Question Paper of

Junior Works Manager 2010

Mechanical Engineering

UPSC

1. **Match List I with List II and select the correct answer using the code given below the lists :**

List I	List II
A. Pendulum-type governor	1. Pickering governor
B. Deadweight governor	2. Rites governor
C. Spring-controlled governor	3. Proell governor
D. Intertia governor	4. Watt governor

Code :

(a)	A	B	C	D
	4	3	1	2
(b)	A	B	C	D
	2	3	1	4
(c)	A	B	C	D
	4	1	3	2
(d)	A	B	C	D
	2	1	3	4

2. **Consider the following statements :**
Effect of unbalanced primary force along the line of stroke produces
1. Swaying couple
2. Variations in tractive force
3. Hammer blow

Which of these statements are correct ?

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

3. **A cannonball is fired from a tower 80 m above the ground with a horizontal velocity of 100 m/s. Determine the horizontal distance at which the ball will hit the ground. (Take g = 10 m/s^2)**

(a) 400 m (b) 280
(c) 200 m (d) 100 m

4. **Match List I with List II and select the correct answer using the code given below the lists :**

List I	List II
A. Von-Mises yield criterion	1. Fatigue design

B. Soderberg's law — 2. Failure in machine elements made of ductile materials
C. Sommerfield number — 3. Design of journal bearings
D. Buckingham equation — 4. Dynamic tooth load in gears in mesh

Code :

(a)	A	B	C	D
	4	1	3	2
(b)	A	B	C	D
	2	1	3	4
(c)	A	B	C	D
	4	3	1	2
(d)	A	B	C	D
	2	3	1	4

5. Consider the following statements :
Shear force in beams is caused by
1. Lateral forces acting on the beam
2. Variation of bending moment along beam length
3. A couple acting on the beam

Which of the above statements is/are correct ?
(a) 1 only (b) 1 and 2
(c) 2 and 3 (d) 1 and 3

6. A car travels on a horizontal circular track of radius 9 m, starting from rest at a constant tangential acceleration of 3 m/s². What is the resultant acceleration of the car, 2 sec after starting ?
(a) 3 m /sec² (b) 4 m/sec²
(c) 5 m/sec² (d) 7 m/sec²

7. Match List I with List II and select the correct answer using the code given below the lists :

List I
A. Double-helical gears connecting parallel shafts
B. Two non-parallel or intersecting but coplanar shafts
C. Two non-intersecting and non- parallel shafts connected by gears
D. Gear of a shaft meshing externally with a straight toothed member

List II
1. Rack and pinion
2. Spiral gear
3. Bevel gear
4. Herringbone gear

Code :

(a)	A	B	C	D
	1	2	3	4
(b)	A	B	C	D
	4	2	3	1
(c)	A	B	C	D
	1	3	2	4
(d)	A	B	C	D
	4	3	2	1

8. Select the correct option for the velocity profile

$$\frac{u}{v} = \frac{5}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^2 + \frac{2}{3}\left(\frac{y}{\delta}\right)^3$$

(a) Flow has separated
(b) Flow is on the verge of a separation
(c) Flow will not separate
(d) All of the above

9. Consider the following statements :
If a beam is to bend without being twisted,
1. Plane of a load must contain one of the axes of symmetry of the beam
2. The beam cross-section must have at least an axis of symmetry
Which of the above statements is/are correct ?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

10. Water drops from a tap at the rate of four droplets per second. Determine the vertical separation between two consecutive drops after the lower drop attained a velocity of 4 m/s. (Take g = 10 m/s^2)
(a) 0·49 m (b) 0·31 m
(c) 0·50 m (d) 0·30 m

11. Match List I with List II and select the correct answer using the code given below the lists :

List I	List II
A. Degree of reaction	1. Power given by water to runner
B. Net head	2. Inverse of $\sqrt{H}$, where H is head on turbine
C. Flow ratio	3. Change of total energy inside the runner
D. Hydraulic efficiency	4. Friction between water and penstock

Code :

(a)	A	B	C	D
	3	2	4	1
(b)	A	B	C	D
	1	2	4	3
(c)	A	B	C	D
	3	4	2	1
(d)	A	B	C	D
	1	4	2	3

12. Consider the following properties of engineering materials :
1. Density
2. Conductivity
3. Elasticity
4. Hardness
5. Ductility
Which of these are mechanical properties of a material ?
(a) 1, 2 and 4 only (b) 1, 2, 3 and 4
(c) 3, 4 and 5 (d) 2, 4 and 5

13. A 50-kg box rests on horizontal floor for which coefficient of friction is 0·3. If the box is subjected to a horizontal towing force of 400 N, what is its velocity after 5 sec from rest? (Take g = 10 m/s²)
(a) 40 m/s (b) 30 m/s
(c) 27·5 m/s (d) 25 m/s

14. Consider the following operations regarding boring machines :
1. Counterboring
2. Countersinking
3. Trepanning
Which of the above operations is/are correct ?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 only

