Answer Key

of

Mechanical Engineering

GATE-2015

Forenoon Session   **1st Feb, 2015**

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Section - I (General Aptitude)

Q.1 Choose the correct verb to fill in the blank below:
Let us _____.
(a) introvert
(b) alternate
(c) atheist
(d) altruist

Ans. (B)

● ● ● End of Solution

Q.2 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.
(a) should practise
(b) should have practised
(c) practised
(d) should be practising

Ans. (B)

● ● ● End of Solution

Q.3 If $x > y > 1$, which of the following must be true?
i.   In x > In 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

Ans. (A)

● ● ● End of Solution

Q.4 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

Ans. (B)

● ● ● End of Solution

Q.5 Find the missing sequence in the letter series below:

A, CD, GHI, ?, UVWXY
(a) *LMN*
(b) *MNO*
(c) *MNOP*
(d) *NOPQ*

Ans. (C)

● ● ● End of Solution

Q.6   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 statement 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.

Ans.   (B)

⚫ ⚫ ⚫ *End of Solution*

Q.7   log tan 1° + log tan 2° + ... + log tan 89° is _____.

(a) 1
(b) $\dfrac{1}{\sqrt{2}}$

(c) 0
(d) − 1

Ans.   (C)

⚫ ⚫ ⚫ *End of Solution*

Q.8   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 _____.

Ans.   (2.0647)

⚫ ⚫ ⚫ *End of Solution*

Q.9   In the following questions, 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 exchanges 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

Ans.   (B)

⚫ ⚫ ⚫ *End of Solution*

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Q.10 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

Ans. **(C)**

Section - II (Mechanical Engineering)

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

(a) $\dfrac{s-5i}{s^2-25}$ (b) $\dfrac{s+5i}{s^2+25}$

(c) $\dfrac{s+5i}{s^2-25}$ (d) $\dfrac{s-5i}{s^2+25}$

Ans. **(B)**

● ● ● *End of Solution*

Q.2 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
(a) 35   (b) 70
(c) 140   (d) 280

Ans. **(C)**

● ● ● *End of Solution*

Q.3 In the laminar flow of air ($Pr = 0.7$) over a heated plate, if δ and δ_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 $\delta_T \neq 0$

Ans. **(C)**

● ● ● *End of Solution*

Q.4 The Van der Waals equation of state is $\left(p + \dfrac{a}{v^2}\right)(v - b) = RT$, where p is pressure, v is specific volume, T is temperature and R is characteristic gas constant. The *SI* unit of a is

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(a) J/kg-K

(b) m^3/kg

(c) m^5/kg-s^2

(d) Pa/kg

Ans. **(C)**

● ● ● *End of Solution*

Q.5 If the fluid velocity for a potential flow is given by $V(x, y) = u(x, y)\ i + v(x, y)j$ with usual notations, then the slope of the potential line at (x, y) is

(a) $\dfrac{v}{u}$

(b) $-\dfrac{u}{v}$

(c) $-\dfrac{v^2}{u^2}$

(d) $\dfrac{u}{v}$

Ans. **(B)**

● ● ● *End of Solution*

Q.6 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 _____.

Ans. **(25)**

● ● ● *End of Solution*

Q.7 The number of degree of freedom of the planetary gear train shown in the figure is

20 teeth gear

arm

50 teeth gear
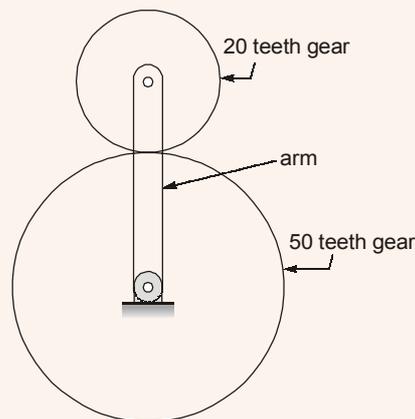
(a) 0

(b) 1

(c) 2

(d) 3

Ans. **(C)**

● ● ● *End of Solution*

Q.8   At least one eigenvalue of a singular matrix is
(a) positive   (b) zero
(c) negative   (d) imaginary

Ans.   (B)

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Q.9   Curl of vector $V(x, y, z) = 2x^2 i + 3z^2 j + y^3 k$ at $x = y = z = 1$ is
(a) $-3i$ (b) $3i$
(c) $3i - 4j$ (d) $3i - 6k$

Ans.   (A)

━━━━━━━━━━━━━━━━━━━━━━━━━━━━━●●● *End of Solution*

Q.10   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 _____.

