Engineering Services (P)
Examination - 2025

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

T.B.C. : ASNP–T–MCHE **Test Booklet Series**

A

Serial No. 1014985

TEST BOOKLET

MECHANICAL ENGINEERING

Time Allowed : Three Hours **Maximum Marks : 300**

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. **Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.**
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write *anything else* on the Test Booklet.
4. This Test Booklet contains **150** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.
5. You have to mark all 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** 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 a **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. The percentage of incoming radiation energy reflected back to space by the earth is about

(a) 10%

(b) 20%

(c) 30%

(d) 40%

2. Consider the following statements regarding flat-plate collector :

1. One of the desirable characteristics of thermal insulating material is low thermal conductivity.
2. Copper is often chosen for absorber plates due to its high thermal conductivity and good corrosion resistance.
3. Absorber plate material should have low thermal conductivity.

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

3. Consider the following statements regarding performance indices of a solar collector :

1. Temperature range is the range of temperature to which the heat transporting fluid is heated up by the collector.
2. Collector efficiency is defined as the ratio of the energy actually absorbed and transferred to heat transporting fluid by the collector to the energy incident on the collector.
3. Concentration ratio is defined as the ratio of the area of the receiver to the area of aperture of the system.

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

4. Consider the following statements regarding solar thermal systems :

1. In cold climate regions, large amount of low-grade thermal energy is required for heating air for comfort.
2. Solar energy is best suited for low-grade thermal applications.
3. Solar thermal energy is not utilized in drying industries.

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

5. Consider the following statements regarding chemical energy storage :

1. The chemical energy in hydrogen can be converted into thermal energy.
2. Hydrogen-fired steam turbine may also be used to obtain mechanical energy.
3. Electrical energy may also be obtained more efficiently directly from hydrogen by means of fuel cell.

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

6. Consider the following statements regarding solar space heating system :

1. Passive systems do not require any mechanical device and make use of natural process of convection, radiation and conduction for transport of heat.
2. Uses of active heating systems put restrictions on the building design to make possible the flow of heat naturally.
3. Active heating systems employ mechanical devices to circulate the working fluid for transportation of heat.

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

7. Consider the following statements regarding solar refrigeration and air-conditioning systems :

1. In absorption cycle cooling systems, two working fluids—a refrigerant and an absorbent-refrigerant solution are used.
2. The absorbent-refrigerant combination is so chosen that the absorbent has low affinity for the refrigerant.
3. The absorbent cooling is based on the principle that the refrigerant can be bound by a liquid or solid solvent, known as absorbent, to release heat during absorption.

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

8. Consider the following statements regarding solar greenhouse :

1. The design of a greenhouse depends on local climatic conditions.
2. Greenhouses for arid zone are designed to conserve water resources.
3. In tropical countries, the solar insolation and ambient temperatures are quite high and therefore, 'winter greenhouses' are used to maintain low temperatures inside and allow just sufficient sunlight for photosynthesis.

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

9. Consider the following statements regarding solar distillation :

1. Distillation is the process to convert saline water into freshwater.
2. About 20 percent of water available on the earth is brackish.
3. Only 30 percent of water available on the earth is fresh.

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

10. Consider the following statements regarding wind energy :

1. A generator coupled to wind turbine is known as aerogenerator.
2. Australians were probably the first to introduce the horizontal axis windmill around 12th century.
3. The electric power generation through wind was first proposed in Denmark in 1890.

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

11. Consider the following statements regarding ocean tidal energy conversion schemes :

1. In single-basin, double-effect scheme, power is generated on both flood and ebb.
2. Linked basin scheme consists of two basins, one topped up at high tide and the other emptied at low tide.
3. In single-effect scheme, power is not generated during either filling or emptying the basin.

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

12. Consider the following statements regarding biomass energy :

1. Pelletization is a process in which waste wood is pulverized, dried and forced under pressure through an extrusion device.
2. Biomass briquettes are made from woody matter.
3. Concentrated vegetable oils may be obtained from certain agro-products but cannot be used as fuel in diesel engines.

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

13. Consider the following statements regarding fuel cell :

1. A fuel cell continuously converts mechanical energy directly into electrical energy.
2. Fuel cell is a static power conversion device.
3. The only exhaust of a fuel cell, if pure hydrogen is used as fuel and pure oxygen as oxidant, is water vapour.

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

14. Consider the following statements regarding reheating in Rankine cycle :

1. Erosion and corrosion problems in the steam turbine are eliminated.
2. Final dryness fraction of steam is improved.
3. There is decrease in the nozzle and blade efficiencies.

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

15. What is the primary purpose of superheating steam and supplying it to the prime movers?

(a) To decrease the power plant efficiency
(b) To avoid too much wetness at the end of expansion
(c) To increase the initial condensation losses in steam engines
(d) To make the steam visible

16. Consider the following statements regarding reheating in Rankine cycle :

1. The reheater may be heated by a coil carrying high-pressure superheated steam.
2. Reheating should be done at optimum pressure.
3. A large proportion of the heat supplied in the reheating process will be thrown to waste in the condenser.

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

17. In case of a steam turbine working on Rankine cycle, the work done per kg of steam flowing through the turbine and the amount of total heat supplied during the processes are 1080 kJ/kg and 3076·1 kJ/kg respectively. What is the thermal efficiency of the cycle?

(a) 23·7%

(b) 29·3%

(c) 35·1%

(d) 41·4%

18. Consider the following statements regarding advantages of regenerative cycle over simple Rankine cycle :

1. The heating process in the boiler tends to become reversible.
2. Heat rate is increased.
3. A small size condenser is required.

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

19. A grade written as '5–10 cm, 500-A8-F24-S1.6' indicates the coal as having

1. a size of 5–10 cm
2. heating value of 5000 kcal/kg
3. 8 to 10% ash

Which of the above are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

20. A boiler generates 360 kg of steam per hour. The quantity of heat supplied per kg of steam is 2560·6 kJ/kg. The calorific value of coal is 29245·4 kJ/kg. If the hourly rate of burning is 60 kg, what is the boiler efficiency?