15. A 500-kg elevator starts from rest and travels upwards with a constant acceleration of a_c = 2 m/s². What is the power output of the motor when t = 3 sec? (Take g = 10 m/s²)
(a) 18 kW (b) 30 kW
(c) 36 kW (d) 54 kW

16. Consider the following components regarding numerical control system :
1. Programme of instructions
2. Machine control unit
3. Processing equipment
Which of these are correct ?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

17. Consider the following advantages of DNC systems :
1. Time-sharing
2. Greater computational capability
3. Remote computer location
Which of the above is/are correct ?
(a) 1 and 2 only (b) 2 and 3 only
(c) 2 only (d) 1, 2 and 3

18. In a vapour-compression refrigerator, the design pressure at the condenser will depend on
(a) Type of compressor (b) Refrigerant used
(c) Its capacity (d) Its coefficient of performance

19. In a domestic refrigerator, periodical defrosting is necessary to
(a) Protect the coil from damage
(b) Avoid wastage of power
(c) Reduce evaporator pressure
(d) Reduce condenser pressure

20. In a vapour-compression refrigeration system, the thermodynamic process which the refrigerant undergoes while passing through the expansion valve is
(a) Isentripic (b) Adiabatic
(c) Throttling (d) Free expansion

21. Consider the following statements :

In a shell-and-tube heat exchanger, baffles are provided on the shell side to

1. Prevent the stagnation of shell-side fluid
2. Improve heat transfer
3. Provide support for tube
4. Prevent fouling of tubes

Which of the above statements are correct ?

(a) 1, 2, 3 and 4 (b) 1 and 2 only
(c) 3 and 4 only (d) 2 and 3 only

22. A 2-ton capacity water cooler has water entering at 30° C and leaving at 15° C. What is the water flow rate in Lph?

(a) 40 (b) 66·6
(c) 402 (d) 502

23. Consider the following statements pertaining to heat transfer using fins :

1. Fins should be used on the side where heat-transfer coefficient is small.
2. Long and thick fins should be used.
3. Short and thin fins should be used.
4. Thermal conductivity of the fin material should be large.

Which of the above statements are correct ?

(a) 1, 2 and 4 (b) 1 and 3 only
(c) 3 and 4 only (d) 1, 3 and 4

24. A composite hollow sphere with radial outflow of heat is made of two layers of materials of equal thickness with thermal conductivities in the ratio of 2 : 3 for inner and outer layers. Ratio of outer to inner diameter is 1·25. What will be the ratio of temperature drops across the inner layer to the outer layer?

(a) 0·833 (b) 1·2
(c) 1·875 (d) 2·34

25. Consider the following statements related to transient heat conduction :

1. Biot number and Fourier number play a vital role in unsteady heat conduction.
2. Schmidt plot is used in one-dimensional transient heat conduction problems.

Which of the above statements is/are correct ?

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

26. A composite slab has 3 layers of insulation of equal thickness with thermal resistances in the ratio of 1 : 2 : 3. What will be the ratio of respective temperature drops across the layers?

(a) 1 : 2 : 3 (b) 3 : 2 : 1
(c) 1 : 1·5 : 3 (d) 3 : 1·5 : 1

27. Consider the following characteristics of the system under investigation regarding queuing model choice :

1. Number of servers
2. Arrival and service time patterns
3. Queue discipline (order of service)
4. VIP items and their number

Queuing model choice is affected by which of these characteristics?
(a) 1, 2, 3 and 4 (b) 2, 3 and 4 only
(c) 1, 2 and 3 only (d) 1, 3 and 4 only

28. A copper ball at 227°C cools by radiation to ambient atmosphere at 27°C. When the body has cooled down to 127 °C, what will be the decreasing cooling rate as percentage of original cooling rate?
(a) 90·2 (b) 67·8
(c) 59 (d) 11

29. Consider the following characteristics :
1. Limited time frame
2. Narrow focus
3. Less bureaucratic
4. Used only for providing services
For which of these characteristics, the project management is different from general operations management?
(a) 1, 2, 3 and 4 (b) 1, 3 and 4 only
(c) 2, 3 and 4 only (d) 1, 2 and 3 only

30. A body at 500 K cools down to 400 K by radiation to atmosphere at 300 K. What will be the ratio of heat loss rate at 500 K to the heat loss rate at 400 K?
(a) 1·25 (b) 2·00
(c) 2·44 (d) 3·11

31. Consider the following data to apply the material requirement planning technique:
1. Bill of material
2. Inventory stock status
3. Lead times for items procured
4. EOQ
5. Master production schedule
Which of these are correct?
(a) 1, 2, 3, 4 and 5 (b) 2, 3, 4 and 5 only
(c) 1, 2, 3 and 4 only (d) 1, 2, 3 and 5 only

32. Surface temperatures on the two sides of a flat wall are measured to be 600°C and 400° C respectively. Thermal conductivity of the wall material is 0·1 kW/m-K. If the wall thickness is 0·2 m, the heat flux through the wall will be
(a) 1 kW/m^2 (b) 100 kW/m^2
(c) 236·5 kW/m^2 (d) 1000 kW/m^2

33. A short cast iron cylindrical piece of cross-sectional area 100 mm^2 and length 25 mm is tested in compression and fails at a load of 50 kN. The shear strength of cast iron is.
(a) 500 N/mm^2 (b) 400 N/mm^2
(c) 300 N/mm^2 (d) 250 N/mm^2

34. Consider the following assumptions on EOQ model of inventory management :
1. Annual demand is known and constant.
2. Ordering cost is known.
3. Inventory carrying cost (holding cost) is known.

