



ESE 2026

Prelims Solutions

**Mechanical
Engineering**

SET-C

Exam held on 08-02-2026

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MECHANICAL ENGINEERING
Paper Analysis of ESE 2026
Preliminary Examination

Sl.	Subjects	Number of Questions
1.	Strength of Materials	13
2.	Machine Design	09
3.	Industrial Engineering	02
4.	Manufacturing Engineering	08
5.	Theory of Machines	14
6.	Material Science	13
7.	Thermodynamics	03
8.	Refrigeration & Air-conditioning	03
9.	Heat Transfer	07
10.	Power Plant Engineering	19
11.	IC Engines	09
12.	Fluid Mechanics	13
13.	Fluid Machinery	08
14.	Renewable Source of energy	13
15.	Mechatronics	10
16.	Robotics	02
17.	Engineering Mechanics	04

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UPSC ESE Prelims 2026
MECHANICAL ENGINEERING Solutions
by **MADE EASY** faculties



- Q.6** How much electricity consumption can be cut back with the installation of solar flat-plate collectors in any household instead of power-grid geysers?
- (a) 20% (b) 10%
(c) 30% (d) 15%

Ans. (a)

Solar flat-plate collectors are the best alternative to the conventional geysers used in the winters to heat the water. The electricity consumption that reaches its peak using the power-grid geysers can be cut back to 20% consumption with the installation of solar flat-plate collectors in any household.

End of Solution

- Q.7** If the lifetime of the solar power plant and the interest rate is known, then the cost per kWh can be calculated and is known as:
- (a) Levelised energy cost (b) Total energy cost
(c) Life-cycle cost (d) Operational cost

Ans. (a)

Since a solar power plant does not use any fuel, the cost consists mostly of capital cost with minor operational and maintenance cost. If the lifetime of the plant and interest rate is known, then the cost per kWh can be calculated. This is called the levelised energy cost.

End of Solution

- Q.8** Operational Energy Footprint (OEF) in solar thermal energy is also called :
- (a) Life-Cycle Assessment (LCA) (b) Carbon Clawback Ratio (CCR)
(c) Energy Parasitics Ratio (EPR) (d) Operational Carbon Footprint (OCF)

Ans. (c)

Operational carbon/energy footprint and life-cycle assessment.

Terminology

1. Operational energy footprint (OEF) is also called energy parasitics ratio (EPR) or coefficient of performance (CoP).
2. Operational carbon footprint (OCF) is also called carbon clawback ratio (CCR).
3. Life-cycle assessment is usually referred to as LCA.

End of Solution

- Q.9** Consider the following statements regarding solar trackers :
1. A solar tracker is a generic term used to describe devices that orient various payloads toward the Sun.
 2. Payloads can be photovoltaic panels, reflectors, lenses or other optical devices.
 3. In flat-panel photovoltaic (PV) applications, trackers are used to maximize the angle of incidence between the incoming light and a photovoltaic panel.
- Which of the above statements are correct?
- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3



Ans. (a)

A solar tracker is a generic term used to describe devices that orient various payloads toward the sun. Payloads can be photovoltaic panels, reflectors, lenses or other optical devices. In flat-panel photovoltaic (PV) applications trackers are used to minimise the angle of incidence between the incoming light and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity.

End of Solution

Q.10 Consider the following statements regarding photovoltaic cells :

1. Photovoltaic cells are made of at least two layers of semiconductor material.
2. When two modules are wired in parallel, their current remains constant while the voltage varies.

Which of the above statements is/are correct?

- (a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Ans. (a)

Photovoltaic cells convert sunlight directly into electricity without creating any air or water pollution. Photovoltaic cells are made of at least two layers of semiconductor material. One layer has a positive charge, the other negative. When light enters the cell, some of the photons from the light are absorbed by the semiconductor atoms, freeing electrons from the cell's negative layer to flow through an external circuit and back into the positive layer.

When two modules are wired in parallel, their current is doubled while the voltage varies.

End of Solution

Q.11 The performance of photovoltaic modules and arrays under standard test conditions (STC) are defined by module operating temperature of :

- (a) 200°C (b) 225°C
(c) 250°C (d) 275°C

Ans. (c)

The performance of photovoltaic modules and arrays are generally rated according to their maximum DC power output under standard test conditions (STC). Standard test conditions are defined by an module operating temperature of 250°C, and incident solar irradiance level of 1000 W/m² and under air mass 1.5 spectral distribution. Since these conditions are not always typical of how PV modules and arrays operate in the field, actual performance is usually 85-90 per cent of the STC rating.

End of Solution



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Q.24 A steam power plant works on :

- (a) Rankine cycle (b) Diesel cycle
(c) Otto cycle (d) Gas turbine cycle

Ans. (a)

Steam power plant works on Rankine cycle.

End of Solution

Q.25 Which of the following is not a primary fuel?

- (a) Lignite (b) Peat
(c) Petroleum (d) Diesel

Ans. (d)

Primary fuels : Lignite, Peat, Petroleum

Secondary fuels : Diesel

End of Solution

Q.26 Match the following lists for different types of calorimeters which are used to determine the calorific value of fuels :

List-I

P. Solid and liquid fuels

Q. Only solid fuels

R. Only gaseous fuels

List-II

1. Bomb calorimeter

2. Lewis Thompson calorimeter

3. Junker's calorimeter

Select the correct answer using the code given below :

- | | P | Q | R |
|-----|---|---|---|
| (a) | 2 | 1 | 3 |
| (b) | 1 | 2 | 3 |
| (c) | 2 | 3 | 1 |
| (d) | 3 | 1 | 2 |

Ans. (b)

- Bomb calorimeter used for solid and liquid fuels.
- Junker's calorimeter works on constant pressure and used for only gaseous fuels.
- Lewis Thompson calorimeter used only for solid fuels.

End of Solution

Q.27 If the boilers are designed to operate above critical pressure, then those are known as:

- (a) Once-through boilers (b) Drum boilers
(c) Forced circulation boilers (d) Natural circulation boilers



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Ans. (a)

Boilers which are designed to operate above critical pressure are supercritical boilers or once through boilers. In these boilers boiler-drum is not required.

End of Solution

Q.28 Which one of the following is the method of reducing turbine blade speed for a given overall pressure drop?

- (a) Compounding (b) Momentum
(c) Curtis (d) Impulsion

Ans. (a)

End of Solution

Q.29 In which of the following types of condensers does exhaust steam coming from the turbine mix directly with the circulating cooling water?

- (a) Jet condenser (b) Non-mixing-type condensers
(c) Surface condensers (d) Central flow condensers

Ans. (a)

Direct-contact condensers are also known as mixing-type or jet condensers. In such type of condensers, exhaust steam coming from the turbine mixes directly with the circulating cooling water. Steam condenses into cooling water. These condensers are used where large quantity of clean cooling water is available. However, the drawback of using these condensers is that pure condensate is lost to the mixing water that cannot be re-circulated.

End of Solution

Q.30 Consider the following statements regarding cooling towers :

1. Cooling tower is a wooden or metallic rectangular structure, with packed baffling devices.
2. The hot water is delivered to the top of the tower and falls down through the tower and is broken into small particles while passing over the baffling devices.
3. The hot water falls down into a tank below the tower from where it can again be circulated to the compressor.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (a)

A cooling tower is a wooden or metallic rectangular structure, with packed baffling devices. The hot water is delivered to the top of tower and falls down through the tower and is broken into small particles while passing over the baffling devices. Air enters the towers at the bottom and flows upwards and cools the water. The hot air leaves the tower at the top. The cooled water falls down into a tank below the tower from where it can again be circulated to the condenser.

