GA - General Aptitude

Q1 - Q5 carry one mark each.

Q.No. 1 He is known for his unscrupulous ways. He always sheds_____tears to deceive people.

(A) fox's

(B) crocodile's

(C) crocodile

(D) fox

Q.No. 2 Jofra Archer, the England fast bowler, is_____than accurate.

(A) more fast

(B) faster

(C) less fast

(D) more faster

Q.No. 3 Select the word that fits the analogy:

Build : Building :: Grow : _____

(A) Grown

(B) Grew

(C) Growth

(D) Growed

Q.No. 4 I do not think you know the case well enough to have opinions. Having said that, I agree with your other point.
What does the phrase "having said that" mean in the given text?

(A) as opposed to what I have said

(B) despite what I have said

(C) in addition to what I have said

(D) contrary to what I have said

Q.No. 5 Define $[x]$ as the greatest integer less than or equal to x, for each $x \in (-\infty, \infty)$. If $y = [x]$, then area under y for $x \in [1,4]$ is _____.

(A) 1

(B) 3

(C) 4

(D) 6

Q6 - Q10 carry two marks each.

Q.No. 6 Crowd funding deals with mobilisation of funds for a project from a large number of people, who would be willing to invest smaller amounts through web-based platforms in the project.

Based on the above paragraph, which of the following is correct about crowd funding?

(A) Funds raised through unwilling contributions on web-based platforms.

(B) Funds raised through large contributions on web-based platforms.

(C) Funds raised through coerced contributions on web-based platforms.

(D) Funds raised through voluntary contributions on web-based platforms.

Q.No. 7 P, Q, R and S are to be uniquely coded using α and β. If P is coded as αα and Q as αβ, then R and S, respectively, can be coded as ______.

(A) βα and αβ

(B) ββ and αα

(C) αβ and ββ

(D) βα and ββ

Q.No. 8 The sum of the first *n* terms in the sequence 8, 88, 888, 8888, … is______.

(A) $\frac{81}{80}(10^n - 1) + \frac{9}{8}n$

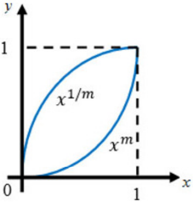
(B) $\frac{81}{80}(10^n - 1) - \frac{9}{8}n$

(C) $\frac{80}{81}(10^n - 1) + \frac{8}{9}n$

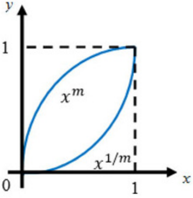
(D) $\frac{80}{81}(10^n - 1) - \frac{8}{9}n$

Q.No. 9 Select the graph that schematically represents BOTH $y = x^m$ and $y = x^{1/m}$ properly in the interval $0 \leq x \leq 1$, for integer values of $m,$ where $m > 1$.

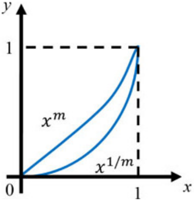
(A)



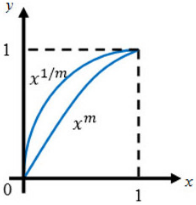
(B)



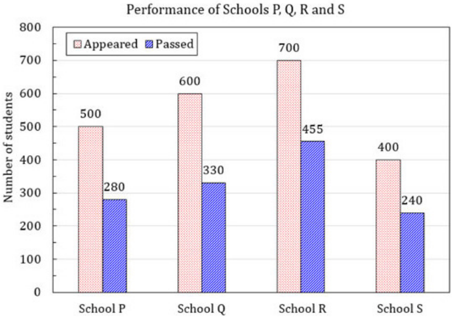
(C)



(D)



Q.No. 10 The bar graph shows the data of the students who appeared and passed in an examination for four schools P, Q, R and S. The average of success rates (in percentage) of these four schools is _____.



(A) 58.5 %

(B) 58.8 %

(C) 59.0 %

(D) 59.3 %

ME1: Mechanical Engineering

Q1 - Q25 carry one mark each.