Which of these are correct?
(a) 1, 2 and 3 (b) 1 and 2 only
(c) 2 and 3 only (d) 1 and 3 only

35. Match List-I with List-II and select the correct answer using the code given below the lists :

List I	List II
A. Atomic hydrogen welding	1. Two pieces are brought together and power supply is switched on
B. Plasma-arc welding	2. Nugget is formed at the interface of two plates
C. Spot welding	3. Gas is ionized
D. Flash welding	4. Inert gas shielded arc welding

Code :

(a)	A	B	C	D
	4	3	2	1
(b)	A	B	C	D
	1	3	2	4
(c)	A	B	C	D
	4	2	3	1
(d)	A	B	C	D
	1	2	3	4

36. A furnace wall has a thickness of 50cm and thermal conductivity of 0·7 W/m-K. What will be the required thickness of a new material having thermal conductivity equal to 0·14 W/m-K, if the heat loss and temperature drop across the wall are the same as before ?
(a) 5 cm (b) 10 cm
(c) 20 cm (d) 50 cm

37. Consider the following statements regarding multistage centrifugal pumps :
1. For discharging large quantity of liquid, the impellers are connected in parallel.
2. At the outlet of 2nd impeller, the pressure of water will be less than the pressure of water at the outlet of 1st impeller, when the impellers are connected in series.

Which of the above statements is/are correct?
(a) Both 1 and 2 (b) 1 only
(c) 2 only (d) Neither 1 nor 2

38. The two-dimensional state of stress at a point is $\sigma_x = 100$ N/mm^2, $\sigma_y = 20$ N/mm^2 and τ_{zy}. If the larger principal stress at the point is 110 N/mm^2, the smaller principal stress will be
(a) 10 N/mm^2 (b) 15 N/mm^2
(c) 16 N/mm^2 (d) 18 N/mm^2

39. Consider the following statements :
The amount of water striking the vanes of the runner of a turbine is controlled by a spear which is
1. Provided in the nozzle
2. Conical needle shaped
Which of the above statements is/are correct?

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

40. Match List-I with List-II and select the correct answer using the code given below the lists :

List I	List II
A. $\bar{X}$ -chart	1. Precision
B. R-chart	2. Number of defects
C. p-chart	3. Fractional defect
D. c-chart	4. Accuracy

Code :

(a)	A	B	C	D
	2	3	1	4
(b)	A	B	C	D
	4	3	1	2
(c)	A	B	C	D
	2	1	3	4
(d)	A	B	C	D
	4	1	3	2

41. In the frictionless flow of the steam, the critical pressure ratio will occur

(a) At exit of the nozzle
(b) Where area is minimum
(c) Where discharge is minimum
(d) Where condition of steam is dry saturated

42. Consider the following properties :

1. Specific heat
2. Thermal diffusivity
3. Dynamic viscosity
4. Density

Which of these properties of air increase with increase of temperature ?

(a) 1, 2, 3 and 4 (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3 only

43. A cantilever beam of square cross-section (100mm × 100mm) and length 2 m carries a concentrated load of 5 kN at its free end. What is the maximum normal bending stress at its mid-length cross-section ?

(a) 10 N/mm^2 (b) 20 N/mm^2
(c) 30 N/mm^2 (d) 40 N/mm^2

44. Consider the following statements for moist air, when it has attained the dew-point temperature.

1. Dry-and wet-bulb temperatures are indentical.
2. Relative humidity is 100%.
3. Air is fully saturated with water vapour.
4. Humidity ratio is 100%.

Which of the above statements is/are correct ?

(a) 1 only (b) 2 and 3 only
(c) 1, 2 and 3 (d) 3 and 4

45. A refrigerating unit has a COP of 5. It extracts 480 kJ of heat from the cold reservoir in one minute. As a heat pump, how much heat it would deliver to the environment ?

(a) 1·6 kW (b) 6·67 kW
(c) 9·6 kW (d) 576 kW

46. Consider the following properties :

1. Wet-bulb temperature
2. Specific enthalpy of air-vapour mixture

Which of these properties decrease(s) during sensible cooling of air-water vapour mixture?

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

47. In an adiabatic process, 5000 J of work is performed on a system. In the non-adiabatic process by which the system returns to its original state, 1000 J of heat is added to the system. The work done during the non-adiabatic process is

(a) +6000 J (b) –6000 J
(c) +4000 J (d) –4000 J

48. A hollow shaft of outside diameter 40 mm and inside diameter 20 mm is to be replaced by a solid shaft of 30 mm diameter. If the maximum shear stresses induced in the two shafts are to be equal, what is the ratio of the maximum resistible torque in the hollow to that of solid shaft ?