Ans.   (76.923)

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Q.11   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 _____.

Foam
k_{foam} = 0.1 W/m-K

$\varnothing$ 4 cm

h_i = 15 W/m²-K

h_o = 2 W/m²-K

Pipe
k_{pipe} = 15 W/m-K
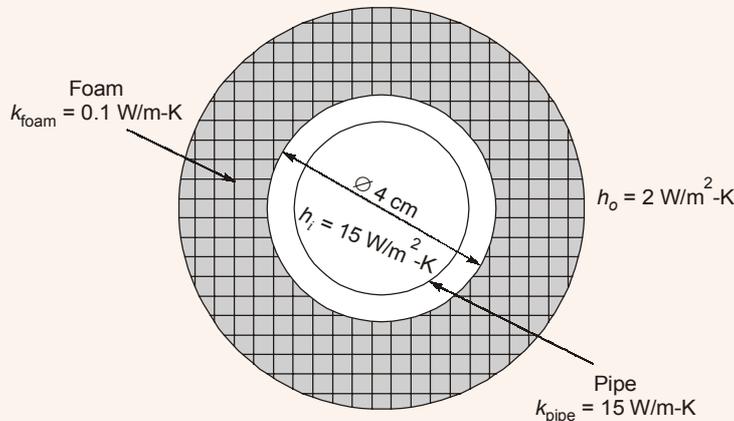
Ans.   (5)

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Q.12   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_____

Ans.   (8)

━━━━━━━━━━━━━━━━━━━━━━━━━━━━━●●● *End of Solution*

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Q.13 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

Ans. **(D)**

● ● ● *End of Solution*

Q.14 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 _____.

Ans. **(0.97)**

● ● ● *End of Solution*

Q.15 At $x = 0$, the function $f(x) = |x|$ has
(a) a minimum
(b) a maximum
(c) a point of inflection
(d) neither a maximum nor minimum

Ans. **(A)**

● ● ● *End of Solution*

Q.16 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

Ans. **(D)**

● ● ● *End of Solution*

Q.17 The primary mechanism of material removal in electrochemical machining (ECM) is
(a) chemical corrosion
(b) etching
(c) ionic dissolution
(d) spark erosion

Ans. **(C)**

● ● ● *End of Solution*

Q.18 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 kg/s. In another spring-mass system, the mass is 2 m and the spring constant is 8 k. The critical damping coefficient (in kg/s) of this system is _____.

Ans. **(0.4)**

● ● ● *End of Solution*

Q.19 Which of the following statements regarding a Rankine cycle with reheating are TRUE?
(i)   increase in a 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

Ans. **(C)**

● ● ● *End of Solution*

Q.20 The uniaxial yield stress of a material is 300 MPa. According to von Mises criterion, the shear yield stress (in MPa) of the material is _____.

Ans. **(173.1)**

● ● ● *End of Solution*

Q.21 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) Regession will forecast a higher value compared to moving average.

Ans. **(D)**

● ● ● *End of Solution*

Q.22 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 _____.

Ans. **(35,000)**

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End of Solution

Q.23 Which one of the following statements is TURE?
(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 control the lower limit of a hole

Ans. (C)

End of Solution

Q.24 The COP of a carnot heat pump operating between 6°C and 37°C is _____.

Ans. (10)

End of Solution

Q.25 The atomic packing factor for a material with body centered cubic structure is _____.

Ans. (0.68)

End of Solution

Q.26 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 J/(kg-K) and gravitational acceleration is 10 m/s^2. 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 _____.

Ans. (4.5)

End of Solution

Q.27 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
(a) 0.24
(b) 0.58
(c) 0.60
(d) 1.00

Ans. (B)

End of Solution

Q.28 One kg of air ($R = 287$ J/kg-K) undergoes an irreversible process between equilibrium state 1 (20°C, 0.9 m³) and equilibrium state 2 (20°C, 0.6 m³). The change in entropy $s_2 - s_1$ (in J/kg-K) is _____.

