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T.B.C. : B-GTD-O-NDA

Test Booklet Series

Seri

TEST BOOKLET
MECHANICAL ENGINEERING



Paper—I

Time Allowed : Two Hours

Maximum Marks : 200

INSTRUCTIONS

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5. You have to mark your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**
THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.
 - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0.33)** of the marks assigned to that question will be deducted as penalty.
 - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
 - (iii) If a question is left blank, i.e. no answer is given by the candidate, there will be **no penalty** for that question.

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1. A body of mass 20 kg falls freely in vacuum. It has fallen through a vertical distance of 50 m. The gravitational acceleration may be assumed as 10 m/s^2 . What is the thermodynamic work done by the body?

- (a) 1000 Nm
- (b) 10 kJ
- (c) 0
- (d) 1 kNm

2. When a system is taken from state 'x' to state 'y', 30 kJ of heat flows into the system and the system does 10 kJ of work. When the system is returned from 'y' to 'x' along another path, work done on the system is 8 kJ. What is the amount of heat liberated or absorbed?

- (a) 12 kJ of heat liberated
- (b) 28 kJ of heat liberated
- (c) 12 kJ of heat absorbed
- (d) 28 kJ of heat absorbed

3. A closed gaseous system undergoes a reversible constant pressure process at 2 bar in which 100 kJ of heat is rejected and the volume changes from 0.2 m^3 to 0.1 m^3 . The change in the internal energy of the system is

- (a) -100 kJ
- (b) -80 kJ
- (c) -60 kJ
- (d) -40 kJ

4. A Carnot engine receives 100 kJ of heat at 600 K. Heat is rejected at 300 K. The displacement volume is 0.2 m^3 . The mean effective pressure is

- (a) 2 bar
- (b) 2.5 bar
- (c) 3 bar
- (d) 3.5 bar

5. The values of heat transfer and work transfer for the processes of a thermodynamic cycle are given below:

Process	Heat transfer (kJ)	Work transfer (kJ)
1	300	300
2	00	250
3	-100	-100
4	00	-250

The thermal efficiency of the cycle and the work ratio will be respectively:

- (a) 33% and 0.66
- (b) 66% and 0.36
- (c) 36% and 0.66
- (d) 33% and 0.36

6. The performance of reciprocating compressors with provision of cooling cylinder is compared with

- (a) Mechanical efficiency
- (b) Isothermal efficiency
- (c) Adiabatic efficiency
- (d) Isentropic efficiency

7. A body of mass 2 kg and $C_p = 1.00 \text{ kJ/kg K}$ is available at 600 K. If the atmosphere is 300 K and $\ln 2 = 0.693$, the maximum work obtainable from the body till it comes to equilibrium with the atmosphere is

- (a) 150 kJ
- (b) 142 kJ
- (c) 184.2 kJ
- (d) 190.5 kJ

8. A liquid of heat capacity 5 J/K in an insulated container is heated electrically from 300 K to 600 K. If $\ln 2 = 0.693$, entropy generation of the universe would be
- 6.93 J/K
 - 3.465 J/K
 - 34.65 J/K
 - 10.65 J/K
9. Which of the following relationships represents the change of entropy of a perfect gas?
- $C_p \frac{dT}{T} + \frac{R}{V} dV$
 - $C_p \frac{dT}{T} - \frac{R}{P} dP$
 - $C_v \frac{dP}{P} + C_p \frac{dV}{V}$
 - $C_p \frac{dP}{P} - C_v \frac{dV}{V}$
- 1, 2 and 4 only
 - 1, 2 and 3 only
 - 2, 3 and 4 only
 - 1, 2, 3 and 4
10. Consider the following statements regarding availability:
- It is generally conserved
 - It can either be negative or positive
 - It is the maximum theoretical work obtainable
 - It can be destroyed in irreversibility
- Which of the above statements are correct?
- 3 and 4
 - 1 and 2
 - 1 and 3
 - 2 and 4
11. During a thermodynamic process, 100 kJ of heat is transferred from a reservoir at 800 K to a sink at 400 K. The ambient temperature is 300 K. The loss of available energy is
- 27.5 kJ
 - 32.5 kJ
 - 37.5 kJ
 - 62.5 kJ
12. A refrigerator that operates on a Carnot cycle is required to transfer 2000 kJ/min to the atmosphere at 27°C, where the low temperature reservoir is at 0°C. What is the power required?
- 200 W
 - 32.93 kW
 - 200 kW
 - 3.33 kW
13. Consider the following statements:
- Carnot, Ericsson and Stirling cycles are ideal power cycles that are completely reversible
 - Ericsson cycle is not a practical engine cycle
 - Stirling cycle is the only practical power cycle among the above
 - All these cycles have the same thermal efficiency
- Which of the above statements are correct?
- 1, 2, 3 and 4
 - 1, 2 and 4 only
 - 2, 3 and 4 only
 - 1, 2 and 3 only

14. The vapour pressure of a liquid at any arbitrary temperature can be estimated approximately with the help of
- Gibbs equation
 - Joule-Kelvin equation
 - Clausius-Clapeyron equation
 - Gibbs-Duhem equation
15. In order to determine the quality of wet steam by a separating and throttling calorimeter, the steam should be first separated and then throttled such that the final state is
- Saturated vapour only
 - Superheated vapour only
 - At a pressure higher than the original pressure
 - A mixture of saturated liquid and vapour
16. The work done in a steady flow process is equal to $-\int v dp$. In the Rankine cycle, the turbine work is much greater than the pump work because
- The specific volume of water is much higher than that of steam
 - The specific volume of steam is much higher than that of water
 - The pressure drop in the turbine is much higher than that in the pump
 - There is less irreversibility in the turbine than in the pump
17. The maximum net specific work obtainable in an ideal Brayton cycle for $T_{\text{max}} = 900 \text{ K}$ and $T_{\text{min}} = 400 \text{ K}$ is given by
- 100 Cp
 - 500 Cp
 - 700 Cp
 - 800 Cp
18. The tendency of detonation is high in engines of larger cylinder diameter because of
- Higher intake pressure in larger cylinder
 - Higher fuel/air ratio in larger cylinder
 - Flame having to travel longer distance in larger cylinder
 - Sparks are advanced more in larger cylinder
19. Consider the following statements:
- The only practical way of improving efficiency of Otto cycle is to increase the compressor ratio of an internal combustion engine
 - Ericsson cycle needs heat transfer in all the processes
 - Ericsson and Stirling cycles employ regenerative heat exchangers for reversible heat transfer
 - Atkinson cycle has a greater specific work than a comparable Otto cycle engine
- Which of the above statements are correct?
- 1, 2, 3 and 4
 - 1, 2 and 4 only
 - 2, 3 and 4 only
 - 1, 2 and 3 only

20. For a multistage reciprocating compressor; which of the following statements are correct?
1. It decreases volumetric efficiency
 2. The work of compression is reduced
 3. The high pressure cylinder is smaller in size
- (a) 1 and 2 only
 (b) 2 and 3 only
 (c) 1 and 3 only
 (d) 1, 2 and 3
21. An open cycle pressure gas turbine uses a fuel of calorific value 40,000 kJ/kg with air-fuel ratio of 80:1 and develops a net output of 80 kJ/kg of air. The thermal efficiency of the cycle is
- (a) 12%
 (b) 16%
 (c) 20%
 (d) 18%
22. Consider the following statements regarding cycles:
1. Stirling cycle consists of two isothermal and two adiabatic processes.
 2. In vapour compression cycle, the refrigerant is in the form of dry saturated vapour before entering compressor.
 3. Diesel cycle consists of one constant pressure; one constant volume and two isentropic processes
- Which of the above statements are correct?
- (a) 1, 2 and 3
 (b) 1 and 2 only
 (c) 1 and 3 only
 (d) 2 and 3 only
23. The efficiency of the vapour power Rankine cycle can be increased by
1. Increasing the temperature of the working fluid at which heat is added
 2. Increasing the pressure of the working fluid at which heat is added
 3. Decreasing the temperature of the working fluid at which heat is rejected
- 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
24. An ideal refrigerating machine works between the temperature limits of 45°C and -8°C. The power required per ton of refrigeration is
- (a) 1.0 kW
 (b) 1.2 kW
 (c) 0.8 kW
 (d) 0.7 kW
25. Consider the following data referring to a refrigerator working on Vapour-compression refrigeration cycle:
1. Enthalpy at entry to compressor = 180 kJ/kg
 2. Enthalpy at exit from compressor = 210 kJ/kg
 3. Enthalpy at exit of condenser = 60 kJ/kg
- What is the COP of the refrigerator?
- (a) 2
 (b) 3
 (c) 4
 (d) 5

26. Consider the following statements about two-stage reciprocating compressors:

1. For the same pressure ratio the volumetric efficiency of a two-stage compressor is more than that of single stage compressor.
2. A two-stage compressor requires minimum work when inter-cooling is perfect.
3. The intercooler pressure p_2 is the average of inlet pressure p_1 and delivery pressure p_3 .

Which of the above statements are correct?

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

27. A single cylinder, 4-stroke cycle engine is fitted with a rope brake. The diameter of the brake wheel is 600 mm and the rope diameter is 26 mm. The dead weight on the brake is 200 N and the spring balance reads 30 N. If the engine runs at 450 rpm, what will be the brake power of the engine?

- (a) 1.5 kW
- (b) 2.5 kW
- (c) 3.5 kW
- (d) 4.5 kW

28. Consider the following statements

1. Fuels of higher octane number can be employed at higher compression ratio
2. In CI engines, brake specific fuel consumption decreases with increasing load

Which of the above statements is/are correct?