(a) $\frac{10}{9}$ (b) $\frac{20}{9}$
(c) $\frac{30}{9}$ (d) $\frac{40}{9}$

49. Consider the following statements :

1. Energy gradient line always drops in the direction of flow.
2. Hydraulic gradient line always rises in the direction of flow.
3. Vertical intercept between the energy gradient line and hydraulic gradient line is equal to the velocity head.]
4. For a pipe of uniform section, slope of hydraulic gradient line is equal to the slope of energy gradient line.

Which of the above statements is/are correct ?

(a) 1 only (b) 2 and 3 only
(c) 1, 3 and 4 only (d) 1, 2, 3 and 4

50. When 2 gm of a gas A is introduced into an evacuated flask kept at 25°C, the pressure is found to be 1 atmosphere. If 3 gm of another gas B is then added to the same flask, the total pressure becomes 1·5 atmospheres. Assuming ideal gas behaviour, the ratio of molecular weights, $M_A : M_B$ will be

(a) 1 : 3 (b) 3 : 1
(c) 2 : 3 (d) 3 : 2

51. A refrigerating machine working on reversed Carnot cycle takes out 2 kW of heat from the system while working between temperature limits of 300 K and 200 K. COP and power consumed by the cycle respectively will be

(a) 1, 1 kW/min (b) 1, 2 kW/min

(c) 2, 1 kW/min (d) 2, 2 kW/min

52. A water tank has a gate in its vertical wall 5 m high and 3 m wide. The top edge of the gate is 2 m below the water surface. The hydrostatic force on the gate surface is

(a) 147 kN (b) 367 kN
(c) 490 kN (d) 662 kN

53. Consider the following methods :

1. Mechanical pulverization
2. Atomization
3. Sintering
4. Electrolytic deposition

Which of these methods is/are used for production of metal powders ?

(a) 1 only (b) 2 and 3
(c) 3 and 4 (d) 1, 2 and 4

54. A compound rod is formed by tightly inserting an aluminium rod inside a steel tube. The length of this compound rod is l and its ends are welded together so as to prevent any relative motion. This rod is subjected to a torque T, applied to its ends in opposite directions. If polar moment of inertia of the tube and rod are same and modulus of rigidity of steel is three times that of aluminium, what is the ratio of torque shared by steel tube to that of aluminium rod?

(a) 4 : 1 (b) 3 : 1
(c) 2 : 1 (d) 1 : 1

55. The stream function in a two-dimensional flow field is given by $\Psi = x^2 + y^2$. The magnitude of the velocity at point (1, 1) will be

(a) 2 (b) $2\sqrt{2}$
(c) 4 (d) $4\sqrt{2}$

56. Water flows through a pipe of 200 mm diameter at a discharge of 62·8 Lps. At a section which is 5 m above the datum, the water pressure is 150 kN/m². In such a case, the total energy of the flow in terms of water head will be

(a) 12·5 m (b) 15·5 m
(c) 17·5 m (d) 20·5 m

57. Consider the following materals :

1. Wax 2. Wood
3. Plastic

Which of these materials can be used as pattern in investment casting process ?

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

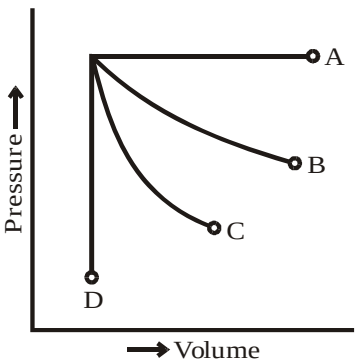
58. A flowmeter when tested in a laboratory gives a pressure drop of 100 kN/m² for a discharge of 0.1 m³/s in a 150-mm diameter pipe. If a geometrically similar model is tested in 600-mm diameter pipe at identical conditions of fluid, the corresponding discharge will be

(a) 0·1 m³/s (b) 0·2 m³/s
(c) 0·3 m³/s (d) 0·4 m³/s

59. Steam at a pressure of 6 bars (enthalpy 2988 kJ/kg) passes through a frictionless nozzle to a pressure of 4 bars (enthalpy 2888 kJ/kg). Neglecting velocity of approach, the final velocity of steam at exit of nozzle will be

(a) 447·2 nm/s (b) 44·72 m/s
(c) 4·472 m/s (d) 4472 m/s

60.



The figure shows thermodynamic expansion processes A, B, C and D. Which line is very close to the isentropic process?

(a) A (b) B
(c) C (d) D

Directions : Each of the next twenty (20) items consists of two statements, one labelled as the 'Assertion (A)' and the other as 'Reason (R)' . You are to examine these two statements carefully and select the answer to these items using the codes given below :

Codes :

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true and R is ***not*** the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

61. **Assertion (A) :** Stress at a point is completely defined by specifying its magnitude, nature, direction and orientation of the plane containing the point.
Reason (R) : Stress is a tensor of second order.

62. **Assertion (A) :** Bead is the metal added during single pass of welding.
Reason (R) : Bead material is same as base metal.

