = -5y; \text{ initial condition: } y=2 \text{ at } t=0.$$

The value of  $y$  at  $t = 3$  is

- (A)  $-5e^{-10}$       (B)  $2e^{-10}$       (C)  $2e^{-15}$       (D)  $-15e^2$

**Options :**

1. ✘ A
2. ✘ B
3. ✓ C
4. ✘ D

**Question Number : 39 Question Type : NAT**

The values of function  $f(x)$  at 5 discrete points are given below:

$x$	0	0.1	0.2	0.3	0.4
$f(x)$	0	10	40	90	160

Using Trapezoidal rule with step size of 0.1, the value of  $\int_0^{0.4} f(x) dx$  is \_\_\_\_\_

**Correct Answer :**

21.8 to 22.2

**Question Number : 40 Question Type : NAT**

The initial velocity of an object is 40 m/s. The acceleration  $a$  of the object is given by the following expression:

$$a = -0.1v,$$

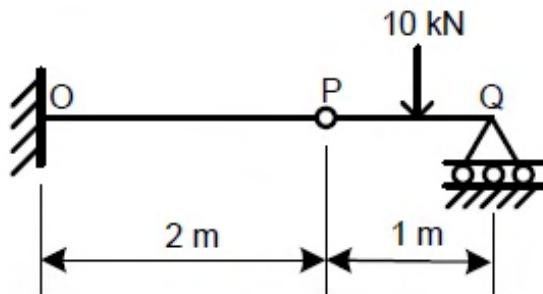
where  $v$  is the instantaneous velocity of the object. The velocity of the object after 3 seconds will be \_\_\_\_\_

**Correct Answer :**

29.5 to 29.7

**Question Number : 41 Question Type : MCQ**

A cantilever beam OP is connected to another beam PQ with a pin joint as shown in the figure. A load of 10 kN is applied at the mid-point of PQ. The magnitude of bending moment (in kN-m) at fixed end O is



(A) 2.5

(B) 5

(C) 10

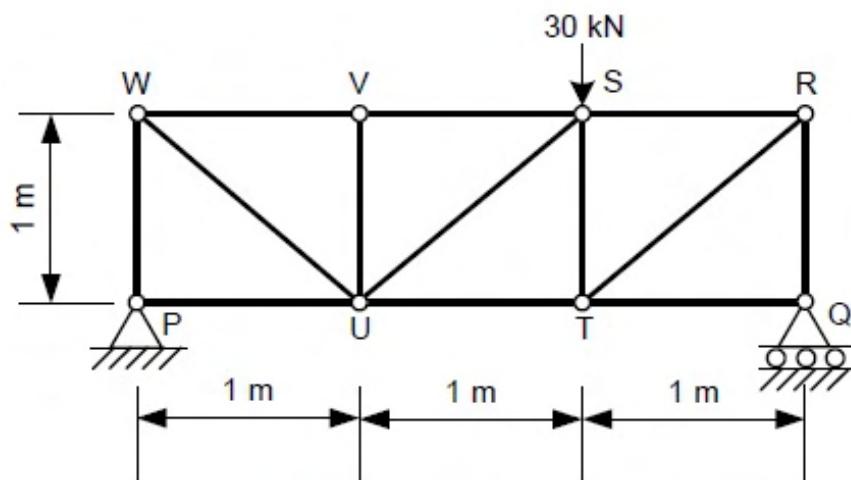
(D) 25

**Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

**Question Number : 42 Question Type : MCQ**

For the truss shown in the figure, the magnitude of the force (in kN) in the member SR is



(A) 10

(B) 14.14

(C) 20

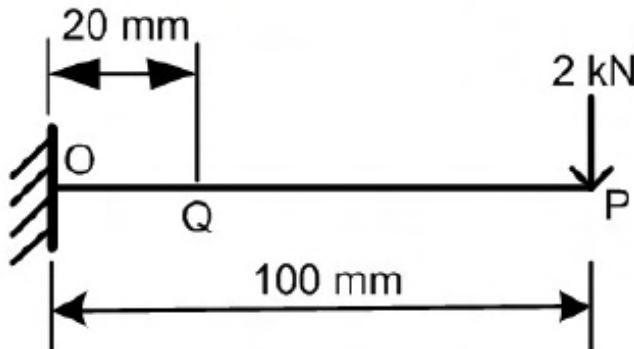
(D) 28.28

**Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

**Question Number : 43 Question Type : NAT**

A cantilever beam with square cross-section of 6 mm side is subjected to a load of 2 kN normal to the top surface as shown in the figure. The Young's modulus of elasticity of the material of the beam is 210 GPa. The magnitude of slope (in radian) at Q (20 mm from the fixed end) is \_\_\_\_\_



**Correct Answer :**

0.15 to 0.17

**Question Number : 44 Question Type : MCQ**

In a plane stress condition, the components of stress at a point are  $\sigma_x = 20$  MPa,  $\sigma_y = 80$  MPa and  $\tau_{xy} = 40$  MPa. The maximum shear stress (in MPa) at the point is



## Options :

1. ✘ A
  2. ✘ B
  3. ✓ C
  4. ✘ D

**Question Number : 45 Question Type : NAT**

In a certain slider-crank mechanism, lengths of crank and connecting rod are equal. If the crank rotates with a uniform angular speed of 14 rad/s and the crank length is 300 mm, the maximum acceleration of the slider (in  $\text{m/s}^2$ ) is

**Correct Answer :** 115 to 120

**Question Number : 46 Question Type : MCQ**

A single-degree-freedom spring-mass system is subjected to a sinusoidal force of 10 N amplitude and frequency  $\omega$  along the axis of the spring. The stiffness of the spring is 150 N/m, damping factor is 0.2 and the undamped natural frequency is  $10\omega$ . At steady state, the amplitude of vibration (in m) is approximately

- (A) 0.05      (B) 0.07      (C) 0.70      (D) 0.90

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 47 Question Type : NAT

A hollow shaft of 1 m length is designed to transmit a power of 30 kW at 700 rpm. The maximum permissible angle of twist in the shaft is  $1^\circ$ . The inner diameter of the shaft is 0.7 times the outer diameter. The modulus of rigidity is 80 GPa. The outside diameter (in mm) of the shaft is \_\_\_\_\_

Correct Answer :

43 to 45

Question Number : 48 Question Type : MCQ

A hollow shaft ( $d_o = 2d_i$  where  $d_o$  and  $d_i$  are the outer and inner diameters respectively) needs to transmit 20 kW power at 3000 RPM. If the maximum permissible shear stress is 30 MPa,  $d_o$  is