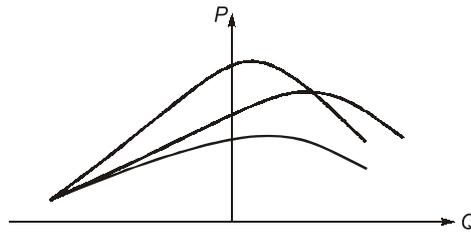
End of Solution

Q.31 Which one of the following does not promote knocking in SI engines?

- (a) High compression ratio (b) Poor cylinder cooling
(c) Optimum mixture strength (d) Retarded ignition timing

Ans. (d)

- Factors which increase temperature in SI engine increase knocking.
- Retarded ignition timing decrease maximum temperature and hence, it does not promote knocking in SI engines.



End of Solution

Q.32 In SI engines, the Performance Number (PN) is a useful measure of :

- (a) Thermal Efficiency (b) Mechanical Efficiency
(c) Indicated Power (d) Detonation Tendency

Ans. (d)

Performance Number (PN): Performance number is a useful measure of detonation tendency. It has been developed from the conception of knock limited indicated mean effective pressure (klimep), when inlet pressure is used as the dependent variable.

$$\text{Performance number (PN)} = \frac{\text{klimep of test fuel}}{\text{klimep of iso-octane}}$$

The performance number is obtained on specified engine, under specified set of conditions by varying the inlet pressure.

End of Solution

Q.33 The Performance Number (PN) of an SI engine is obtained on a specified engine under specified set of conditions by varying the :

- (a) Inlet Pressure (b) Inlet Temperature
(c) Compression Ratio (d) Valve Timing

Ans. (a)

Performance Number (PN): Performance number is a useful measure of detonation tendency. It has been developed from the conception of knock limited indicated mean effective pressure (klimep), when inlet pressure is used as the dependent variable.

$$\text{Performance number (PN)} = \frac{\text{klimep of test fuel}}{\text{klimep of iso-octane}}$$

The performance number is obtained on specified engine, under specified set of conditions by varying the inlet pressure.

End of Solution

Q.34 Which one of the following is not an assumption of the standard vapour compression cycle?

- (a) Compression is isentropic
- (b) Heat rejection is isentropic
- (c) Saturated liquid at condenser exit
- (d) Heat absorption is by evaporation and is isobaric

Ans. (b)

Heat rejection is isentropic.

Standard Vapour Compression Cycle (VCRS)

- Compression is isentropic.
- Heat absorption and heat rejection both are isobaric.
- Saturated liquid exit at condenser.

End of Solution

Q.35 R22 Refrigerant is compressed in a centrifugal compressor from 3 bar to 12 bar. The small stage efficiency is 80%. Assume that the small stage efficiency and isentropic efficiency of the compressor are same. The isentropic index of the vapour is 1.10. What is the polytropic index of the vapour?

- (a) 0
- (b) 0.12
- (c) 1
- (d) 1.12

Ans. (d)

$$\eta_{\text{poly}} = \frac{(\gamma-1)/\gamma}{(n-1)/n} = \frac{\gamma-1}{\gamma} \times \frac{n}{n-1}$$

$$0.80 = \frac{1.1-1}{1.1} \times \frac{1}{1-\frac{1}{n}}$$

$$\Rightarrow n = 1.12$$

End of Solution

- Q.36** In case of azeotropes, from the performance point of view, it is desirable to have refrigerant mixtures with zero temperature glide so that :
- (a) Dew point temperature = Bubble point temperature
 - (b) Dew point temperature > Bubble point temperature
 - (c) Dew point temperature < Bubble point temperature
 - (d) Dew point temperature = Bubble point temperature = 100°C

Ans. (a)

At dew point temperature initiation of condensation will start. In case of azeotropes, from the performance point of views, it is desirable to have refrigerant mixtures with zero temperature glide so that dew point temperature are equal to bubble point temperatures (boiling temperature).

End of Solution

- Q.37** In a vapour absorption refrigeration system, which one of the following statements is correct regarding the effect of aqua-ammonia mixture inside of pure ammonia entering the evaporator?
- (a) Evaporator temperature remains constant
 - (b) Refrigeration effect is increased
 - (c) Coefficient of performance is decreased
 - (d) Condenser temperature remains constant

Ans. (c)

In case of aqua-ammonia mixture instead of pure ammonia entering the evaporator, the refrigeration effect will be reduced and hence, coefficient of performance is decreased.

End of Solution

- Q.38** Consider the following statements regarding gas turbine plant :
1. If the gas turbine plant is used as an aircraft engine, the net output at turbine shaft is used to drive a propeller in a turbo-prop engine.
 2. In simple open circuit gas turbine plants, the hot gases from the combustion chamber pass out to the atmosphere after expanding through the turbine.
 3. In closed circuit gas turbine plants, the same working fluid circulates through its various components.
- Which of the above statements are correct?
- (a) 1 and 2 only
 - (b) 1 and 3 only
 - (c) 2 and 3 only
 - (d) 1, 2 and 3

Ans. (d)

End of Solution

Ans. (a)

Given data: $\eta_H = 87.7\% = \frac{RP}{WP}$, $C_V = 0.97$

$\Rightarrow RP = 0.877 \times \rho g QH$

$$\frac{\eta_{\text{wheel}}}{\eta_{\text{Blade}}} = \frac{RP}{\frac{1}{2} \dot{m} V_1^2} = \frac{0.877 \times \rho g QH}{\frac{1}{2} \dot{m} (C_V \sqrt{2gH})^2}$$

$$\eta_{\text{wheel}} = \frac{0.877}{0.97^2} = 93.2\%$$

Ans.

End of Solution

Q.42 Which one of the following is defined as the ratio of reaction effect (energy transfer by static pressure) to the total energy transfer in the rotor?

- (a) Degree of freedom (b) Degree of impulse
(c) Effective power (d) Degree of reaction

Ans. (d)

$$\text{Degree of reaction (R)} = \frac{\text{Contribution of PE head into } \left(\frac{RP}{\dot{m}g}\right)}{\text{Total contribution of KE + PE head into } \left(\frac{RP}{\dot{m}g}\right)}$$

Where, RP = Runner power
PE = Pressure energy
KE = Kinetic energy

End of Solution

Q.43 A Francis turbine has hydraulic efficiency 95% and mechanical efficiency 80%. What is the overall efficiency?

- (a) 76.0% (b) 87.6%
(c) 98.7% (d) 85.4%

Ans. (a)

Given Data: $\eta_H = 0.95$, $\eta_M = 0.8$

$$\eta_o = \eta_o \eta_M = 0.95 \times 0.8 = 76\%$$

Ans.

End of Solution

Q.44 In a Kaplan turbine, the number of blades varies from :

- (a) 10 to 24 (b) 3 to 8
(c) 10 to 15 (d) 15 to 24

Ans. (b)

In Kaplan turbine generally 3 to 8 vanes are used.

End of Solution

Q.45 A reciprocating pump which is used to pump water has a bore of 120 mm and a stroke of 220 mm. It runs at a speed of 40 rpm. The delivery pipe is 80 mm in diameter and 30 m in length. What is the acceleration head without the air vessel?