63. **Assertion (A) :** Electric arc furnace can be used for acid and basic method of steel making.
Reason (R) : Impurities are eliminated extensively in acid are process.

64. **Assertion (A) :** In die-casting method, small thickness can be filled with liquid metal.
Reason (R) : The air in die cavity trapped inside the casting causes problems.

65. **Assertion (A) :** In magnetic pulse-forming method, magnetic field produced by eddy currents is used to create force between coil and workpiece.

Reason (R) : It is necessary for the workpiece material to have magnetic properties.

66. **Assertion (A) :** In open-coiled helical springs, axial load causes normal stress and shearing stress in the spring wire.
Reason (R) : Helix angle is large in open-coiled helical springs.

67. **Assertion (A) :** Quality assurance is superior to quality control as a technique.
Reason (R) : Quality assurance is a down-stream activity and quality control is an upstream activity.

68. **Assertion (A) :** Method study, motion analysis and time study are technique for improving productivity.
Reason (R) : All of them are used for establishing experimental time standards.

69. **Assertion (A) :** Spatter is one of the welding defects.
Reason (R) : In submerged arc welding process, there is no spatter of molten metal.

70. **Assertion (A) :** Cost overrum is preferred to time overrum in project management using PERT technique.
Reason (R) : Early availability of product or service minimizes the penalty costs.

71. **Assertion (A) :** Extrusion speed depends on work material.
Reason (R) : High extrusion speed causes cracks in the material.

72. **Assertion (A) :** Comfort is a function of temperature, humidity and velocity in the conditioned space.
Reason (R) : By controlling temperature, humidity and velocity in the conditioned space, one can select a combination which consumes less energy without compromising the comfort.

73. **Assertion (A) :** A surge tank is provided in high-head power plant between main reservoir and penstock.
Reason (R) : In high-head power plants, the water hammer affects penstock.

74. **Assertion (A) :** Forecasts for groups of items tend to be more accurate than forecasts for individual items.
Reason (R) : Opportunities for grouping arise if parts or raw materials are used for multiple products manufactured in the same organization.

75. **Assertion (A) :** The pressure of flowing liquid in any part of the hydraulic system should not be allowed to fall below its vapour pressure.
Reason (R) : The absolute pressure head for water should not be below 2·5 m of water.

76. **Assertion (A) :** While steam flows through a nozzle, its velocity increases and specific volume decreases.
Reason (R) : In a nozzle when steam expands, there is drop in its pressure and enthalpy.

77. **Assertion (A) :** Sometimes particular combination of refrigerant and piping will result in a resonant frequency which may amplify the sound and vibration to an undesirable level.

Reason (R) : Muffler is used to solve the above problem.

78. **Assertion (A) :** Thin wires should be used in thermocouples for measuring transient temperatures.

Reason (R) : The value of time constant for thin wire is low which leads to better response.

79. **Assertion (A) :** A gib and cotter joint is usually used in small end of a connecting rod of a reciprocating engine mechanism.

Reason (R) : The gib provides a larger bearing surface for the cotter to slide on and thus the tendency of cotter to slacken back owing to friction is considerably decreased.

80. **Assertion (A) :** A long column fails (becomes elastically unstable) due to excessive bending.

Reason (R) : Euler's buckling load is inversely proportional to the equivalent length of the column.

81. **A car traveling at a speed of 20 m/s is subjected to acceleration $a = 10 - \frac{t}{2}$. Determine the maximum speed of the car.**

(a) 200 m/s (b) 120 m/s
(c) 100 m/s (d) 80 m/s

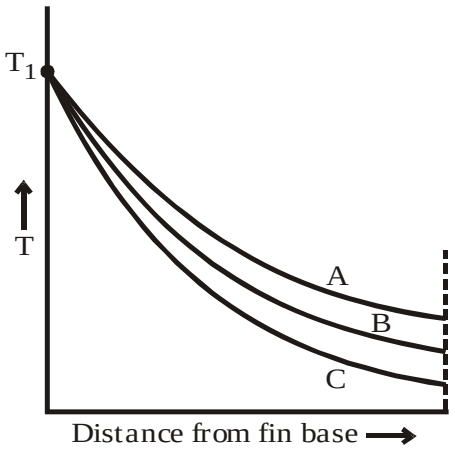
82. **A laminar boundary layer has a velocity distribution given by $\frac{u}{u_0} = \frac{y}{\delta}$. The displacement thickness for this boundary layer will be**

(a) δ (b) $\frac{\delta}{2}$
(c) $\frac{\delta}{4}$ (d) $\frac{\delta}{6}$

83. **A long thin cylindrical shell is fabricated by making longitudinal and circumferential weld seams. The efficiencies of longitudinal and circumferential weld seams are 80% and 75% respectively. Now this shell is subjected to internal fluid pressure. The ratio of the larger to smaller principal stresses induced in the shell material is**

(a) 2 (b) $\frac{15}{8}$
(c) 1·75 (d) 1·50

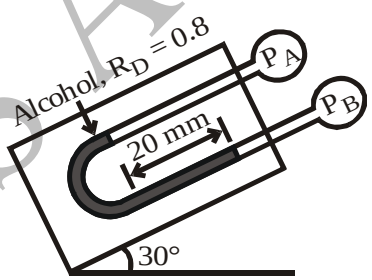
84.