- (A) 11.29 mm      (B) 22.58 mm      (C) 33.87 mm      (D) 45.16 mm

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 49 Question Type : MCQ

The total emissive power of a surface is  $500 \text{ W/m}^2$  at a temperature  $T_1$  and  $1200 \text{ W/m}^2$  at a temperature  $T_2$ , where the temperatures are in Kelvin. Assuming the emissivity of the surface to be constant, the ratio of the temperatures  $\frac{T_1}{T_2}$  is

- (A) 0.308      (B) 0.416      (C) 0.803      (D) 0.874

Options :

1. ✗ A
2. ✗ B
3. ✓ C

4 \* D

**Question Number : 50 Question Type : MCQ**

The head loss for a laminar incompressible flow through a horizontal circular pipe is  $h_1$ . Pipe length and fluid remaining the same, if the average flow velocity doubles and the pipe diameter reduces to half its previous value, the head loss is  $h_2$ . The ratio  $h_2/h_1$  is



### **Options :**

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

**Question Number : 51 Question Type : NAT**

For a fully developed laminar flow of water (dynamic viscosity 0.001 Pa-s) through a pipe of radius 5 cm, the axial pressure gradient is  $-10 \text{ Pa/m}$ . The magnitude of axial velocity (in m/s) at a radial location of 0.2 cm is

**Correct Answer :**

6.2 to 6.3

**Question Number : 52 Question Type : MCQ**

A balanced counterflow heat exchanger has a surface area of  $20 \text{ m}^2$  and overall heat transfer coefficient of  $20 \text{ W/m}^2\text{-K}$ . Air ( $C_p=1000 \text{ J/kg-K}$ ) entering at  $0.4 \text{ kg/s}$  and  $280 \text{ K}$  is to be preheated by the air leaving the system at  $0.4 \text{ kg/s}$  and  $300 \text{ K}$ . The outlet temperature (in K) of the preheated air is

- (A) 290      (B) 300      (C) 320      (D) 350

### **Options :**

1. ✓ A
  2. ✗ B
  3. ✗ C
  4. ✗ D

**Question Number : 53 Question Type : MCQ**

A cylindrical uranium fuel rod of radius 5 mm in a nuclear reactor is generating heat at the rate of  $4 \times 10^7 \text{ W/m}^3$ . The rod is cooled by a liquid (convective heat transfer coefficient  $1000 \text{ W/m}^2\text{-K}$ ) at  $25^\circ\text{C}$ . At steady state, the surface temperature (in K) of the rod is



### Options :

- Options

2. ✓ B  
3. ✗ C  
4. ✗ D

Question Number : 54 Question Type : NAT

Work is done on an adiabatic system due to which its velocity changes from 10 m/s to 20 m/s, elevation increases by 20 m and temperature increases by 1 K. The mass of the system is 10 kg,  $C_v = 100 \text{ J/(kg.K)}$  and gravitational acceleration is 10 m/s<sup>2</sup>. If there is no change in any other component of the energy of the system, the magnitude of total work done (in kJ) on the system is \_\_\_\_\_

Correct Answer :

4.5

Question Number : 55 Question Type : NAT

One kg of air ( $R = 287 \text{ J/kg-K}$ ) undergoes an irreversible process between equilibrium state 1 (20 °C, 0.9 m<sup>3</sup>) and equilibrium state 2 (20 °C, 0.6 m<sup>3</sup>). The change in entropy  $s_2 - s_1$  (in J/kg-K) is \_\_\_\_\_

Correct Answer :

-117 to -115

Question Number : 56 Question Type : MCQ

For the same values of peak pressure, peak temperature and heat rejection, the correct order of efficiencies for Otto, Dual and Diesel cycles is

- (A)  $\eta_{Otto} > \eta_{Dual} > \eta_{Diesel}$   
(B)  $\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$   
(C)  $\eta_{Dual} > \eta_{Diesel} > \eta_{Otto}$   
(D)  $\eta_{Diesel} > \eta_{Otto} > \eta_{Dual}$

Options :

1. ✗ A  
2. ✓ B  
3. ✗ C  
4. ✗ D

Question Number : 57 Question Type : NAT

In a Rankine cycle, the enthalpies at turbine entry and outlet are 3159 kJ/kg and 2187 kJ/kg, respectively. If the specific pump work is 2 kJ/kg, the specific steam consumption (in kg/kW-h) of the cycle based on net output is \_\_\_\_\_

### **Correct Answer :**

3.6 to 3.8

**Question Number : 58 Question Type : NAT**

A cube and a sphere made of cast iron (each of volume  $1000 \text{ cm}^3$ ) were cast under identical conditions. The time taken for solidifying the cube was 4 s. The solidification time (in s) for the sphere is

**Correct Answer :**

6.0 to 6.3

**Question Number : 59 Question Type : MCQ**

In a two-stage wire drawing operation, the fractional reduction (ratio of change in cross-sectional area to initial cross-sectional area) in the first stage is 0.4. The fractional reduction in the second stage is 0.3. The overall fractional reduction is



## **Options :**

1. \* A
  2. ✓ B
  3. \* C
  4. \* D

Question Number : 60 Question Type : NAT

The flow stress (in MPa) of a material is given by

$$\sigma = 500 \varepsilon^{0.1},$$

where  $\varepsilon$  is true strain. The Young's modulus of elasticity of the material is 200 GPa. A block of thickness 100 mm made of this material is compressed to 95 mm thickness and then the load is removed. The final dimension of the block (in mm) is

**Correct Answer :**

**Question Number : 61 Question Type : MCQ**

During a TIG welding process, the arc current and arc voltage were 50 A and 60 V, respectively, when the welding speed was 150 mm/min. In another process, the TIG welding is carried out at a welding speed of 120 mm/min at the same arc voltage and heat input to the material so that weld quality remains the same. The welding current (in A) for this process is

- (A) 40.00      (B) 44.72      (C) 55.90      (D) 62.25

**Options :**

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

**Question Number : 62 Question Type : NAT**

A single point cutting tool with  $0^\circ$  rake angle is used in an orthogonal machining process. At a cutting speed of 180 m/min, the thrust force is 490 N. If the coefficient of friction between the tool and the chip is 0.7, then the power consumption (in kW) for the machining operation is \_\_\_\_\_

**Correct Answer :**

2.0 to 2.2

**Question Number : 63 Question Type : MCQ**

A resistance-capacitance relaxation circuit is used in an electrical discharge machining process. The discharge voltage is 100 V. At a spark cycle time of  $25 \mu\text{s}$ , the average power input required is 1 kW. The capacitance (in  $\mu\text{F}$ ) in the circuit is

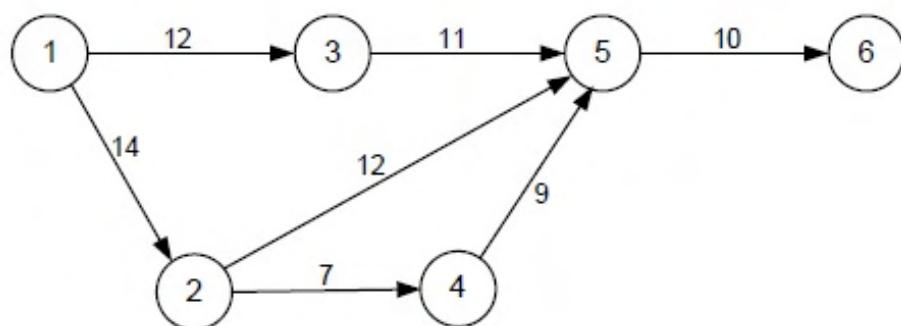
- (A) 2.5      (B) 5.0      (C) 7.5      (D) 10.0

**Options :**

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

**Question Number : 64 Question Type : NAT**

A project consists of 7 activities. The network along with the time durations (in days) for various activities is shown in the figure.