(a) 21·41%

(b) 34·87%

(c) 52·53%

(d) 65·86%

21. Consider the following statements regarding locomotive boiler :

1. It consists of a cylindrical barrel with a rectangular firebox at one end and a smoke box at the other end.
2. The hot gases which are generated due to burning of coal are deflected by an arch of firebricks.
3. The fire tubes are placed inside the smoke box.

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

22. Consider the following statements regarding Babcock and Wilcox boiler :

1. It is a fire tube boiler.
2. It may be designed for stationary or marine purposes.
3. It consists of a drum connected to a series of front-end and rear-end headers by short riser tubes.

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

23. The ratio of heat received by 1 kg of water under working conditions to that received by 1 kg of water evaporated from and at 100 °C is known as

(a) factor of evaporation
(b) boiler efficiency
(c) overall efficiency
(d) evaporation efficiency

24. In a reaction turbine, the fixed blades and moving blades are of the same shape but reversed in direction. The work done per pair of blades per kg of steam is 7600 N-m. If the heat drop per pair is 10·04 kJ/kg, what is the efficiency of the pair?

(a) 57·1%
(b) 68·4%
(c) 75·7%
(d) 81·3%

25. Consider the following statements regarding air leakage in condenser :

1. The leakage air in the condenser results in decrease in back pressure on the prime mover.
2. The leaked air in the condenser lowers the partial pressure of steam.
3. The air has poor thermal conductivity; hence the leaked air reduces the rate of heat transfer from vapour.

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

26. Consider the following statements regarding centrifugal pumps :

1. The speed ratio varies from 0·95 to 1·25.
2. The flow ratio varies from 0·1 to 0·25.
3. For low-to-medium specific speed pumps, the number of vanes varies from 15 to 25.

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

27. A centrifugal pump has an impeller of 30 cm outer diameter. The vane tips are radial at the outlet. For a rotative speed of 1450 r.p.m., what is the manometric head developed? (Assume a manometric efficiency of 82%)

(a) 17·82 m
(b) 23·34 m
(c) 29·82 m
(d) 43·38 m

28. A discharge of 0·4 m^3/s of water is needed to be pumped to a total head of 240 m. How many pumps connected in series and each having a specific speed of 35 and running at a speed of 1500 r.p.m. would be needed for the job? (The dynamic head in the system can be neglected)

(a) 1 pump
(b) 5 pumps
(c) 3 pumps
(d) 4 pumps

29. Consider the following statements regarding reciprocating pumps :

1. The ratio of theoretical discharge to actual discharge is known as coefficient of discharge.
2. The difference between theoretical discharge and actual discharge is called the slip of the pump.
3. In a double-acting pump, both sides of the piston will be displacing the liquid.

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

30. Consider the following statements regarding advantages of air vessels in suction pipe :

1. Power expended in pumping will reduce.
2. Frictional losses will reduce.
3. For a given speed, there will be increase in the cavitation susceptibility.

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 one of the following statements correctly distinguishes gas turbine plants from steam turbine plants?

(a) Gas turbine plants operate at lower inlet gas temperatures and higher pressures.

(b) Gas turbine plants and steam turbine plants operate at the same inlet gas temperatures and pressures.

(c) Gas turbine plants operate at higher inlet gas temperatures and lower pressures.

(d) Gas turbine plants operate at higher inlet gas temperatures and higher pressures.

32. Consider the following statements regarding effects of increasing the initial steam pressure in a steam turbine plant :

1. Increase in the initial steam pressure gives a higher saturation temperature of steam below the critical value.
2. The gains in thermal efficiency obtained by a large increase in the initial steam pressure in the higher ranges are of the order of 5% or more.
3. The wet steam in the larger part of the turbine would give lower turbine stage efficiencies.

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

33. If a Kaplan turbine produces 6·5 MW of power at a head of 15 m under a speed of 150 r.p.m., what is the specific speed?

(a) 450

(b) 510

(c) 410

(d) 360

34. Consider the following statements about a ramjet engine :

1. A ramjet engine does not have a compressor and turbine.
2. Ramjet engine is ideal for hypersonic aircraft.
3. Test shows that a subsonic flow system is right choice for a ramjet engine.

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

35. Consider the following statements about advantages of a pulsejet engine :

1. A pulsejet engine can be mass produced in a short time due to its simple construction and low cost.
2. It is suitable for one-time military use.
3. It has turbine and compressor, allowing it to employ low temperature.

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

36. Consider the following statements about advantages of a turbojet engine :

1. It is suitable for long-distance flight at higher speed and altitudes.
2. Reheat can be employed to increase thrust.
3. Pressure rise through inlet diffuser is significant.

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

37. Consider the following statements regarding compressor :

1. A centrifugal compressor like a pump is a head-producing device.
2. The centrifugal type of compressor is suitable for low specific speed and higher pressure ratio applications.
3. The centrifugal compressor is less efficient than the axial type.

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

38. In axial compressor stages, the ratio of 'actual change of enthalpy in the rotor' to 'actual change of enthalpy in the stage' is known as

(a) degree of reaction

(b) degree of enthalpy

(c) enthalpy ratio

(d) rotor efficiency

39. Consider the following statements regarding molecular weight :

1. The molecular weight of air is 28·97 g/mole.
2. The molecular weight of argon is 39·95 g/mole.
3. The molecular weight of carbon monoxide is 20·42 g/mole.

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

40. Consider the following statements regarding engine operating characteristics :

1. At very low engine speeds, the throttle will be almost closed, resulting in a high vacuum in the intake manifold.
2. When quick deceleration is desired and the throttle is closed at high engine speed, a very large vacuum is created in the intake system.
3. When a cold engine is started, an over-rich supply of fuel must be supplied to assure enough fuel vapour to create a combustible gas mixture.