Ans. **(–116.3684)**

● ● ● *End of Solution*

Q.29 The initial velocity of an object is 40 m/s. The acceleration a of the object is given by the following expression.

$$a = -0.1\ v,$$

where v is the instantaneous velocity of the object. The velocity of the object after 3 seconds will be _____.

Ans. **(29.6327)**

● ● ● *End of Solution*

Q.30 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 _____.

Ans. **(3.7113)**

● ● ● *End of Solution*

Q.31 The surface integral $\iint_s \dfrac{1}{\pi}(9xi - 3yj)\cdot n\, dS$ over the sphere given by $x^2 + y^2 + z^2 = 9$ is _____.

Ans. **(216)**

● ● ● *End of Solution*

Q.32 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 _____

FIGURE

(a) 2.5   (b) 5
(c) 10   (d) 25

Ans. **(C)**

● ● ● *End of Solution*

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Q.33 The total emissive power of a surface is 500 W/m^2 at temperature T_1 and 1200 W/m^2 at a temperature T_2, where the temperature are in Kelvin. Assuming the emissivity of the surface to be constant, the ratio of the temperature $\dfrac{T_1}{T_2}$ is

(a) 0.0308
(b) 0.416
(c) 0.803
(d) 0.874

Ans. **(C)**

● ● ● *End of Solution*

Q.34 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) $\dfrac{1}{18}$
(b) $\dfrac{1}{4}$

(c) $\dfrac{2}{9}$
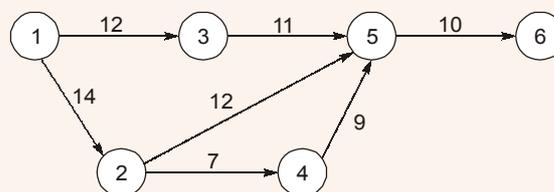(d) $\dfrac{5}{18}$

Ans. **(B)**

● ● ● *End of Solution*

Q.35 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

(a) 20
(b) 25
(c) 50
(d) 100

Ans. **(C)**

● ● ● *End of Solution*

Q.36 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 day) for completion of the project is _____.

Ans. **(40)**

● ● ● *End of Solution*

Q.37 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

Ans. (A)

● ● ● **End of Solution**

Q.38 A cylindrical uranium fuel rod of radius 5 mm in a nuclear is generating heat at the rate of 4×10^7 W/m^3. The rod is cooled by a liquid (convective heat transfer coefficient 1000 W/m^2-K) at 25°C. At steady state, the surface temperature (in K) of the rod is

(a) 308   (b) 398

(c) 418   (d) 448

Ans. (B)

● ● ● **End of Solution**

Q.39 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 _____.
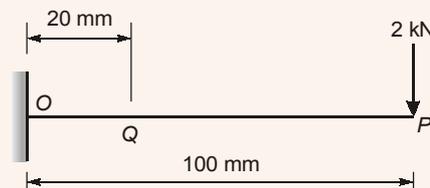
Ans. (0.1587)

● ● ● **End of Solution**

Q.40 A cube and a sphere made of cast iron (each of volume 1000 cm^3) were cast under identical conditions. The time taken for solidifying the cube was 4 s. The solidification time (in s) for the for the sphere is _____.

Ans. (6.1573)

● ● ● **End of Solution**

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Rank Improvement Batch is designed for students who have already appeared in GATE/ESE exam and are looking forward of getting the extra edge to score better by focusing entirely on problem solving skills. The batch is oriented towards improvement of analytical and problem solving skills. Some of the key benefits of this programme are:

- Comprehensive problem solving session
- Useful techniques to improve accuracy and speed.
- Regular tests followed by discussion.
- Smart Techniques to solve numerical problems.
- Cyclic revision of all subjects with quality questions.
- GATE/ESE Online Test Series

» **COURSE DURATION:**
(250-300 teaching hours)

» **BATCH TYPE :**
Both Regular & Weekend

» **Streams Offered :**
CE ME EE E&T

ADMISSIONS OPEN

RANK IMPROVEMENT
Batches will be commencing
From
Jul/Aug, 2015

For more details at :