- (a) 20.45 m (b) 15.98 m
(c) 10.34 m (d) 13.26 m

Ans. (d)

Given data: $D = 0.12$ m, $L = 0.22$ m, $N = 40$ rpm, $d_d = 0.08$ m, $L_d = 30$ m

$$A = \frac{\pi}{4} D^2 = \frac{\pi}{4} \times 0.12^2 = 0.01131 \text{ m}^2$$

$$A_d = \frac{\pi}{4} d_d^2 = \frac{\pi}{4} \times 0.08^2 = 0.00503 \text{ m}^2$$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 40}{60} = 4.19 \text{ rad/s}$$

$$h_{d, \max} = \frac{l_d}{g} \left(\frac{A}{A_d} \right) r \omega^2 = \frac{30}{9.81} + \frac{0.1131}{0.00503} \times 0.11 \times 4.19^2$$

$$h_{d, \max} = 13.26 \text{ m}$$

End of Solution

Q.46 The correct expression for air standard efficiency in Otto Cycle with compression ratio r is :

(a) $\eta_{\text{otto}} = 1 - \left[\frac{\gamma - 1}{(r)^{\gamma - 1}} \right]$ (b) $\eta_{\text{otto}} = 1 - \left[\frac{1}{(r)^{1 - \gamma}} \right]$

(c) $\eta_{\text{otto}} = 1 - \left[\frac{1}{(r)^{\frac{\gamma - 1}{\gamma}}} \right]$ (d) $\eta_{\text{otto}} = 1 - \left[\frac{1}{(r)^{\gamma - 1}} \right]$

Ans. (d)

The air standard of the Otto cycle is given by

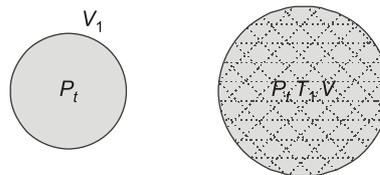
$$\eta_{\text{otto}} = 1 - \left[\frac{1}{(r)^{\gamma - 1}} \right]$$

End of Solution

- Q.47** Which one of the following models assumes that each mixture component behaves as an ideal gas if it existed separately at the pressure p and temperature T of the mixture?
- (a) Dalton's Model (b) Kay's Model
(c) Amagat's Model (d) Newton's Model

Ans. (c)

Amagat's Model: It assumes that each mixture component behaves as an ideal gas as if it is existed separately at the pressure p and temperature T of the mixture.



End of Solution

- Q.48** With increase in pressure ratio, the isentropic efficiency of a compressor and a turbine:
- (a) Increases for both
(b) Decreases for both
(c) Increases for turbine and decreases for compressor
(d) Decreases for turbine and increases for compressor

Ans. (b)

As pressure ratio increases the process irreversibility increases and hence isentropic efficiency decreases.

End of Solution

- Q.49** At the surface of an electric heater, the heat flux q is 5000 W/m^2 . The heater temperature is 130°C , when it is cooled by air at 50°C . What is the heater temperature if the power is reduced so that q is 2500 W/m^2 ?
- (a) $T_{\text{heater}} = 60^\circ\text{C}$ (b) $T_{\text{heater}} = 70^\circ\text{C}$
(c) $T_{\text{heater}} = 80^\circ\text{C}$ (d) $T_{\text{heater}} = 90^\circ\text{C}$

Ans. (d)

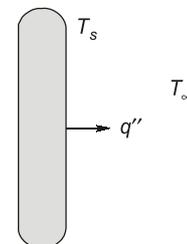
Given data: $T_{s1} = 130^\circ\text{C}$, $T_\infty = 50^\circ\text{C}$, $q'_1 = 5000 \text{ W/m}^2$, $T_{s2} = ?$, $q'_2 = 2500 \text{ W/m}^2$.

$$q'' = h(T_{s1} - T_\infty)$$

$$\Rightarrow h = \frac{q'_1}{T_{s1} - T_\infty} = \frac{q'_2}{T_{s2} - T_\infty}$$

$$\Rightarrow \frac{5000}{130 - 50} = \frac{2500}{T_{s2} - 50}$$

$$\Rightarrow T_{s2} = 90^\circ\text{C}$$



End of Solution



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Ans. (c)

Given data: $T_\infty = 150^\circ\text{C}$, $L = 250$ mm, $d = 2$ mm, $I = 100$ A, $V = 2.5$ voltage, $T_{\text{wire}} = 200^\circ\text{C}$.

$d_w = 2$ mm,

Ohm's law:

$$V = I R_{\text{elect}}$$

$$2.5 = 100 \times R_{\text{elect}}$$

$$R_{\text{elect}} = \left(\frac{2.5}{100} \right) \Omega$$

$$\text{Power loss, } q = I^2 R_{\text{elect}} = 100^2 \times \left(\frac{2.5}{100} \right) = 250 \text{ W}$$

Also,

$$q = hA (T_{\text{wire}} - T_\infty)$$

$$h = \frac{q}{A(T_{\text{wire}} - T_\infty)} = \frac{250}{\pi \left(\frac{2}{1000} \right) \left(\frac{250}{1000} \right) (200 - 150)}$$

$$= \frac{10000}{\pi} \text{ W/m}^2\text{ }^\circ\text{C}$$

End of Solution

Q.53 Fouling inside the pipes of a heat exchanger increases with which one of the following fluid properties?

- Decrease in temperature and increase in velocity
- Increase in temperature and decrease in velocity
- Is independent of temperature and increase in velocity
- Decrease of temperature and is independent of velocity

Ans. (b)

Increase in temperature causes increase in rate of precipitation. At low velocity viscous wall shear stress is less. Both factors contribute to fouling inside the pipes.

End of Solution

Q.54 A pyramid is having a square base and isosceles triangle side surfaces. What are the view factors (F) from the base of the pyramid? Consider pyramid base as surface 1 and remaining side faces as 2, 3, 4 and 5. (F_{ij}) represents view factors of subject i and j .

- $F_{12} = F_{13} = F_{14} = F_{15} = 0$
- $F_{12} = F_{13} = F_{14} = F_{15} = 0.15$
- $F_{12} = F_{13} = F_{14} = F_{15} = 0.20$
- $F_{12} = F_{13} = F_{14} = F_{15} = 0.25$

Ans. (d)

'X' Type Engine: This design is a variation of 'V' type. It has four banks of cylinders attached to a single crankshaft.

'H' Type Engine: The 'H' type is essentially two 'Opposed cylinder' type utilizing two separate but interconnected crankshafts.

'U' Type Engine: The 'U' type is a variation of opposed piston arrangement.

Delta Type Engine: The delta type is essentially a combination of three opposed piston engine with three crankshafts interlinked to one another.

End of Solution

Q.57 An engine with 50 kW power has a mechanical efficiency of 75%. If the frictional power is assumed to be constant with load, what is the mechanical efficiency at 50% of the load?

- (a) 50% (b) 55%
(c) 60% (d) 65%

Ans. (c)

Given: $BP_{100\%} = 50 \text{ kW}$

$$\eta_{m,100} = 0.75$$

$$\eta_{m,100} = \frac{BP}{BP + FP} \Rightarrow 0.75 = \frac{50}{50 + FP}$$

$$\Rightarrow FP = 16.67 \text{ kW}$$

$$\text{at 50\% load, } BP_{50\%} = 0.5 \times 50 = 25 \text{ kW}$$

$$\eta_{m,50\%} = \frac{BP_{50\%}}{BP_{50\%} + FP} = \frac{25}{25 + 16.67}$$

$$\Rightarrow \eta_{m,50\%} = 0.6 \text{ or } 60\%$$

End of Solution

Q.58 Which of the following sources contribute(s) majorly for the formation of hydrocarbon emissions in spark ignition engines?

- (a) Crevices (b) Liquid fuel
(c) Exhaust valve leakage (d) Deposits

Ans. (a)

Blow-by losses are major reason for HC emissions and these occur due to crevices /gap between piston and cylinder.