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

29. A spark ignition engine has a compression ratio of 8 and the volume before compression is $0.9 \text{ m}^3/\text{kg}$. Net heat interaction per cycle is 1575 kJ/kg. What is the mean effective pressure?

- (a) 20 kPa
- (b) 20 bar
- (c) 2000 Pa
- (d) 2 bar

30. In case of a vapour compression refrigerator, if the condenser temperature of the refrigerant is closer to the critical temperature, then there will be

1. Excessive power consumption
2. High compression
3. Large volume flow

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

31. Which of the following factors can control detonation in spark ignition engines?

1. Increasing engine rpm
2. Advancing spark timing
3. Making fuel-air ratio very rich

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

32. Consider the following statements:

1. Free expansion of a gas
2. Slow heating of oil from a constant temperature source
3. Evaporation of water at its saturation temperature by a source at the same temperature
4. Isentropic compression of an ideal gas

Which of these processes are irreversible?

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

33. Consider the following statements regarding supercharging of CI engines:

1. Supercharging results in quieter and smoother operation of a CI engine
2. Supercharging of a CI engine requires increase in valve overlap
3. The limit of supercharging for a CI engine is reached by thermal and mechanical loading

Which of the above statements are correct?

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

34. Consider the following statements with regard to IC engines:

1. For best fuel economy of spark ignition engines, the fuel-air mixture should be lean
2. With supercharging, the specific consumption in compression ignition engines increases
3. With increase of load, knocking tendency in compression ignition engines decreases

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

35. Consider the following statements pertaining to supercharging of engines:

1. The power output for a given engine increases
2. The loss of power due to altitude is compensated
3. The increase in supercharging pressure decreases the tendency to detonate in spark ignition engines
4. The mechanical efficiency of supercharged engines is quite high compared to naturally aspirated engines

Which of the above statements are correct?

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

36. Consider the following statements for a combustion process:

1. The total mass of each chemical element in the reactants is preserved in the products
2. The presence of carbon monoxide in the products of combustion implies incomplete combustion

Which of the above statements is/are correct?

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

37. There is a uniform distributed source of heat present in a plane wall whose one side ($x = 0$) is insulated and other side ($x = L$) is exposed to ambient temperature (T_∞), with heat transfer coefficient (h). Assuming constant thermal conductivity (k), steady state and one dimensional conduction, the temperature of the wall is maximum at x equal to

- (a) 0
- (b) L
- (c) $L/2$
- (d) $L/4$

38. An insulating material with a thermal conductivity, $k = 0.12 \text{ W/mK}$ is used for a pipe carrying steam. The local coefficient of heat transfer (h) to the surroundings is $4 \text{ W/m}^2\text{K}$. In order to provide effective insulation, the minimum outer diameter of the pipe should be

- (a) 45 mm
- (b) 60 mm
- (c) 75 mm
- (d) 90 mm

39. A plane wall is 20 cm thick with an area perpendicular to heat flow of 1 m^2 and has a thermal conductivity of 0.5 W/mK . A temperature difference of 100°C is imposed across it. The rate of heat flow is

- (a) 0.10 kW
- (b) 0.15 kW
- (c) 0.20 kW
- (d) 0.25 kW

40. The laminar flow is characterized by Reynolds number which is

- (a) Equal to critical value
- (b) Less than the critical value
- (c) More than the critical value
- (d) Zero critical value

41. Consider the following statements:

An increase in pin fin effectiveness is caused by high value of

1. Convective coefficient
2. Thermal conductivity
3. Sectional area
4. Circumference

Which of the above statements are correct?

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

42. In a laminar developing flow through a pipe with constant wall temperature, the magnitude of the pipe wall inner surface convective heat transfer coefficient shall be maximum at the:

- (a) Middle length of flow
- (b) Beginning of flow
- (c) End of flow
- (c) None of the above

43. For minimum compression work in a 2-stage reciprocating air compressor, which of the following expressions gives the ratio of low pressure cylinder to high pressure cylinder diameters?

(a) $\left(\frac{p_3}{p_1}\right)^{\frac{1}{4}}$

(b) $\left(\frac{p_3}{p_1}\right)^{\frac{1}{3}}$

(c) $\left(\frac{p_3}{p_1}\right)^{\frac{1}{2}}$

(d) $\left(\frac{p_3}{p_2}\right)^{\frac{1}{4}}$

where p_1 , p_2 and p_3 are suction, intermediate and delivery pressures respectively.

44. Oxides of nitrogen in Petrol engine exhaust can be reduced by the following methods:

1. Use of 5% lean mixture
2. Advancing the spark timing
3. Recirculating a fraction of exhaust gas
4. Using an oxidation catalyst in the exhaust manifold

Which of the above statements is/are correct?

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

45. A counter flow shell and tube exchanger having an area of 32.5 m^2 , is used to heat water with hot exhaust gases. The water ($C_p = 4.16 \text{ kJ/kg K}$) flows at a rate of 2 kg/sec while the exhaust gases ($C_p = 1.03 \text{ kJ/kg K}$) flow at a rate of 5.15 kg/sec . If the overall heat transfer surface coefficient is $200 \text{ W/m}^2\text{K}$, the NTU for the heat exchanger is

- (a) 1.2
- (b) 2.4
- (c) 3.6
- (d) 4.8

46. Consider the following statements with regard to heat transfer:

1. The temperature variations in lumped heat capacity analysis is exponential with time
2. In situations involving simultaneous heat and mass transfer, the ratio of convective heat transfer to convective mass transfer varies with Lewis number, Le , as $(Le)^{1/3}$.

Which of the above statements are correct?

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

47. For a fluid with Prandtl number $Pr > 1$, momentum boundary layer thickness

- (a) Decreases rapidly compared to the thermal boundary layer thickness
- (b) And thermal boundary layer thickness increase at the same rate
- (c) Increases rapidly compared to the thermal boundary layer thickness
- (d) And thermal boundary layer thickness decrease at the same rate

48. For the same type of shapes, the value of Radiation Shape Factor will be higher when surfaces are

- (a) More closer or ly
- (b) Moved further apart
- (c) Smaller and held closer
- (d) Larger and held closer

49. In a pipe, laminar flow in fully developed region with constant heat flux from pipe wall, bulk mean temperature of fluid

- (a) and pipe wall temperature increase in flow direction
- (b) and pipe wall temperature decrease in flow direction
- (c) remains constant, but pipe wall temperature increases in flow direction
- (d) increases but pipe wall temperature remains constant

50. Which of the following statements is correct for steam boiler ?

- (a) Boiler secondary heat transfer surface includes super-heater, economizer and air pre- heater.
- (b) Boiler primary heat transfer surface includes evaporator section, super-heater section, and reheat section.
- (c) Boiler primary heat transfer surface includes evaporator section, economizer and super-heater section.
- (d) Boiler secondary heat transfer surface includes evaporator section, economizer and air pre- heater

51. In a wall of constant thermal conductivity, the temperature profile for heat conduction in the presence of a heat source inside the wall is

- (a) Linear
- (b) Logarithmic
- (c) Parabolic
- (d) Hyperbolic

52. Determine the heat transfer through a plane of length 4 m, height 3 m and thickness 0.2 m. The temperatures of inner and outer surfaces are 150°C and 90°C respectively. Thermal conductivity of the wall is 0.5 W/mK .
- (a) 1800 W
 (b) 2000 W
 (c) 2200 W
 (d) 2400 W
53. In a Psychrometric chart, which of the following statement/s is/are correct?
- (a) It is used to determine properties of refrigerants
 (b) It cannot determine WBT and DBT
 (c) It is seldom used for air conditioning design
 (d) It provides plots for moist air conditioning
54. In a Psychrometric chart, horizontal lines represent constant
- (a) Humidity ratio and vertical lines represent constant dry bulb temperature
 (b) Humidity ratio and vertical lines represent constant wet bulb temperature
 (c) Dry bulb temperature and vertical lines represent constant absolute humidity ratio
 (d) Wet bulb temperature and vertical lines represent constant humidity ratio
55. Air is passed through a cooling coil at a temperature of -5°C . If the temperature of air drops from 25°C to 10°C , the Bypass factor of the coil is
- (a) 0.2
 (b) 0.5
 (c) 0.7
 (d) 1.0
56. The multistage compression of air as compared to single stage compression
- (a) Improves volumetric efficiency for the given pressure ratio
 (b) Reduces work done per kg of air
 (c) Gives more uniform torque
 (d) All of the above
57. In sensible cooling of moist air, its physical properties vary as follows:
1. The wet bulb temperature decreases
 2. The dew point temperature remains constant
 3. The relative humidity increases
- Which of the above statements are correct?
- (a) 1, 2 and 3
 (b) 1 and 2 only
 (c) 1 and 3 only
 (d) 2 and 3 only

58. A desert cooler having a cooling efficiency of 70% reduces the temperature of atmospheric air from 37°C to 30°C. The wet bulb temperature of the air is

- (a) 24°C
- (b) 25°C
- (c) 26°C
- (d) 27°C

59. Consider the following statements with regard to air-conditioning systems:

1. In adiabatic saturation process, air-vapour mixture undergoes a process of constant relative humidity
2. Wet bulb temperature of air whose relative humidity is 100 is equal to the dew point temperature
3. In winter air conditioning, the process is heating and humidification
4. For designing air conditioning ducts, equal friction method automatically reduces the air velocity in the duct in the direction of flow

Which of the above statements are correct?