Three fins of identical shape and size, each 10 cm long, are attached to a source at temperature T_1, while the surrounding temperature is T_0. A, B and C are the temperature profiles observed along the fins as shown in the figure. The fin materials are aluminium, copper and fibreglass. The correct sequence of A, B and C is

(a) Aluminium, fibreglass and copper
(b) Fibreglass, aluminium and copper
(c) Copper, aluminium and fibreglass
(d) Copper, fibreglass and aluminium

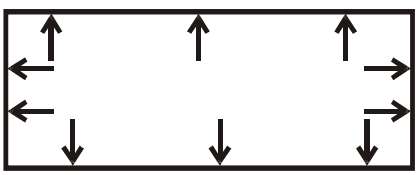
85.



For an inclined manometer as shown in the figure, the pressure difference $P_A - P_B$ will be

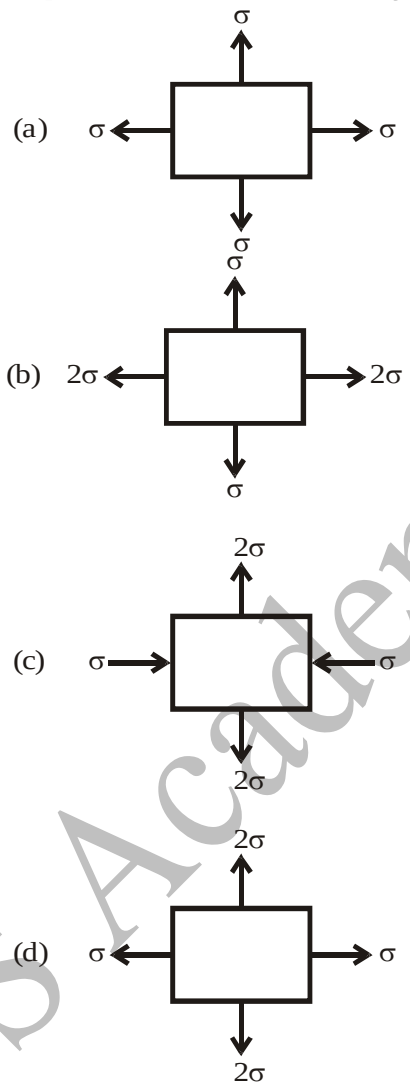
(a) 50 N/m^2 (b) 78 N/m^2
(c) 128 N/m^2 (d) 156 N/m^2

86.

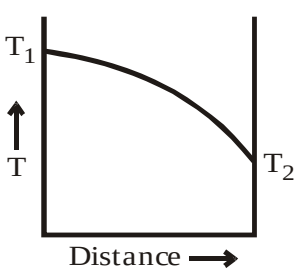


Cylindrical shell

Principal stresses on the outside surface element of a thin cylindrical shell subjected to internal fluid pressure as shown in the figure, are represented by



87.



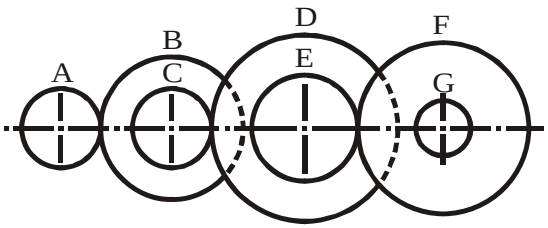
Temperature distribution in a furnace wall is shown in the figure. Which of the following expressions would represent the correct variation of thermal conductivity of this material with respect to temperature ?

(a) $\frac{K_0}{1+\alpha T}$ (b) $K_0(1+\alpha T)$

(c) $\frac{K_0}{\alpha T}$ (d) $K_0(1 - \alpha T)$

Where K_0 is thermal conductivity at 0°C. T is in °C and α is a constant.

88.



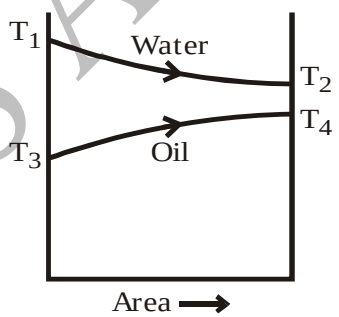
The gearing arrangement used in a machine-tool device is shown in the figure. The motor shaft is connected to gear A and rotates at 750 r.p.m. The gear wheels B, C, D and E are fixed to parallel shafts. The last gear F is fixed on the output shaft. The number of teeth on each wheel is as given below :

Gear	A	B	C	D	E	F
No. of teeth	20	50	25	75	30	60

The speed of the output shaft on which the gear G is mounted is

(a) 200 r.p.m. (b) 100 r.p.m.
(c) 80 r.p.m. (d) 50 r.p.m.

89.



In a heat exchanger used to heat up oil by hot water, the temperature profiles are as shown in the figure. If the rate of flow of oil is decreased, which of the following quantities will decrease?