Q.No. 1 Multiplication of real valued square matrices of same dimension is

(A) associative

(B) commutative

(C) always positive definite

(D) not always possible to compute

Q.No. 2 The value of

$$\lim_{x\to 1}\left(\frac{1-e^{-c(1-x)}}{1-x\,e^{-c(1-x)}}\right) \text{ is}$$

(A) c

(B) $c+1$

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

(D) $\frac{c+1}{c}$

Q.No. 3 The Laplace transform of a function $f(t)$ is $\mathcal{L}(f) = \frac{1}{(s^2+\omega^2)}$. Then, $f(t)$ is

(A) $f(t) = \frac{1}{\omega^2}(1 - \cos \omega t)$

(B) $f(t) = \frac{1}{\omega}\cos \omega t$

(C) $f(t) = \frac{1}{\omega}\sin \omega t$

(D) $f(t) = \frac{1}{\omega^2}(1 - \sin \omega t)$

Q.No. 4 Which of the following function $f(z)$, of the complex variable z, is **NOT** analytic at all the points of the complex plane?

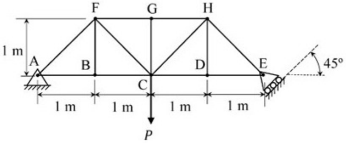
(A) $f(z) = z^2$

(B) $f(z) = e^z$

(C) $f(z) = \sin z$

(D) $f(z) = \log z$

Q.No. 5 The members carrying zero force (i.e. zero-force members) in the truss shown in the figure, for any load $P > 0$ with no appreciable deformation of the truss (i.e. with no appreciable change in angles between the members), are



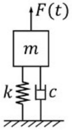
(A) BF and DH only

(B) BF, DH and GC only

(C) BF, DH, GC, CD and DE only

(D) BF, DH, GC, FG and GH only

Q.No. 6 A single-degree-of-freedom oscillator is subjected to harmonic excitation $F(t) = F_0 \cos(\omega t)$ as shown in the figure.



The non-zero value of ω, for which the amplitude of the force transmitted to the ground will be F_0, is

(A) $\sqrt{\frac{k}{2m}}$

(B) $\sqrt{\frac{k}{m}}$

(C) $\sqrt{\frac{2k}{m}}$

(D) $2\sqrt{\frac{k}{m}}$

Q.No. 7 The stress state at a point in a material under plane stress condition is equi-biaxial tension with a magnitude of 10 MPa. If one unit on the $\sigma-\tau$ plane is 1 MPa, the Mohr's circle representation of the state-of-stress is given by

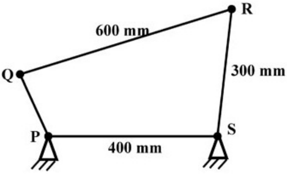
(A) a circle with a radius equal to principal stress and its center at the origin of the $\sigma-\tau$ plane

(B) a point on the σ axis at a distance of 10 units from the origin

(C) a circle with a radius of 10 units on the $\sigma-\tau$ plane

(D) a point on the τ axis at a distance of 10 units from the origin

Q.No. 8 A four bar mechanism is shown below.



For the mechanism to be a crank-rocker mechanism, the length of the link PQ can be

(A) 80 mm

(B) 200 mm

(C) 300 mm

(D) 350 mm

Q.No. 9 A helical gear with 20° pressure angle and 30° helix angle mounted at the mid-span of a shaft that is supported between two bearings at the ends. The nature of the stresses induced in the shaft is

(A) normal stress due to bending only

(B) normal stress due to bending in one plane and axial loading; shear stress due to torsion

(C) normal stress due to bending in two planes and axial loading; shear stress due to torsion

(D) normal stress due to bending in two planes; shear stress due to torsion

Q.No. 10 The crystal structure of γ iron (austenite phase) is

(A) BCC

(B) FCC

(C) HCP

(D) BCT

Q.No. 11 Match the following.