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

60. A fin will be more effective when Biot number is

- (a) Greater than 1
- (b) Equal to 1
- (c) Between $\frac{1}{4}$ and $\frac{3}{4}$
- (d) Less than 1

61. In a convergent divergent nozzle, the velocity at throat of nozzle is given by

(a) $V = \left[\frac{2np_1v_1}{n-1} \right]^{\frac{1}{2}}$

(b) $V = \left[\frac{2np_1v_1}{n+1} \right]^{\frac{1}{2}}$

(c) $V = [2np_1v_1]^{\frac{1}{2}}$

(d) $V = [np_1v_1]^{\frac{1}{2}}$

where p_1 = initial entry pressure, v_1 = initial entry specific volume and n = isentropic index of expansion

62. Which of the following refrigeration systems is most suitable for solar cooling?

- (a) Ejector refrigeration system
- (b) Vapour absorption system
- (c) Desiccant refrigeration system
- (d) Vertex tube refrigeration system

63. A tank of length, breadth and height in the ratio of 2:1:2 is full of water. The ratio of hydrostatic force at the bottom to that at any larger vertical surface is

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

64. Which of the following fluids exhibit a certain shear stress at zero shear strain rate followed by a straight line relationship between shear stress and shear strain rate?
- Newtonian fluids
 - Ideal Bingham plastic fluids
 - Pseudo-plastic fluids
 - Dilatent fluids
65. What is the specific gravity of a marble stone, which weighs 400 N in air, and 200 N in water? ($g = 10\text{m/s}^2$)
- 8
 - 6
 - 4
 - 2
66. What is the intensity of pressure in the following SI units, when specific gravity of mercury is 13.6 and the intensity of pressure is 400 KPa?
- 0.3 bar or 4.077 m of water or 0.299 m of Hg
 - 4 bar or 5.077 m of water or 0.399 m of Hg
 - 0.3 bar or 5.077 m of water or 0.599 m of Hg
 - 4 bar or 4.077 m of water or 0.299 m of Hg
67. Consider the following statements:
- If a small upward displacement is given to a floating body, it results in the reduction of the buoyant force acting on the body
 - A slight horizontal displacement does not change either the magnitude or the location of the buoyant force
- Which of the above statements is/are correct?
- Both 1 and 2
 - 1 only
 - 2 only
 - Neither 1 nor 2
68. State whether following flow field is physically possible?
- $$u = 3xy^2 + 2x + y^2 \text{ and } v = x^2 - 2y - y^3$$
- Possible for steady, incompressible flow
 - Possible for unsteady, incompressible flow
 - Possible for steady, compressible flow
 - Not possible
69. A steady incompressible flow field is given by $u = 2x^2 + y^2$ and $v = -4xy$. The convective acceleration along x-direction at point (1, 2) is
- 6 units
 - 24 units
 - 8 units
 - 24 units
70. Consider the following remarks pertaining to the irrotational flow:
- The Laplace equation of stream function $\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = 0$ must be satisfied for the flow to be potential.
 - The Laplace equation for the velocity potential $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$ must be satisfied to fulfil the criterion of mass conservation i.e continuity equation.
- Which of the above statements is/are correct?
- 1 only
 - Both 1 and 2
 - 2 only
 - Neither 1 nor 2

71. In a two dimensional incompressible fluid flow field, the stream function at a point P (2, 1) is given by an expression $\psi = 2xy$. The value of velocity potential at P is

- (a) 3
- (b) 2.5
- (c) 4
- (d) 5

72. In a stream line steady flow, two points A and B on a stream line are 1 m apart and the flow velocity varies uniformly from 2 m/s to 5 m/s. What is the acceleration of fluid at B?

- (a) 3 m/s²
- (b) 6 m/s²
- (c) 9 m/s²
- (d) 15 m/s²

73. The stream function is given by $\psi = 3xy$, then the velocity at the point (2, 3) is

- (a) 9
- (b) -6
- (c) 117
- (d) 10.8

74. The head loss in a sudden expansion from 8 cm diameter pipe to 16 cm diameter pipe in terms of velocity V_1 in the smaller pipe is

- (a) $\frac{1}{4} \left(\frac{V_1^2}{2g} \right)$
- (b) $\frac{3}{16} \left(\frac{V_1^2}{2g} \right)$
- (c) $\frac{1}{64} \left(\frac{V_1^2}{2g} \right)$
- (d) $\frac{9}{16} \left(\frac{V_1^2}{2g} \right)$

75. What is the ratio of momentum thickness to the boundary layer thickness δ when the layer velocity profile is given by

$$\frac{u}{U_\infty} = \left(\frac{y}{\delta} \right)^{\frac{1}{2}} ?$$

- (a) 0.133
- (b) 0.333
- (c) 0.166
- (d) 0.136

where u is velocity at height y above surface and U_∞ is free stream velocity of flow.

76. The boundary layer thickness at a given distance from the leading edge of a flat plate is

- (a) More for lighter fluid
- (b) More for denser fluid
- (c) Less for denser fluid
- (d) Less for lighter fluid

77. In laminar flow through a circular pipe, the discharge varies

- (a) Linearly with fluid density
- (b) Inversely with pressure drop
- (c) Directly as square of pipe radius
- (d) Inversely with fluid viscosity

78. A fluid is flowing over a flat plate. At distance of 8 cm from the leading edge, the Reynolds number is found to be 25600. The thickness of the boundary layer at this point is

- (a) 1.5 mm
- (b) 2.5 mm
- (c) 4.0 mm
- (d) 5.0 mm

79. Air is flowing over a flat plate with a free stream velocity of 24 m/s, and its kinematic viscosity is $72 \times 10^{-6} \text{ m}^2/\text{s}$. If at a particular point, the Reynolds number is 30000, its location from the leading edge is
- 0.05 m
 - 0.07 m
 - 0.08 m
 - 0.09 m
80. Consider the following statements pertaining to boundary layer on a flat plate:
- The thickness of laminar boundary layer at a distance x from the leading edge varies as $x^{1/2}$
 - The thickness of turbulent boundary layer at a distance x from the leading edge varies as $x^{4/5}$
 - Boundary layer is laminar when Reynolds number is less than 5×10^5
- Which of the above statements are correct?
- 1, 2 and 3
 - 1 and 2 only
 - 1 and 3 only
 - 2 and 3 only
81. Which of the following parameters of fluid will increase as a result of friction while flowing adiabatically through a convergent divergent nozzle?
- Available heat drop
 - Entropy
 - Stagnation pressure
 - Stagnation temperature
82. In a shock wave, the flow passes from a
- Subsonic to a sonic state
 - Subsonic to a supersonic state
 - Supersonic to a sonic state
 - Supersonic to a subsonic state
83. A jet of water issues from a nozzle with a velocity of 20 m/s and it impinges normally on a flat plate moving away from it at 10 m/s. If the cross sectional area of the jet is 0.01 m^2 and the density of water is taken as 1000 kg/m^3 , then the force developed on the plate will be
- 100 N
 - 200 N
 - 1000 N
 - 2000 N
84. A two dimensional velocity field is given by
- $$V = (x^2 - y^2 + x) i - (2xy - y) j$$
- The convective acceleration at $(x, y) = (1, 2)$ is
- 0
 - 14 units
 - 2 units
 - None of the above
85. Jet pumps are often used in process industry for their
- Large capacity
 - High efficiency
 - Capacity to transport gases, liquids and mixtures of both
 - None of the above

86. Mainly hydraulic turbines are used to drive the electrical alternators which require maintaining the peripheral speed constant even at part load conditions to avoid the change in frequency of electric power. The governing of the hydraulic turbine is done by
- Controlling the flow area
 - Controlling the velocity
 - Using the fly wheel
 - Combined control of flow area and velocity
87. In a hydraulic coupling
- The magnitudes of input and output torques are equal
 - The magnitude of input torque is greater than output torque
 - The magnitude of input torque is less than output torque
 - The magnitude of input torque is negligible as compared to output torque
88. Considering the flow of steam through a Convergent-Divergent nozzle under real conditions, where supersaturation occurs, the difference between the saturation temperature corresponding to the pressure and the supersaturated temperature is defined as degree of
- Under cooling
 - Superheat
 - Reaction
 - Saturation
89. For maximum discharge of hot gases through a chimney, the height of hot column producing draught is
- Twice the height of chimney
 - Equal to the height of chimney
 - Half the height of chimney
 - None of the above
90. Consider the following statements:
- In natural convection turbulent flow over heated vertical plate, h is independent of the characteristic length
 - In turbulent flow, non-dimensional heat transfer coefficient for natural convection over a heated vertical plate is given by

$$Nu = c (Pr)^{\frac{1}{3}}$$
- Which of the above statements is/are correct?
- 1 only
 - Both 1 and 2
 - 2 only
 - Neither 1 nor 2
91. For accelerating an ideal gas isentropically from rest to supersonic speed, we require a convergent-divergent nozzle. To decelerate an ideal gas isentropically from supersonic speed to subsonic speed the diffuser should be
- Diverging
 - Converging
 - Convergent-divergent
 - Divergent-convergent

92. Consider the following statements with regard to steam turbines:

1. A single stage impulse turbine has a nozzle angle α . The maximum blade efficiency of the turbine will be $\cos^2 \alpha$
2. For a reaction steam turbine with identical stator and rotor blades, the blade velocity for maximum blade efficiency is equal to inlet steam velocity
3. Velocity compounded impulse steam turbine gives less speed and less efficiency