1. $(T_1 - T_2)$
2. T_2
3. $(T_1 - T_4)$
4. $(T_4 - T_3)$

Select the correct answer using the code given below :

Code :

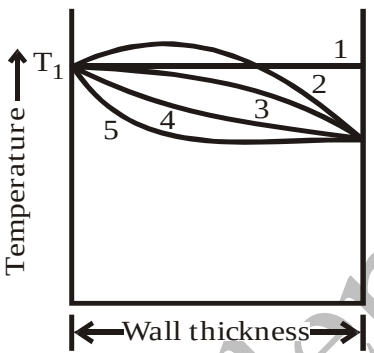
(a) 2 and 3 (b) 1 only
(c) 1 and 3 (d) 3 and 4

90. Match List I with List II and select the correct answer using the code given below the Lists :

List I
(Type of wall material)

A. With internal heating and constant thermal conductivity
B. Constant thermal conductivity
C. Infinite thermal conductivity
D. Thermal conductivity increasing with temperature

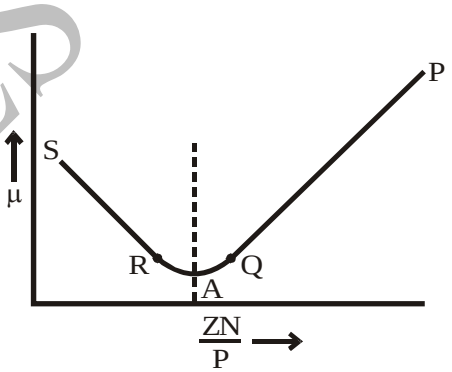
List II
(Temperature profits)



Code :

(a)	A	B	C	D
	1	4	2	5
(b)	A	B	C	D
	2	4	1	3
(c)	A	B	C	D
	1	4	3	5
(d)	A	B	C	D
	2	1	4	5

91.



The variation of coefficient of friction (μ) with bearing characteristic number $\left(\frac{ZN}{P}\right)$ is shown in the figure. Match List I with List II and select the correct answer using the code given below the Lists :

List I (Portion of curve)	List II (Condition of bearing action)
A. S–R	1. Thin film or boundary lubrication (unstable)

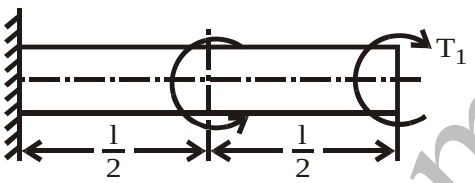
B. R–Q
C. A
D. Q–P

2. Partial lubrication
3. Limiting condition of bearing modulus
4. Thick film lubrication (stable)

Code :

(a)	A	B	C	D
	1	2	3	4
(b)	A	B	C	D
	4	2	3	1
(c)	A	B	C	D
	1	3	2	4
(d)	A	B	C	D
	4	3	2	1

92.



A solid circular shaft, of polar moment of inertia J and modulus of rigidity of the material G, is fixed at one end and loaded by two torques as shown in the figure. The twist at the free end of the shaft will be zero when

(a) $T_2 = 0 \cdot 5\ T_1$
(b) $T_2 = T_1$
(c) $T_2 = 2T_1$
(d) $T_1 = 0$

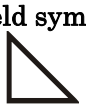
93. Match List I with List II and select the correct answer using the code given below the List :

List I (Screw thread designation)	List II (Form of screw thread)
A. Knuckle	1. 
B. Acme	2. 
C. Buttress	3. 
D. Whitworth	4. 

Code :

(a)	A	B	C	D
	1	2	4	3
(b)	A	B	C	D
	3	2	4	1
(c)	A	B	C	D
	1	4	2	3
(d)	A	B	C	D
	3	4	2	1

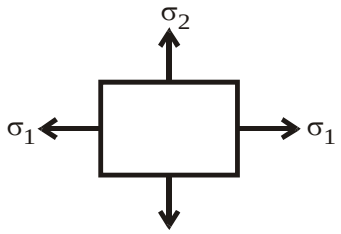
94. Match List I with List II and select the correct answer using the code given below the List :

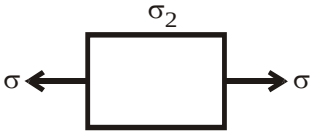
List I (Basic form of weld)	List II (weld symbol)
A. Fillet	1. 
B. Square butt	2. 
C. Spot weld	3. 
D. seam weld	4. 

