

DO NOT OPEN THIS TEST BOOKLET TILL YOU ARE ASKED TO DO SO.

TR/TES/Mech-II/M/Degree-V(A)/24

Test Booklet Series

**TEST BOOKLET
MECHANICAL ENGINEERING
PAPER – II**

B

(Signature of the Candidate)

(Invigilator's Signature)

Time allowed – 3 hours (Three hours)

Maximum Marks – 200

INSTRUCTIONS

1. IMMEDIATELY BEFORE 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 TEST BOOKLET OF SAME SERIES.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES IN THE OMR ANSWER SHEET ONLY IN THE APPROPRIATE PLACE IN THE ANSWER SHEET BY BLACK BALL POINT PEN ONLY.
3. This Test Booklet is divided into three SECTIONS i.e., SECTION-A, SECTION-B and SECTION-C.
(A) SECTION-A (MCQ pattern) contains 40 items (questions). Each question, carrying two (2) marks only, has four responses (answers). You will select the response which you want to mark on the OMR Sheet. In case you feel that there is more than one correct response, mark the response which you consider the most appropriate. In any case choose ONLY ONE response for each item.
(B) Questions under SECTION-B (Conventional Method) and SECTION-C (Conventional Method) are to be answered in separate Answer Book.
4. You have to mark all your responses of SECTION-A by Black Ball Point pen only on the separate OMR Answer Sheet provided. See directions in the Answer Sheet.
5. Before you proceed to mark in the answer sheet the responses to various items of SECTION-A in the Test Booklet, you have to fill in some particulars in the answer sheet.
6. On completion of the Examination, you should handover the OMR Answer Sheet for SECTION-A and Answer Book for SECTION-B and C to the Invigilator only. You are permitted to take the Test Booklet with you.
7. Sheets for rough work are appended on the Test Booklet at the end.
8. Instructions for wrong and multiple answer(s) SECTION-A :
 - (a) There will be four alternatives for the answer to every question. However, there will be no negative marking for wrong answer.
 - (b) 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.

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INSTRUCTIONS

1. There are a total of 60 questions. Q. Nos. 1 to 40 in **SECTION-A** are Multiple Choice questions having 2 marks each.
2. In **SECTION-B** there are 15 questions, (Q.Nos. 41 to 55) of 6 marks each, answers to which is restricted to 40 words each.
3. In **SECTION-C** there are 5 numerical questions, (Q.Nos. 56 to 60) of 6 marks each.
4. All symbols used in the questions carry their usual meaning.

SECTION - A

Example : Poise is the unit of

- (A) Surface tension (B) Buoyant force
☒ (C) Coefficient of viscosity (D) Gravitational force

Answer : ☒ Coefficient of viscosity.

● Choose the correct answer from the following :

$$2 \times 40 = 80$$

1. Which one of the following is the extensive property of a thermodynamic system ?
 (A) Volume (B) Pressure
 (C) Temperature (D) Density
2. In case of power failure, a battery is used to light a bulb, run a fan and heat an electric iron (each of 100W rating) for 10 minutes. In this operation, the work done W and heat supplied Q by the battery are
 (A) $W = 0, Q = 0$ (B) $W = 180 \text{ kJ}, Q = 0$
 (C) $W = 60 \text{ kJ}, Q = 120 \text{ kJ}$ (D) None of these

3. Change in internal energy in a reversible process occurring in a closed system is equal to the heat transferred if the process occurs at constant
- (A) Pressure (B) Volume
(C) Temperature (D) Enthalpy
4. Which one of the following thermodynamic processes approximate the steaming of food in a pressure cooker ?
- (A) Isenthalpic (B) Isobaric
(C) Isochoric (D) Isothermal
5. Which one of the following parameters remains constant in a throttling pressure ?
- (A) Temperature (B) Pressure
(C) Enthalpy (D) Entropy
6. Three engines A, B and C operating on carnot cycle respectively use argon, oxygen and helium as the working fluid. If all the engines operate within the same high and low temperature limits, then which engine will have the highest efficiency ?
- (A) Engine A
(B) Engine B
(C) Engine C
(D) All engines will have the same efficiency
7. The relation, $Tds = du + pdv$, is true for
- (A) any system, any process
(B) any system, reversible process
(C) closed system, any process
(D) closed system and reversible process only