The minimum time (in days) for completion of the project is \_\_\_\_\_

**Correct Answer :**

39 to 40

**Question Number : 65 Question Type : NAT**

A manufacturer has the following data regarding a product:

Fixed cost per month = Rs. 50000

Variable cost per unit = Rs. 200

Selling price per unit = Rs. 300

Production capacity = 1500 units per month

If the production is carried out at 80% of the rated capacity, then the monthly profit (in Rs.) is \_\_\_\_\_

**Correct Answer :**

68000 to 72000

# **SESSION - 3**

# Graduate Aptitude Test in Engineering

## Notations :

1. Options shown in green color and with ✓ icon are correct.
2. Options shown in red color and with ✗ icon are incorrect.

**Question Paper Name:** ME: MECHANICAL ENGINEERING 1st Feb shift2

**Number of Questions:** 65

**Total Marks:** 100.0

Wrong answer for MCQ will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks Questions.

## General Aptitude

Number of Questions: 10  
Section Marks: 15.0

Q.1 to Q.5 carry 1 mark each & Q.6 to Q.10 carry 2 marks each.

### Question Number : 1 Question Type : MCQ

Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:

Apparent lifelessness \_\_\_\_\_ dormant life.

- (A) harbours      (B) leads to      (C) supports      (D) affects

#### Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

### Question Number : 2 Question Type : MCQ

Fill in the blank with the correct idiom/phrase.

That boy from the town was a \_\_\_\_\_ in the sleepy village.

- (A) dog out of herd      (B) sheep from the heap  
(C) fish out of water      (D) bird from the flock

#### Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

### Question Number : 3 Question Type : MCQ

Choose the statement where underlined word is used correctly.

- (A) When the teacher eludes to different authors, he is being elusive.
- (B) When the thief keeps eluding the police, he is being elusive.
- (C) Matters that are difficult to understand, identify or remember are allusive.
- (D) Mirages can be allusive, but a better way to express them is illusory.

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 4 Question Type : MCQ

Tanya is older than Eric.

Cliff is older than Tanya.

Eric is older than Cliff.

If the first two statements are true, then the third statement is:

- (A) True
- (B) False
- (C) Uncertain
- (D) Data insufficient

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 5 Question Type : MCQ

Five teams have to compete in a league, with every team playing every other team exactly once, before going to the next round. How many matches will have to be held to complete the league round of matches?

- (A) 20
- (B) 10
- (C) 8
- (D) 5

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 6 Question Type : MCQ

Select the appropriate option in place of underlined part of the sentence.

Increased productivity necessary reflects greater efforts made by the employees.

- (A) Increase in productivity necessary
- (B) Increase productivity is necessary
- (C) Increase in productivity necessarily
- (D) No improvement required

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 7 Question Type : MCQ

Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.

Statements:

- I. No manager is a leader.
- II. All leaders are executives.

Conclusions:

- I. No manager is an executive.
- II. No executive is a manager.

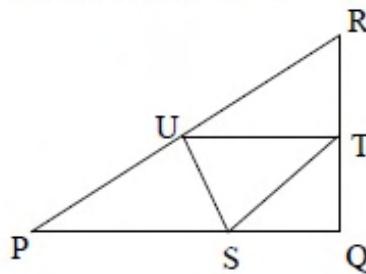
- (A) Only conclusion I follows.
- (B) Only conclusion II follows.
- (C) Neither conclusion I nor II follows.
- (D) Both conclusions I and II follow.

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 8 Question Type : NAT

In the given figure angle Q is a right angle,  $PS:QS = 3:1$ ,  $RT:QT = 5:2$  and  $PU:UR = 1:1$ . If area of triangle QTS is  $20 \text{ cm}^2$ , then the area of triangle PQR in  $\text{cm}^2$  is \_\_\_\_\_.



Correct Answer :

**Question Number : 9 Question Type : MCQ**

Right triangle PQR is to be constructed in the xy - plane so that the right angle is at P and line PR is parallel to the x-axis. The x and y coordinates of P, Q, and R are to be integers that satisfy the inequalities:  $-4 \leq x \leq 5$  and  $6 \leq y \leq 16$ . How many different triangles could be constructed with these properties?



## Options :

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

**Question Number : 10 Question Type : MCQ**

A coin is tossed thrice. Let  $X$  be the event that head occurs in each of the first two tosses. Let  $Y$  be the event that a tail occurs on the third toss. Let  $Z$  be the event that two tails occur in three tosses. Based on the above information, which one of the following statements is TRUE?

- (A)  $X$  and  $Y$  are not independent      (B)  $Y$  and  $Z$  are dependent  
 (C)  $Y$  and  $Z$  are independent      (D)  $X$  and  $Z$  are independent

### **Options :**

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

## Mechanical Engineering

### Number of Questions:

55

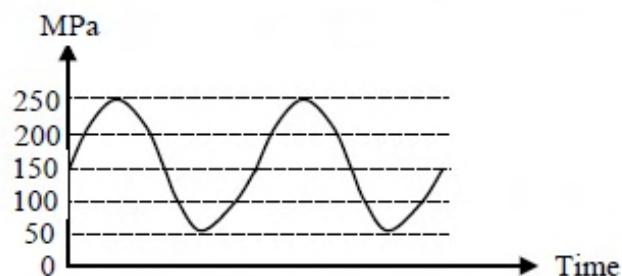
**Section Marks:**

85.0

Q.11 to Q.35 carry 1 mark each & Q.36 to Q.65 carry 2 marks each.