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

41. Consider the following statements regarding compression ignition engines :

1. In atomization process, fuel drops break into very small droplets.
2. In vaporization process, the small droplets of liquid fuel evaporate to vapour.
3. The smaller the fuel drop size emitted by the injector, the less efficient will be atomization process.

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

42. Consider the following statements regarding combustion in internal combustion engines :

1. At higher engine speeds, ignition delay is decreased in real time.
2. If injection is too early, ignition delay time will decrease.
3. If the cetane number is low, ignition delay will be too long.

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

43. Consider the following statements regarding emissions and air pollution of two-stroke cycle SI engines :

1. Addition of hydrocarbon emissions to the exhaust during scavenging process takes place.
2. The air-fuel intake mixture is used to push exhaust residual out of the open exhaust port.
3. Lubricating oil is fully combustible as readily as fuel.

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

44. Consider the following statements regarding vapour compression refrigeration cycle :

1. Normally in the practical cycles, the temperature of the liquid refrigerant leaving the condenser is lower than the saturation temperature.
2. Subcooling ensures that no vapour enters the expansion valve and furthermore, it increases the refrigerating effect.
3. The refrigerant is also subcooled before leaving the evaporator to make sure that only the wet vapour will enter the compressor.

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

45. Consider the following statements regarding critical temperature of various refrigerants :

1. The critical temperature of CO_2 is 30·98 °C.
2. The critical temperature of CH_4 is 94·47 °C.
3. The critical temperature of NH_3 is 132·22 °C.

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

46. Consider the following statements regarding properties of refrigerants :

1. Ammonia is highly toxic and highly irritating refrigerant.
2. Carbon dioxide is corrosive refrigerant.
3. Sulphur dioxide is highly toxic refrigerant.

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

47. Consider the following statements regarding vapour absorption cycle :

1. Absorbent should have negligible vapour pressure at generator temperature compared to refrigerant.
2. Absorbent should have low specific heat.
3. Lithium bromide is a hygroscopic salt with low affinity for water.

Which of the above statements are correct?

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

48. Consider the following statements regarding properties of moist air :

1. Percentage saturation is defined as the ratio of specific humidities, saturated versus actual at a given temperature.
2. Specific humidity is defined as the mass of water vapour in kilograms which is associated with one kilogram of dry air-water vapour mixture.
3. Relative humidity is the ratio of actual water vapour pressure in the air to the vapour pressure which would exist in a saturated mixture at the temperature of the air.

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

49. The sensible heat gain of a room is 4·8 kW and its latent heat gain is 1·4 kW. What is the sensible heat ratio?

(a) 0·98 *(b)* 0·77
(c) 0·59 *(d)* 0·65

50. Consider the following statements regarding psychrometry :

1. Dry-bulb temperature is the temperature of the air measured with an ordinary thermometer.
2. Dew-point temperature is the temperature at which water vapour in the air is saturated.
3. Sensible heat is necessary to produce a change of state of a material at a constant temperature.

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

51. Consider the following statements regarding thermodynamic systems :

1. Close system is that system which exchanges neither energy nor matter with any other system or with environment.
2. A system which consists of two phases is called a heterogeneous system.
3. A phase is a quantity of matter which is homogeneous throughout in chemical composition and physical structure.

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

52. Consider the following statements regarding pure substance :

1. It is homogeneous in composition.
2. It is homogeneous in chemical aggregation.
3. It is variable in chemical aggregation.

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

53. Consider the following statements regarding phase change of a pure substance :

1. The difference between super-heated temperature and saturation temperature at the given pressure is called the degree of superheat.
2. The amount of heat required to convert liquid water completely into vapour is called the heat of sublimation.
3. If the temperature of liquid water on cooling becomes lower than the saturation temperature for the given pressure, the liquid water is called a subcooled liquid.

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

54. Consider the following statements regarding thermometer and thermo-metric property :

1. Constant volume gas thermometer is used to measure resistance.
2. Thermocouple is used to measure electromotive force.
3. Pyrometer is used to measure intensity of radiation.

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

55. Consider the following statements regarding first law of thermodynamics :

1. The first law applies to reversible as well as irreversible transformations.
2. It is impossible to construct a perpetual motion machine of first kind.
3. It is observed that when a system is made to undergo a complete cycle, then net work is done on or by the system.

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

56. Consider the following statements regarding reversible processes :

1. Frictionless adiabatic expansion is an ideal reversible process.
2. Condensation and boiling of liquids are ideal reversible processes.
3. Mixing of two fluids is an ideal reversible process.

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

57. Consider the following statements regarding perpetual motion machine (PMM) :

1. Machine which would continuously absorb heat from a single thermal reservoir and would convert this heat completely into work is called the PMM of the second kind.
2. Machine which violates the first law of thermodynamics is called the PMM of the first kind.
3. The PMM of the second kind does not violate the second law of thermodynamics.

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

58. Consider the following statements regarding Carnot cycle :

1. It cannot be performed in practice because it is impossible to perform a frictionless process.
2. Compression and expansion are non-reversible.
3. Working medium is a perfect gas and has constant specific heat.

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

59. A cyclic heat engine operates between a source temperature of 1000 °C and a sink temperature of 40 °C. Find the least rate of heat rejection per kW net output of the engine.

(a) 0·758 kW *(b)* 0·543 kW
(c) 0·326 kW *(d)* 0·917 kW

60. The efficiency of an Otto cycle is 60% and the ratio of specific heats is 1·5. What is the compression ratio?

(a) 6·25 *(b)* 4·26
(c) 9·85 *(d)* 8·15

61. Consider the following statements regarding diesel cycle :

1. Heat is supplied at constant pressure.
2. It has adiabatic expansion process.
3. Rejection of heat is at constant pressure.