Heat treatment process	Effect
P: Tempering	1. Strengthening
Q: Quenching	2. Toughening
R: Annealing	3. Hardening
S: Normalizing	4. Softening

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

(B) P-1, Q-1, R-3, S-2

(C) P-3, Q-3, R-1, S-3

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

Q.No. 12 The base of a brass bracket needs rough grinding. For this purpose, the most suitable grinding wheel grade specification is

(A) C30Q12V

(B) A50G8V

(C) C90J4B

(D) A30D12V

Q.No. 13 In the Critical Path Method (CPM), the cost-time slope of an activity is given by

(A) $\frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Crash Time}}$

(B) $\frac{\text{Normal Cost}}{\text{Crash Time} - \text{Normal Time}}$

(C) $\frac{\text{Crash Cost}}{\text{Crash Time} - \text{Normal Time}}$

(D) $\frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal Time} - \text{Crash Time}}$

Q.No. 14 Froude number is the ratio of

(A) buoyancy forces to viscous forces

(B) inertia forces to viscous forces

(C) buoyancy forces to inertia forces

(D) inertia forces to gravity forces

Q.No. 15 Match the following non-dimensional numbers with the corresponding definitions:

Non-dimensional number		**Definition**	
P	Reynolds number	**1**	$\frac{\text{Buoyancy force}}{\text{Viscous force}}$
Q	Grashof number	**2**	$\frac{\text{Momentum diffusivity}}{\text{Thermal diffusivity}}$
R	Nusselt number	**3**	$\frac{\text{Inertia force}}{\text{Viscous force}}$
S	Prandtl number	**4**	$\frac{\text{Convective heat transfer}}{\text{Conduction heat transfer}}$

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

Q.No. 16 The velocity field of an incompressible flow in a Cartesian system is represented by

$$\vec{V} = 2(x^2 - y^2)\hat{\imath} + v\hat{\jmath} + 3\hat{k}$$

Which one of the following expressions for v is valid?

(A) $-4xz + 6xy$
(B) $-4xy - 4xz$
(C) $4xz - 6xy$
(D) $4xy + 4xz$

Q.No. 17 For an ideal gas, the value of the Joule-Thomson coefficient is

(A) positive
(B) negative
(C) zero
(D) indeterminate

Q.No. 18 For an ideal gas, a constant pressure line and a constant volume line intersect at a point, in the Temperature (T) versus specific entropy (s) diagram. C_P is the specific heat at constant pressure and C_V is the specific heat at constant volume. The ratio of the slopes of the constant pressure and constant volume lines at the point of intersection is

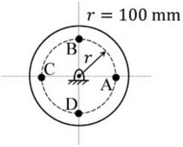
(A) $\frac{C_P - C_V}{C_P}$
(B) $\frac{C_P}{C_V}$
(C) $\frac{C_P - C_V}{C_V}$

(D) $\frac{C_V}{C_P}$

Q.No. 19 For three vectors $\vec{A} = 2\hat{\jmath} - 3\hat{k}$, $\vec{B} = -2\hat{\imath} + \hat{k}$ and $\vec{C} = 3\hat{\imath} - \hat{\jmath}$, where $\hat{\imath}$, $\hat{\jmath}$ and $\hat{k}$ are unit vectors along the axes of a right-handed rectangular/Cartesian coordinate system, the value of $(\vec{A} \cdot (\vec{B} \times \vec{C}) + 6)$ is ________________.

Q.No. 20 A flywheel is attached to an engine to keep its rotational speed between 100 rad/s and 110 rad/s. If the energy fluctuation in the flywheel between these two speeds is 1.05 kJ then the moment of inertia of the flywheel is ________________ kg.m^2 (*round off to 2 decimal places*).

Q.No. 21 A balanced rigid disc mounted on a rigid rotor has four identical point masses, each of 10 grams, attached to four points on the 100 mm radius circle shown in the figure.



The rotor is driven by a motor at uniform angular speed of 10 rad/s. If one of the masses gets detached then the magnitude of the resultant unbalance force on the rotor is ________________ N (*round off to 2 decimal places*).

Q.No. 22 A sheet metal with a stock hardness of 250 HRC has to be sheared using a punch and a die having a clearance of 1 mm between them. If the stock hardness of the sheet metal increases to 400 HRC, the clearance between the punch and the die should be __________ mm.

Q.No. 23 A company is hiring to fill four managerial vacancies. The candidates are five men and three women. If every candidate is equally likely to be chosen then the probability that at least one woman will be selected is ________(*round off to 2 decimal places*).