**Question Number : 11 Question Type : MCQ**

For the given fluctuating fatigue load, the values of stress amplitude and stress ratio are respectively



- (A) 100 MPa and 5  
(B) 250 MPa and 5  
(C) 100 MPa and 0.20  
(D) 250 MPa and 0.20

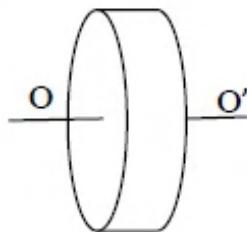
### **Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

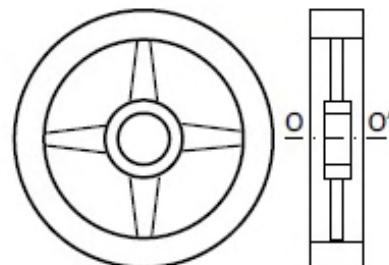
Question Number : 12 Question Type : MCQ

For the same material and the mass, which of the following configurations of flywheel will have maximum mass moment of inertia about the axis of rotation  $OO'$  passing through the center of gravity.

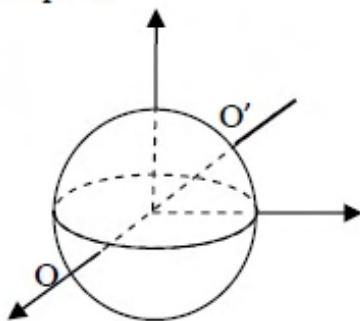
(A) Solid Cylinder



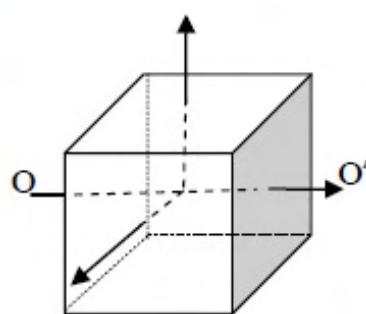
(B) Rimmed wheel



(C) Solid sphere



(D) Solid cube

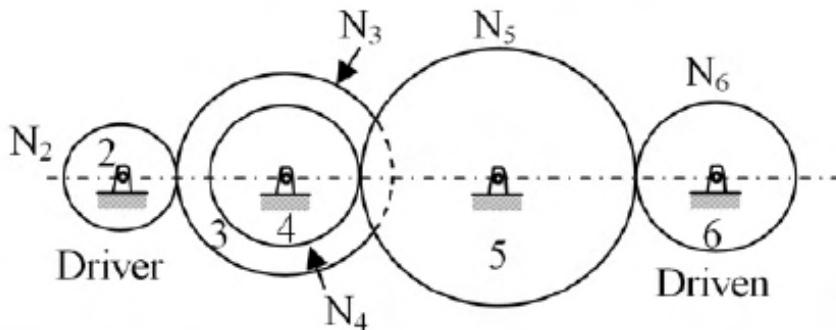


Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 13 Question Type : MCQ

A gear train is made up of five spur gears as shown in the figure. Gear 2 is driver and gear 6 is driven member.  $N_2$ ,  $N_3$ ,  $N_4$ ,  $N_5$  and  $N_6$  represent number of teeth on gears 2, 3, 4, 5, and 6 respectively. The gear(s) which act(s) as idler(s) is/are



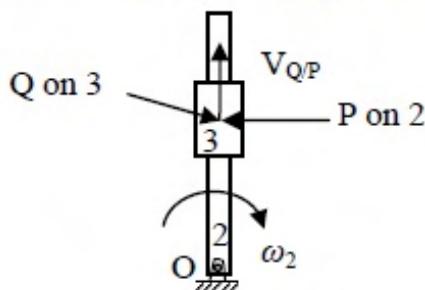
- (A) Only 3      (B) Only 4      (C) Only 5      (D) Both 3 and 5

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 14 Question Type : MCQ

In the figure, link 2 rotates with constant angular velocity  $\omega_2$ . A slider link 3 moves outwards with a constant relative velocity  $V_{Q/P}$ , where Q is a point on slider 3 and P is a point on link 2. The magnitude and direction of Coriolis component of acceleration is given by



- (A)  $2 \omega_2 V_{Q/P}$ ; direction of  $V_{Q/P}$  rotated by  $90^\circ$  in the direction of  $\omega_2$   
 (B)  $\omega_2 V_{Q/P}$ ; direction of  $V_{Q/P}$  rotated by  $90^\circ$  in the direction of  $\omega_2$   
 (C)  $2 \omega_2 V_{Q/P}$ ; direction of  $V_{Q/P}$  rotated by  $90^\circ$  opposite to the direction of  $\omega_2$   
 (D)  $\omega_2 V_{Q/P}$ ; direction of  $V_{Q/P}$  rotated by  $90^\circ$  opposite to the direction of  $\omega_2$

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 15 Question Type : MCQ

The strain hardening exponent  $n$  of stainless steel SS 304 with distinct yield and UTS values undergoing plastic deformation is

- (A)  $n < 0$       (B)  $n = 0$       (C)  $0 < n < 1$       (D)  $n = 1$

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 16 Question Type : MCQ

In a machining operation, if the generatrix and directrix both are straight lines, the surface obtained is

- (A) cylindrical      (B) helical      (C) plane      (D) surface of revolution

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 17 Question Type : MCQ

In full mould (cavity-less) casting process, the pattern is made of

- (A) expanded polystyrene      (B) wax  
(C) epoxy      (D) plaster of Paris

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 18 Question Type : MCQ

In the notation  $(a/b/c) : (d/e/f)$  for summarizing the characteristics of queueing situation, the letters 'b' and 'd' stand respectively for

- (A) service time distribution and queue discipline  
(B) number of servers and size of calling source  
(C) number of servers and queue discipline  
(D) service time distribution and maximum number allowed in system

Options :

1. ✓ A
2. ✗ B

3. \* C

**Question Number : 19 Question Type : MCQ**

Couette flow is characterized by

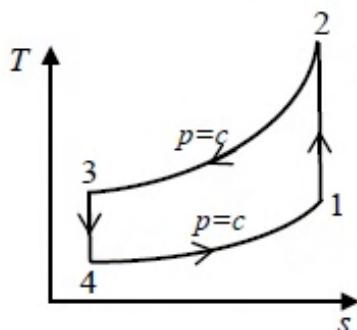
- (A) steady, incompressible, laminar flow through a straight circular pipe
  - (B) fully developed turbulent flow through a straight circular pipe
  - (C) steady, incompressible, laminar flow between two fixed parallel plates
  - (D) steady, incompressible, laminar flow between one fixed plate and the other moving with a constant velocity

## Options :

1. ✘ A
  2. ✘ B
  3. ✘ C
  4. ✓ D

**Question Number : 20 Question Type : MCQ**

The thermodynamic cycle shown in figure ( $T-s$  diagram) indicates






### **Options :**

1. ✗ A
  2. ✓ B
  3. ✗ C
  4. ✗ D

**Question Number : 21 Question Type : MCO**

The ratio of momentum diffusivity ( $\nu$ ) to thermal diffusivity ( $\alpha$ ), is called



## Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

**Question Number : 22 Question Type : MCQ**

Saturated vapor is condensed to saturated liquid in a condenser. The heat capacity ratio is  $C_r = \frac{C_{min}}{C_{max}}$ . The effectiveness ( $\varepsilon$ ) of the condenser is

(A)  $\frac{1 - \exp[-NTU(1+C_r)]}{1+C_r}$

(B)  $\frac{1 - \exp[-NTU(1-C_r)]}{1-C_r \exp[-NTU(1-C_r)]}$

(C)  $\frac{NTU}{1+NTU}$

(D)  $1 - \exp(-NTU)$

**Options :**

1. ✗ A
2. ✗ B
3. ✗ C
4. ✓ D

**Question Number : 23 Question Type : NAT**

Using a unit step size, the value of integral  $\int_1^2 x \ln x \, dx$  by trapezoidal rule is \_\_\_\_\_

**Correct Answer :**

0.68 to 0.70

**Question Number : 24 Question Type : MCQ**

If  $P(X) = 1/4$ ,  $P(Y) = 1/3$ , and  $P(X \cap Y) = 1/12$ , the value of  $P(Y/X)$  is

(A)  $\frac{1}{4}$

(B)  $\frac{4}{25}$

(C)  $\frac{1}{3}$

(D)  $\frac{29}{50}$

**Options :**

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

**Question Number : 25 Question Type : NAT**

The lowest eigenvalue of the  $2 \times 2$  matrix  $\begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$  is \_\_\_\_\_

**Correct Answer:**

2

**Question Number : 26 Question Type : NAT**

The value of  $\lim_{x \rightarrow 0} \left( \frac{-\sin x}{2 \sin x + x \cos x} \right)$  is \_\_\_\_\_

**Correct Answer :**

-0.35 to -0.30

**Question Number : 27 Question Type : NAT**

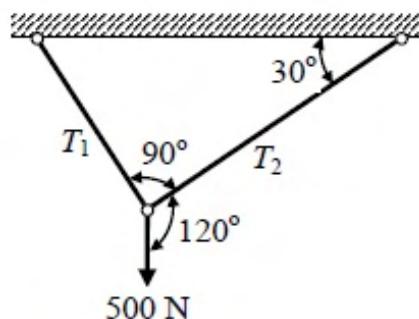
A cylindrical tank with closed ends is filled with compressed air at a pressure of 500 kPa. The inner radius of the tank is 2 m, and it has wall thickness of 10 mm. The magnitude of maximum in-plane shear stress (in MPa) is \_\_\_\_\_

**Correct Answer :**

25

**Question Number : 28 Question Type : MCQ**

A weight of 500 N is supported by two metallic ropes as shown in the figure. The values of tensions  $T_1$  and  $T_2$  are respectively



- (A) 433 N and 250 N  
(C) 353.5 N and 250 N

- (B) 250 N and 433 N  
(D) 250 N and 353.5 N

**Options :**

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

**Question Number : 29 Question Type : MCQ**

Which of the following statements are TRUE for damped vibrations?

- P. For a system having critical damping, the value of damping ratio is unity and system does not undergo a vibratory motion.
- Q. Logarithmic decrement method is used to determine the amount of damping in a physical system.
- R. In case of damping due to dry friction between moving surfaces resisting force of constant magnitude acts opposite to the relative motion.
- S. For the case of viscous damping, drag force is directly proportional to the square of relative velocity.

(A) P and Q only

(B) P and S only

(C) P, Q and R only

(D) Q and S only

**Options :**

1. ✗ A

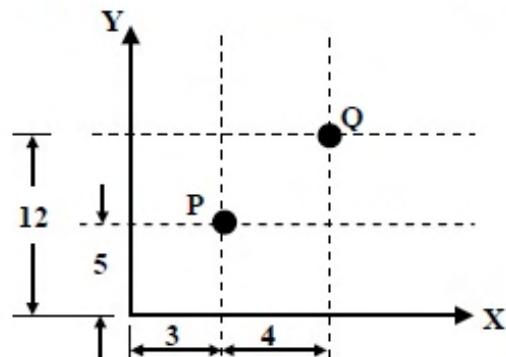
2. ✗ B

3. ✓ C

4. ✗ D

**Question Number : 30 Question Type : MCQ**

A drill is positioned at point P and it has to proceed to point Q. The coordinates of point Q in the incremental system of defining position of a point in CNC part program will be



(A) (3, 12)

(B) (5, 7)

(C) (7, 12)

(D) (4, 7)

**Options :**

1. ✗ A

2. ✗ B

3. ✗ C

4. ✓ D

**Question Number : 31 Question Type : MCQ**

Which two of the following joining processes are autogeneous?

- (i) Diffusion welding
- (ii) Electroslag welding
- (iii) Tungsten inert gas welding
- (iv) Friction welding

(A) (i) and (iv)      (B) (ii) and (iii)      (C) (ii) and (iv)      (D) (i) and (iii)

Options :

- 1. ✓ A
- 2. ✗ B
- 3. ✗ C
- 4. ✗ D

Question Number : 32 Question Type : MCQ

Three parallel pipes connected at the two ends have flow-rates  $Q_1$ ,  $Q_2$  and  $Q_3$  respectively, and the corresponding frictional head losses are  $h_{L1}$ ,  $h_{L2}$  and  $h_{L3}$  respectively. The correct expressions for total flow rate ( $Q$ ) and frictional head loss across the two ends ( $h_L$ ) are

- (A)  $Q = Q_1 + Q_2 + Q_3$ ;  $h_L = h_{L1} + h_{L2} + h_{L3}$
- (B)  $Q = Q_1 + Q_2 + Q_3$ ;  $h_L = h_{L1} = h_{L2} = h_{L3}$
- (C)  $Q = Q_1 = Q_2 = Q_3$ ;  $h_L = h_{L1} + h_{L2} + h_{L3}$
- (D)  $Q = Q_1 = Q_2 = Q_3$ ;  $h_L = h_{L1} = h_{L2} = h_{L3}$

Options :

- 1. ✗ A
- 2. ✓ B
- 3. ✗ C
- 4. ✗ D

Question Number : 33 Question Type : MCQ

A rigid container of volume  $0.5 \text{ m}^3$  contains  $1.0 \text{ kg}$  of water at  $120^\circ\text{C}$  ( $v_f = 0.00106 \text{ m}^3/\text{kg}$ ,  $v_g = 0.8908 \text{ m}^3/\text{kg}$ ). The state of water is

- (A) compressed liquid
- (B) saturated liquid
- (C) a mixture of saturated liquid and saturated vapor
- (D) superheated vapor

Options :

- 1. ✗ A
- 2. ✗ B
- 3. ✓ C
- 4. ✗ D

Question Number : 34 Question Type : MCQ

Let  $\phi$  be an arbitrary smooth real valued scalar function and  $\vec{V}$  be an arbitrary smooth vector valued function in a three-dimensional space. Which one of the following is an identity?