Corporate Office: 44-A/I, Kalu Sarai, Sarvapriya Vihar, New Delhi-110016

📞 011-45124612   🌐 www.madeeasy.in

Q.41 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 µs, the average power input required is 1 kW. The capacitance (in µF) in the circuit is

(a) 2.5   (b) 5.0

(c) 7.5   (d) 10.0

Ans. **(B)**

— — — End of Solution

Q.42 A single-degree-freedom spring-mass system is subjected to a sinusoidal force of 10 N amplitude and frequency ω 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 10ω. At steady state, the amplitude of vibration (in m) is approximately

(a) 0.05   (b) 0.07

(c) 0.70   (d) 0.90

Ans. **(B)**

— — — End of Solution

Q.43 A single point cutting tool with 0° 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 _____.

Ans. **(2.1)**

— — — End of Solution
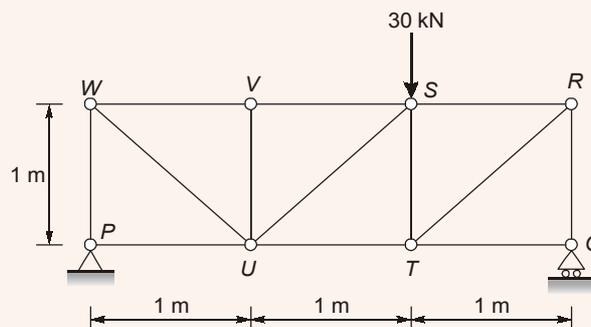
Q.44 In a certain slider-crank mechanism, lengths of crank and connecting rod are equal. If the crank rotates with a uniform angular speed of 14 rad/s and the crank length is 300 mm, the maximum acceleration of the slider (in m/s^2) is _____.

Ans. **(117.6)**

— — — End of Solution

Q.45 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

Ans. **(C)**

● ● ● *End of Solution*

Q.46 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 step size of 0.1, the value of $\int_{0}^{0.4} f(x)dx$ is _____.

Ans. **(22)**

● ● ● *End of Solution*

Q.47 A balanced counterflow heat exchanger has a surface area of 20 m² and overall heat transfer coefficient of 20 W/m²-K. Air (C_p = 1000 J/kg-K) entering at 0.4 kg/s and 280 K is to be preheated by the air leaving the system at 0.4 kg/s and 300 K. The temperature (in K) of the preheated air is _____.

(a) 290   (b) 300

(c) 320   (d) 350

Ans. **(B)**

● ● ● *End of Solution*

Q.48 The flow stress (in MPa) of a material is given by

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

where ε 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 _____.

Ans. **(95.1285)**

● ● ● *End of Solution*

Q.49 For a fully developed laminar flow of water (dynamic viscosity 0.001 Pa-s) through a pipe radius 5 cm, the axial pressure gradient is –10 Pa/m. The magnitude of axial velocity (in m/s) at a radial location of 0.2 cm is _____.

Ans. **(6.24)**

● ● ● *End of Solution*

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India's Best Institute for IES, GATE & PSUs

Announces

Conventional Questions
Practice Batch *for* ESE - 2015

These batches are designed for improving the capability to answer conventional/subjective type questions appearing in engineering services examination. Special emphasis is given on writing skills, choosing questions and proper presentation of answers. Students will be taught smart and short cut methods to solve the numerical questions.

» **COURSE DURATION:**
45-50 days (200 teaching hours)

» **BATCH TYPE :**
Regular (6-7 days a week)

» **Streams Offered :**
CE ME EE E&T

ADMISSIONS OPEN

BATCHES
COMMENCING *from*
15th March
2015

For more details at :

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Q.50 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

Ans. (B)

••• *End of Solution*

Q.51 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) $-15e^{2}$

Ans. (C)

••• *End of Solution*

Q.52 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 _____.

Ans. (70,000)

••• *End of Solution*

Q.53 For the same values of peak pressure, peak temperature and heat rejection, the correct order of efficiencies for Otto, Duel 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) $\eta_{Diesel} > \eta_{Otto} > \eta_{Dual}$

Ans. (B)

••• *End of Solution*

Q.54 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°. 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 _____.

Ans. **(44.5212)**

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Q.55 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

(a) 1   (b) 4

(c) 8   (d) 16

Ans. **(C)**

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