8. Which thermodynamic property is evaluated with the help of Maxwell equations from the data of other measurable properties of a system ?
- (A) Enthalpy (B) Entropy
(C) Latent heat (D) Specific heat
9. In statistical thermodynamics, entropy is defined as
- (A) reversible heat transfer
(B) measure of reversibility of a system
(C) degree of randomness
(D) an universal property
10. The temperature at which a real gas obeys the ideal gas law over a wide range of pressure is called
- (A) Boyle's temperature (B) Reduced temperature
(C) Critical temperature (D) Triple point temperature
11. The throttling of certain gases may be used for getting the refrigerating effect. The value of joule co-efficient for such a process is
- (A) $\mu = 0$ (B) $\mu = 1$
(C) $\mu < 0$ (D) $\mu > 1$
12. Joule Thomson Co-efficient for an ideal gas in a throttling process is
- (A) equal to one at all temperatures and pressures
(B) greater than one at all temperatures and pressures
(C) less than one at all temperatures and pressures
(D) less than zero at all temperatures and pressures

13. Critical temperature of a gas is the temperature

- (A) at which the intermolecular gap is reduced to zero
- (B) at which its liquefaction just starts
- (C) at which its liquefaction is complete
- (D) above which it can not be liquefied

14. The thermal conductivity K and the electrical conductivity σ of a metal at absolute temperature T are related as

- (A) $K / \sigma = \text{constant}$
- (B) $K / \sigma T = \text{constant}$
- (C) $K \sigma / T = \text{constant}$
- (D) $KT / \sigma = \text{constant}$

15. In solar flat-plate collectors, the absorber plate is painted with selective paints. The selectivity is the ratio of

- (A) solar radiation-absorption to thermal infrared radiation-emission
- (B) solar radiation-emission to thermal infrared radiation-absorption
- (C) solar radiation-reflection to thermal infrared radiation-absorption
- (D) solar radiation-absorption to thermal infrared radiation-reflection

16. Fins are made as thin as possible to

- (A) reduce the total weight
- (B) accommodate more number of fins
- (C) increase the width for the same profile area
- (D) improve flow of coolant around the fin

17. For a perfectly black body
- (A) absorptivity $\alpha = 1$, reflectivity $\rho = 0$ and transmissivity $\tau = 0$
 - (B) $\rho = 1$ and $\alpha = \tau = 0$
 - (C) $\tau = 1$ and $\alpha = \rho = 0$
 - (D) $\alpha + \tau = 1$ and $\rho = 0$
18. A sphere, a cube and a thin circular plate, all made of the same material and having the same mass are initially heated to a temperature of 250°C . When left in air at room temperature, what will be their response to cooling ?
- (A) they will cool at the same rate
 - (B) circular plate will cool at the slowest rate
 - (C) sphere will cool faster
 - (D) cube will cool faster than sphere but slower than the circular plate
19. The Nusselt number in convective heat transfer
- (A) signifies the velocity gradient at the surface
 - (B) is the ratio of conduction to convection resistance
 - (C) represents the ratio of viscous to inertia force
 - (D) is the ratio of molecular momentum diffusivity to thermal diffusivity
20. In a flooded evaporator refrigerator, an accumulator at the suction side of the compressor is provided to
- (A) collect the vapours
 - (B) detect any liquids in the vapour
 - (C) retain the refrigeration effect as originally working
 - (D) collect the liquid refrigerant and preclude its reversion to the compressor

21. Air refrigeration cycle is generally employed in

- (A) domestic refrigerators
- (B) commercial refrigerators
- (C) air-conditioning
- (D) gas liquefaction