(A)  $\text{Curl}(\phi\vec{V}) = \nabla(\phi \text{ Div} \vec{V})$

(B)  $\text{Div} \vec{V} = 0$

(C)  $\text{Div} \text{Curl} \vec{V} = 0$

(D)  $\text{Div}(\phi\vec{V}) = \phi \text{ Div} \vec{V}$

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 35 Question Type : MCQ

An air-standard Diesel cycle consists of the following processes:

1-2: Air is compressed isentropically.

2-3: Heat is added at constant pressure.

3-4: Air expands isentropically to the original volume.

4-1: Heat is rejected at constant volume.

If  $\gamma$  and  $T$  denote the specific heat ratio and temperature, respectively, the efficiency of the cycle is

(A)  $1 - \frac{T_4 - T_1}{T_3 - T_2}$

(B)  $1 - \frac{T_4 - T_1}{\gamma(T_3 - T_2)}$

(C)  $1 - \frac{\gamma(T_4 - T_1)}{T_3 - T_2}$

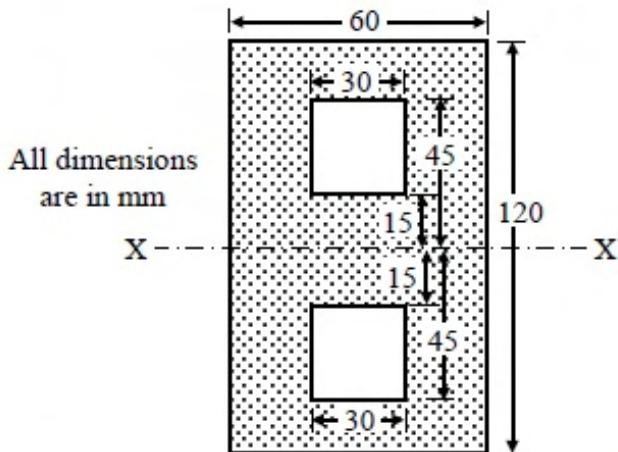
(D)  $1 - \frac{T_4 - T_1}{(\gamma - 1)(T_3 - T_2)}$

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 36 Question Type : MCQ

The value of moment of inertia of the section shown in the figure about the axis-XX is



(A)  $8.5050 \times 10^6 \text{ mm}^4$   
(C)  $7.7625 \times 10^6 \text{ mm}^4$

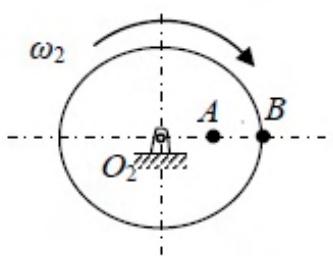
(B)  $6.8850 \times 10^6 \text{ mm}^4$   
(D)  $8.5725 \times 10^6 \text{ mm}^4$

Options :

1. ✘ A
2. ✓ B
3. ✘ C
4. ✘ D

Question Number : 37 Question Type : NAT

Figure shows a wheel rotating about  $O_2$ . Two points  $A$  and  $B$  located along the radius of wheel have speeds of 80 m/s and 140 m/s respectively. The distance between the points  $A$  and  $B$  is 300 mm. The diameter of the wheel (in mm) is \_\_\_\_\_

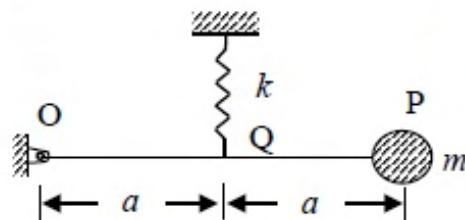


Correct Answer :

1390 to 1410

Question Number : 38 Question Type : MCQ

Figure shows a single degree of freedom system. The system consists of a massless rigid bar OP hinged at O and a mass  $m$  at end P. The natural frequency of vibration of the system is



(A)  $f_n = \frac{1}{2\pi} \sqrt{\frac{k}{4m}}$

(B)  $f_n = \frac{1}{2\pi} \sqrt{\frac{k}{2m}}$

(C)  $f_n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$

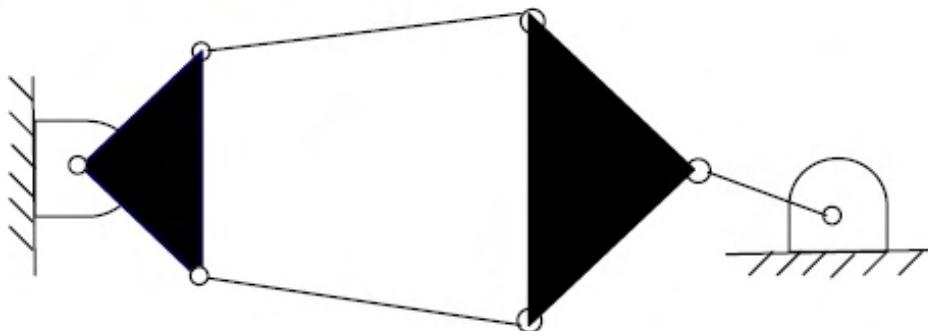
(D)  $f_n = \frac{1}{2\pi} \sqrt{\frac{2k}{m}}$

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 39 Question Type : MCQ

The number of degrees of freedom of the linkage shown in the figure is



(A) -3

(B) 0

(C) 1

(D) 2

Options :

1. ✗ A
2. ✗ B
3. ✓ C
4. ✗ D

Question Number : 40 Question Type : NAT

For ball bearings, the fatigue life  $L$  measured in number of revolutions and the radial load  $F$  are related by  $FL^{1/3} = K$ , where  $K$  is a constant. It withstands a radial load of 2 kN for a life of 540 million revolutions. The load (in kN) for a life of one million revolutions is \_\_\_\_\_

**Correct Answer:**

15 to 17

**Question Number : 41 Question Type : NAT**

In a rolling operation using rolls of diameter 500 mm, if a 25 mm thick plate cannot be reduced to less than 20 mm in one pass, the coefficient of friction between the roll and the plate is \_\_\_\_\_

**Correct Answer :**

0.10 to 0.15

**Question Number : 42 Question Type : NAT**

Ratio of solidification time of a cylindrical casting (height = radius) to that of a cubic casting of side two times the height of cylindrical casting is \_\_\_\_\_