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

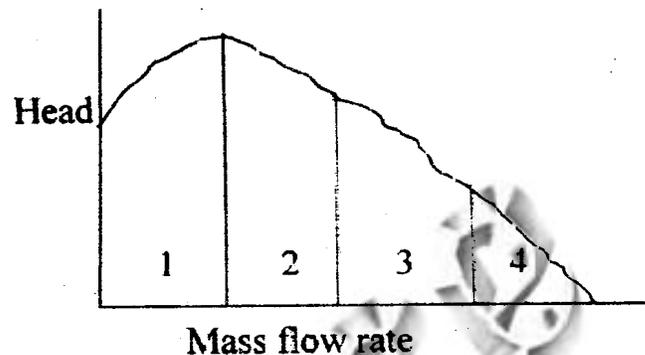
93. Surging is the phenomenon of

- (a) Steady, periodic and reversed flow
- (b) Unsteady, periodic and reversed flow
- (c) Unsteady, periodic and uniform flow
- (d) 1-dimensional steady and uniform flow

94. In an axial flow compressor, the ratio of pressure in the rotor blades to the pressure rise in the compressor in one stage is known as

- (a) Work factor
- (b) Slip factor
- (c) Degree of reaction
- (d) Pressure coefficient

95. In the following diagram, for axial flow compressors, surging is likely to occur in



- (a) 4th zone
- (b) 2nd zone
- (c) 1st zone
- (d) 3rd zone

96. In a centrifugal compressor, an increase in speed at a given pressure ratio causes

- (a) Increase in flow and increase in efficiency
- (b) Increase in flow and decrease in efficiency
- (c) Decrease in flow and decrease in efficiency
- (d) Decrease in flow and increase in efficiency

97. The optimum ratio of blade speed to tangential component of jet speed for the de Laval and Parsons turbine are

- (a) 1 for both
- (b) 1/2 for de Laval turbine and 1 for Parsons turbine
- (c) 1 for de Laval turbine and 1/2 for Parsons turbine
- (d) 1/2 for both

98. What is the correct sequence in increasing order of air handling/compressing machines based on the pressure ratios?

- (a) Air blower, axial flow fan, centrifugal compressor and reciprocating compressor
- (b) Axial flow fan, centrifugal compressor, air blower and reciprocating compressor
- (c) Air blower, centrifugal compressor, axial flow fan, and reciprocating compressor
- (d) Axial flow fan, air blower, centrifugal compressor and reciprocating compressor

99. The head developed is maximum (keeping other parameters such as rotor diameter, speed, width, inlet angle, etc. constant) for a centrifugal compressor with

- (a) Rotor with backward curved blades
- (b) Rotor with forward curved blades
- (c) Rotor with radial blades
- (d) All of the above

100. The velocity of a gas flowing through a duct is 300 m/s; its temperature is 127°C; Gas constant $R = 0.25$ kJ/kg K, the ratio of specific heat is $C_p/C_v = \gamma = 1.6$. What is the value of Mach number?

- (a) 0.70
- (b) 0.72
- (c) 0.75
- (d) 0.77

Directions: —

Each of the next Twenty (20) items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **NOT** the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

101. Statement (I) : Temperature potential difference is a necessary condition for heat interaction between systems.

Statement (II) : Heat transfer to a system inevitably increases the temperature of the system.

102. Statement (I) : In an isolated system, the heat transfer δQ and the work transfer δW are always zero.

Statement (II) : In an isolated system, the entropy always remains constant.

103. Statement (I) : $\oint \frac{\delta Q}{T} = 0$, the cycle is reversible.

Statement (II) : $\oint \frac{\delta Q}{T} > 0$, the cycle is irreversible and possible.

104. Statement (I) : The three phase (triple state/point) of a single component system possesses a single set of properties.

Statement (II) : For a single component system, the Gibbs phase rule, $F = C + 2 - P$ (where F is number of independent intensive properties, C is number of components in the system and P is number of phases), reduces to $F = 3 - P$.

105. Statement (I) : The Clapeyron equation enables us to determine the enthalpy change associated with phase change.

Statement (II) : Using usual notations, the Clapeyron equation is given by

$$\left(\frac{dT}{dP} \right)_{\text{sat}} = \frac{h_{fg}}{T v_{fg}}$$

106. Statement (I) : A mixture of liquid air and air cannot be considered as pure substance.

Statement (II) : Proportions of oxygen and nitrogen differ in liquid and gaseous states in equilibrium.

107. Statement (I) : A good CI engine fuel, like diesel oil, is a bad SI engine fuel and a good SI engine fuel, like petrol, is a bad CI engine fuel.

Statement (II) : A good CI engine fuel requires high self-ignition temperature and a good SI engine fuel requires low self-ignition temperature.

108. Statement (I) : The specific fuel consumption of a CI engine is lower than that of an SI engine.

Statement (II) : For the same power, a CI engine is bigger in size than an SI engine.

109. Statement (I) : The cut off ratio of a Diesel engine cycle should be greater than one, but should be as low as possible.

Statement (II) : Lower cut off ratio does improve the thermal efficiency but lowers the specific work output. Hence, the value of cut off ratio must be optimized.

110. Statement (I) : In CI engine, increase of load decreases the knocking tendency.

Statement (II) : Increase of load increases the temperature of mixture and thereby increase in delay angle.

111. Statement (I) : Liquid-cooled engines are able to vary the size of their passage ways through the engine block, so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots.

Statement (II) : Air-cooled engines may also vary their cooling capacity by using more closely spaced cooling fins in that area, but this can make their manufacture difficult and expensive.

112. Statement (I) : A counter flow heat exchanger is more effective than a parallel flow heat exchanger.

Statement (II) : For same temperature limits of hot and cold fluids, the overall heat transfer coefficient of counter flow heat exchanger is more than parallel flow heat exchanger.

113. Statement (I) : The COP of an air conditioning plant is higher than the COP of a household refrigerator.

Statement (II) : For the same condenser temperature, the suction pressure of the evaporator is higher in air conditioning plant than in household refrigerator.

114. Statement (I) : The main difference between vapour compression refrigeration cycle and Bell-Coleman gas refrigeration cycle is that in gas cycle, an expander is used in place of a throttle valve.

Statement (II) : In throttling of a perfect gas, temperature remains constant.

115. Statement (I) : Humidity ratio of moist air is the ratio of the mass of water vapour to the mass of moist air in a given value of air-water vapour mixture.

Statement (II) : For any given barometric pressure, humidity ratio is a function of the dew point temperature alone.

116. Statement (I) : With heat exchanger gas turbine cycle, the cycle efficiency reduces as the pressure ratio increases.

Statement (II) : As the pressure ratio increases, the delivery temperature from the compressor increases and ultimately will exceed that of the exhaust gas from the turbine.

117. Statement (I) : The estimation of exact cooling load calculations of space to be conditioned is important to know because it involves both the initial cost and operating cost.

Statement (II) : The outside heat gain to conditioned space is called external load and the heat gain from inside the conditioned space is called internal load.

118. Statement (I) : Entropy across the normal shock increases.

Statement (II) : Stagnation temperature across the normal shock remains constant.

119. Statement (I) : Axial flow air compressors need many stages to develop high pressure ratios.

Statement (II) : The amount of turning of air flow in blade row is limited by the occurrence of separation, a phenomenon caused by adverse pressure gradient.

120. Statement (I) : The supersaturated expansion in nozzle is a process in which the steam expands beyond the saturated vapour line in superheated condition.

Statement (II) : Steam cannot exist in superheated state when the expansion process in nozzle reaches the saturated vapour line.

SPACE FOR ROUGH WORK



SPACE FOR ROUGH WORK



SPACE FOR ROUGH WORK



DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO

T.B.C. : B-GTD-O-NDB

Test Booklet Series

Serial No.

A

TEST BOOKLET
MECHANICAL ENGINEERING
Paper—II

Time Allowed : Two Hours

Maximum Marks : 200

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 - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0.33)** of the marks assigned to that question will be deducted as penalty.
 - (ii) If a candidate gives more than one answer, it will be treated as **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
 - (i.i) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO

1. In a crank and slotted lever type quick return mechanism, the link moves with an angular velocity of 20 rad/s, while the slider moves with a linear velocity of 1.5 m/s. The magnitude and direction of Coriolis component of acceleration with respect to angular velocity are

- (a) 30 m/s² and direction is such as to rotate slider velocity in the same sense as the angular velocity
- (b) 30 m/s² and direction is such as to rotate slider velocity in the opposite sense as the angular velocity
- (c) 60 m/s² and direction is such as to rotate slider velocity in the same sense as the angular velocity
- (d) 60 m/s² and direction is such as to rotate slider velocity in the opposite sense as the angular velocity

2. Which of the following are associated with Ackerman steering mechanism used in automobiles?

- 1. Has both sliding and turning pairs
- 2. Less friction and hence long life
- 3. Mechanically correct in all positions
- 4. Mathematically not accurate except in three positions
- 5. Has only turning pairs
- 6. Controls movement of two front wheels

- (a) 2, 4, 5 and 6
- (b) 1, 2, 3 and 6
- (c) 2, 3, 5 and 6
- (d) 1, 2, 3 and 5

3. The displacement of a follower of a cam in a printing machine is represented by the expression

$$x = 10\theta + 120\theta^2 - 1500\theta^3 + 2000\theta^4 + 2500\theta^5$$

where θ is the angle of rotation of the cam. The jerk given by the system at any position is

- (a) $9000\omega^3 + 48000\omega^3\theta + 150000\omega^3\theta^2$
- (b) $9000\omega^3$
- (c) $240\omega^2 + 9000\omega^2\theta + 24000\omega^2\theta^2 + 50000\omega^3\theta^3$
- (d) $48000\omega^3\theta + 150000\omega^3\theta^2$

