



Booklet Series



22/AE/CM/M-2024-05

Question Booklet  
MECHANICAL ENGINEERING – I  
Paper – V

Booklet Serial No.

Candidate's Roll Number

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Time Allowed : 01 Hour

Maximum Marks : 100

Read the following instructions carefully before you begin to answer the questions.

### IMPORTANT INSTRUCTIONS

1. This Question Booklet contains 50 questions in all.
2. All questions carry equal marks.
3. Attempt all questions.
4. An Answer Sheet has been supplied inside the question booklet to mark the answers. **You must write your Roll Number and encode it and write other particulars in the space provided in the Answer Sheet, failing which your Answer Sheet will not be evaluated.**
5. **Immediately after commencement of the examination, you should check up your Question Booklet and attached answer sheet and ensure that the Question Booklet Series is printed on the top left-hand corner of the Booklet and the series encoded in answer sheet are same. Also please check that the Booklet contains 12 printed pages including two pages (Page Nos. 11 and 12) for Rough Work and no page or question is missing or unprinted or torn or repeated or question booklet and answer sheet have different series. If you find any defect in this Booklet and attached answer sheet, get it replaced immediately by a complete Booklet with OMR sheet of the same series.**
6. You must write your Roll Number in the space provided on the top of this page. Do not write anything else on the Question Booklet.
7. Questions and their responses are printed in English version in this Booklet. Each question comprises of **four** responses — (A), (B), (C) and (D). You are to select **ONLY ONE** correct response and mark it in your Answer Sheet. In case you feel that there are more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each question. Your total marks will depend on the number of correct responses marked by you in the Answer Sheet.
8. In the Answer Sheet, there are **four** circles — (A), (B), (C) and (D) against each question. To answer the questions, you are to mark with **Black/Blue ink ballpoint pen ONLY ONE circle** of your choice for each question. Select only one response for each question and mark it in your Answer Sheet. If you mark more than one circle for one question, the answer will be treated as wrong. **Use Black/Blue ink ballpoint pen only to mark the answer in the Answer Sheet. Any erasure or change is not allowed.**
9. You should not remove or tear off any sheet from the Question Booklet. You are not allowed to take this Question Booklet and the Answer Sheet out of the Examination Hall during the examination. **After the examination has concluded, you must hand over your Answer Sheet to the Invigilator.** Thereafter, you are permitted to take away the Question Booklet with you.
10. Failure to comply with any of the above instructions will render you liable to such action or penalty as the Commission may decide at their discretion.
11. Candidates must assure before leaving the Examination Hall that their Answer Sheets will be kept in Self Adhesive LDPE Bag and completely packed/sealed in their presence.



1. The flash chamber in vapour compression cycle (Single stage) is incorporated to

- (A) Increase the compressor pressure ratio
- (B) Decrease the refrigerating effect
- (C) Reduce the size of evaporator
- (D) Increase the refrigerating effect



2. Which one of the following pairs of materials is used as moderators in nuclear reactors ?

- (A) Cadmium and beryllium
- (B) Zirconium and beryllium
- (C) Beryllium and heavy water
- (D) Heavy water and zirconium

3. An ideal Brayton cycle, operating between the pressure limits of 1 bar and 6 bar, has minimum and maximum temperatures of 300 K and 1500 K. The ratio of specific heats of the working fluid is 1.4. The approximate final temperatures in Kelvin at the end of the compression and expansion processes are respectively

- (A) 500 and 500
- (B) 900 and 500
- (C) 900 and 900
- (D) 500 and 900



4. What assumption is made about frictional power in the Morse test ?

- (A) It decreases when a cylinder is cut off
- (B) It increases when a cylinder is cut off
- (C) It varies with the speed of the engine
- (D) It remains constant whether a cylinder is working or not



5. The maximum efficiency of transmission of power through a pipe is

- (A) 33.3%
- (B) 66.66%
- (C) 50%
- (D) 25%



6. In incompressible fluid flows over a flat plate with zero pressure gradient. The boundary layer thickness is 1 mm at a location where the Reynolds number is 1000. If the velocity of the fluid alone is increased by a factor of 4, then the boundary layer thickness at the same location, in mm, will be

- (A) 0.5
- (B) 2
- (C) 0.25
- (D) 4



7. Under ideal conditions, for a drop of 50 kJ/kg enthalpy, what will be the approximate velocity of steam at the outlet of the nozzle if the inlet velocity of the steam is 5 m/s ?