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

62. Heat is conducted through a material with a temperature gradient of -9000 °C/m. The thermal conductivity of the material is 25 W/m-K. If this heat is convected to surroundings at 30 °C with a convection coefficient of 345 W/m^2-K, what is the surface temperature?

(a) 957·24 °C
(b) 1108·61 °C
(c) 682·17 °C
(d) 394·82 °C

63. Consider the following statements regarding convective heat transfer coefficient :

1. It is influenced by viscosity.
2. It is influenced by flow velocity.
3. It is influenced by surface geometry.

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

64. If the specific gravity of a fluid is known, then the density of the fluid will be equal to the specific gravity of the fluid multiplied by the density of

(a) air
(b) water
(c) mercury
(d) oxygen

65. Upon cooling, a liquid phase is transformed into the two solid phases α and β at the temperature T_E; the opposite reaction occurs upon heating. This is called

(a) eutectic reaction
(b) eutectoid reaction
(c) peritectic reaction
(d) cementite reaction

66. A pipe contains an oil of specific gravity 0·9. A differential manometer connected at the two points A and B shows a difference in mercury level as 15 cm. What is the difference of pressures at the two points?

(a) 18789 N/m^2
(b) 18688 N/m^2
(c) 18888 N/m^2
(d) 18989 N/m^2

67. Which principle is the basis for differential pressure measuring devices?

(a) Torricelli's
(b) Bernoulli's
(c) Euler's
(d) Continuity

68. Consider the following statements regarding floating bodies :

1. During the movement, the volume immersed on both right-hand side and left-hand side increases.
2. The angular displacement of a boat or ship about its longitudinal axis is known as rolling.
3. The angular displacement of a boat or ship about its transverse axis is known as pitching.

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

69. Match the following lists :

List–I	*List–II*
P. Steady uniform flow	1. Flow at varying rates through a long straight pipe of uniform cross-section
Q. Steady non-uniform flow	2. Flow at constant rate through a duct of uniform cross-section
R. Unsteady uniform flow	3. Flow at varying rates through a duct of non-uniform cross-section
S. Unsteady non-uniform flow	4. Flow at constant rate through a duct of non-uniform cross-section

Select the correct answer using the code given below.

(a)	P	Q	R	S
	1	2	3	4
(b)	P	Q	R	S
	2	4	1	3
(c)	P	Q	R	S
	4	1	2	3
(d)	P	Q	R	S
	3	4	2	1

70. Consider the following statements regarding properties of stream function and potential function :

1. If velocity potential (ϕ) exists, the flow should be rotational.
2. If velocity potential (ϕ) satisfies the Laplace equation, it represents the possible steady incompressible irrotational flow.
3. If stream function (ψ) exists, it is a possible case of fluid flow which may be rotational or irrotational.

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

71. Match the following lists (where the notations have their usual meanings) :

List–I	*List–II*
P. Orifice meter	1. $Q_{act} = C_d \left[\frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}}\right]\sqrt{2gh}$
Q. Venturi meter	2. $V = C_v\sqrt{2gh}$
R. Pitot tube	3. $Q = \frac{C_d\, a_0 a_1 \sqrt{2gh}}{\sqrt{a_1^2 - a_0^2}}$

Select the correct answer using the code given below.

(a) P Q R
2 3 1

(b) P Q R
1 2 3

(c) P Q R
3 1 2

(d) P Q R
3 2 1

72. What is the pressure gradient along the flow, if the oil viscosity is 0·02 N-s/m^2 flowing between two stationary parallel plates 1 m wide maintained 10 mm apart? (The velocity midway between the plates is 2 m/s)

(a) – 3150 N/m^2 per m

(b) – 3180 N/m^2 per m

(c) – 3200 N/m^2 per m

(d) – 3210 N/m^2 per m

73. Which type of glass is used in flat-plate collectors?

(a) Low-iron tempered glass

(b) High-iron tempered glass

(c) Low-iron black glass

(d) High-iron black glass

74. Consider the following statements regarding transitional flow :

1. Tollmien and Schlichting predicted that the waves would form and grow in the boundary layer.
2. It has been seen that in the presence of an adverse pressure gradient, at a high Reynolds number, two-dimensional waves appear.
3. The instantaneous velocity profiles produce low shear in the outer region of the boundary layer.

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

75. What type of turbulence is generated by two adjacent layers of fluid in the absence of wall?

(a) Wall turbulence

(b) Free turbulence

(c) Fixed turbulence

(d) Isotropic turbulence

76. Consider the following statements regarding mechatronics and robots :

1. Mechatronics is the synergistic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and manufacturing processes.
2. All robots are not mechatronic systems, but all mechatronic systems are robots.
3. All machines that do not have any kind of autonomy in their behaviour, because they simply automatically act according to the inputs they receive from humans, are strictly pure mechatronic systems.

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

77. How much voltage can be produced by a typical cell at full rated load?

(a) 0·2 V to 0·3 V
(b) 0·4 V to 0·5 V
(c) 0·6 V to 0·7 V
(d) 0·9 V to 1 V

78. Consider the following statements regarding graph theory and consensus :

1. Graphs are often exploited for modelling the communication between robots in multi-robot systems.
2. Consensus problem is a well-known and widely studied problem in the field of decentralized control of multi-robot systems.
3. Rendezvous is the problem of controlling the robots in such a way that based on locally available quantities, their positions converge to a common value.

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

79. Consider the following statements regarding Microsoft Robotics Developer Studio (MRDS) :

1. MRDS was a freely available .NET-based programming environment for building robotic applications.
2. MRDS can be used by professional developers.
3. MRDS can be used by non-professional developers.