4. A body starting from rest moves in a straight line with its equation of motion being

$$s = 2t^3 - 3t^2 + 2t + 1$$

where s is displacement in m and t is time in s. Its acceleration after one second is

- (a) 6 m/s²
- (b) 2 m/s²
- (c) 12 m/s²
- (d) 3 m/s²

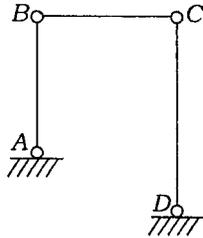
5. The crankshaft of a reciprocating engine having a 20 cm crank and 100 cm connecting rod rotates at 210 r.p.m. When the crank angle is 45°, the velocity of piston is nearly

- (a) 1.8 m/s
- (b) 1.9 m/s
- (c) 18 m/s
- (d) 19 m/s

6. While designing a cam, pressure angle is one of the most important parameters which is directly proportional to

- (a) pitch circle diameter
- (b) prime circle diameter
- (c) lift of cam
- (d) base circle diameter

7. A four-bar mechanism is as shown in the figure below. At the instant shown, AB is shorter than CD by 30 cm. AB is rotating at 5 rad/s and CD is rotating at 2 rad/s :



The length of AB is

- (a) 10 cm (b) 20 cm
 (c) 30 cm (d) 40 cm
8. A governor is said to be isochronous when the equilibrium speed is
- (a) variable for different radii of rotation of governor balls
 (b) constant for all radii of rotation of the balls within the working range
 (c) constant for particular radii of rotation of governor balls
 (d) constant for only one radius of rotation of governor balls
9. A planetary gear train is a gear train having
- (a) a relative motion of axes and the axis of at least one of the gears also moves relative to the frame
 (b) no relative motion of axes and no relative motion of axes with respect to the frame
 (c) no relative motion of axes and the axis of at least one of the gears also moves relative to the frame
 (d) a relative motion of axes and none of the axes of gears has relative motion with the frame

10. The flywheel of a machine having weight of 4500 N and radius of gyration of 2 m has cyclic fluctuation of speed from 125 r.p.m. to 120 r.p.m. Assuming $g = 10 \text{ m/s}^2$, the maximum fluctuation of energy is

- (a) 12822 N-m (b) 24200 N-m
 (c) 14822 N-m (d) 12100 N-m

11. Alumina doped with magnesia will have reduced thermal conductivity because its structure becomes

- (a) amorphous
 (b) free of pores
 (c) crystalline
 (d) mixture of crystalline and glass

12. Which of the following statements are associated with complete dynamic balancing of rotating systems?

1. Resultant couple due to all inertia forces is zero.
2. Support reactions due to forces are zero but not due to couples
3. The system is automatically statically balanced.
4. Centre of masses of the system lies on the axis of rotation.

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

13. Which of the following statements is correct about the balancing of a mechanical system?

- (a) If it is under static balance, then there will be dynamic balance also
 (b) If it is under dynamic balance, then there will be static balance also
 (c) Both static as well as dynamic balance have to be achieved separately
 (d) None of the above

14. The accelerometer is used as a transducer to measure earthquake in Richter scale. Its design is based on the principle that
- its natural frequency is very low in comparison to the frequency of vibration
 - its natural frequency is very high in comparison to the frequency of vibration
 - its natural frequency is equal to the frequency of vibration
 - measurement of vibratory motion is without any reference point
15. As compared to the time period of a simple pendulum on the earth, its time period on the moon will be
- 5 times higher
 - 5 times lower
 - $\sqrt{6}$ times higher
 - $\sqrt{6}$ times lower
16. While calculating the natural frequency of a spring-mass system, the effect of the mass of the spring is accounted for by adding X times its value to the mass, where X is
- $\frac{1}{2}$
 - $\frac{1}{3}$
 - $\frac{1}{4}$
 - $\frac{3}{4}$
17. A block of mass 10 kg is placed at the free end of a cantilever beam of length 1 m and second moment of area 300 mm^4 . Taking Young's modulus of the beam material as 200 GPa, the natural frequency of the system is
- $30\sqrt{2}$ rad/s
 - $2\sqrt{3}$ rad/s
 - $3\sqrt{2}$ rad/s
 - $20\sqrt{3}$ rad/s
18. The speed rating for turbine rotors is invariably more than $\sqrt{2}$ times its natural frequency to
- increase stability under heavy load and high speed
 - isolate vibration of the system from the surrounding
 - minimize deflection under dynamic loading as well as to reduce transmissibility of force to the surrounding
 - None of the above
19. The magnitude of swaying couple due to partial balance of the primary unbalancing force in locomotive is
- inversely proportional to the reciprocating mass
 - directly proportional to the square of the distance between the centre-lines of the two cylinders
 - inversely proportional to the distance between the centrelines of the two cylinders
 - directly proportional to the distance between the centrelines of the two cylinders
20. The power of a governor is the work done at
- the governor balls for change of speed
 - the sleeve for zero change of speed
 - the sleeve for a given rate of change of speed
 - each governor ball for given percentage change of speed

21. Consider the following :

The parallel fillet welded joint is designed for

1. tensile strength
2. compressive strength
3. bending strength
4. shear strength

Which of the above is/are correct?

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

22. If the permissible crushing stress for the material of a key is double the permissible shear stress, then the sunk key will be equally strong in shearing and crushing if the key is a

- (a) rectangular key with width equal to half the thickness
- (b) rectangular key with width equal to twice the thickness
- (c) square key
- (d) rectangular key with width equal to one-fourth the thickness

23. Very small quantity of carbon in iron as in steels forms interstitial solid solution mainly because atomic size(s) of

- (a) carbon and iron are almost same
- (b) iron is very much smaller than that of carbon
- (c) carbon is very much smaller than that of iron
- (d) None of the above

24. In a cotter joint, the width of the cotter at the centre is 5 cm, while its thickness is 1.2 cm. The load acting on the cotter is 60 kN. The shear stress developed in the cotter is

- (a) 50 N/mm²
- (b) 100 N/mm²
- (c) 120 N/mm²
- (d) 200 N/mm²

25. The use of straight or curved external gear teeth in mesh with internal teeth in 'gear and spline couplings' is specifically employed to accommodate

- (a) torsional misalignment
- (b) parallel misalignment
- (c) angular misalignment
- (d) substantial axial movements between shafts

26. For a power screw having square threads with lead angle of 45° and coefficient of friction of 0.15 between screw and nut, the efficiency of the power screw, neglecting collar friction, is given by

- (a) 74%
- (b) 64%
- (c) 54%
- (d) 44%

27. Aquaplaning occurs in vehicle tyres when there is continuous film of fluid between the tyre and the wet road. It leads to

- (a) oscillatory motion of the vehicle
- (b) jamming the brakes of the vehicle
- (c) jamming the steering mechanism of the vehicle
- (d) loss of control of the vehicle

28. If the angle of wrap on smaller pulley of diameter 250 mm is 120° and diameter of larger pulley is twice the diameter of smaller pulley, then the centre distance between the pulleys for an open belt drive is

- (a) 1000 mm
- (b) 750 mm
- (c) 500 mm
- (d) 250 mm

29. If the velocity ratio for an open belt drive is 8 and the speed of driving pulley is 300 r.p.m., then considering an elastic creep of 2% the speed of the driven pulley is

- (a) 104.04 r.p.m.
- (b) 102.04 r.p.m.
- (c) 100.04 r.p.m.
- (d) 98.04 r.p.m.

30. Two shafts *A* and *B* are of same material, and *A* is twice the diameter of *B*. The torque that can be transmitted by *A* is

- (a) 2 times that of *B*
- (b) 8 times that of *B*
- (c) 4 times that of *B*
- (d) 6 times that of *B*

31. A worm gear set is designed to have pressure angle of 30° which is equal to the helix angle. The efficiency of the worm gear set at an interface friction of 0.05 is

- (a) 87.9%
- (b) 77.9%
- (c) 67.9%
- (d) 57.9%

32. Consider the following statements :

The axes of spiral bevel gear are non-parallel and intersecting.

1. The most common pressure angle for spiral bevel gear is 20° .
2. The most common spiral angle for spiral bevel gear is 35° .
3. Spiral bevel gears are generally interchangeable.
4. Spirals are noisy and recommended for low speeds of 10 m/s.

Which of the above statements are correct?

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

33. Consider the following statements :

In case of helical gears, teeth are cut at an angle to the axis of rotation of the gears.

1. Helix angle introduces another ratio called axial contact ratio.
2. Transverse contact ratio is equal to axial contact ratio in helical gears.
3. Large transverse contact ratio does not allow multiple teeth to share the load.
4. Large axial contact ratio will cause larger axial force component.

Which of the above statements are correct?

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

34. In an interference fit between a shaft and a hub, the state of stress in the shaft due to interference fit is

- (a) only compressive radial stress
- (b) a tensile radial stress and a compressive tangential stress
- (c) a tensile tangential stress and a compressive radial stress
- (d) a compressive tangential stress and a compressive radial stress

35. In case the number of teeth on two bevel gears in mesh is 30 and 60 respectively, then the pitch cone angle of the gear will be

(c) $\tan^{-1} 2$

(k) $\frac{\pi}{2} + \tan^{-1} 2$

(c) $\frac{\pi}{2} - \tan^{-1} 0.5$

(ā) $\tan^{-1} 0.5$

36. In skew bevel gears, the axes are

(a) non-parallel and non-intersecting, and teeth are curved

(b) non-parallel and non-intersecting, and teeth are straight

(c) intersecting, and teeth are curved and oblique

(d) intersecting, and teeth are curved and can be ground

37. Consider that modern machines mostly use short bearings due to the following reasons :

1. l/d of the most modern bearings is in the range of $\frac{1}{4}$ to 2

2. No end leakage of oil from the bearing

3. Shaft deflection and misalignment do not affect the operation

4. Can be applied to both hydrodynamic and hydrostatic cases

Which of the above are correct?