End of Solution

- Q.59** Indicated specific fuel consumption of a four-stroke SI engine improves at a faster rate with increasing compression ratio than the brake specific fuel consumption, because both friction and heat losses :
- are decreasing with compression ratio
 - are increasing with compression ratio
 - are unaffected with compression ratio
 - increase with cutoff ratio

Ans. (b)

We know that,
$$isfc = \frac{\dot{m}_f}{IP}$$

$$bsfc = \frac{\dot{m}_f}{BP}$$

When compression ratio increases, the mechanical load increases. With compression ratio, the indicated power and brake power both increase but increase in indicated power is more because the mechanical stress of the engine increase i.e. friction power increases.

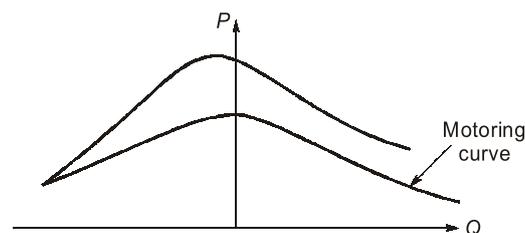
Therefore, *isfc* improves at faster rate than the *bsfc* because both friction and heat losses increases with compression ratio.

End of Solution

- Q.60** The advancement of peak cylinder pressures ahead of Top Dead Centre (TDC) in an SI engine due to pre-ignition results in :
- Negative work
 - Positive work
 - Improved combustion
 - Increase in mechanical efficiency

Ans. (a)

Negative Work



In the case of advancement of peak cylinder pressure ahead of TDC, we have to provide work to the compressor.

End of Solution



- Q.61** Which one of the following statements is correct regarding the traction vector on any surface within a general fluid element?
- (a) The traction vector consists of only one contribution related to pressure.
 - (b) The traction vector has two separate contributions: pressure and gravitational force.
 - (c) The traction vector has two separate contributions: pressure and deformation-related forces.
 - (d) The traction vector is solely determined by the velocity of the fluid element.

Ans. (c)

Traction vector is a surface-force and it has two separate contributions pressure and deformation related forces.

End of Solution

- Q.62** What does specific gravity of liquids represent?
- (a) It is the ratio of density of a liquid at actual conditions to the density of pure water at 101 kN/m² and at 4°C.
 - (b) It is the ratio of density of a liquid at actual conditions to the density of pure water at 25°C.
 - (c) It is the ratio of density of pure water at 25°C to the density of liquid at actual conditions.
 - (d) It is the ratio of density of pure water to the density of liquid.

Ans. (a)

$$\text{Specific gravity (s)} = \frac{\rho_{\text{fluid}}}{\rho_{\text{std. fluid}}}$$

for liquids, $\rho_{\text{std. fluid}} = \rho_{\text{water}}$ at 40°C and 1 atm

End of Solution

- Q.63** A cylinder of 0.12 m radius rotates concentrically inside a fixed hollow cylinder of 0.13 m radius. Both the cylinders are 0.3 m long. What is the viscosity of the liquid which fills the space between the cylinders, if a torque of 0.88 Nm is required to maintain an angular velocity of 2π rad/s?
- (a) 0.597 Pa·s
 - (b) 1.397 Pa·s
 - (c) 1.597 Pa·s
 - (d) 0.397 Pa·s



Ans. (c)

Thermal stratification effects:

- Layering of fluid elements that occur due to the density gradient created by changes in temperature.
- Thermal stratification can't make flow irrotational from rotational and vice-versa.

Coriolis force effect:

- An originally irrotational flow may become rotational.

End of Solution

Q.66 Consider the following statements regarding flowmeters :

1. A venturimeter is less accurate than an orificemeter.
2. An orifice meter is a thin circular plate with a sharp-edged concentric circular hole in it.
3. The stagnation pressure at a point in a fluid flow is the pressure which could result if the fluid were brought to rest isentropically.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

Venturimeter have high accuracy than orificemeter.

Orificemeter is constructed using sharp edged concentric circular hole in it.

Stagnation state is state obtained when fluid were brought to rest isentropically.

End of Solution

Q.67 Consider the following statements regarding dynamics of inviscid flows :

1. Euler's equation of motion describes the dynamics of inviscid flows.
2. Flows having only tangential velocities with streamlines as concentric circles are known as plane circular vortex flows.
3. A free vortex flow is a rotational vortex flow where the tangential velocity is directly proportional to the radius of curvature.

Which of the above statements are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

- Q.69** Consider the following statements regarding laminar-turbulent transition :
1. The turbulent boundary layer continues to grow in thickness with a small region below it, called a viscous sublayer.
 2. In viscous sublayer, the flow is well behaved, just as the turbulent boundary layer.
 3. The possibility of instability in boundary layer was first proposed by Prandtl.
- Which of the above statements are correct?
- (a) 1 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

- The turbulent boundary layers continuous to grown in thickness -e.g. $\delta \propto x^{0.8}$).
- Turbulent boundary layer contains a small region in which flow is laminar.
- In viscous sublayer flows is laminar (well behaved) whereas in other parts of turbulent boundary layer flow is turbulent.
- The possibility of instability was felt by Prandtl.

End of Solution

- Q.70** Consider the following statements regarding correlation functions :
1. Correlation studies reveal that turbulent motion is composed of eddies which are convected by the mean motion.
 2. The size of the large eddies is comparable with the dimensions of the neighbouring objects or the dimensions of the flow passage.
 3. The size of the smallest eddies can be of the order of 5 mm to 10 mm.
- Which of the above statements are correct?
- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

End of Solution

- Q.71** In a fully developed flow through a pipe of 300 mm diameter, the shear stress at the wall is 50 Pa. The Darcy's friction factor is 0.05. What is the rate of flow in case of water flowing through the pipe?
- (a) 2.8 m³/s (b) 1.8 m³/s
(c) 1.5 m³/s (d) 0.8 m³/s

Ans. (*)

Given data: $d = 300$ mm, $\tau_w = 50$ Pa, $f = 0.05$

$$\tau_w = \frac{\rho f V^2}{8} \Rightarrow 50 = \frac{1000 \times 0.05 \times V^2}{8}$$

$$V = 2.8284 \text{ m/s}$$

$$Q = Av = \frac{\pi}{4} d^2 \times V = \frac{\pi}{4} \times 0.3^2 \times 2.8284$$

$$\simeq 0.2 \text{ m}^3/\text{s}, 11.9957 \text{ m}^3/\text{min}$$

Ans.

End of Solution

Q.72 Consider the following statements regarding friction factor :

1. In turbulent flow friction factor depends on both the Reynolds number and the roughness of the pipe surface.
2. Moody's diagram can be used for predicting the values of friction factor.
3. Roughness in commercial pipes is due to the protrusions at the surface which are random both in size and spacing.

Which of the above statements are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

- For the turbulent flow friction factor, $f = f(\text{Re}, \text{pipe roughness})$
- Moody's diagram can be used for predicting values of friction factor.
- Roughness in commercial pipes is due to protrusions at the surface which are random both in size and spacing.

End of Solution

Q.73 Which one of the following is used to find the increase in entropy between absolute zero and any given state?

- (a) Spectrometric data (b) Calorimetric data
(c) Isometric data (d) polymetric data

Ans. (b)

Calorimetric data:

Calorimetric data (Specific heat etc.) is used to find the increase in entropy between absolute zero and any given state.

$$\int_0^s ds = \int_0^T \frac{cdT}{T}$$

End of Solution

Q.74 Critical value of Reynolds number at which boundary layer changes from laminar to turbulence does not depend on :

- (a) Surface roughness (b) Pressure gradient
(c) Plate curvature (d) Flow velocity

Ans. (d)

$(\text{Re})_{cr}$ is independent of flow velocity
whereas $(\text{Re}) = f(\rho, v, x, \mu)$

End of Solution

Q.75 Which one of the following statements is correct, if the heat is added to a system at a high temperature?