**Correct Answer :**

0.5 to 0.6

**Question Number : 43 Question Type : NAT**

The annual requirement of rivets at a ship manufacturing company is 2000 kg. The rivets are supplied in units of 1 kg costing Rs. 25 each. If it costs Rs. 100 to place an order and the annual cost of carrying one unit is 9% of its purchase cost, the cycle length of the order (in days) will be \_\_\_\_\_

**Correct Answer :**

76 to 78

**Question Number : 44 Question Type : MCQ**

Orthogonal turning of a mild steel tube with a tool of rake angle  $10^\circ$  is carried out at a feed of 0.14 mm/rev. If the thickness of the chip produced is 0.28 mm, the values of shear angle and shear strain will be respectively

- (A)  $28^\circ 20'$  and 2.19    (B)  $22^\circ 20'$  and 3.53    (C)  $24^\circ 30'$  and 4.19    (D)  $37^\circ 20'$  and 5.19

Options :

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

Question Number : 45 Question Type : MCQ

In a CNC milling operation, the tool has to machine the circular arc from point (20, 20) to (10, 10) at sequence number 5 of the CNC part program. If the center of the arc is at (20, 10) and the machine has incremental mode of defining position coordinates, the correct tool path command is

- (A) N 05 G90 G01 X-10 Y-10 R10  
(B) N 05 G91 G03 X-10 Y-10 R10  
(C) N 05 G90 G03 X20 Y20 R10  
(D) N 05 G91 G02 X20 Y20 R10

Options :

1. ✗ A
2. ✓ B
3. ✗ C
4. ✗ D

Question Number : 46 Question Type : NAT

A Prandtl tube (Pitot-static tube with  $C=1$ ) is used to measure the velocity of water. The differential manometer reading is 10 mm of liquid column with a relative density of 10. Assuming  $g = 9.8 \text{ m/s}^2$ , the velocity of water (in m/s) is \_\_\_\_\_

Correct Answer :

1.30 to 1.34

Question Number : 47 Question Type : NAT

Refrigerant vapor enters into the compressor of a standard vapor compression cycle at  $-10^\circ\text{C}$  ( $h = 402 \text{ kJ/kg}$ ) and leaves the compressor at  $50^\circ\text{C}$  ( $h = 432 \text{ kJ/kg}$ ). It leaves the condenser at  $30^\circ\text{C}$  ( $h = 237 \text{ kJ/kg}$ ). The COP of the cycle is \_\_\_\_\_

**Correct Answer:**

5.5

**Question Number : 48 Question Type : NAT**

Steam enters a turbine at 30 bar, 300°C ( $u = 2750 \text{ kJ/kg}$ ,  $h = 2993 \text{ kJ/kg}$ ) and exits the turbine as saturated liquid at 15 kPa ( $u = 225 \text{ kJ/kg}$ ,  $h = 226 \text{ kJ/kg}$ ). Heat loss to the surrounding is 50 kJ/kg of steam flowing through the turbine. Neglecting changes in kinetic energy and potential energy, the work output of the turbine (in kJ/kg of steam) is

**Correct Answer :**

2717

**Question Number : 49 Question Type : NAT**

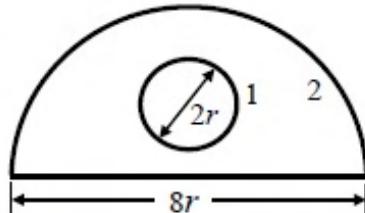
Air in a room is at  $35^{\circ}\text{C}$  and 60% relative humidity ( $RH$ ). The pressure in the room is 0.1 MPa. The saturation pressure of water at  $35^{\circ}\text{C}$  is 5.63 kPa. The humidity ratio of the air (in gram/kg of dry air) is

**Correct Answer :**

21.7 to 21.9

**Question Number : 50 Question Type : MCQ**

A solid sphere 1 of radius ' $r$ ' is placed inside a hollow, closed hemispherical surface 2 of radius ' $4r$ '. The shape factor  $F_{2-1}$  is



- (A)  $\frac{1}{12}$       (B)  $\frac{1}{2}$       (C) 2      (D) 12

## Options :

1. ✓ A
  2. ✗ B
  3. ✗ C
  4. ✗ D

**Question Number : 51 Question Type : NAT**

The value of

$\int_C [(3x - 8y^2)dx + (4y - 6xy)dy]$ , (where  $C$  is the boundary of the region bounded by  $x = 0$ ,  $y = 0$  and  $x+y = 1$ ) is

**Correct Answer :**

1.60 to 1.70

**Question Number : 52 Question Type : MCQ**

For a given matrix  $P = \begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$ , where  $i = \sqrt{-1}$ , the inverse of matrix P is

(A)  $\frac{1}{24} \begin{bmatrix} 4-3i & i \\ -i & 4+3i \end{bmatrix}$

(B)  $\frac{1}{25} \begin{bmatrix} i & 4-3i \\ 4+3i & -i \end{bmatrix}$

(C)  $\frac{1}{24} \begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$

(D)  $\frac{1}{25} \begin{bmatrix} 4+3i & -i \\ i & 4-3i \end{bmatrix}$

**Options :**

1. ✓ A

2. ✗ B

3. ✗ C

4. ✗ D

**Question Number : 53 Question Type : NAT**

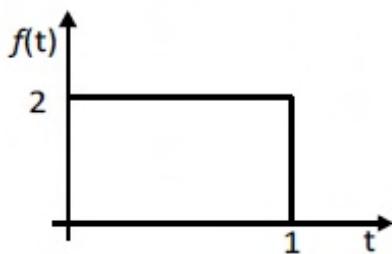
Newton-Raphson method is used to find the roots of the equation,  $x^3 + 2x^2 + 3x - 1 = 0$ . If the initial guess is  $x_0 = 1$ , then the value of  $x$  after 2<sup>nd</sup> iteration is \_\_\_\_\_

**Correct Answer :**

0.29 to 0.31

**Question Number : 54 Question Type : MCQ**

Laplace transform of the function  $f(t)$  is given by  $F(s) = L\{f(t)\} = \int_0^{\infty} f(t)e^{-st} dt$ .  
Laplace transform of the function shown below is given by



(A)  $\frac{1-e^{-2s}}{s}$

(B)  $\frac{1-e^{-s}}{2s}$

(C)  $\frac{2-2e^{-s}}{s}$

(D)  $\frac{1-2e^{-s}}{s}$

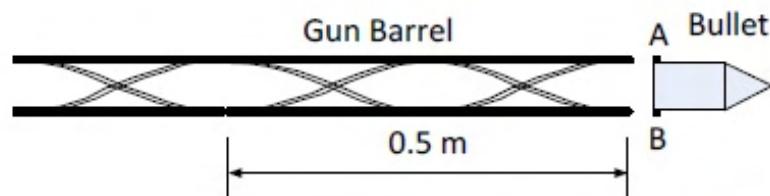
**Options :**

1. ✗ A

2. ✗ B  
 3. ✓ C  
 4. ✗ D

**Question Number : 55 Question Type : NAT**

A bullet spins as the shot is fired from a gun. For this purpose, two helical slots as shown in the figure are cut in the barrel. Projections A and B on the bullet engage in each of the slots.