22. In a vapour compression refrigeration system, a throttle valve is used in place of expander because

- (A) it leads to significant cost reduction
- (B) it considerably reduces the system work
- (C) positive work in isentropic expansion of liquid is very small
- (D) it improves COP

23. A diesel engine is usually more efficient than a spark ignition engine because

- (A) diesel being a heavier hydrocarbon, releases more heat per kg than gasoline
- (B) the air standard efficiency of diesel cycle is higher than the Otto cycle, at a fixed compression ratio
- (C) the compression ratio of a diesel engine is higher than that of an SI engine
- (D) self ignition temperature of diesel is higher than that of gasoline

24. A positive value to Joule-Thomson coefficient of a fluid means

- (A) temperature drops during throttling
- (B) temperature remains constant during throttling
- (C) temperature rises during throttling
- (D) None of these

25. If x is the distance measured from the leading edge of a flat plate, then laminar boundary layer thickness varies as
- (A) $1/x$ (B) $x^{4/5}$
 (C) x^2 (D) $x^{1/2}$
26. In Break-even analysis, total cost consists of
- (A) fixed cost + sales revenue (B) variable cost + sales revenue
 (C) fixed cost + variable cost (D) fixed cost + variable cost + profit
27. In a two-fluid heat exchanger, the inlet and outlet temperatures of the hot fluid are 65°C and 40°C respectively. For the cold fluid, these are 15°C and 43°C . The heat exchanger is a
- (A) Counter flow heat exchanger (B) Parallel flow heat exchanger
 (C) Mixed flow heat exchanger (D) Phase-changer heat exchanger
28. PERT analysis is based upon
- (A) optimistic time (B) pessimistic time
 (C) most likely time (D) All of these
29. The wet bulb and dry bulb temperatures of an air sample will be equal when
1. Air is fully saturated
 2. Dew point temperature is reached
 3. Partial pressure of vapour equals the total pressure
 4. Humidity ratio is 100%
- (A) 1 and 2 (B) 2 and 3
 (C) 3 and 4 (D) 1 and 4

30. A refrigeration plant is designed to work between -3°C and 27°C . The plant works on the Carnot cycle. If the same plant is used as a heat-pump system, then the COP of the heat pump becomes
- (A) 9 (B) 10
(C) 8 (D) 7
31. The correct sequence of increasing production volume is
- (A) batch, job, flow and mass (B) job, batch, mass and flow
(C) job, flow, mass and batch (D) mass, flow, batch and job
32. The data for Break-even analysis of a product are given as : fixed cost is Rs. 10,000 ; variable cost is Rs.10/unit ; selling price is Rs.15/unit. The break-even volume is
- (A) 2000 (B) 2500
(C) 3500 (D) 4000
33. In ABC inventory control of spare parts, the items A, B and C respectively refer to
- (A) high stock-out cost, moderate stock-out cost and low stock-out cost
(B) low stock-out cost, moderate stock-out cost, and high stock-out cost
(C) moderate stock-out cost, high stock-out cost and low stock-out cost
(D) stock-out costs whose sequence depends on other factors also
34. Work sampling is applied for
- (A) estimation of the percentage utilisation of machine tools
(B) estimating the percentage of the time consumed by various job activities
(C) finding out time standards, specially where the job is not repetitive and where time study by stop watch method is not possible
(D) All of the above

35. In a time study, the observed time is 0.75min, the rating factor is 110% and the allowances are 20% of normal time. Then the standard time in minutes is
- (A) 0.82 (B) 0.97
(C) 0.99 (D) 1.03
36. The most suitable refrigeration system utilizing solar energy is
- (A) Ammonia–Water vapour absorption refrigeration system
(B) Lithium Bromide Water vapour absorption refrigeration system
(C) Desiccant refrigeration system
(D) Thermo-electric refrigeration system
37. In a solar collector, the function of the transparent cover is to
- (A) transmit solar radiation only
(B) protect the collector from dust
(C) absorb all types of radiation and protect the collector from dust
(D) decrease the heat loss from collector beneath to atmosphere
38. Which of the following processes are irreversible ?
1. Heat transfer through a finite temperature difference
 2. Free expansion
 3. Transfer of electricity through a resistor
- (A) 1,2, and 3 (B) 1 and 2 only
(C) 2 and 3 only (D) 1 and 3 only

39. Which of the following statements are correct for a blackbody ?

1. A blackbody continues to emit radiation even when it is in thermal equilibrium with its surroundings.
2. A blackbody is a perfect emitter.
3. Absorptivity, $\alpha = 1$, represent a black surface.