Q.No. 24 The compressor of a gas turbine plant, operating on an ideal intercooled Brayton cycle, accomplishes an overall compression ratio of 6 in a two-stage compression process. Intercooling is used to cool the air coming out from the first stage to the inlet temperature of the first stage, before its entry to the second stage. Air enters the compressor at 300 K and 100 kPa. If the properties of gas are constant, the intercooling pressure for minimum compressor work is ________________ kPa (*round off to 2 decimal places*).

Q.No. 25 In a concentric tube counter-flow heat exchanger, hot oil enters at 102°C and leaves at 65°C. Cold water enters at 25°C and leaves at 42°C. The log mean temperature difference (LMTD) is ______________ °C (*round off to one decimal place*).

Q26 - Q55 carry two marks each.

Q.No. 26 The evaluation of the definite integral $\int_{-1}^{1.4} x|x|\, \mathrm{d}x$ by using Simpson's 1/3rd (one-third) rule with step size $h = 0.6$ yields

(A) 0.914

(B) 1.248

(C) 0.581

(D) 0.592

Q.No. 27 A vector field is defined as

$$\vec{f}(x,y,z) = \frac{x}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{\imath} + \frac{y}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{\jmath} + \frac{z}{[x^2+y^2+z^2]^{\frac{3}{2}}}\hat{k}$$

where, $\hat{\imath}, \hat{\jmath}, \hat{k}$ are unit vectors along the axes of a right-handed rectangular /Cartesian coordinate system. The surface integral $\iint \vec{f}.\mathrm{d}\vec{S}$ (where $\mathrm{d}\vec{S}$ is an elemental surface area vector) evaluated over the inner and outer surfaces of a spherical shell formed by two concentric spheres with origin as the center, and internal and external radii of 1 and 2, respectively, is

(A) 0

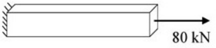
(B) 2π

(C) 4π

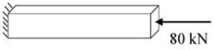
(D) 8π

Q.No. 28 Bars of square and circular cross-section with 0.5 m length are made of a material with shear strength of 20 MPa. The square bar cross-section dimension is 4 cm × 4 cm and the cylindrical bar cross-section diameter is 4 cm. The specimens are loaded as shown in the figure.

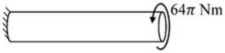
Tensile load



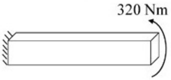
Compressive load



Torsional load



Bending load



Which specimen(s) will fail due to the applied load as per maximum shear stress theory?

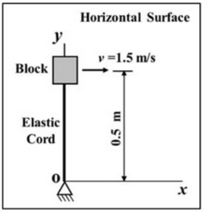
(A) Tensile and compressive load specimens

(B) Torsional load specimen

(C) Bending load specimen

(D) None of the specimens

Q.No. 29 The 2 kg block shown in figure (top view) rests on a smooth horizontal surface and is attached to a massless elastic cord that has a stiffness 5 N/m.



The cord hinged at **O** is initially unstretched and always remains elastic. The block is given a velocity v of 1.5 m/s perpendicular to the cord. The magnitude of velocity in m/s of the block at the instant the cord is stretched by 0.4 m is

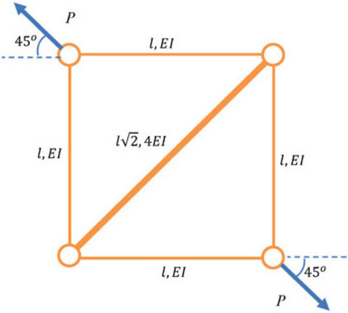
(A) 0.83

(B) 1.07

(C) 1.36

(D) 1.50

Q.No. 30 The truss shown in the figure has four members of length l and flexural rigidity EI, and one member of length $l\sqrt{2}$ and flexural rigidity $4EI$. The truss is loaded by a pair of forces of magnitude P, as shown in the figure.



The smallest value of P, at which any of the truss members will buckle is

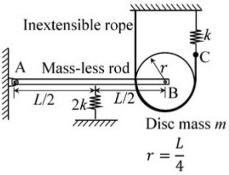
(A) $\frac{\sqrt{2}\pi^2 EI}{l^2}$

(B) $\frac{\pi^2 EI}{l^2}$

(C) $\frac{2\pi^2 EI}{l^2}$

(D) $\frac{\pi^2 EI}{2l^2}$

Q.No. 31 A rigid mass-less rod of length L is connected to a disc (pulley) of mass m and radius $r = L/4$ through a friction-less revolute joint. The other end of that rod is attached to a wall through a friction-less hinge. A spring of stiffness $2k$ is attached to the rod at its mid-span. An inextensible rope passes over half the disc periphery and is securely tied to a spring of stiffness k at point C as shown in the figure. There is no slip between the rope and the pulley. The system is in static equilibrium in the configuration shown in the figure and the rope is always taut.