(a) 1 and 4

(b) 2 and 3

(c) 1 and 3

(d) 2 and 4

38. Consider the following statements in connection with thrust bearings :

1. Cylindrical thrust bearings have higher coefficient of friction than ball thrust bearings.

2. Taper rollers cannot be employed for thrust bearings.

3. Double-row thrust ball bearing is not possible.

4. Lower race, outer race and retainer are readily separable in thrust bearings.

Which of the above statements are correct?

(a) 1 and 2

(b) 2 and 3

(c) 3 and 4

(d) 1 and 4

39. The behaviour of metals in which strength of a metal is increased and the ductility is decreased on heating at a relatively low temperature after cold-working is known as

(a) clustering

(b) strain ageing

(c) twinning

(d) screw dislocation

40. If the equivalent load in case of a radial ball bearing is 500 N and the basic dynamic load rating is 62500 N, then L_{10} life of this bearing is

(a) 1.953 million of revolutions

(b) 3.765 million of revolutions

(c) 6.953 million of revolutions

(d) 9.765 million of revolutions

41. A copper rod of 2 cm diameter is completely encased in a steel tube of inner diameter 2 cm and outer diameter 4 cm. Under an axial load, the stress in the steel tube is 100 N/mm^2 . If $E_s = 2E_c$, then the stress in the copper rod is

- (a) 50 N/mm^2
- (b) 33.33 N/mm^2
- (c) 100 N/mm^2
- (d) 300 N/mm^2

42. A system under biaxial loading induces principal stresses of 100 N/cm^2 tensile and 50 N/cm^2 compressive at a point. The normal stress at that point on the maximum shear stress plane is

- (a) 75 N/cm^2 tensile
- (b) 50 N/cm^2 compressive
- (c) 100 N/cm^2 tensile
- (d) 25 N/cm^2 tensile

43. In a biaxial state of stress, normal stresses are $\sigma_x = 900 \text{ N/mm}^2$, $\sigma_y = 100 \text{ N/mm}^2$ and shear stress $\tau = 300 \text{ N/mm}^2$. The maximum principal stress is

- (a) 800 N/mm^2
- (b) 900 N/mm^2
- (c) 1000 N/mm^2
- (d) 1200 N/mm^2

44. A constitutional diagram shows relationship among which of the following combinations in a particular alloy system?

- (a) Temperature and composition
- (b) Temperature and phases present
- (c) Temperature, composition and phases present
- (d) Temperature and pressure

45. The state of stress at a point in a body is given by $\sigma_x = 100 \text{ MPa}$ and $\sigma_y = 200 \text{ MPa}$. One of the principal stresses $\sigma_1 = 250 \text{ MPa}$. The magnitudes of the other principal stress and the shearing stress τ_{xy} are respectively

- (a) $50\sqrt{3} \text{ MPa}$ and 50 MPa
- (b) 100 MPa and $50\sqrt{3} \text{ MPa}$
- (c) 50 MPa and $50\sqrt{3} \text{ MPa}$
- (d) $50\sqrt{3} \text{ MPa}$ and 100 MPa

45. Consider the following statements regarding powder metallurgy :

1. Refractory materials made of tungsten can be manufactured easily.
2. In metal powder control of grain size results in relatively much uniform structure.
3. The powder heated in die or mold at high temperature is then pressed and compacted to get desired shape and strength.
4. In sintering, the metal powder is gradually heated resulting in coherent bond.

Which of the above statements are correct?

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

47. The magnitudes of principal stresses at a point are 250 MPa tensile and 150 MPa compressive. The magnitudes of the shearing stress on a plane on which the normal stress is 200 MPa tensile and the normal stress on a plane at right angle to this plane are

- (a) $50\sqrt{7}$ MPa and 100 MPa (tensile)
- (b) 100 MPa and 100 MPa (compressive)
- (c) $50\sqrt{7}$ MPa and 100 MPa
(compressive)
- (d) 100 MPa and $50\sqrt{7}$ MPa (tensile)

48. The state of stress at a point is given by $\sigma_x = 100$ MPa, $\sigma_y = -50$ MPa and $\tau_{xy} = 100$ MPa. The centre of Mohr's circle and its radius will be

- (a) ($\sigma_x = 75$ MPa, $\tau_{xy} = 0$) and 75 MPa
- (b) ($\sigma_x = 25$ MPa, $\tau_{xy} = 0$) and 125 MPa
- (c) ($\sigma_x = 25$ MPa, $\tau_{xy} = 0$) and 150 MPa
- (d) ($\sigma_x = 75$ MPa, $\tau_{xy} = 0$) and 125 MPa

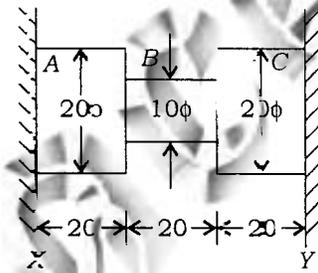
49. Consider the following statements related to Mohr's circle for stresses in case of plane stress :

1. The construction is for variations of stress in a body.
2. The radius of the circle represents the magnitude of the maximum shearing stress.
3. The diameter represents the difference between the two principal stresses.

Which of the above statements are correct?

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

50. The figure shows a steel piece of diameter 20 mm at A and C, and 10 mm at B. The lengths of three sections A, B and C are each equal to 20 mm. The piece is held between two rigid surfaces X and Y. The coefficient of linear expansion $\alpha = 1.2 \times 10^{-3} / ^\circ\text{C}$ and Young's modulus $E = 2 \times 10^5$ MPa for steel :



When the temperature of this piece increases by 50°C , the stresses in sections A and B are

- (a) 120 MPa and 480 MPa
- (b) 60 MPa and 240 MPa
- (c) 120 MPa and 120 MPa
- (d) 60 MPa and 120 MPa

51. For a material following Hooke's law, the values of elastic and shear moduli are 3×10^5 MPa and 1.2×10^5 MPa respectively. The value for bulk modulus is

- (a) 1.5×10^5 MPa
- (b) 2×10^5 MPa
- (c) 2.5×10^5 MPa
- (d) 3×10^5 MPa

52. At a point in a body, $\epsilon_1 = 0.0004$ and $\epsilon_2 = -0.00012$. If $E = 2 \times 10^5$ MPa and $\mu = 0.3$, the smallest normal stress and the largest shearing stress are

- (a) 40 MPa and 40 MPa
- (b) 0 MPa and 40 MPa
- (c) 80 MPa and 0 MPa
- (d) 0 MPa and 80 MPa

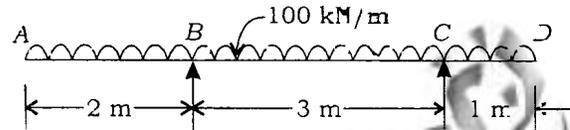
53. A cantilever of length 1.2 m carries a concentrated load of 12 kN at the free end. The beam is of rectangular cross-section with breadth equal to half the depth. The maximum stress due to bending is not to exceed 100 N/mm^2 . The minimum depth of the beam should be

- (a) 120 mm
- (b) 60 mm
- (c) 75 mm
- (d) 240 mm

54. Two strain gauges fixed along the principal directions on a plane surface of a steel member recorded strain values of 0.0013 tensile and 0.0013 compressive respectively. Given that the value of $E = 2 \times 10^5$ MPa and $\mu = 0.3$, the largest normal and shearing stress at this point are

- (a) 200 MPa and 200 MPa
- (b) 400 MPa and 200 MPa
- (c) 260 MPa and 260 MPa
- (d) 260 MPa and 520 MPa

55. A beam ABCD, 6 m long is supported at B and C, 3 m apart with overhangs AB = 2 m and CD = 1 m. It carries a uniformly distributed load of 100 kN/m over its entire length :



The maximum magnitudes of bending moment and shear force are

- (a) 200 kN-m and 250 kN
- (b) 200 kN-m and 200 kN
- (c) 50 kN-m and 200 kN
- (d) 50 kN-m and 250 kN

56. A solid circular cross-section cantilever beam of diameter $\phi = 100$ mm carries a shear force of 10 kN at the free end. The maximum shear stress is

- (a) $\frac{4}{3\pi}$ Pa
- (b) $\frac{3\pi}{4}$ Pa
- (c) $\frac{3\pi}{16}$ Pa
- (d) $\frac{16}{3\pi}$ Pa

57. A beam of length L simply supported at its ends carrying a total load W uniformly distributed over its entire length deflects at the centre by δ and has a maximum bending stress σ . If the load is substituted by a concentrated load W_1 at mid-span such that the deflection at the centre remains unchanged, the magnitude of the load W_1 and the maximum bending stress will be

- (a) $0.3W$ and 0.3σ
- (b) $0.6W$ and 0.6σ
- (c) $0.3W$ and 0.6σ
- (d) $0.6W$ and 0.3σ