- (a) The increase in entropy is greater. (b) The increase in entropy is small.
(c) There is no change in entropy. (d) The entropy becomes zero.



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Ans. (d)

Machine cells can be classified as follows:

1. **Single machine cell** : It consists of one machine, supporting fixtures and tooling. One or more part families with one basic type of process (such as milling) can be processed.
2. **Group machine cell with manual handling** : This type of cell is often organized into a U-shaped layout. It includes more than one machine to process one or more part families. Material handling is performed by the human operators who run the cell.
3. **Group machine cell with semi-integrated handling** : A mechanized handling system, such as a conveyor, is used to move parts between machines in the cell. If the parts made in the cell have identical routings, in-line layout is selected. If the routings vary, loop layout is more appropriate.
4. **Flexible manufacturing system** : This is highly automated machine cell. It combines automated processing stations with a fully integrated handling system.

End of Solution

Q.78 How many BCD numbers can be accommodated in an 8-bit register in the 8085 microprocessor?

- (a) One (b) Two
(c) Three (d) Four

Ans. (b)
8-bit register



BCD : Binary coded decimal



$$\Rightarrow 2^n = 10$$

$$\Rightarrow 3 < n < 4$$

To generate 10 codes, we required at least 4 bit of value.



\therefore 2 BCD can be stored.

End of Solution

Q.79 In which of the following robots, it positions the wrist through two rotations and one linear actuation?

- (a) Articulated Geometry Robot
(b) Cartesian Coordinate Robot
(c) Cylindrical Coordinate Robot
(d) Polar Coordinate Robot

Ans. (d)

Spherical Co-ordinate Robot : This is also known as a polar co-ordinate robot. This robot positions the wrist through two rotations and one linear actuation. The orientation of the tool plate is achieved through three rotations in the wrist, with roll of A, pitch of B and yaw of C. The robot is easy to control. For a given maximum reach of the robot, the work envelope is smaller than that of cylindrical robot.

End of Solution

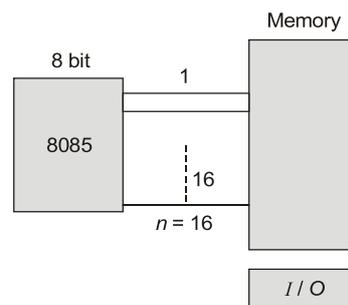
Q.80 In systems, peripheral I/O becomes essential if the memory requirement is:

- (a) 64K (b) 32K
(c) 16K (d) 8K

Ans. (a)

Two methodologies are there to give addresses to I / O devices :

- (i) Memory mapped I / O
(ii) Peripheral mapped I / O



Maximum memory connected = $2^n = N$

n : number of address lines

N : Number of addresses for the memory

$\therefore N = 2^{16} = (2^6)(2^{10}) = 2^6 (1K) = 64 K$

So, if we use all the addresses for memory then there is no address for I / O device, hence, peripheral I / O becomes essential.

End of Solution

Q.81 A dial gauge is used to measure the pressure in a vessel. The readings are 7.0 kN/m^2 for a dial reading of zero and 31.0 kN/m^2 for a reading of 120. If the variation is linear, what is the value of pressure for a dial reading of 90?

- (a) 12.5 kN/m^2 (b) 15 kN/m^2
(c) 25 kN/m^2 (d) 7.5 kN/m^2

Q.83 Which one of the following is an analog input device?

- (a) Potentiometer (b) Pressure switch
(c) Temperature switch (d) Encoder

Ans. (a)

Potentiometer as it can measure resistance it is used to have analog input.
Pressure switch has binary value as 1/0.
Encoder as 2^n i/p's, where n is o/p's.

End of Solution

Q.84 Which one of the following devices is used for switching AC voltages and acts as a two-way SCR with one gate connected at the output unit?

- (a) Relay output circuit (b) Transistor output unit
(c) Triac output unit (d) DAC interface

Ans. (c)

TRIAC is a bidirectional device that can be used to give a controlled AC output and is essentially a two-way SCR with one gate.

End of Solution

Q.85 What is the force needed to apply to a piston of 2 cm radius in order to result a force of 8000 N at the working piston of radius 8 cm?

- (a) 1000 N (b) 250 N
(c) 2000 N (d) 500 N

Ans. (d)

Given data : $r_1 = 2$ m; $F_2 = 8000$ N; $r_2 = 8$ cm
From Pascal's law

$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

As

$$A \propto r^2$$

$$\therefore F_1 = \left(\frac{r_1}{r_2}\right)^2 F_2 = \left(\frac{2}{8}\right)^2 8000 = \frac{8000}{16} = 500 \text{ N}$$

End of Solution

Q.86 The filter at the pump outlet which can remove the contaminants passing through or generated by the pump in order to protect valves, is known as:

- (a) Inlet line filter (b) Pressure line filter
(c) Return line filter (d) Mechanical filter

- Q.89** DCV as a processing element can generate or cancel or redirect signals depending on the control desired conditions and a processing element is normally known as:
- (a) Flow control valve (b) Non-return valve
(c) Logic valve (d) Pressure control valve

Ans. (c)

DCV as a processing element is normally known as logic valve. It generates or cancels or redirects signals depending on the desired control conditions.

End of Solution

- Q.90** Which one of the following is an application of continuous path robot?
- (a) Pick and place (b) Tracing of contours
(c) Interact with the environment (d) Make decisions

Ans. (b)

Continuous path robot: Here the numbers of individual (path nodes) locations that can be stored in the memory are far greater than in the point-to-point robot. The path nodes in a path move are entered into the memory as program data or are captured, while having the arm manually guided through the move. Therefore, the points constituting the motion cycle can be spaced very closely together, which allows the robot to accomplish a continuous smooth motion. Continuous path robots are used in applications such as tracing of contours, especially in arc welding, spray painting, etc.

End of Solution

- Q.91** A line shaft rotating at 200 r.p.m. is to transmit 20 kW. The shaft may be made of mild steel with allowable shear stress of 42 MPa. What is the torque transmitted by the shaft?
- (a) $\frac{\pi}{4}$ kN·m (b) $\frac{4}{\pi}$ kN·m
(c) $\frac{\pi}{3}$ kN·m (d) $\frac{3}{\pi}$ kN·m

Ans. (d)

Given data: $N = 200$ rpm, $P = 20$ kW, $\tau_{per} = 42$ MPa

$$T = \frac{P \times 60}{2\pi \times 200} = \frac{3}{\pi} \text{ kN-m}$$

End of Solution

- Q.92** Consider the following statements regarding gear teeth:
1. The beam strength of gear teeth is determined from a Lewis equation.
 2. The load carrying ability of the toothed gears as determined by Lewis equation gives satisfactory results.
 3. Lewis assumed that as the load is being transmitted from one gear to another, it is all given and taken by several teeth.
- Which of the above statements are correct?
- (a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

Given : $P_r = 4000$ N; $P_a = 5000$ N; $N = 1600$ rpm; 10 hr/day; 300 working days/year
 $L_{50} = 5 \times 300 \times 10 = 15000$ hours

End of Solution

Q.95 Which type of clutches are frequently applied to sprocket wheels, gears and pulleys?

- (a) Jaw clutches (b) Cone clutches
(c) Plate clutches (d) Centrifugal clutches

Ans. (a)

Gear is a positive drive and hence positive clutch is required "Jaw-clutch" is a positive clutch.