- (A) 400 m/s
- (B) 410 m/s
- (C) 325 m/s
- (D) 317 m/s

8. In order to achieve maximum heat dissipation, the fin should be designed in such a way that

- (A) It should have maximum lateral surface near the centre of the fin
- (B) It should have maximum lateral surface towards the tip side of the fin
- (C) It should have minimum lateral surface near the centre of the fin
- (D) It should have maximum lateral surface at the root side of the fin



9. The centrifugal compressor in vapour compression refrigeration system is very sensitive to

- (A) evaporator temperature
- (B) condenser temperature
- (C) both (A) and (B)
- (D) none of the above

10. Gauge pressure is equal to

- (A)  $P_{\text{atmospheric}} - P_{\text{absolute}}$
- (B)  $P_{\text{absolute}} - P_{\text{atmospheric}}$
- (C)  $P_{\text{atmospheric}} - P_{\text{vacuum}}$
- (D)  $P_{\text{absolute}} + P_{\text{atmospheric}}$



11. Interaction of unsaturated air with water droplets in air washer can leads to

- (A) Dehumidification
- (B) Humidification
- (C) Constant DPT line
- (D) All of the above



12. Consider the following statements, High condenser pressure in a refrigeration system can occur because

1. The water flow rate is lower than the desired value.
2. Non-condensable gases are present in the system.
3. Of accumulation of lubricating oil in condenser.
4. Of low charge of refrigerant in the system.

Of these statements :

- (A) 1, 2 and 4 are correct
- (B) 1, 2 and 3 are correct
- (C) 2, 3 and 4 are correct
- (D) 1, 3 and 4 are correct





13. A centrifugal pump gives the maximum efficiency when its blade are

- (A) Straight
- (B) Bent backward
- (C) Wave shaped
- (D) Bent forward



14. Given below are two statements, one is labelled as Assertion (A) and other as Reason (R). Choose the correct answer from the options given below.

**Assertion (A) :** Fire tube boilers do not operate at high pressures while water tube boilers operate at high pressures.

**Reason (R) :** Due to high temperature of flue gases, fire tubes may fail due to creep.

- (A) (A) is true but (R) is false
- (B) Both (A) and (R) are individually true but (R) is not the correct explanation of (A)
- (C) (A) is false but (R) is true
- (D) Both (A) and (R) are individually true and (R) is the correct explanation of (A)



15. For burning of 2 kilograms of methane ( $\text{CH}_4$ ) completely, the minimum number of kilograms of oxygen needed is (take atomic weight of H, C and O as 1, 12 and 16 respectively)



- (A) 6
- (B) 4
- (C) 8
- (D) 2

16. The fluid forces considered in the Navier-Stokes equation are

- (A) Pressure, viscous and turbulent
- (B) Gravity, pressure and turbulent
- (C) Gravity, viscous and turbulent
- (D) Gravity, pressure and viscous

17. If there is no change in the fluid pressure between the inlet and outlet of the rotor of an axial flow machine, then degree of reaction (R)

- (A)  $R > 0$
- (B)  $R = 1$
- (C)  $R < 0$
- (D)  $R = 0$





18. Consider the following statements :

1. Pulverized fuel gives high and controlled burning rate.
2. Insufficient air causes excessive smoking of exhaust.
3. Excess air is provided to control the flue gas temperature.
4. Effect of sulphur in fuel is to give high heat transfer rate.



Which of these statements are correct ?

- (A) 1 and 4
- (B) 1, 2 and 3
- (C) 1 and 2
- (D) 1 and 3

19. Cooling tower in steam power station is a device

- (A) Reducing the temperature of superheated steam
- (B) Cooling the exhaust gases coming out of the boiler
- (C) Reducing the temperature of cooling water used in condenser
- (D) Condensing the steam into water



20. Which of the following is true about the optimum effective temperature for human comfort ?

- (A) Lower in winter than in summer
- (B) Not dependent on season
- (C) Higher in winter than in summer
- (D) Same in winter and summer

21. It is proposed to build refrigeration plant for a cold storage to be maintained at  $-3^{\circ}\text{C}$ . The ambient temperature is  $27^{\circ}\text{C}$ . If  $5 \times 10^6$  kJ/h of energy is to be continuously removed from the cold storage, the minimum power required to run the refrigerator will be

- (A) 154.3 kW
- (B) 75.3 kW
- (C) 245.3 kW
- (D) 14.3 kW



22. Surging is instability of operation caused by mismatch between the impeller and the diffuser at \_\_\_\_\_ flow rates.