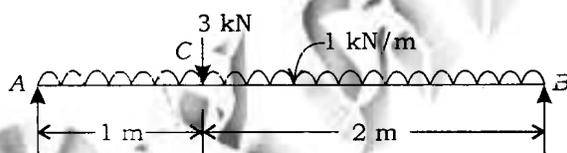
58. For a rectangular section beam, if the beam depth is doubled, keeping the width, length and loading same, the bending stress is decreased by a factor

- (a) 2
- (b) 4
- (c) 6
- (d) 8

59. A helical compression spring of stiffness K is cut into two pieces, each having equal number of turns and kept side-by-side under compression. The equivalent spring stiffness of this new arrangement is equal to

- (a) $4K$
- (b) $2K$
- (c) K
- (d) $0.5K$

60. A beam AB simply supported at its ends A and B , 3 m long, carries a uniformly distributed load of 1 kN/m over its entire length and a concentrated load of 3 kN, at 1 m from A :



If ISJB 150 with $I_{XX} = 300 \text{ cm}^4$ is used for the beam, the maximum value of bending stress is

- (a) 75 MPa
- (b) 85 MPa
- (c) 125 MPa
- (d) 250 MPa

61. Copper has FCC structure; its atomic radius is 1.28 Å and atomic mass is 63.5. The density of copper will be

- (a) $8.9 \times 10^3 \text{ kg/mm}^3$
- (b) $8.9 \times 10^3 \text{ kg/cm}^3$
- (c) $8.9 \times 10^3 \text{ kg/m}^3$
- (d) $8.9 \times 10^3 \text{ g/mm}^3$

62. A plane intersects the coordinate axes at $x = \frac{2}{3}$, $y = \frac{1}{3}$ and $z = \frac{1}{2}$. What is the Miller index of this plane?

- (a) 932
- (b) 432
- (c) 423
- (d) 364

63. What is the diameter of the largest sphere in terms of lattice parameter a , which will fit the void at the centre of the cube edge of a BCC crystal?

- (a) $0.134a$
- (b) $0.25a$
- (c) $0.433a$
- (d) $0.5a$

64. If the atomic radius of aluminium is r , what is its unit cell volume?

- (a) $\left(\frac{2r}{\sqrt{2}}\right)^3$
- (b) $\left(\frac{4r}{\sqrt{2}}\right)^3$
- (c) $\left(\frac{2r}{\sqrt{3}}\right)^3$
- (d) $\left(\frac{4r}{\sqrt{3}}\right)^3$

65. Consider the following statements regarding the behaviour of dislocations :

1. Only edge dislocation and mixed dislocation can have glide motion.
2. A screw dislocation cannot have glide motion.
3. Dislocation moves in the direction perpendicular to that of shear stress.
4. Motion of dislocation occurs on slip plane that contains Burger's vector and direction vector.

Which of the above statements are correct?

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

66. A binary alloy of Cu and Ni containing 20 wt% Ni at a particular temperature coexists with solid phase of 26 wt% Ni and liquid phase of 16 wt% Ni. What is the weight ratio of solid phase and liquid phase?

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

67. Elements A and B form eutectic type binary phase diagram and the eutectic composition is 60 wt% B. If just below eutectic temperature, the eutectic phase contains equal amounts (by wt) of two solid phases, then the compositions of the two solid phases are

- (a) 20 wt% B and 90 wt% B
(b) 30 wt% B and 90 wt% B
(c) 20 wt% B and 80 wt% B
(d) 30 wt% B and 80 wt% B

68. Consider the following statements :

In a binary phase diagram

1. the freezing point of the alloy is minimum.
2. eutectic mixture solidifies at a constant temperature like pure metal
3. eutectic reaction is irreversible
4. at eutectic temperature, liquids of two metals will change into two solids

Which of the above statements are correct?

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

69. At room temperature, α -iron contains negligible amount of carbon, cementite contains 6.67% C and pearlite contains 0.8% C. Pearlite contains how much cementite?

- (a) 8% (b) 10%
(c) 12% (d) 14%

70. Two metals A and B are completely immiscible in solid and liquid state. Melting point of A is 800 °C and melting point of B is 600 °C. They form eutectic at 200 °C with 40% B and 60% A. The 50% B alloy contains

- (a) 83.33% B and 16.67% of eutectic
(b) 83.33% of eutectic and 16.67% B
(c) 50% B and 50% of eutectic
(d) 40% B and 60% of eutectic

71. What is the interplanar spacing between (200), (220), (111) planes in an FCC crystal of atomic radius 1.246 Å?

(a) $d_{(200)} = 1.762 \text{ Å}$, $d_{(220)} = 1.24 \text{ Å}$ and $d_{(111)} = 2.034 \text{ Å}$

(b) $d_{(200)} = 1.24 \text{ Å}$, $d_{(220)} = 1.762 \text{ Å}$ and $d_{(111)} = 2.034 \text{ Å}$

(c) $d_{(200)} = 2.034 \text{ Å}$, $d_{(220)} = 1.24 \text{ Å}$ and $d_{(111)} = 1.762 \text{ Å}$

(d) $d_{(200)} = 2.5 \text{ Å}$, $d_{(220)} = 4.2 \text{ Å}$ and $d_{(111)} = 2.6 \text{ Å}$

72. Rotary swaging is a process for shaping

(a) round bars and tubes

(b) billets

(c) dies

(d) rectangular blocks

73. Consider the following statements :

In shell moulding

1. a single parting plane should be provided for mould

2. detachable pattern parts and cores could be included

3. minimum rounding radii of 2.5 mm to 3 mm should be used

4. draft angles of not less than 1° should be used

Which of the above statements are correct?

(a) 1, 3 and 4 only

(b) 1, 2 and 3 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

74. A big casting is to have a hole, to be produced by using a core of 10 cm diameter and 200 cm long. The density ρ_{metal} is 0.077 N/cm^3 and density ρ_{core} is 0.0165 N/cm^3 . What is the upward force acting on the core prints?

(a) 200.5 N (b) 1100.62 N

(c) 950.32 N (d) 350.32 N

75. Consider the following :

The purpose of lapping process is

1. to produce geometrically true surface

2. to correct minor surface imperfections

3. to improve dimensional accuracy

4. to provide very close fit between the contact surfaces

Which of the above are correct?

(a) 1, 2 and 3 only

(b) 1, 3 and 4 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

76. Centre lathe is to be used to cut inch thread of 4 threads per inch. Lead screw of lathe has 3 mm pitch. Then change gear to be used is

(a) $\frac{1}{12}$ (b) $\frac{127}{60}$

(c) $\frac{30}{127}$ (d) $\frac{20}{80}$

77. Consider the following statements in respect of the oxidizing flame due to excess of oxygen in welding :

1. At high temperature, it combines with many metals to form hard and brittle oxides.

2. It causes the weld bead and the surrounding area to have a scummy appearance.

3. It has good welding effect in welding of copper-base metal.

Which of the above statements are correct?

(a) 1, 2 and 3

(b) 1 and 2 only

(c) 1 and 3 only

(d) 2 and 3 only

78. A cutter tip is initially at $X = 10$ mm, $Y = 20$ mm. In a rapid motion, using G00 code, it moves to $X = 160$ mm, $Y = 120$ mm. The X and Y axes have maximum speed of 10000 mm/min and 5000 mm/min respectively. Operating at maximum speed, what is the time it will take to reach the destination?

- (a) 0.90 s
- (b) 1.08 s
- (c) 1.20 s
- (d) 2.16 s

79. If $n = 0.5$ and $C = 300$ for the cutting speed and the tool life relation, when cutting speed is reduced by 25%, the tool life will be increased by

- (a) 100%
- (b) 95%
- (c) 78%
- (d) 50%

80. Which of the following statements are correct for temperature rise in metal cutting operation?

1. It adversely affects the properties of tool material.
2. It provides better accuracy during machining.
3. It causes dimensional changes in workpiece and affects accuracy of machining.
4. It can distort the accuracy of machine tool itself.

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

81. Which of the following statements apply to provision of flash gutter and flash land around the parts to be forged?

1. Small cavities are provided which are directly outside the die impression.
2. The volume of flash land and flash gutter should be about 20%–25% of the volume of forging.
3. Gutter is provided to ensure complete closing of the die.

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

82. A hole and a shaft have a basic size of 25 mm, and are to have a clearance fit with a maximum clearance of 0.02 mm and a minimum clearance of 0.01 mm. The hole tolerance is to be 1.5 times the shaft tolerance. The limits of both hole and shaft using hole basis system will be

- (a) low limit of hole = 25 mm, high limit of hole = 25.006 mm, upper limit of shaft = 24.99 mm and low limit of shaft = 24.986 mm
- (b) low limit of hole = 25 mm, high limit of hole = 25.025 mm, upper limit of shaft = 24.8 mm and low limit of shaft = 24.75 mm
- (c) low limit of hole = 25 mm, high limit of hole = 25.006 mm, upper limit of shaft = 25 mm and low limit of shaft = 24.99 mm
- (d) low limit of hole = 25.006 mm, high limit of hole = 25 mm, upper limit of shaft = 24.99 mm and low limit of shaft = 25 mm

83. Consider the following statements :

In case of assembly of mating parts

1. the difference between hole size and shaft size is called allowance
2. in transition fit, small positive or negative clearance between the shaft and hole member is employable

Which of the above statements is/are correct?