End of Solution

Q.96 Consider the following statements regarding metallic sand processes and equipment:

1. Expendable moulds typically are made of sand, plaster, ceramic, and similar materials and are generally mixed with various binders.
2. Permanent moulds are made of metals that maintain their strength at high temperatures.
3. A typical sand mould consists of 50% sand, 30% clay, and 20% water.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (a)

- Expendable moulds are used only once and hence are made of sand, plaster, ceramic and similar materials.
- Permanent moulds are made of metals and they maintain their strength at high temperature also.
- A typical sand moulds consists of 70% to 85% silica sand, 10-20% clay, 2-8% water and 1-6% resin binders.

End of Solution

Q.97 Consider the following statements regarding sand casting:

1. Typical applications of sand casting include large turbine impellers and propellers.
2. Most sand casting operations use silica sand as the mould material.
3. Sands having fine, round grains can be packed closely and thus form a smooth mould surface.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3



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Ans. (c)

Forced vibration is generally caused by some periodic applied force present in the machine tool, such as that from gear drives, imbalance of the machine-tool components, misalignment, and motors and pumps. In processes such as milling or turning a splined shaft or a shaft with a keyway, forced vibrations are caused by the periodic engagement of the cutting tool with entry to and exit from the workpiece surface.

The basic solution to forced vibration is to isolate or remove the forcing element. If the forcing frequency is at or near the natural frequency of a component of the machine-tool system, one of the frequencies may be raised or lowered. The amplitude of vibration can be reduced by increasing the stiffness or by damping the system. Although changing the cutting parameters generally does not appear to greatly influence the magnitude of forced vibrations, changing the cutting speed and the tool geometry can be helpful.

Alternatively,

The amplitude of vibration decreases with increase in the stiffness of the system.

$$A = \frac{F_0/k}{\sqrt{\left(1 - \left(\frac{\omega}{\omega_n}\right)^2\right)^2 + \left(\frac{2\xi\omega}{\omega_n}\right)^2}}$$

or $A \propto \frac{1}{k}$

End of Solution

Q.106 Consider the following statements regarding forces acting on the mass attached to a helical spring, suspended from a fixed support with no damping subjected to an oscillating force:

1. The mass experiences impressed oscillating force.
2. The mass experiences inertia force.
3. The mass experiences restoring force.

Which of the above statements are correct?

- | | |
|------------------|------------------|
| (a) 1 and 2 only | (b) 1 and 3 only |
| (c) 2 and 3 only | (d) 1, 2 and 3 |

Ans. (b)

The inertia force is a pseudo force method used in D'Alembert's principle. Mass will never feel inertia force.

End of Solution

Q.107 A refrigerator unit of mass 35 kg is to be supported on three springs, each having the same spring stiffness. The natural circular frequency of vibration is 15.15 rad/s. The stiffness of each spring is:

- | | |
|--------------|--------------|
| (a) 1.2 N/mm | (b) 1.9 N/mm |
| (c) 2.1 N/mm | (d) 2.7 N/mm |

Ans. (b)

Given, the length of connecting rod is large

$$\Rightarrow n \left(= \frac{l}{r} \right) \text{ is large}$$

$$\Rightarrow \begin{aligned} x &= r [1 - \cos\theta] \\ \text{or } V &\propto \sin\theta \end{aligned}$$

Thus, the piston executes a simple harmonic motion.

End of Solution

Q.113 Match the following lists for the relation between endurance limit (σ_e) and ultimate tensile strength (σ_u):

List-I (Material)

- P. Steel
- Q. Cast steel
- R. Cast iron

List-II (Relation)

- 1. $\sigma_e = 0.5 \sigma_u$
- 2. $\sigma_e = 0.4 \sigma_u$
- 3. $\sigma_e = 0.35 \sigma_u$

Select the correct answer using the code given below:

	P	Q	R
(a)	2	1	3
(b)	1	2	3
(c)	2	3	1
(d)	3	1	2

Ans. (b)

Endurance limit of steel corresponding to ultimate tensile strength.

For steel, $\sigma_e = 0.5 \sigma_u$;

For steel, $\sigma_e = 0.4 \sigma_u$;

For steel, $\sigma_e = 0.35 \sigma_u$;

For non-ferrous metals and alloys,

$$\sigma_e = 0.3 \sigma_u$$

End of Solution

Q.114 When designing machine parts, it is desirable to keep the stress lower than the maximum stress at which failure of the material takes place. This stress is known as:

- (a) Ultimate stress
- (b) Working stress
- (c) Yield stress
- (d) Shear stress

Ans. (b)

When designing machine parts, it is desirable to keep the stress lower than the maximum or ultimate stress at which failure of the material takes place. This stress is known as the working stress or design stress. It is also known as safe or allowable stress.

Note: By failure it is not meant actual breaking of the material. Some machine parts are said to fail when they have plastic deformation set in them, and they no more perform their function satisfactory.

End of Solution

Q.115 The maximum principal or normal stress (σ_{p1}) in a bi-axial stress system for Ductile materials is (where σ_{yt} = yield point stress in tension, σ_u = ultimate stress, F.S. = factor of safety):

- (a) $\frac{\sigma_{yt}}{F.S}$ (b) $\frac{\sigma_u}{F.S}$
(c) $\frac{F.S}{\sigma_{yt}}$ (d) $\frac{F.S}{\sigma_u}$

Ans. (a)

As per maximum principal stress theory,

$$\sigma_1 \leq \frac{S_{yt}}{N} \text{ for ductile material}$$

$$\sigma_1 \leq \frac{S_{ut}}{N} \text{ for ductile material}$$

End of Solution

Q.116 What is the type of theory in which, the failure or yielding occurs at a point in a member when the strain energy per unit volume in a bi-axial stress system reaches the limiting strain energy (i.e. strain energy at the yield point) per unit volume as determined from simple tension test?

- (a) Haigh's Theory (b) Hencky and Von-Mises Theory
(c) Saint Venant's Theory (d) Tresca Theory

Ans. (a)

According to this theory, the failure or yielding occurs at a point in a member when the strain energy per unit volume in a bi-axial stress system reaches the limiting strain energy (i.e. strain energy at the yield point) per unit volume as determined from simple tension test.

End of Solution

Q.122 Consider the following statements regarding atomic crystal structures for metals:

1. Zinc has a face-centered cubic crystal structure.
2. Lead has a face-centered cubic crystal structure.
3. Cobalt has a hexagonal close-packed crystal structure.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

Element	Symbol	Atomic Number	Atomic Weight (amu)	Crystal Structure, 20°C	Atomic Radius (nm)	Ionic Radius (nm)	Most Common Valence	Melting Point (°C)
Zinc	Zn	30	65.41	HCP	0.133	0.074	2+	420
Lead	Pb	82	207.2	FCC	0.175	0.120	2+	327
Cobalt	Co	27	58.3	HCP	0.125	0.072	2+	1495

End of Solution

Q.123 Consider the following statements regarding atomic radii for metals:

1. The atomic radii of Tungsten is 0.1371 nm.
2. The atomic radii of Cadmium is 0.1490 nm.
3. The atomic radii of Nickel is 0.1246 nm.

Which of the above statements are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

Element	Symbol	Atomic Number	Atomic Weight (amu)	Density of solid, 2.0°C (g/cm ³)	Atomic Radius (nm)	Ionic Radius (nm)	Most Common Valence	Melting Point (°C)
Tungsten	W	74	183.84	BCC	0.137	0.070	4+	3410
Cadmium	Cd	48	112.41	HCP	0.149	0.095	2+	321
Nickel	Ni	28	58.69	NCC	0.125	0.069	2+	1455

End of Solution

Q.124 Consider the following statements regarding pearlite:

1. Pearlite is a microstructural mixture of cementite and ferrite.
2. Fine pearlite is harder and stronger than coarse pearlite.
3. Coarse pearlite is more ductile than fine pearlite.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

In pearlite, there are alternate strips (layers) of ferrite and cementite. Ferrite is soft but cementite is harder and more brittle than ferrite. Rather, cementite reinforces the ferrite. If ultimate strength, yield strength and hardness of the steel are plotted with respect to carbon percentage, all three parameters increase with increasing carbon percentage. However, since cementite is more brittle, the ductility and toughness of the steel decrease with increase in carbon percentage.