Neglecting the influence of gravity, the natural frequency of the system for small amplitude vibration is

(A) $\sqrt{\frac{3}{2}}\sqrt{\frac{k}{m}}$

(B) $\frac{3}{\sqrt{2}}\sqrt{\frac{k}{m}}$

(C) $\sqrt{3}\sqrt{\frac{k}{m}}$

(D) $\sqrt{\frac{k}{m}}$

Q.No. 32 A strip of thickness 40 mm is to be rolled to a thickness of 20 mm using a two-high mill having rolls of diameter 200 mm. Coefficient of friction and arc length in mm, respectively are

(A) 0.45 and 38.84

(B) 0.39 and 38.84

(C) 0.39 and 44.72

(D) 0.45 and 44.72

Q.No. 33 For an assembly line, the production rate was 4 pieces per hour and the average processing time was 60 minutes. The WIP inventory was calculated. Now, the production rate is kept the same, and the average processing time is brought down by 30 percent. As a result of this change in the processing time, the WIP inventory

(A) decreases by 25%

(B) increases by 25%

(C) decreases by 30%

(D) increases by 30%

Q.No. 34 A small metal bead (radius 0.5 mm), initially at 100°C, when placed in a stream of fluid at 20°C, attains a temperature of 28°C in 4.35 seconds. The density and specific heat of the metal are 8500 kg/m^3 and 400 J/kg.K, respectively. If the bead is considered as lumped system, the convective heat transfer coefficient (in W/m^2.K) between the metal bead and the fluid stream is

(A) 283.3
(B) 299.8
(C) 149.9
(D) 449.7

Q.No. 35 Consider two exponentially distributed random variables X and Y, both having a mean of 0.50. Let Z $=$ X $+$ Y and r be the correlation coefficient between X and Y. If the variance of Z equals 0, then the value of r is ________________ *(round off to 2 decimal places)*.

Q.No. 36 An analytic function of a complex variable $z = x + iy$ $(i = \sqrt{-1})$ is defined as

$$f(z) = x^2 - y^2 + i\,\psi(x, y),$$

where $\psi(x, y)$ is a real function. The value of the imaginary part of $f(z)$ at $z = (1 + i)$ is ________________ *(round off to 2 decimal places)*.

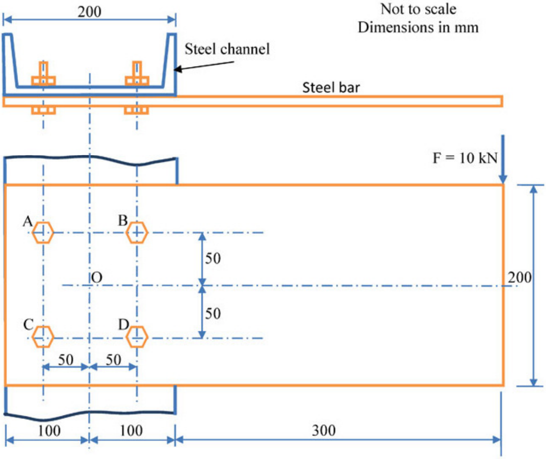
Q.No. 37 In a disc-type axial clutch, the frictional contact takes place within an annular region with outer and inner diameters 250 mm and 50 mm, respectively. An axial force F_1 is needed to transmit a torque by a new clutch. However, to transmit the same torque, one needs an axial force F_2 when the clutch wears out. If contact pressure remains uniform during operation of a new clutch while the wear is assumed to be uniform for an old clutch, and the coefficient of friction does not change, then the ratio F_1/F_2 is ________________ *(round off to 2 decimal places)*.

