

B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Fourth Semester

Mechanical Engineering

20 MEPC 404 - THERMAL ENGINEERING

Regulations - 2020

(Use of Steam Tables, Mollier Chart, Refrigeration Tables are permitted)

Duration: 3 Hours

Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

<i>Marks</i>	<i>K – Level</i>	<i>CO</i>
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| 1. What is the primary characteristic of the Otto cycle? | 1 | K1 | CO1 |
| (a) Constant pressure heat addition | (b) Constant volume heat addition | | |
| (c) Constant temperature heat addition | (d) Constant entropy heat addition | | |
| 2. Which component is responsible for heat addition in a Brayton cycle? | 1 | K1 | CO1 |
| (a) Compressor | (b) Turbine | (c) Heat exchanger | (d) Combustor |
| 3. The steam enters the nozzle at a | 1 | K1 | CO2 |
| (a) High pressure and a low velocity | (b) High pressure and a high velocity | | |
| (c) Low pressure and a low velocity | (d) Low pressure and a high velocity | | |
| 4. Which of the following is a steam turbine? | 1 | K1 | CO3 |
| (a) De-laval | (b) Kaplan | (c) Francis | (d) Bulb |
| 5. Which compression process assumes no heat transfer and is reversible? | 1 | K1 | CO4 |
| (a) Isentropic | (b) Isothermal | (c) Adiabatic | (d) Polytropic |
| 6. In multi-stage compression, what is typically used to reduce the temperature of the air between stages? | 1 | K1 | CO4 |
| (a) Super-cooling | (b) Inter-cooling | (c) Pre-cooling | (d) Post-cooling |
| 7. In the two-stroke engine, the process of replacing the exhaust gas in a cylinder with the fresh air/fuel mixture is known as | 1 | K1 | CO5 |
| (a) Scavenging | (b) Compression | (c) Suction | (d) Exhaust |
| 8. The compression ratio is the ratio of | 1 | K1 | CO5 |
| (a) Swept volume to Total volume | (b) Total volume to Swept volume | | |
| (c) Swept volume to Clearance volume | (d) Total volume to Clearance volume | | |
| 9. In the vapour compression refrigeration system, the condition of refrigerant is saturated liquid | 1 | K1 | CO6 |
| (a) After passing through the condenser | (b) Before passing through the condenser | | |
| (c) Before entering the compressor | (d) After passing through the expansion valve | | |
| 10. In the SI unit, one ton of refrigeration is equal to | 1 | K1 | CO6 |
| (a) 210 kJ/min | (b) 21 kJ/min | (c) 3.5 kJ/min | (d) 420 kJ/min |

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

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| 11. Write the assumptions made in deriving Air Standard Cycle efficiency. | 2 | K1 | CO1 |
| 12. Draw the Dual cycle on P-V and T-S Diagrams. | 2 | K2 | CO1 |
| 13. Define nozzle efficiency. | 2 | K1 | CO2 |
| 14. What are the main functions of steam nozzles? | 2 | K1 | CO2 |
| 15. Explain the principle of impulse turbine. | 2 | K2 | CO3 |
| 16. Classify steam turbines. | 2 | K1 | CO3 |
| 17. List out the applications of Air compressors. | 2 | K1 | CO4 |
| 18. Differentiate Swept Volume and Clearance volume. | 2 | K2 | CO4 |
| 19. Draw the theoretical valve timing diagram of SI engine. | 2 | K2 | CO5 |

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| 20. What are the functions of piston rings? | 2 | K1 | CO5 |
| 21. What are the major applications of Refrigeration? | 2 | K1 | CO6 |
| 22. Name the various components used in simple vapour absorption system. | 2 | K1 | CO6 |

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

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| 23. a) | Derive the Air Standard efficiency for Constant Volume Cycle. | 11 | K3 | CO1 |
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| b) | An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel Cycle. The inlet pressure and temperature of air are 1 bar and 300 K. The cut off is 8 % of the stroke. Calculate the following parameters (i) Theoretical air standard efficiency (ii) Pressure and Temperature at various points of the cycle. Assume that the compression ratio is 15 and working fluid is air. | 11 | K3 | CO1 |
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| 24. a) | Derive the expression of maximum mass flow rate when steam passes through steam nozzle. | 11 | K2 | CO2 |
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| b) | Air enters a frictionless adiabatic converging nozzle at 10 bar 500 K with negligible velocity. The nozzle discharges to a region at 2 bar. If the exit area of the nozzle is 2.5 cm^2 , Calculate the flow rate of air through the nozzle. | 11 | K2 | CO2 |
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| 25. a) | A single-stage impulse turbine is supplied steam at 6 bar and 220°C at the rate of 55 kg/min and it expands into a condenser at a pressure of 0.3 bar. The blade speed is 400 m/s and nozzles are inclined at 20°C to the plane of the wheel. The blade angle at the exit of the moving blade is 28°C . Neglecting friction losses in the moving blade, Identify (i) Velocity of the steam entering the blades (ii) Power developed, (iii) Blade efficiency and (iv) Stage efficiency. | 11 | K3 | CO3 |
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| b) | Construct and explain the velocity and pressure compounding in detail and interpret the significance of compounding. | 11 | K3 | CO3 |
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| 26. a) | A single cylinder single acting air compressor compresses $30 \text{ m}^3/\text{s}$ of air at a pressure of 1 bar and 27°C to 700 kPa. Identify the power required for the compressor, if the compression is (i) Isothermal, (ii) Polytropic, (iii) Adiabatic. Take $n=1.25$. | 11 | K3 | CO4 |
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| b) | A three stage air compressor with perfect intercooling takes 15 m^3 of air per minute at 95 kPa and 27°C and delivers the air at 3.5 Mpa. If the compression process is polytropic ($PV^{1.3}=C$). Identify the Power required if the mechanical efficiency is 90%. | 11 | K3 | CO4 |
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| 27. a) | Describe the working of Four stroke cycle Spark ignition engine with a suitable sketch. | 11 | K2 | CO5 |
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| b) | Illustrate stages of combustion in SI engines? How much heat is released in each stage? | 11 | K2 | CO5 |
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| 28. a) | Construct and explain the working of vapour compression refrigeration system. | 11 | K3 | CO6 |
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OR

- b) A cinema hall of seating capacity 1500 persons has been provided with an air conditioned plant with the following data: *11 K3 CO6*
Outdoor conditions = 40°C DBT and 20°C WBT
Required conditions = 20°C DBT and 60% RH
Amount of air supplied = 0.3 m³/min/person.
If the required condition is achieved first by adiabatic humidifying and then cooling, Identify: (i) The capacity of the cooling coil and (ii) Capacity of the humidifier.