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

80. For software component model, the link between component internal ports (dashed interface) and component external ports (solid interface) is realized via

(a) communication patterns
(b) SmartSoft software component model
(c) agnostic model
(d) hidden dotted model

81. Consider the following statements regarding actuators :

1. The use of multiple extra actuators requires the development of new control strategies to cope with the diverse interactions that may arise compared with standard systems with a single actuator.
2. Two-degree-of-freedom actuators can also be designed to combine two motions, like the roto-translational direct drive motor.
3. Their response time is tens to hundreds of milliseconds, but they can be profitably used in many mechatronic applications.

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

82. Consider the following statements regarding intrinsic tactile sensing :

1. It consists of one strain gauge detecting vertical force and derives both vertical force and position of centre of pressure.
2. Intrinsic sensing is based on a force/torque sensor placed within the mechanical structure of the sensing system.
3. Extrinsic sensing is based on sensors, which are often arranged in arrays that are mounted at or near the contact interface.

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

83. Consider the following statements regarding simple electroencephalography (EEG) :

1. A subjective index is obtained by a questionnaire, whereas an objective index is determined by a biosignal.
2. EEG is one of the biosignals used as indexes for determining preference.
3. Visualization of the mind status cannot be done by using EEG.

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

84. Consider the following statements regarding next-generation motion control :

1. Next-generation motion systems are inherently multi-variable since the flexible dynamical behaviour is generally not aligned with the motion DOFs.
2. Next-generation motion systems are envisaged to be designed with many actuators and sensors to actively control flexible dynamical behaviour, whereas traditionally, the number of inputs and outputs equals the number of motions DOFs.
3. A model-based design provides a systematic control design procedure for multi-variable systems.

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

85. Consider the following statements regarding next-generation impedance control :

1. A mechanical impedance at an interaction port can be defined as a dynamic operator that determines an output force in response to an input velocity at the same port.
2. A mechanical admittance is a dynamic operator that determines an output velocity in response to an input force.
3. For linear systems, admittance is proportional to impedance, and both can be represented as transfer functions in Laplace domain.

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

86. Consider the following statements regarding component-based software engineering (CBSE) :

1. It shifts the emphasis in system building from traditional requirements analysis, system design, and implementation to composing software systems from a mixture of reusable off-the-shelf and custom-built components.
2. CBSE is based on the explication of all relevant information about a component to make it usable by other software elements without the need to get in contact with the component provider.
3. Software components explicitly cannot consider reusable pieces of software.

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

87. Consider the following statements regarding service-oriented architectures (SOAs) :

1. SOAs are the policies, practices, and frameworks that enable application functionality to be provided and consumed as sets of services published at a granularity relevant to the service consumers.
2. Services are the key entities performing communication between providers and consumers.
3. SOA is not related to policy, practice and frameworks.

Which of the above statements is/are correct?

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

88. Consider the following statements regarding simultaneous localization and mapping (SLAM) :

1. SLAM forms the backbone of mobile robotics, as it is a prerequisite for higher-level tasks such as path planning and navigation.
2. SLAM has received a lot of attention in the robotics community, and many algorithms that address different aspects of the problem have been proposed over the years.
3. The architecture of a SLAM algorithm can be divided into two main parts—the front-end and the back-end.

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

89. Match the following lists :

List–I	*List–II*
P. Refractoriness	1. Ability of sand to stick to other bodies
Q. Permeability	2. Ability of sand grains to stick together
R. Cohesiveness	3. Ability to allow gases, water vapour and air to pass through it
S. Adhesiveness	4. It should be able to withstand high temperatures

Select the correct answer using the code given below.

(a)	P	Q	R	S
	4	3	2	1
(b)	P	Q	R	S
	1	2	3	4
(c)	P	Q	R	S
	3	1	4	2
(d)	P	Q	R	S
	4	1	2	3

90. Consider the following statements regarding hot and cold working :

1. Cold working may be defined as plastic deformation of metals and alloys at a temperature above the recrystallization temperature for that metal or alloy.
2. Hot working may be explained as plastic deformation of metals and alloys at such a temperature at which recovery and recrystallization take place simultaneously with the strain hardening.
3. Recrystallization temperature is not a fixed temperature but is actually a temperature range.

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

91. What is the property developed by the cutting tools due to addition of tungsten and molybdenum to high-carbon steel?

(a) Hardness

(b) White hardness

(c) Red hardness

(d) None of the above

92. Match the following lists :

List–I	*List–II*
P. Clearance fit	1. The largest permissible diameter of the shaft is smaller than the diameter of the smallest hole
Q. Interference fit	2. The diameter of the largest permissible hole is greater than the diameter of the smallest shaft, and the diameter of the smallest hole is smaller than the diameter of the largest shaft
R. Transition fit	3. The minimum permissible diameter of the shaft exceeds the maximum allowable diameter of the hole

Select the correct answer using the code given below.

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

93. The formula for sine of angle (θ) formed between the upper surface of a sine bar and the surface plate (datum) is

(a) L/h

(b) h/L

(c) $2h/L$

(d) $2L/h$

where L = the distance between the centres of the rollers and h = the height difference between the two rollers.

94. Match the following lists :

List–I (Layout configuration)	*List–II (Typical material handling system)*
P. In-line layout	1. In-floor towline carts
Q. Loop layout	2. Rail-guided vehicle system
R. Robot-centred layout	3. Industrial robot

Select the correct answer using the code given below.

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

95. Consider the following statements regarding material requirements planning (MRP) :

1. MRP is a computational technique that converts the master schedule for end products into a detailed schedule for the raw materials and components used in the end products.
2. MRP is often thought of as a method of inventory control.
3. The distinction between independent demand and dependent demand is important in MRP.

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

96. Which activity simply shows the logical relationship and does ***not*** consume any resource?

(a) Dummy
(b) Tail
(c) Head
(d) Cross

97. Match the following lists :

List–I (Selective control technique)	*List–II (Basis of classification)*
P. ABC	1. Criticality of item
Q. VED	2. Value of items in storage
R. XYZ	3. Annual consumption value

Select the correct answer using the code given below.