- (a) 1 only
(b) Both 1 and 2
(c) 2 only
(d) Neither 1 nor 2
84. An organization has decided to produce a new product. Fixed cost for producing the product is estimated as ₹ 1,00,000. Variable cost for producing the product is ₹ 100. Market survey indicated that the product selling price could be ₹ 200. The break-even quantity is
- (a) 1000 (b) 2000
(c) 500 (d) 900
85. Using exponential smoothening, a car manufacturing company predicted the demand for that year as 1040 cars. The actual sale was found to be 1140 cars. If the company's forecast for the next year is 1080, what is the value of the smoothening constant?
- (a) 0.4 (b) 0.6
(c) 0.7 (d) 1.2
86. Coarse feed, low rake angle, low cutting speed and insufficient cooling help produce
- (a) continuous chips in ductile materials
(b) discontinuous chips in ductile materials
(c) continuous chips with built-up edges in ductile materials
(d) discontinuous chips in brittle materials

87. In NC machining, coordinated movement of separately driven axes motion is required to achieve the desired path of tool relative to workpiece. The generation of these reference signals is accomplished through a device called

- (a) approximator
(b) interpolator
(c) coordinator
(d) director

88. A part is made from solid brass rod of 38 mm diameter and length 25 mm. The machining time taken to finish the part is 90 minutes and labour rate is ₹ 2 per hour. Factory overheads are 50% of direct labour cost. The density of material is 8.6 gm per cubic cm and its cost is ₹ 1.625 per newton. The factory cost of the part will be

- (a) ₹ 8.40 (b) ₹ 4.80
(c) ₹ 14.80 (d) ₹ 18.40

89. A company wants to expand the solid propellant manufacturing plant by the addition of more than 1 ton capacity curing furnace. Each ton of propellant must undergo 30 minutes of furnace time including loading and unloading operations. Furnace is used only 80 percent of the time due to power restrictions. The required output for the new layout is to be 16 tons per shift (3 hours). Plant (system) efficiency is estimated at 50 percent of system capacity. The number of furnaces required will be

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

90. The purpose of providing side rake angle on the cutting tool is to

- (a) avoid work from rubbing against tool
- (b) control chip flow
- (c) strengthen tool edge
- (d) break chips

91. The annual demand of a commodity in a supermarket is 80000. The cost of placing an order is ₹ 4,000 and the inventory cost of each item is ₹ 40. What is the economic order quantity?

- (a) 2000
- (b) 4000
- (c) 5656
- (d) 5666

92. Consider the following statements :

In a single-server queueing model

- 1. the arrivals is a memoryless process
- 2. the arrivals is described as a Poisson distribution
- 3. uncertainty concerning the demand for service exists

Which of the above statements are correct?

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

93. To construct an operating characteristic curve, an agreement has to be reached between producer and consumer through which of the following points?

- 1. Maximum proportion of defectives that will make the lot definitely unacceptable
- 2. The producer is willing to accept that some of satisfying the quality level (AQL) will be rejected ($\alpha = 5\%$)
- 3. Maximum level of percentage defectives that will make the lot definitely unacceptable
- 4. The consumer is willing to take lots of quality level (LTPD) even though they are unacceptable ($\beta = 10\%$)

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

94. Assuming X and Y are the two control variables, the following are the constraints laid out for maximizing the profit :

$$\text{Maximize profit } (P) = 8X - 5Y$$

subject to

- Constraint-1 : $2X + Y \leq 1000$
- Constraint-2 : $3X + 4Y \leq 2400$
- Constraint-3 : $X + Y \leq 800$
- Constraint-4 : $X - Y \leq 350$
- Constraint-5 : $X \geq 0$
- Constraint-6 : $Y \geq 0$

Which of the above constraints is a redundant one and does not have any effect on the solution?

- (a) Constraint-1
- (b) Constraint-3
- (c) Constraint-4
- (d) Constraint-5 and Constraint-6

95. A transportation problem consists of 3 sources and 5 destinations with appropriate rim conditions. The number of possible solutions is

- (a) 15 (b) 225
(c) 6435 (d) 150

96. Maximize $Z = 2X_1 + 3X_2$

subject to

$$2X_1 + X_2 \leq 6$$

$$X_1 - X_2 \geq 3$$

$$X_1, X_2 \geq 0$$

The solution to the above LPP is

- (a) optimal
(b) infeasible
(c) unbounded
(d) degenerate

97. A company has a store which is manned by 1 attendant who can attend to 8 technicians in an hour. The technicians wait in the queue and they are attended on first-come-first-served basis. The technicians arrive at the store on an average 6 per hour. Assuming the arrivals to follow Poisson and servicing to follow exponential distribution, what is the expected time spent by a technician in the system, what is the expected time spent by a technician in the queue and what is the expected number of technicians in the queue?

- (a) 22.5 minutes, 30 minutes and 2.75 technicians
(b) 30 minutes, 22.5 minutes and 2.25 technicians
(c) 22.5 minutes, 22.5 minutes and 2.75 technicians
(d) 30 minutes, 30 minutes and 2.25 technicians

98. Objective function

$$Z = 5X_1 + 4X_2 \text{ (Maximize)}$$

subject to

$$0 \leq X_1 \leq 12$$

$$0 \leq X_2 \leq 9$$

$$3X_1 + 6X_2 \leq 66$$

$$X_1, X_2 \geq 0$$

What is the optimum value?

- (a) 6, 9
(b) 12, 5
(c) 4, 10
(d) 0, 9

99. Which of the following defines the compiler's function correctly?

- (a) It translates high-level language programs into object code
(b) It translates object code into a high-level language
(c) It translates object code into assembly language instructions
(d) It translates assembly language instructions into object code

100. Which one of the following properties of work materials is responsible for the material removal rate in electrochemical machining?

- (a) Hardness
(b) Atomic weight
(c) Thermal conductivity
(d) Ductility

Directions : Each of the following **twenty (20)** items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below.

Codes :

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **not** the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

101. Statement (I) :

The cam in contact with a follower is a case of complete constraint.

Statement (II) :

The pair, cam and follower, by itself does not guarantee continuity of contact all the time.

102. Statement (I) :

Involute pinions can have any number of teeth.

Statement (II) :

Involute profiles in mesh satisfy the constant velocity ratio condition.

103. Statement (I) :

Hooke's joint connects two non-parallel non-intersecting shafts to transmit motion with a constant velocity ratio.

Statement (II) :

Hooke's joint connects two shafts the axes of which do not remain in alignment while in motion.

104. Statement (I) :

Lewis equation for design of involute gear tooth predicts the static load capacity of a cantilever beam of uniform strength.

Statement (II) :

For a pair of gears in mesh, pressure angle and module must be same to satisfy the condition of interchangeability and correct gearing.

105. Statement (I) :

Tensile strength of CI is much higher than that of MS.

Statement (II) :

Percentage of carbon in CI is more than 1.5.

106. Statement (I) :

Centrifugal clutches are designed to provide automatic and smooth engagement of load to driving member.

Statement (II) :

Since the operating centrifugal force is a function of square of angular velocity, the friction torque for accelerating a load is also a function of square of speed of driving member.

107. Statement (I) :

Heating the steel specimen in the furnace up to austenitizing temperature followed by furnace cooling is termed annealing.

Statement (II) :

Annealed steel specimen possesses fine pearlitic structure.

108. Statement (I) :

The susceptibility of a ferromagnetic material decreases with an increase in Curie temperature.

Statement (II) :

A critical temperature at which the alignment of magnetic moments vanishes is called Curie temperature.

109. Statement (I) :

Fiberglass is a polymer composite made of a plastic matrix containing fine fibers of glass.

Statement (II) :

Fiberglass acquires strength from the polymer and flexibility from the glass.

110. Statement (I) :

Industrial rotors will not have uniform diameter throughout their lengths.

Statement (II) :

These rotors will have to accommodate transmission elements like pulleys and gears and supports like anti-friction bearings.

111. Statement (I) :

Cored induction furnace cannot be used for intermittent operation.

Statement (II) :

Cored induction furnace, though most efficient, requires a liquid metal charge while starting.

112. Statement (I) :

Low-carbon steel has high weldability and is more easily welded.

Statement (II) :

Higher carbon contents tend to soften the welded joints resulting in development of cracks.

113. Statement (I) :

For cutting multi-start threads, the speed ratio is expressed in terms of the lead of the job thread and lead of the lead screw threads.

Statement (II) :

The speed of the job is reduced to one-third or one-fourth of the job speed used in the turning operation.

114. Statement (I) :

The Bauschinger effect is observed in tension test of mild steel specimen due to loss of mechanical energy during local yielding.

Statement (II) :

The Bauschinger effect is a function of section modulus of specimen under test.

115. Statement (I) :

The ceramic tools used in machining of material have highly brittle tool tips.

Statement (II) :

Ceramic tools can be used on hard-to-machine work material.

116. Statement (I) :

In chain drives, angle of articulation through which link rotates during engagement and disengagement, is greater for a small number of teeth.

Statement (II) :

The greater angle of articulation will increase the life of the chain.

117. Statement (I) :

The DNC is an NC system utilizing a dedicated stored program to perform all numerical control functions in manufacturing.

Statement (II) :

The DNC is a manufacturing process in which a number of process machines are controlled by a computer through direct connection and real-time analysis.

118. Statement (I) :

In interference fit, the outer diameter of the shaft is greater than the inner diameter of the hole.

Statement (II) :

The amount of clearance obtained from the assembly of hole and shaft resulting in interference fit is called positive clearance.

119. Statement (I) :

One of the most commonly used techniques for testing surface integrity of material is metallography.

Statement (II) :

Surface integrity of a material does not contribute for the mechanical and metallurgical properties.

120. Statement (I) :

The change in critical path requires rescheduling in a PERT network.

Statement (II) :

Some of the activities cannot be completed in time due to unexpected breakdown of equipment or non-availability of raw materials.

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