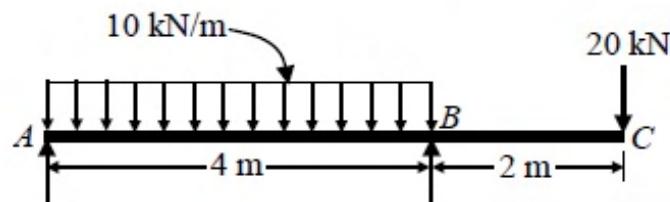
Helical slots are such that one turn of helix is completed over a distance of 0.5 m. If velocity of bullet when it exits the barrel is 20 m/s, its spinning speed in rad/s is \_\_\_\_\_

**Correct Answer:**

251 to 252

**Question Number : 56 Question Type : NAT**

For the overhanging beam shown in figure, the magnitude of maximum bending moment (in kN-m) is \_\_\_\_\_



**Correct Answer:**

40

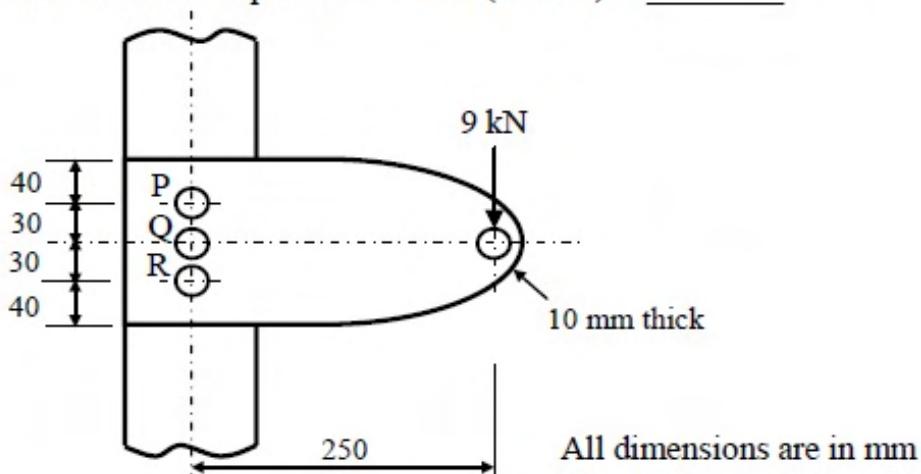
**Question Number : 57 Question Type : NAT**

The torque (in N-m) exerted on the crank shaft of a two stroke engine can be described as  $T = 10000 + 1000 \sin 2\theta - 1200 \cos 2\theta$ , where  $\theta$  is the crank angle as measured from inner dead center position. Assuming the resisting torque to be constant, the power (in kW) developed by the engine at 100 rpm is \_\_\_\_\_

**Correct Answer:**

**Question Number : 58 Question Type : NAT**

A cantilever bracket is bolted to a column using three M12×1.75 bolts P, Q and R. The value of maximum shear stress developed in the bolt P (in MPa) is \_\_\_\_\_

**Correct Answer:**

332 to 494

**Question Number : 59 Question Type : MCQ**

A shaft of length 90 mm has a tapered portion of length 55 mm. The diameter of the taper is 80 mm at one end and 65 mm at the other. If the taper is made by tailstock set over method, the taper angle and the set over respectively are

- |                                  |                                  |
|----------------------------------|----------------------------------|
| (A) $15^{\circ}32'$ and 12.16 mm | (B) $18^{\circ}32'$ and 15.66 mm |
| (C) $11^{\circ}22'$ and 10.26 mm | (D) $10^{\circ}32'$ and 14.46 mm |

**Options :**

1. ✓ A
2. ✗ B
3. ✗ C
4. ✗ D

**Question Number : 60 Question Type : NAT**

The dimensions of a cylindrical side riser (height = diameter) for a  $25 \text{ cm} \times 15 \text{ cm} \times 5 \text{ cm}$  steel casting are to be determined. For the tabulated shape factor values given below, the diameter of the riser (in cm) is \_\_\_\_\_

Shape factor	2	4	6	8	10	12
Riser volume/ Casting volume	1.0	0.70	0.55	0.50	0.40	0.35

**Correct Answer:**

10.5 to 10.7

**Question Number : 61 Question Type : MCQ**

For the linear programming problem:

$$\begin{aligned}
 & \text{Maximize} \quad Z = 3X_1 + 2X_2 \\
 & \text{Subject to} \\
 & -2X_1 + 3X_2 \leq 9 \\
 & X_1 - 5X_2 \geq -20 \\
 & X_1, X_2 \geq 0
 \end{aligned}$$

The above problem has



### **Options :**

- 1. ✓ A
  - 2. ✗ B
  - 3. ✗ C
  - 4. ✗ D

**Question Number : 62 Question Type : MCQ**

Which of the following statements are TRUE, when the cavitation parameter  $\sigma = 0$ ?



## **Options :**

1. ✘ A
  2. ✘ B
  3. ✘ C
  4. ✓ D

**Question Number : 63 Question Type : NAT**

One side of a wall is maintained at 400 K and the other at 300 K. The rate of heat transfer through the wall is 1000 W and the surrounding temperature is 25°C. Assuming no generation of heat within the wall, the irreversibility (in W) due to heat transfer through the wall is

**Correct Answer:**

247 to 249

Question Number : 64 Question Type : MCQ

A brick wall ( $k = 0.9 \frac{W}{m \cdot K}$ ) of thickness 0.18 m separates the warm air in a room from the cold ambient air. On a particular winter day, the outside air temperature is  $-5^\circ\text{C}$  and the room needs to be maintained at  $27^\circ\text{C}$ . The heat transfer coefficient associated with outside air is  $20 \frac{W}{m^2 \cdot K}$ . Neglecting the convective resistance of the air inside the room, the heat loss, in  $(\frac{W}{m^2})$ , is



## **Options :**

1. ✗ A
  2. ✗ B
  3. ✓ C
  4. ✗ D

**Question Number : 65 Question Type : NAT**

A mixture of ideal gases has the following composition by mass:

$N_2$	$O_2$	$CO_2$
60%	30%	10%

If the universal gas constant is 8314 J/kmol-K, the characteristic gas constant of the mixture (in J/kg-K) is

**Correct Answer :**

274 to 276