Q.No. 38 A cam with a translating flat-face follower is desired to have the follower motion

$$y(\theta) = 4\left[2\pi\theta - \theta^2\right], \qquad 0 \le \theta \le 2\pi .$$

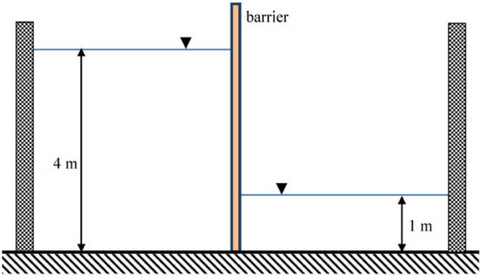
Contact stress considerations dictate that the radius of curvature of the cam profile should not be less than 40 mm anywhere. The minimum permissible base circle radius is ______________ mm *(round off to one decimal place)*.

Q.No. 39 A rectangular steel bar of length 500 mm, width 100 mm, and thickness 15 mm is cantilevered to a 200 mm steel channel using 4 bolts, as shown.



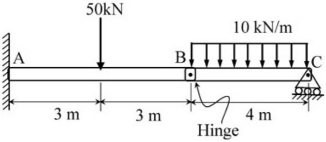
For an external load of 10 kN applied at the tip of the steel bar, the resultant shear load on the bolt at B, is ________________ kN (*round off to one decimal place*).

Q.No. 40 The barrier shown between two water tanks of unit width (1 m) into the plane of the screen is modeled as a cantilever.



Taking the density of water as 1000 kg/m^3, and the acceleration due to gravity as 10 m/s^2, the maximum absolute bending moment developed in the cantilever is ____________ kN·m (*round off to the nearest integer*).

Q.No. 41 The magnitude of reaction force at joint C of the hinge-beam shown in the figure is ________________ kN (*round off to 2 decimal places*).



Q.No. 42 A slot of 25 mm × 25 mm is to be milled in a workpiece of 300 mm length using a side and face milling cutter of diameter 100 mm, width 25 mm and having 20 teeth.

For a depth of cut 5 mm, feed per tooth 0.1 mm, cutting speed 35 m/min and approach and over travel distance of 5 mm each, the time required for milling the slot is ________ minutes (*round off to one decimal place*).

Q.No. 43 The following data applies to basic shaft system:

tolerance for hole = 0.002 mm,
tolerance for shaft = 0.001 mm,
allowance = 0.003 mm,
basic size = 50 mm.
The maximum hole size is _____ mm (*round off to 3 decimal places*).

Q.No. 44 A steel part with surface area of 125 cm^2 is to be chrome coated through an electroplating process using chromium acid sulphate as an electrolyte. An increasing current is applied to the part according to the following current time relation:

$$I = 12 + 0.2t$$

where, I = current (A) and t = time (minutes). The part is submerged in the plating solution for a duration of 20 minutes for plating purpose. Assuming the cathode efficiency of chromium to be 15% and the plating constant of chromium acid sulphate to be 2.50×10^{-2} mm^3/A·s, the resulting coating thickness on the part surface is ____________ μm (*round off to one decimal place*).

Q.No. 45 In a turning process using orthogonal tool geometry, a chip length of 100 mm is obtained for an uncut chip length of 250 mm.

The cutting conditions are: cutting speed = 30 m/min, rake angle = 20°.

The shear plane angle is _________ degrees (*round off to one decimal place*).

Q.No. 46 The thickness of a steel plate with material strength coefficient of 210 MPa, has to be reduced from 20 mm to 15 mm in a single pass in a two-high rolling mill with a roll radius of 450 mm and rolling velocity of 28 m/min. If the plate has a width of 200 mm and its strain hardening exponent, n is 0.25, the rolling force required for the operation is ____________ kN (*round off to 2 decimal places*).

Note: *Average Flow Stress* = *Material Strength Coefficient* × $\frac{(True\ Strain)^n}{(1+n)}$

Q.No. 47 Two business owners Shveta and Ashok run their businesses in two different states. Each of them, independent of the other, produces two products A and B, sells them at Rs. 2,000 per kg and Rs. 3,000 per kg, respectively, and uses Linear Programming to determine the optimal quantity of A and B to maximize their respective daily revenue. Their constraints are as follows: i) for each business owner, the production process is such that the daily production of A has to be at least as much as B, and the upper limit for production of B is 10 kg per day, and ii) the respective state regulations restrict Shveta's production of A to less than 20 kg per day, and Ashok's production of A to less than 15 kg per day. The demand of both A and B in both the states is very high and everything produced is sold.