Moreover, fine pearlite is harder and stronger than coarse pearlite, but coarse pearlite is more ductile than fine pearlite.

For fine pearlite, there are more boundaries through which dislocation must pass during plastic deformation. So with greater reinforcement and restriction of dislocation motion in fine grains, pearlite accounts for its higher strength and hardness.

End of Solution

Q.125 Consider the following statements regarding anelasticity:

1. For metals, the anelastic component is normally small.
2. In anelasticity, deformation will continue after the stress application, and upon load release, some finite time is required for complete recovery.
3. Time-independent elastic behaviour is known as anelasticity.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

In most engineering materials, however, there will also exist a time-dependent elastic strain component—that is, elastic deformation will continue after the stress application, and upon load release, some finite time is required for complete recovery. This time-dependent elastic behavior is known as anelasticity, and it is due to time-dependent microscopic and atomistic processes that are attendant to the deformation. For metals the anelastic component is normally small and is often neglected.

End of Solution

Q.126 A piece of copper, originally 305 mm long is pulled in tension with a stress of 276 MPa. If the deformation is entirely elastic, what is the resultant elongation?

(Take Young's modulus for copper as 110 GPa)

- (a) 0.91 mm (b) 0.77 mm
(c) 0.43 mm (d) 0.24 mm

Ans. (b)

Given data: $L = 305$ mm, $\sigma = 276$ MPa, $E = 110$ GPa.

$$\epsilon = \frac{\delta}{L} = \frac{\sigma}{E} \Rightarrow \delta = \frac{\sigma L}{E} = \frac{276 \times 305}{110 \times 10^3} = 0.7653 \text{ mm}$$

End of Solution

Q.127 Consider the following statements regarding ductility and brittleness:

1. Ductility is a measure of the degree of plastic deformation that has been sustained at fracture.
2. A material that experiences very little or no plastic deformation upon fracture is termed brittle.
3. Brittleness is expressed quantitatively as either percent elongation or percent reduction in area.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

Ductility is another important mechanical property. It is a measure of the degree of plastic deformation that has been sustained at fracture. A metal that experiences very little or no plastic deformation upon fracture is termed brittle. The tensile stress-strain behaviors for both ductile and brittle metals are schematically illustrated.

Ductility may be expressed quantitatively as either percent elongation or percent reduction in area. Percent elongation (%EL) is the percentage of plastic strain at fracture, or

$$\%EL = \left(\frac{l_f - l_0}{l_0} \right) \times 100$$

End of Solution

Q.128 Consider the following statements regarding corrosion:

1. Corrosion is defined as the destructive and unintentional attack of a metal.
2. For metallic materials, the corrosion process is normally electrochemical.
3. Metal atoms characteristically give up electrons in deoxidation reaction.

Which of the above statements is/are correct?

- (a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

Corrosion is defined as the destructive and unintentional attack of a metal; it is electrochemical and ordinarily begins at the surface. The problem of metallic corrosion is one of significant proportions; in economic terms, it has been estimated that approximately 5% of an industrialized nation's income is spent on corrosion.

For metallic materials, the corrosion process is normally electrochemical, in which there is transfer of electrons from one chemical species to another. Metal atoms characteristically lose or give up electrons in what is called an oxidation reaction.

End of Solution

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4 Streams 4 Toppers
all 4 MADE EASY Students

39 selections
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434 selections out of
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ME 10 in Top 10	1 AIR NIMESH CHANDRA Classroom Foundation Course	2 AIR ASHOK KUMAR Classroom Foundation Course	3 AIR HARI SINGH Mains Online Course	4 AIR SIDDESH RAO GS Online Course	5 AIR GOLLANGI SATEESH Mains Online Course	6 AIR AVINASH VERMA Mains Online Course	7 AIR PRASHANT SINGH Mains Offline Course	8 AIR MONU KUMAR Classroom Foundation Course	9 AIR NIKHIL KUMAR SAHA Test Series & IGP	10 AIR AMIT KUMAR SINGH Classroom Foundation Course
EE 10 in Top 10	1 AIR RAJAN KUMAR Classroom Foundation Course	2 AIR VISHNU SAINI Live Online Foundation Course	3 AIR OMPRAKASH RAJPUT Classroom Foundation Course	4 AIR TUSHAR CHAUDHARY Classroom Foundation Course	5 AIR RAM KUMAR Test Series & IGP	6 AIR PUNIT MEENA Classroom Foundation Course	7 AIR JYOTI K. PANDA Classroom Foundation Course	8 AIR D A SAI RAM REDDY Test Series & IGP	9 AIR DHURUV KAWAT Classroom Foundation Course	10 AIR AKSHIT PARASHARI Live Online Foundation Course
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MADE EASY students top in GATE 2025

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45 Selections
in Top 10

399 Selections
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2 AIR IN S. Bhattacharya Test Series	2 AIR ES Jitesh Choudhary Classroom Course	2 AIR ES Tarun Yadav Classroom Course	3 AIR CE Pankaj Meena Classroom Course	3 AIR ME Nimesh Chandra Classroom Course	3 AIR PI Aditya Kr. Prasad Classroom Course	3 AIR XE Rohan Kr. Biswal Test Series	5 AIR CE Kartik Pokhriyal Classroom Course		
5 AIR PI Kuldeep Singh Naruka Classroom Course	5 AIR IN Sachin Yadav Test Series	5 AIR EC M. M. Nafeez Test Series	5 AIR ES Sachin Kumar Classroom Course	6 AIR PI Kaushal Kr. Kaushik Online Course	6 AIR CE Shivnand Chaurasia Online Course	6 AIR CE Nimish Upadhyay Online Course	6 AIR EE Puneet Soni Test Series	6 AIR EE Shivam Kr. Gupta Test Series	
6 AIR EC Pentela J. Bhavani Test Series	6 AIR IN Utkarsh P. Patil Classroom Course	7 AIR PI Waleed Shaikh Test Series	7 AIR ME Abhinn Online Course	7 AIR IN Dev J. Patel Test Series	7 AIR ES Ankit Kumar Classroom Course	8 AIR ME Goutam Kumar Test Series	9 AIR CE Tarun Yadav Classroom Course	9 AIR CS Omhari Test Series	9 AIR EC Chilukuri S. Charan Test Series
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Ans. (b)

Given ; $m = 500$ kg; $s = 300$ N/mm; $x = 1$ m

Kinetic energy of barrel = Energy stored in spring

$$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}sx^2$$

$$\Rightarrow 500v^2 = (300 \times 10^3)(1)^2$$

$$\Rightarrow v = 24.494 \text{ m/s}$$

Alternate method,

$$V_{\max} = \omega_n \times A$$

$$= \sqrt{\frac{s}{m}} \times A = \sqrt{\frac{300 \times 10^3}{500}} \times 1$$

$$\Rightarrow V_{\max} = 24.5 \text{ m/s}$$

End of Solution

Q.136 What is the centroid on the line of symmetry from the centre distance of a quarter circle, if the radius is R?