(A) 1 and 2 only

(B) 1 and 3 only

(C) 1, 2 and 3

(D) 2 and 3 only

40. In a cyclic process, the heat transfer are + 30J, -50J, -10J and + 60J. The net work for the cyclic process is

(A) 30 Nm

(B) 40 Nm

(C) 50 Nm

(D) 60 Nm.

SECTION – B

Answer *all* questions, each question carries 6 marks :

6×15=90

41. In Otto, Diesel and Dual cycle, with same operating conditions which cycle has the maximum thermal efficiency ?
42. What is triple point of a substance ?
43. Explain Gibbs Dalton law.
44. Explain the principle of entropy increase.
45. Describe the selection criteria of heat exchanger.
46. What do you understand by transient heat transfer ?
47. Define the term “ Human comfort”. What are the factors affecting human comfort.
48. What is the Adiabatic saturation process ? Explain.
49. What are the desirable properties of an ideal refrigerant. What are the limitations with ammonia as refrigerant ?
50. Differentiate between mechanisms of heat transfer by free and forced convection. Mention some of the areas where these mechanisms are predominant.
51. What criteria are considered while designing and selecting a fin ? Define the effectiveness of a fin while justifying its usage.
52. Explain the various phase transformation from molten state to room temperature in steel having 1.0% carbon content.
53. Write a brief note on selecting of cutting fluid.
54. What is the use of flash chamber in a vapour compression refrigeration cycle to improve the COP of refrigeration cycle ?
55. Describe the working of a simple air conditioning system used for aircrafts.

SECTION – C

Answer *all* questions, each question carries 6 marks :

6×5=30

56. In an standard otto cycle, the compression ratio is 7 and the compression begins at 1 bar and 313K. The heat added is 2510 kJ/kg. Find the (1). Maximum temperature and pressure of the cycle. (2) Work done per kg of air. (3) Cycle efficiency and mean effective pressure. Take for air $C_v = 0.718$ kJ/kgK and $R = 287$ kJ/kgK.
57. An aircraft refrigeration system has to handle a cabin load of 25 tonnes. The atmospheric temperature is 16°C. The atmospheric air is compressed to a pressure of 0.96 bar and temperature of 29°C due to ram action. The air is then further compressed in a compressor to 4.8 bar, cooled in a heat exchanger to 66°C expanded in a turbine to 1 bar pressure and supplied to cabin. The air leaves the cabin at a temperature of 26°C. The isentropic efficiencies of both compressors and turbine are 0.9. Calculate : 1. Mass of air circulated per minute. 2. COP. Take for air $C_p = 1.005$ kJ/kgK and $\gamma = 1.4$.
58. A thin aluminium sheet with an emissivity of 0.1 on both sides is placed between two very large parallel plates that are maintained at uniform temperature $T_1 = 800$ K and $T_2 = 500$ K and have emissivities $\epsilon_1 = 0.2$ and $\epsilon_2 = 0.7$ respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result to that without shield.
59. Consider convection heat flow to water at 75°C from a cylindrical nuclear reactor fuel rod of 50mm diameter. Under steady state condition, the rate of heat generation within the fuel element is 5×10^7 W/m³ and the connective heat transfer coefficient is 1kW/m²k. So, calculate the outer surface temperature of fuel element.
60. A vapour absorption refrigeration system is a heat pump with three thermal reservoirs as shown below. A refrigerating effect of 100W is required at 250k when the heat source available is at 400k. Heat rejection occurs at 300k. Calculate the minimum value of the required heat.