The absolute value of the difference in daily (optimal) revenue of Shveta and Ashok is ________________ thousand Rupees (*round off to 2 decimal places*).

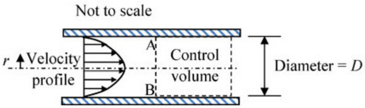
Q.No. 48 **Consider two cases as below.**

Case 1: A company buys 1000 pieces per year of a certain part from vendor 'X'. The changeover time is 2 hours and the price is Rs. 10 per piece. The holding cost rate per part is 10% per year.

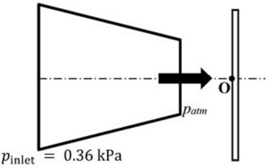
Case 2: For the same part, another vendor 'Y' offers a design where the changeover time is 6 minutes, with a price of Rs. 5 per piece, and a holding cost rate per part of 100% per year. The order size is 800 pieces per year from 'X' and 200 pieces per year from 'Y'.

Assume the cost of downtime as Rs. 200 per hour. The percentage reduction in the annual cost for Case 2, as compared to Case 1 is__________ (*round off to 2 decimal places*).

Q.No. 49 Consider steady, viscous, fully developed flow of a fluid through a circular pipe of internal diameter D. We know that the velocity profile forms a paraboloid about the pipe centre line, given by: $V = -C\left(r^2 - \frac{D^2}{4}\right)$ m/s, where C is a constant. The rate of kinetic energy (in J/s) at the control surface A-B, as shown in the figure, is proportional to D^n. The value of n is _________________.



Q.No. 50 Air discharges steadily through a horizontal nozzle and impinges on a stationary vertical plate as shown in figure.



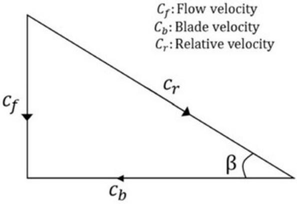
The inlet and outlet areas of the nozzle are 0.1 m^2 and 0.02 m^2, respectively. Take air density as constant and equal to 1.2 kg/m^3. If the inlet gauge pressure of air is 0.36 kPa, the gauge pressure at point **O** on the plate is _______ kPa (*round off to two decimal places*).

Q.No. 51 Air (ideal gas) enters a perfectly insulated compressor at a temperature of 310 K. The pressure ratio of the compressor is 6. Specific heat at constant pressure for air is 1005 J/kg.K and ratio of specific heats at constant pressure and constant volume is 1.4. Assume that specific heats of air are constant. If the isentropic efficiency of the compressor is 85 percent, the difference in enthalpies of air between the exit and the inlet of the compressor is ________ kJ/kg (*round off to nearest integer*).

Q.No. 52 One kg of air, initially at a temperature of 127°C, expands reversibly at a constant pressure until the volume is doubled. If the gas constant of air is 287 J/kg.K, the magnitude of work transfer is _____________ kJ (*round off to 2 decimal places*).

Q.No. 53 For an ideal Rankine cycle operating between pressures of 30 bar and 0.04 bar, the work output from the turbine is 903 kJ/kg and the work input to the feed pump is 3 kJ/kg. The specific steam consumption is ________________ kg/kW.h (*round off to 2 decimal places*).

Q.No. 54 For a Kaplan (axial flow) turbine, the outlet blade velocity diagram at a section is shown in figure.



The diameter at this section is 3 m. The hub and tip diameters of the blade are 2 m and 4 m, respectively. The water volume flow rate is 100 m^3/s. The rotational speed of the turbine is 300 rpm. The blade outlet angle β is ______ degrees (*round off to one decimal place*).

Q.No. 55 The indicated power developed by an engine with compression ratio of 8, is calculated using an air-standard Otto cycle (constant properties). The rate of heat addition is 10 kW. The ratio of specific heats at constant pressure and constant volume is 1.4. The mechanical efficiency of the engine is 80 percent.

The brake power output of the engine is _______ kW (*round off to one decimal place*).