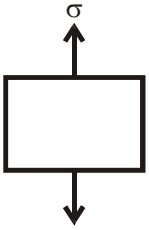
Code :

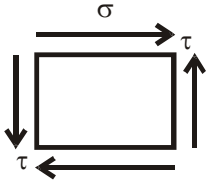
(a)	A	B	C	D
	1	2	3	4
(b)	A	B	C	D
	4	2	3	1
(c)	A	B	C	D
	1	3	2	4
(d)	A	B	C	D
	4	3	2	1

95. Which one of the following represents the state of stress on a surface element of a shaft subjected to a torque?

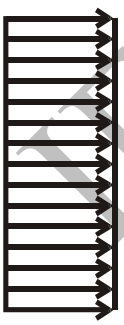
(a) 

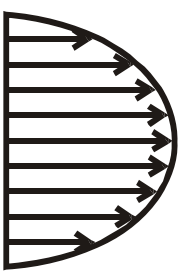
(b) 

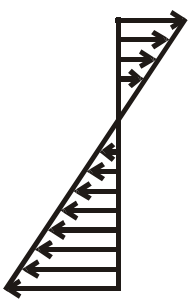
(c) 

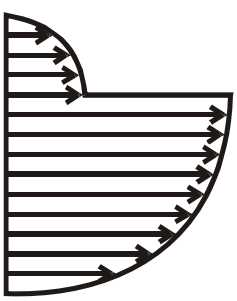
(d) 

96. Which one of the following represents the shearing stress distribution over a cross-section of a T-beam ?

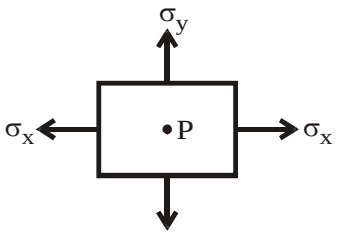
(a) 

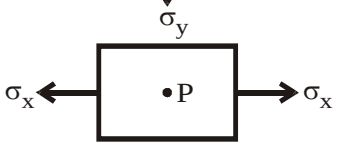
(b) 

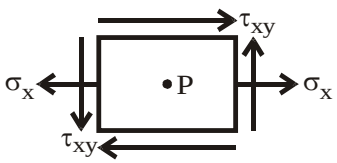
(c) 

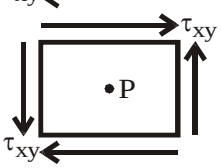
(d) 

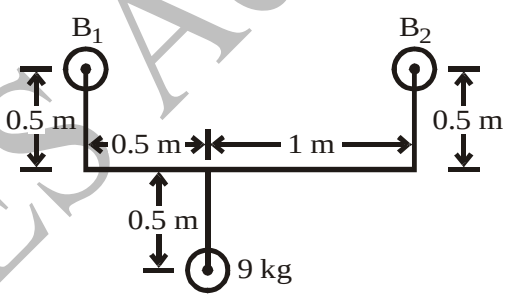
97. A cantilever beam of rectangular cross-section is subjected to a concentrated load at its free end. The state of stress at a point P on the centroidal longitudinal axis of beam is given by

(a) 

(b) 

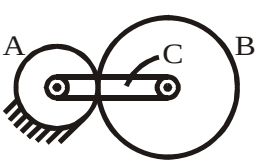
(c) 

(d) 

98. 

A mass of 9 kg is attached to a rotating shaft at a radius of 0·5 m. The balancing masses B_1 and B_2 are attached at a radius of 0·5 m as shown in the figure. The planes of rotation of the three masses are parallel. If the shaft rotates at 100 r.p.m., the magnitude of the balancing mass B_2 is

(a) 9 kg (b) 6 kg
(c) 4 kg (d) 3 kg

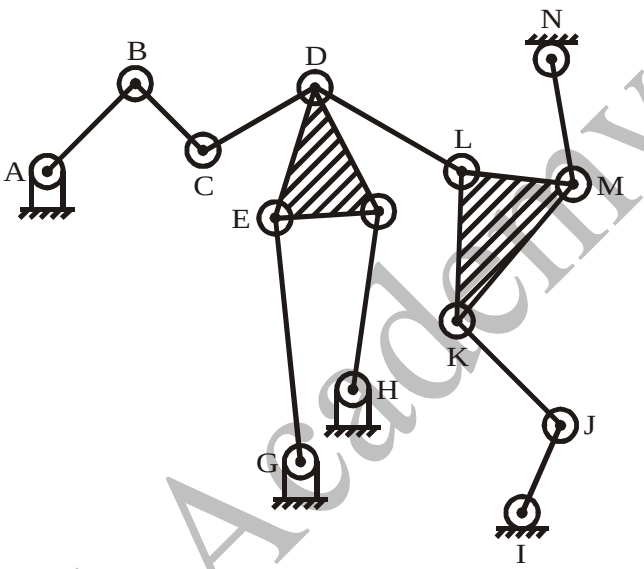
99. 

The figure shows the gear wheel A with the number of teeth T_A fixed to the frame. The arm C with the gear wheel B which has the number of teeth T_B revolves about the gear wheel A. The ratio of the speed of gear B to the speed of the arm is given by

(a) $\frac{N_B}{N_C} = 1 + \frac{T_B}{T_A}$ (b) $\frac{N_B}{N_C} = 1 + \frac{T_A}{T_B}$

(c) $\frac{N_B}{N_C} = 1 - \frac{T_B}{T_A}$ (d) $\frac{N_B}{N_C} = 1 - \frac{T_A}{T_B}$

100.



The mechanism shown in the figure has

(a) One degree of freedom (b) Two degrees of freedom

(c) Three degrees of freedom (d) Four degrees of freedom