- (A) medium
- (B) low
- (C) very high
- (D) high

23. The pressure in meters of oil (specific gravity 0.85) equivalent to 42.5 m of water is

- (A) 52.5 m
- (B) 50 m
- (C) 85 m
- (D) 42.5 m





24. In a parallel flow heat exchanger, if the heat capacity ratio is 1, then what is the maximum value of effectiveness ?

- (A) 0.75
- (B) 2/3
- (C) 0.5
- (D) 1



25. Frosting on the evaporator coils

- (A) causes increase in heat transfer rate
- (B) is the sign of good cooling
- (C) causes decrease in heat transfer rate
- (D) is the sign of good compressor

26. Consider the following statements pertaining to large heat transfer rate using fins

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



Which of the above statements are correct ?

- (A) 2, 3 and 4
- (B) 1, 2 and 4
- (C) 1, 3 and 4
- (D) 1, 2 and 3

27. In modern boilers, stacks alone can *not* create enough mechanical draught because

- (A) The rate of air supply as well as the rate of flue gas removal is high
- (B) Various heat exchangers are used on the way cause large pressure drop
- (C) Both (A) and (B)
- (D) Modern boilers operate at high pressure range



28. Which one of the following statements is true to two-dimensional flow of ideal fluids ?

- (A) Both potential function and stream function must exist for every flow
- (B) Stream function may or may not exist
- (C) Stream function will exist but potential function may or may not exist
- (D) Potential function exists if stream function exists

29. The hydrodynamic boundary layer thickness is defined as the distance from the surface where the

- (A) Momentum equals 99% of the momentum of the free stream
- (B) Velocity equals the approach velocity
- (C) Velocity equals 99% of the local external velocity
- (D) Velocity equals the local external velocity





30. Which one of the following non-dimensional numbers is mostly used for determining the transition from laminar to turbulent flow in free convection ?



- (A) Peclet number
- (B) Grashof number
- (C) Rayleigh number
- (D) Reynolds number

31. Which of the following water turbines does **not** require a draft tube ?



- (A) Kaplan Turbine
- (B) Pelton Turbine
- (C) Francis Turbine
- (D) Propeller Turbine

32. Which law states that for an adiabatic and steady flow, the Mach number can **not** increase across a normal shock wave ?

- (A) First law of thermodynamics
- (B) Rayleigh line
- (C) Second law of thermodynamics
- (D) Rankine-Hugoniot relation

33. The specific speed of a turbine is given by the equation



- (A)  $N\sqrt{P}/(H)^{5/4}$
- (B)  $N\sqrt{Q}/(H)^{3/2}$
- (C)  $N\sqrt{Q}/(H)^{5/4}$
- (D)  $N\sqrt{P}/(H)^{3/2}$

34. If the capillary rise of water in a 2 mm diameter tube is 1.5 cm, the height of capillary rise in a 0.5 mm diameter tube, in cm, will be

- (A) 6.0
- (B) 1.5
- (C) 24.0
- (D) 10.0

35. In a gas cycle refrigeration, an expander is used instead of a throttle valve for pressure drop of the refrigerant, because

- (A) there is inadequate content of temperature
- (B) there can be even heating of the gas if the temperature before throttling is not below the maximum inversion temperature
- (C) there can be leakage of gas
- (D) enough cooling or temperature drop is not obtained by throttling





36. COP of refrigerator based on reverse Carnot cycle decreases on

- (A) increasing the higher temperature and keeping the lower temperature constant
- (B) keeping the higher temperature constant and increasing the lower temperature
- (C) increasing the higher temperature and decreasing the lower temperature
- (D) decreasing the difference in operating temperatures



37. Which of the following can *not* be caused by a hot spark plug ?

1. Pre-ignition
2. Post-ignition
3. Detonation
4. Run-on-ignition

Select the correct answer using the code given below :