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

98. Consider the following statements regarding reliability theory :

1. Reliability analysis can be divided into two broad categories—(i) qualitative and (ii) quantitative.
2. Reliability engineering deals with the design and construction of systems and products, taking into account the reliability of their parts and components.
3. Reliability management deals with the various management issues in the context of managing the design, manufacture, and/or operation of reliable products and systems.

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

99. The failure rate function can have many different shapes. What type of shape it is where, in region *A* (decreasing failure rate), the failure is due to manufacturing and/or assembly errors (often referred to as teething problems), in region *B* (constant failure rate), the failure is purely due to chance (and is not affected by age), and in the final region *C* (increasing failure rate), failure is due to the aging effect?

(a) FMEA

(b) FTA

(c) Bathtub

(d) RBD

100. In which domains, the signals generated by vibration may be analyzed?

(a) Distance or time

(b) Time or frequency

(c) Speed or time

(d) Time or velocity

101. Consider the following statements regarding functions of machine elements :

1. Bearing is used to support the rotating shaft and confine its motion.
2. Key is used to transmit the torque between the shafts.
3. Power screw is used to store and release the energy.

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

102. Consider the following statements regarding ergonomics :

1. Ergonomics is defined as the relationship between man and machine.
2. Ergonomics means the natural laws of work.
3. Ergonomists have not carried out experiments to determine the best dimensions of a driver's seat.

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

103. Two plates, subjected to a tensile force of 50 kN, are fixed together by means of three rivets. The plates and rivets are made of plain carbon steel 10C4. The permissible shear stress for rivets is 50 N/mm^2. Neglecting stress concentration, determine the diameter of the rivets.

(a) 14·75 mm

(b) 20·60 mm

(c) 24·38 mm

(d) 29·52 mm

104. Consider the following statements regarding mechanical properties of engineering materials :

1. Strength is defined as the ability of the material to resist, without rupture.
2. Elasticity is defined as the ability of the material to regain its original shape and size after the deformation.
3. Plasticity is defined as the ability of the material to retain the deformation produced under the load on a permanent basis.

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

105. Which theory states that the failure of the mechanical component subjected to biaxial or triaxial stresses occurs when the maximum principal stress reaches the ultimate strength of the material?

(a) Rankine's theory

(b) Coulomb, Tresca and Guest's theory

(c) Huber, von Mises and Hencky's theory

(d) Haigh's theory

106. Higher calorific value of the fuel can be determined by using

(a) Dunkerley's formula

(b) Euler's formula

(c) Rankine's formula

(d) Dulong's formula

107. Consider the following statements regarding fatigue failure :

1. Fatigue failure is defined as time-delayed fracture under cyclic loading.
2. Fatigue failure begins with a crack at some point in the material.
3. Fatigue cracks are not visible till they reach the surface of the component and by that time, the failure has already taken place.

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

108. Consider the following statements regarding endurance limit and fatigue life :

1. Since the fatigue test cannot be conducted for unlimited or infinite number of cycles, 10^6 cycles are considered as sufficient number of cycles to define the endurance limit.
2. The fatigue life is defined as the number of stress cycles that the standard specimen can complete during the test before the appearance of the first fatigue crack.
3. The S-N curve is the graphical representation of stress amplitude versus number of stress cycles before the fatigue failure on a log-log graph paper.

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

109. Consider the following statements regarding surface finish factor :

1. The surface scratches serve as stress raisers and result in stress concentration.
2. The endurance limit is reduced due to introduction of stress concentration at surface scratches.
3. As the ultimate tensile strength increases, the surface finish factor also increases.

Which of the above statements are correct?

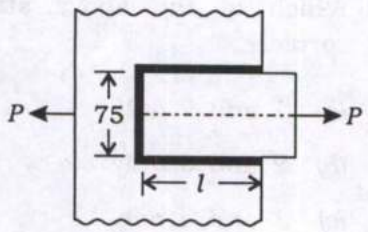
(a) 1 and 2 only

(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

110. A plate, 75 mm wide and 10 mm thick, is joined with another steel plate by means of single transverse and double parallel fillet welds as shown in the figure. The joint is subjected to a maximum tensile force of 55 kN. The permissible tensile and shear stresses in the weld material are 70 N/mm^2 and 50 N/mm^2 respectively. What is the required length of each parallel fillet weld after adding 15 mm for starting and stopping of the weld run?



(a) 40·29 mm

(b) 55·83 mm

(c) 50·74 mm

(d) 60·16 mm

111. A cylindrical pressure vessel with 1 m inner diameter is subjected to internal steam pressure of 1·5 MPa. The thickness of the plate is 14 mm and the diameter of rivets is 23 mm. The permissible stress for the cylinder plate and the rivets in shear is 60 N/mm^2. Find the total number of rivets.

(a) 23

(b) 37

(c) 48

(d) 51

112. Consider the following statements regarding bolt of uniform strength :

1. Resilience is defined as the ability of the material to absorb energy when deformed elastically and to release this energy when unloaded.
2. The shock-absorbing capacity of bolt can be decreased if the shank of bolt is turned down to a diameter equal to the root diameter of threads.
3. The resilience of the bolt can also be increased by increasing its length.

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

113. What is 'addendum' of a gear tooth?

(a) The radial distance between pitch and dedendum circle

(b) The height of the tooth above the pitch circle

(c) The width of the tooth space at the pitch circle

(d) The size of the gear tooth's fillet radius

114. What is the resulting mobility m of a planar n-link mechanism, when we use j_1 to denote the number of single-degree-of-freedom pairs and j_2 for the number of two-degree-of-freedom pairs?