(a) $\frac{2R}{3\pi}$

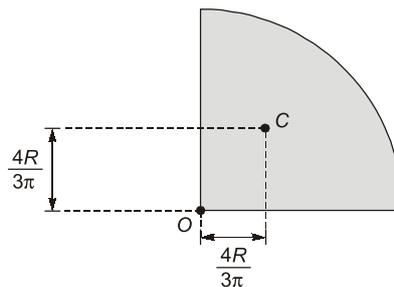
(b) $\frac{3R}{2\pi}$

(c) $\frac{3R}{4\pi}$

(d) $\frac{4R}{3\pi}$

Ans. (d)

$$\frac{4R}{3\pi}$$



End of Solution

Q.137 If a particle has an initial velocity of $V_0 = 12$ m/s to the right, at $S_0 = 0$, what is the position when $t = 10$ s, if $a = 2$ m/s² to the left?

(a) 20 m

(b) 15 m

(c) 25 m

(d) 30 m

Ans. (a)

Given: $V_0 = 12 \text{ m/s}$; $a = -2 \text{ m/s}^2$; $t = 10 \text{ s}$

$$S = V_0 t + \frac{1}{2} a t^2$$

$$= 12(10) + \frac{1}{2}(-2)(10)^2$$

$$\Rightarrow S = 120 - 100 = 20 \text{ m}$$

End of Solution

Q.138 What is the extension ' Δ ' for a uniformly tapering rod of length L with diameter ' d_1 ' at one end and ' d_2 ' at the other end when the member is subjected to an axial tensile load P and the modulus of elasticity is E ?

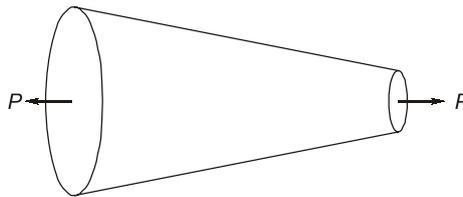
(a) $\frac{4PL}{\pi E d_1 d_2}$

(b) $\frac{4PE}{\pi L d_1 d_2}$

(c) $\frac{4P d_1 d_2}{\pi E L}$

(d) $\frac{4EL}{\pi P d_1 d_2}$

Ans. (a)



$$\sigma = \frac{PL}{A_{\text{eff}} E} = \frac{PL}{\frac{\pi}{4}(d_1 d_2) E} = \frac{4PL}{\pi(d_1 d_2) E}$$

End of Solution

Q.139 Consider the following statements regarding thermal stresses:

1. If the temperature change is uniform throughout the body, the thermal strain is also uniform.
2. If thermal deformation is permitted to occur freely, no internal forces will be induced in the body and there will be no strain and no stress.
3. If the deformation of a body is restricted, either totally or partially, internal forces will develop that oppose the thermal expansion or contraction. The stresses caused by these internal forces are known as thermal stresses.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans. (c)

For uniform temperature change thermal strain is also uniform.

For free thermal expansion there will be no stress but thermal strain will be there.

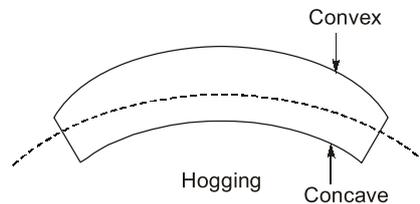
For restricted (fully or partially) thermal deformation internal forces will be developed.

End of Solution

Q.140 The bending moment that tends to bend the beam to produce convexity above the centre line is known as:

- (a) Sagging bending moment (b) Hogging bending moment
(c) Twisting bending moment (d) Pure bending moment

Ans. (b)

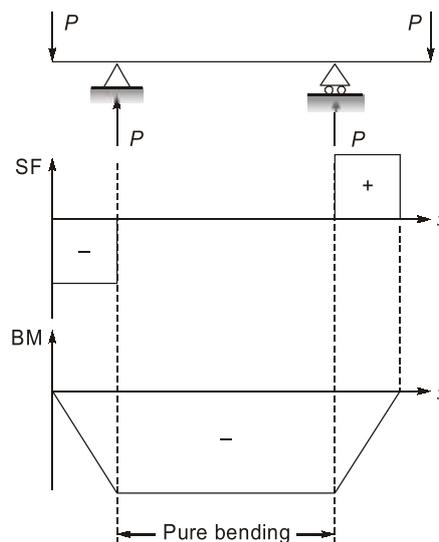


End of Solution

Q.141 The type of bending that occurs between the two supports of an overhanging beam with constant bending moment and no shear stress between the supports and carries equal amount of point load at its each end is:

- (a) Pure bending (b) Pure torsion
(c) Twisting moment (d) Sagging bending moment

Ans. (a)



End of Solution

Q.142 A seamless pipe of 80 cm diameter contains a fluid under a pressure of 20 kg/cm². If the permissible tensile stress is 1000 kg/cm², what is the minimum thickness of the pipe?

- (a) 0.8 cm (b) 0.6 cm
(c) 0.7 cm (d) 0.5 cm

Ans. (a)

Given data: $d = 80$ cm, $P = 20$ kg/cm², $\sigma_{per} = 1000$ kg/cm².

$$\begin{aligned}\sigma_H &\leq (\sigma)_{per} \\ \frac{Pd}{2t} &\leq 1000 \\ \frac{20 \times 80}{2 \times t} &\leq 1000 \\ t &\geq 0.8 \text{ cm} \\ t_{min} &= 0.8 \text{ cm}\end{aligned}$$

End of Solution

Q.143 Consider the following statements regarding the centre of gravity and centroid:

1. Centroid of an area does not lie on the axis of symmetry if it exists.
2. Centre of gravity of a body is a point through which the resultant gravitational force acts for any orientation of the body.
3. Centroid is a point in a line plane area volume such that the moment of area about any axis through that point is zero.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (b)

Centre of gravity of a body is special point through which the resultant gravitational force (weight) acts for any orientation of the body whereas centroid is a point in a plane area such that the moment of area about any axis through that point is zero.

End of Solution

Q.144 Consider the following statements regarding laws of friction:

1. The magnitude of the limiting friction bears a constant ratio to the normal reaction between the two contacting surfaces.
2. The force of friction is independent of the area of contact between the two surfaces.
3. The force of friction does not depend upon the smoothness/roughness of the surfaces.

Which of the above statements are correct?

- (a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3



Ans. (d)

A crystallographic direction is defined as a line between two points, or a vector. The following steps are utilized in the determination of the three directional indices:

1. A vector of convenient length is positioned such that it passes through the origin of the coordinate system. Any vector may be translated throughout the crystal lattice without alteration, if parallelism is maintained.
2. The length of the vector projection on each of the three axes is determined; these are measured in terms of the unit cell dimensions a , b , and c .
3. These three numbers are multiplied or divided by a common factor to reduce them to the smallest integer values.
4. The three indices, not separated by commas, are enclosed in square brackets, thus: $[uvw]$. The u , v , and w integers correspond to the reduced projections along the x , y , and z axes, respectively.

End of Solution

Q.149 In which type of bonding are the stable electron configurations assumed by the sharing of electrons between adjacent atoms?

- (a) Metallic bonding (b) Covalent bonding
(c) Chemical bonding (d) Ionic bonding

Ans. (b)

In covalent bonding, stable electron configurations are assumed by the sharing of electrons between adjacent atoms. Two atoms that are covalently bonded will each contribute at least one electron to the bond, and the shared electrons may be considered to belong to both atoms.

End of Solution

Q.150 The ratio of volume of atoms in a unit cell to the total unit cell volume is called:

- (a) Atomic packing factor (b) Isotropic packing factor
(c) Interatomic packing factor (d) Ionic packing factor

Ans. (a)

$$\text{Atomic packing factor} = \frac{\text{Volume of atoms in a unit cell}}{\text{Volume of unit cell}}$$

End of Solution