**Code :**



- (A) 2 and 3
- (B) 2 only
- (C) 3 only
- (D) 1 and 4

38. The critical pressure ratio of a convergent nozzle is defined as

- (A) The ratio of outlet pressure to inlet pressure only when mass flow rate per unit area is the maximum
- (B) The ratio of inlet pressure to outlet pressure of nozzle
- (C) The ratio of outlet pressure to inlet pressure only when mass flow rate per unit area is the minimum
- (D) The ratio of outlet pressure to inlet pressure of nozzle



39. Match the following :

- |               |                                     |
|---------------|-------------------------------------|
| a. Lancashire | 1. High pressure water tube         |
| b. Cornish    | 2. Horizontal double fire tube      |
| c. La Mont    | 3. Vertical multiple fire tube      |
| d. Cochran    | 4. Low pressure inclined water tube |
|               | 5. Horizontal single fire tube      |



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





40. Steam enters a De Laval steam turbine with an inlet velocity of 30 m/s and leaves with an outlet velocity of 10 m/s. The work done by 1 kg of steam is

- (A) 600 N-m
- (B) 400 N-m
- (C) 800 N-m
- (D) 200 N-m

41. If a hydraulic press has a ram of 12.5 cm diameter and plunger of 1.25 cm diameter, what force would be required on the plunger to raise a mass of 1 ton on the ram ?



- (A) 9.81 N
- (B) 98.1 N
- (C) 0.98 N
- (D) 981 N

42. The correct sequence of the given hydraulic turbine in decreasing order of their specific speeds is

- (A) Kaplan turbine, Pelton wheel and Francis turbine
- (B) Propeller turbine, Francis turbine and Pelton wheel
- (C) Francis turbine, Kaplan turbine and Pelton wheel
- (D) Pelton wheel, Francis turbine and Kaplan turbine

43. A steam turbine receives steam steadily at 10 bar with an enthalpy of 3000 kJ/kg and discharges at 1 bar with an enthalpy of 2700 kJ/kg. The work output is 250 kJ/kg. The changes in kinetic and potential energies are negligible. The heat transfer from the turbine casing to the surroundings is equal to



- (A) 125 kJ
- (B) 75 kJ
- (C) 150 kJ
- (D) 50 kJ

44. A four stroke automobile engine operates at a fuel-air ratio of 0.05, volumetric efficiency of 90% and indicated thermal efficiency of 30%. Given that the calorific value of the fuel is 45 MJ/kg and the density of air at intake is 1 kg/m<sup>3</sup>, the indicated mean effective pressure for the engine is



- (A) 60.75 bar
- (B) 6.075 bar
- (C) 4.35 bar
- (D) 12.15 bar





45. A balloon containing an ideal gas is initially kept in an evacuated and insulated room. The balloon ruptures and the gas fills up the entire room. Which one of the following statements is true at the end of above process ?



- (A) Both internal energy and enthalpy of the gas remains constant
- (B) The internal energy of the gas increases from its initial value, but the enthalpy remains constant
- (C) Both internal energy and enthalpy of the gas increase
- (D) The internal energy of the gas decreases from its initial value, but the enthalpy remains constant

46. The equivalent evaporation (kg/hr) of a boiler producing 2000 kg/hr of steam with enthalpy content of 2426 kJ/kg from feed water at temperature 40°C (liquid enthalpy at 40°C = 168 kJ/kg, enthalpy of vaporization of water at 100°C = 2258 kJ/kg) will be

- (A) 3262
- (B) 2150
- (C) 3248
- (D) 2000

47. If pump NPSH (Net Positive Suction Head) requirements are *not* satisfied



- (A) Efficiency will be low
- (B) It will be cavitated
- (C) No flow will take place
- (D) It will not develop head

48. The conservation of energy principles reduces to conserving mechanical energy alone in case of

- (A) Compressible fluid
- (B) Isothermal fluid
- (C) Incompressible fluid
- (D) None of the above



49. A tank contains 100 kg of liquid water and 5 kg of water vapour under saturation conditions at 20°C. If the specific volume of saturated vapour at that temperature is 57.8 m<sup>3</sup>/kg, what is the approximate volume of the tank ?

- (A) 320 m<sup>3</sup>
- (B) 290 m<sup>3</sup>
- (C) 430 m<sup>3</sup>
- (D) 250 m<sup>3</sup>



50. In steam turbine, what do you mean by diaphragm ?

- (A) Separating wall between rotors carrying nozzles
- (B) A partition between low and high pressure sides
- (C) The flange connecting the turbine exit to the condenser
- (D) The ring of guide blades between rotors



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