(a) $3(n-1)-2j_1-j_2$

(b) $3(n-1)-j_1-2j_2$

(c) $3(n-2)-2j_1-j_2$

(d) $3(n-2)-j_1-2j_2$

115. Which one of the following is a low-level type condenser that operates without extraction pump?

(a) Barometric condenser

(b) Low-level jet condenser

(c) Ejector condenser

(d) Mixing type condenser

116. What is the method of obtaining different mechanisms by fixing different links of a kinematic chain?

(a) Crank-rocker (or lever) mechanism

(b) Crank-crank (or double crank) mechanism

(c) Inversion of the mechanism

(d) Grashof's law

117. Consider the following statements regarding instantaneous centres :

1. For a pivoted or pin joint, the instantaneous centre for the two links lies on the centre of the pin.
2. In a pure rolling contact of the two links, the instantaneous centre lies at their point of contact.
3. In a sliding motion, the instantaneous centre lies at infinity in a direction perpendicular to the path of motion of the slider.

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

118. Match the following lists :

List–I	*List–II*
P. Base circle	1. It is the smallest circle drawn to the pitch curve from the centre of rotation of the cam
Q. Prime circle	2. It is the circle drawn through the centre and pitch point
R. Pitch circle	3. It is the smallest circle that can be drawn to the cam profile from the centre of rotation

Select the correct answer using the code given below.

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

119. What is the damping ratio (ζ) of critically damped system?

(a) $\zeta = 1$

(b) $\zeta < 1$

(c) $\zeta > 2$

(d) $1 < \zeta < 2$

120. The critical speed of a rotating shaft is the speed at which the shaft starts to vibrate violently in

(a) the linear direction

(b) the transverse direction

(c) the rotational direction

(d) the non-linear direction

121. Consider the following statements regarding instantaneous centres :

1. The angle of approach is defined as the angle through which a gear rotates from the instant a pair of teeth comes into contact until the teeth are in contact at the pitch point.
2. The angle of recess is the angle through which a gear rotates from the instant the teeth are in contact at the pitch point until the contact is broken.
3. In general, the angle of approach is equal to the angle of recess.

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

122. What is the name of the gear, half of whose width is cut with a tooth helix in one direction and the other half in the opposite direction?

(a) Bevel gear

(b) Spiral gear

(c) Herringbone gear

(d) Roger gear

123. Which gears do ***not*** in anyway affect the velocity ratio in simple gear train?

(a) First gears

(b) Intermediate gears

(c) Last gears

(d) One-tenth gears

124. Consider the following statements regarding use of turning moment diagram :

1. The area under the turning moment diagram represents work done per cycle.
2. Dividing the area of the turning moment diagram with the length of the base gives the mean turning moment.
3. The maximum ordinate of the turning moment diagram gives the maximum torque to which the crankshaft is subjected to.

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

125. At how many degrees, the cranks of the two cylinders are set to each other so that the engine can be started easily after stopping in any position?

(a) 45°

(b) 75°

(c) 90°

(d) 120°

126. For the FCC crystal structure, total how many whole atoms may be assigned to a given unit cell, if there are eight corner atoms ($N_c = 8$), six face atoms ($N_f = 6$), and no interior atoms ($N_i = 0$)?

(a) 5

(b) 4

(c) 6

(d) 3

127. Match the following lists :

List–I (Crystal systems)	*List–II (Interaxial angles)*
P. Hexagonal	1. $\alpha = \gamma = 90° \neq \beta$
Q. Cubic	2. $\alpha = \beta = 90°, \gamma = 120°$
R. Monoclinic	3. $\alpha = \beta = \gamma = 90°$

Select the correct answer using the code given below.

(a) P Q R
2 3 1

(b) P Q R
1 3 2

(c) P Q R
3 1 2

(d) P Q R
3 2 1

128. Which one of the following is an indication of negatively charged ionized gas molecules that travel from discharge electrodes to grounded collection electrodes?

(a) Corona

(b) Condenser

(c) Ejector

(d) Precipitator

129. The eutectic copper-silver and lead-tin phase diagrams have only two solid phases α and β; these are sometimes termed as

(a) intermediate solid solutions

(b) terminal solid solutions

(c) intermetallic compound solutions

(d) co-terminal solid solutions

130. What properties of martensite may be enhanced and the internal stresses relieved by a heat treatment known as tempering?

(a) Ductility and toughness

(b) Brittleness and strength

(c) Ductility and malleability

(d) Ductility and hardness

131. Consider the following statements regarding ferrous alloys :

1. Ferrous alloys are those in which iron is the prime constituent.
2. Stainless steel is a low-alloy ferrous alloy.
3. Ferrous alloys are extremely versatile, in that they may be tailored to have a wide range of mechanical and physical properties.

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

132. Match the following lists :

List–I	*List–II*
P. Gray iron	1. General engineering service at normal and elevated temperature
Q. Ductile (nodular) iron	2. Miscellaneous soft iron castings in which strength is not a primary consideration
R. Malleable iron	3. Diesel engine blocks, exhaust manifolds, brake discs for high-speed train
S. Compacted graphite iron	4. Pressure-containing parts such as valve and pump bodies

Select the correct answer using the code given below.

(a)	P	Q	R	S
	2	4	1	3
(b)	P	Q	R	S
	1	3	2	4
(c)	P	Q	R	S
	3	1	4	2
(d)	P	Q	R	S
	1	2	3	4

133. Consider the following statements regarding non-ferrous alloys :

1. Molybdenum alloys are used for extrusion dies and structural parts in space vehicles.
2. Tantalum is immune to chemical attack by virtually all environments at temperatures below 150 °C and is frequently used in applications requiring such a corrosion-resistant material.
3. Superalloys are used in aircraft turbine components, which must withstand exposure to severely oxidizing environments and high temperatures for reasonable time periods.

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

134. Consider the following statements regarding nanostructured materials :

1. Nanostructured materials may be defined as those materials whose structural elements—clusters, crystallites or molecules have dimensions in the 1 nm to 100 nm range.
2. Clusters of atoms consisting of typically hundreds to thousands on nanometre (nm) scale are commonly called as nanoclusters.
3. Fullerenes and carbon nanotubes cannot be seen as curved pieces of graphite.

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

135. Which one of the following tests is used to determine the continuing changes in the deformation of materials at elevated temperatures when stresses are below the yield point?

(a) Tensile test

(b) Hardness test

(c) Impact test

(d) Creep test

136. Match the following lists :

List–I	*List–II*
P. Isotropy	1. Physical properties are not dependent upon the direction in the body along which they are measured
Q. Anisotropy	2. Property of a material which governs its ability to be deformed in processes
R. Ductility	3. Variation of physical property with the direction in a body along which the property is measured

Select the correct answer using the code given below.

(a) P Q R
2 3 1

(b) P Q R
1 3 2

(c) P Q R
3 1 2

(d) P Q R
1 2 3

137. What is the relation between K and E?

(a) $K = \dfrac{E}{3(1-2\nu)}$

(b) $K = \dfrac{E}{2(1-2\nu)}$

(c) $K = \dfrac{E(1+\nu)}{2}$

(d) $K = \dfrac{E(1-\nu)}{2}$

where ν = Poisson's ratio, K = bulk modulus and E = Young's modulus of elasticity.

138. Consider the following statements regarding impact strength of a material :

1. Impact strength increases if the dimensions of the specimen are increased.
2. When the sharpness of the notch increases, the impact strength of the material required to cause failure also increases.
3. The angle of notch also improves impact strength after certain values.

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

139. What is the magnitude of the third force P, if three forces of magnitudes 40 kN, 15 kN and P kN are acting at a point O. The angles made by 40 kN, 15 kN and P kN forces with X-axis are 60°, 120° and 240° respectively, and the magnitude and direction of the resultant force are 30·41 kN and 85·28°? (Take cos 85·28° = 0·08229)

(a) 18 kN

(b) 19 kN

(c) 20 kN

(d) 21 kN

140. Consider the following statements regarding laws of friction :

1. The limiting frictional force bears a constant ratio to the normal reaction between two surfaces.
2. The ratio between limiting friction and normal reaction is always greater when the two surfaces are in motion.
3. The limiting frictional force does not depend upon the shape and areas of the surfaces in contact.

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

141. Match the following lists :

List–I (Shape)	*List–II (Centroid ($\bar{y}$))*
P. Semicircular area	1. $h/3$
Q. Triangular area	2. $3b/8$
R. Rectangular area	3. $4r/(3\pi)$
S. Parabolic area	4. $h/2$

Select the correct answer using the code given below.

(a)	P	Q	R	S
	1	2	3	4
(b)	P	Q	R	S
	2	1	4	3
(c)	P	Q	R	S
	4	3	2	1
(d)	P	Q	R	S
	3	1	4	2

142. What is the time required for a particle to reach a velocity of 72 m/s from its initial condition at $t = 0$, if the position coordinate of the particle which is confined to move along a straight line is given by $s = 2t^3 - 24t + 6$, where s is measured in metres from a convenient origin and t is in seconds?

(a) 4 s

(b) 6 s

(c) 8 s

(d) 2 s

143. Match the following lists :

List–I (Name)	*List–II (Symbol)*
P. Tensile strain	1. τ
Q. Tensile stress	2. ϕ
R. Shear strain	3. e
S. Shear stress	4. σ

Select the correct answer using the code given below.

(a)	P	Q	R	S
	1	2	3	4
(b)	P	Q	R	S
	2	1	4	3
(c)	P	Q	R	S
	3	4	2	1
(d)	P	Q	R	S
	3	1	4	2

144. A rod 150 cm long and of diameter 2·0 cm is subjected to an axial pull of 20 kN. If the modulus of elasticity of the material of the rod is 2×10^5 N/mm^2, what is the elongation of the rod?

(a) $1{\cdot}5/\pi$ mm

(b) $1{\cdot}6/\pi$ mm

(c) $1{\cdot}4/\pi$ mm

(d) $1{\cdot}8/\pi$ mm

145. The planes on which the shear stress is zero are known as

(a) normal planes

(b) tangential planes

(c) orthogonal planes

(d) principal planes

146. What is the expression for normal stress when two perpendicular stresses are acting accompanied with a state of simple shear?

(a) $p_1 \cos^2\theta + p_2 \sin^2\theta + q \sin 2\theta$

(b) $\{(p_1 + p_2)/2\} \sin 2\theta + q \cos 2\theta$

(c) $p_1 \sin^2\theta + p_2 \cos^2\theta + q \sin 2\theta$

(d) $\{(p_1 + p_2)/2\} \cos 2\theta + q \sin 2\theta$

where symbols have their usual meanings.

147. The equation commonly used for finding loss of head due to friction in pipes is

(a) Darcy-Weisbach equation

(b) Reynolds equation

(c) Navier-Stokes equation

(d) Hagen-Poiseuille equation

148. Consider the following statements regarding shear force and bending moment diagrams :

1. The shear force between any two vertical loads will be constant and hence the shear force diagram between two vertical loads will be horizontal.
2. The bending moment at the two supports of a simply supported beam and at the free end of a cantilever will be zero. But at the fixed end of the cantilever, there will be bending moment (or fixing moment).
3. The positive values of shear force and bending moment are plotted above the baseline, and negative values below the baseline.

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

149. A steel wire of 10 mm diameter is bent into a circular arc of 20 metres radius. What is the maximum stress induced in it? (Take $E = 2\times10^5$ N/mm^2)

(a) 40 N/mm^2

(b) 45 N/mm^2

(c) 50 N/mm^2

(d) 55 N/mm^2

150. The sum of pressure head and potential head is termed as

(a) datum head

(b) velocity head

(c) piezometric head

(d) static head

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