GUJARAT TECHNOLOGICAL UNIVERSITY

BE- 3 SEMESTER – OLD PAPER – S23 TO S25- QUESTION BANK

Subject Name & Code:
Engineering Thermodynamics (3131905)

Unit 1: Basic Concepts

Repeated Questions:

1. Define: System, Property, Cycle, Process, Isolated system. **(03 Marks - S24, W23)**
2. Explain thermodynamic equilibrium. **(03 Marks - S24, S23, S25, W24)**
3. Explain the Zeroth law of thermodynamics and its applications. **(04 Marks - S24, W23, W24)**

Other Important Questions:

4. **S23:** Discuss the type of thermodynamic system by giving suitable example. **(03 Marks)**
5. **S23:** Explain state and property also describe intensive and extensive property. **(03 Marks)**
6. **W24:** Define and explain: (i) Homogenous and Heterogeneous system (ii) Intensive and Extensive properties. **(04 Marks)**
7. **W22:** Discuss perpetual motion machines of first kind with neat sketch. **(03 Marks)**

Unit 2: First Law of Thermodynamics

Repeated Questions:

1. Derive the Steady Flow Energy Equation (SFEE) and deduce it for a turbine/nozzle. **(07 Marks - S23, S24, S25)**
2. Explain the First Law for a closed system undergoing a cycle and a process. **(07 Marks - W23)**
3. Discuss the limitations of the First Law of Thermodynamics. **(03 Marks - S23, W22)**
4. **Explain PMM1 (Perpetual Motion Machine of the First Kind) with a diagram.**
   ➤ Appeared in: W23 (Q1a, 03 marks), W24 (Q2a, 03 marks), S25 (Q2b, 04 marks)

Other Important Questions:

1. **Compare heat pump and refrigerator.**
   ➤ Appeared in: S24 (Q2b, 04 marks)
2. **Show that COP of a heat pump is greater than COP of a refrigerator by unity.**
   ➤ Appeared in: S23 (Q3b, 04 marks), S25 (Q2a, 03 marks)
3. **At the inlet to an insulated nozzle, steam enters at 687 kPa and 205°C with 3000 m/min velocity and leaves at a pressure of 137 kPa and 30000 m/min velocity. Determine enthalpy of leaving steam. Mention the assumptions made.**
   ➤ Appeared in: W23 (Q2c, 07 marks)
4. **A stream of gases at 750 kPa, 750°C and 140 m/s is passed through a gas turbine of a jet engine. The stream comes out of the turbine at 200 kPa, 550°C and 280 m/s. The enthalpies of gas at the entry and exit of the turbine are 950 kJ/kg and 650 kJ/kg of gas respectively. Determine the capacity of the turbine if the gas flow is 5 kg/s. Assume the process is adiabatic.**
   ➤ Appeared in: S24 (Q2c, 07 marks)
5. **In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate: (i) The rate at which heat is rejected to the turbine and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg.**
   ➤ Appeared in: W24 (Q2c, 07 marks)

Unit 3: Second Law of Thermodynamics

Repeated Questions:

1. State and prove the equivalence of Kelvin-Planck and Clausius statements of the Second Law. **(07 Marks - W23, S24, S23)**
2. Explain PMM-I and PMM-II. **(03 Marks - S23, S24, S25, W24)**
3. Show that the efficiency of a reversible heat engine operating between two constant temperatures is maximum. **(07 Marks - S23, S25)**
4. **Explain Carnot cycle and its limitations.**
   ➤ Appeared in: W23 (Q2a, 03 marks), S23 (Q5a, 03 marks), S24 (Q3a, 03 marks)

Other Important Questions:

1. **S25:** State and prove Clausius theorem. **(03 Marks)**
2. **W22:** Carnot cycle is not practical – Justify the statement. **(03 Marks)**
3. **W23:** Carnot cycle is practically impossible. Justify the statement. **(03 Marks)**
4. **Show that the efficiency of a reversible heat engine operating between two constant temperatures is maximum.**
   ➤ Appeared in: S23 (Q4c, 07 marks), S25 (Q3b, 04 marks)
5. **300 kJ/s of heat is supplied at a constant fixed temperature of 290°C to a heat engine. The heat rejection takes place at 8.5°C. The following results were obtained: (i) 215 kJ/s are rejected, (ii) 150 kJ/s are rejected, (iii) 75 kJ/s are rejected. Classify which of the result report a reversible cycle or irreversible cycle or impossible results.**
   ➤ Appeared in: W24 (Q2c, 07 marks)
6. **Determine the least rate of heat rejection per kW net output of the cyclic heat engine which operates between a source temperature of 1000°C and a sink temperature of 40°C.**
   ➤ Appeared in: S24 (Q2c, 07 marks)
7. **An inventor claims that his engine develops 75 kW of power while operating between 1023K and 298K temperature. The amount of fuel (C.V. of fuel = 74500 kJ/kg) burnt per hour is 3.9 kg. Comment about the validity of his claim and justify your comment.**
   ➤ Appeared in: S25 (Q2c, 07 marks)
8. **An inventor claims that a new heat cycle will develop 0.4 kW for a heat addition of 32.5 kJ/min. The temperature of heat source is 1990 K and that of sink is 850 K. Is his claim possible?**
   ➤ Appeared in: W24 (Q5a, 03 marks)

Unit 4: Entropy

Repeated Questions:

1. Prove that entropy is a property of the system. **(04 Marks - W22, W23, W24)**
2. Explain the principle of increase of entropy. **(07 Marks - S25, W24)**
3. Define and explain: Available energy, Unavailable energy, Exergy, Anergy, Irreversibility. **(03 Marks - S24, W22, W23, S25)**

Other Important Questions:

1. **S23:** Explain the Clausius inequality. **(04 Marks)**
2. **W23:** Derive an expression for exergy of a closed system. **(07 Marks)**
3. **S25:** Explain Guoy-Stodola theorem. **(04 Marks)**
4. **W23:** Explain the Third Law of Thermodynamics. **(03 Marks)**
5. **Show that the efficiency of a reversible heat engine operating between two constant temperatures is maximum.**
   ➤ Appeared in: S23 (Q4c, 07 marks), S25 (Q3b, 04 marks)
6. **300 kJ/s of heat is supplied at a constant fixed temperature of 290°C to a heat engine. The heat rejection takes place at 8.5°C. The following results were obtained: (i) 215 kJ/s are rejected, (ii) 150 kJ/s are rejected, (iii) 75 kJ/s are rejected. Classify which of the result report a reversible cycle or irreversible cycle or impossible results.**
   ➤ Appeared in: W24 (Q2c, 07 marks)
7. **Determine the least rate of heat rejection per kW net output of the cyclic heat engine which operates between a source temperature of 1000°C and a sink temperature of 40°C.**
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8. **An inventor claims that his engine develops 75 kW of power while operating between 1023K and 298K temperature. The amount of fuel (C.V. of fuel = 74500 kJ/kg) burnt per hour is 3.9 kg. Comment about the validity of his claim and justify your comment.**
   ➤ Appeared in: S25 (Q2c, 07 marks)
9. **An inventor claims that a new heat cycle will develop 0.4 kW for a heat addition of 32.5 kJ/min. The temperature of heat source is 1990 K and that of sink is 850 K. Is his claim possible?**
   ➤ Appeared in: W24 (Q5a, 03 marks)

Unit 5: Energy (Exergy & Irreversibility)

Repeated Questions:

1. **Define: Exergy, Anergy, Dead state, Irreversibility.**
   ➤ Appeared in: W23 (Q3a, 03 marks), W24 (Q3a, 03 marks), S23 (Q5a, 03 marks), S25 (Q3a, 03 marks)
2. **Explain types of irreversibility and their effects.**
   ➤ Appeared in: W23 (Q3b, 04 marks), W24 (Q3b, 04 marks)
3. **Derive expression for exergy of a closed system / steady flow system.**
   ➤ Appeared in: W23 (Q3c, 07 marks), S23 (Q5c, 07 marks)

Other Important Questions:

1. **Explain Guoy-Stodola theorem.**
   ➤ Appeared in: S25 (Q3b, 04 marks)
2. **A heat engine receives 1000 kW of heat from an infinite heat source at 559 K and rejects heat at 279 K to an infinite heat sink. Comment whether the cycle is possible or irreversible for following heat rejection amounts: (i) 400 kW, (ii) 490 kW, (iii) 850 kW.**
   ➤ Appeared in: W23 (Q3c, 07 marks)
3. **Explain available and unavailable energy.**
   ➤ Appeared in: S24 (Q4a, 03 marks)
4. **Derive relevant equation to get maximum work from a finite body and thermal energy reservoir.**
   ➤ Appeared in: W23 (Q3c, 07 marks)

Unit 6: Vapor Power Cycles (Rankine Cycle)

Repeated Questions:

1. Compare Carnot and Rankine cycles. **(03 Marks - W22, W23, S24, W24)**
2. Draw the Rankine cycle on P-v, T-s, and h-s diagrams and derive its efficiency. **(07 Marks - S23, S25)**
3. **Explain effect of regeneration on Rankine cycle with diagram.**
   ➤ Appeared in: W24 (Q4b, 04 marks), S25 (Q4b, 04 marks)
4. Solve a numerical problem on an ideal Rankine cycle (find efficiency, work done, etc.). **(07 Marks - S24, W23, S23, W24, S25)**
5. **In an ideal Rankine cycle, steam at 20 bar and 350°C expands in steam turbine to 0.05 bar. The saturated water after condensation fed back to the boiler. Determine (i) net work done per kg of steam, (ii) Rankine cycle efficiency.**
   ➤ Appeared in: W23 (Q4c, 07 marks)
6. **In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine: (i) The pump work, (ii) The turbine work, (iii) The Rankine efficiency, (iv) The condenser heat flow, (v) The dryness at the end of expansion. Assume the mass flow rate of steam equals to 9.5 kg/s.**
   ➤ Appeared in: S24 (Q4c, 07 marks)

Other Important Questions:

4. **S24:** Explain with a neat schematic diagram the Reheat Rankine cycle. **(04 Marks)**
5. **W23:** Explain variables affecting the efficiency of the Rankine cycle. **(03 Marks)**
6. **W23:** Discuss the effect of superheat and condenser pressure variation on the Rankine cycle. **(03 Marks)**
7. **S25:** Explain the simple regenerative Rankine cycle. **(04 Marks)**
8. **W24:** State advantages and disadvantages of regenerative feed heating. **(03 Marks)**
9. **S23:** What is the mean temperature of heat addition? Explain its significance. **(04 Marks)**
10. **Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal processes, find per kg steam the network and the cycle efficiency.**
    ➤ Appeared in: S23 (Q5c, 07 marks)
11. **In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work.**
    ➤ Appeared in: W24 (Q4c, 07 marks), S25 (Q5c, 07 marks)

Unit 7: Gas Power Cycles (Otto, Diesel, Dual)

Repeated Questions:

1. Derive the air standard efficiency equation for the Otto cycle. **(07 Marks - S24, W24)**
2. Derive the air standard efficiency equation for the Diesel cycle. **(07 Marks - S23, W22)**
3. Compare Otto, Diesel, and Dual cycles for the same compression ratio and heat supplied. **(04 Marks - S23, S25, W24)**
4. **State assumptions made for analysis of air standard cycles.**
   ➤ Appeared in: W23 (Q4a, 03 marks), W24 (Q4a, 03 marks), S25 (Q4a, 03 marks)

Other Important Questions:

1. **S24:** An oil engine works on the dual combustion cycle. Find the ideal efficiency. **(04 Marks)**
2. **W22:** Compare Otto, Diesel, and Dual cycles for the same maximum pressure and temperature. **(04 Marks)**
3. **W24:** Derive an expression for the thermal efficiency of an Otto cycle. **(04 Marks)**
4. **In an engine working on Otto cycle, air has a pressure of 1 bar and temperature 30°C at the entry. Air is compressed with a compression ratio of 6. The heat is added at constant volume until the temperature rises to 1500°C. Determine (i) air standard efficiency, (ii) pressure and temperature at the end of compression, (iii) heat supplied, (iv) mean effective pressure. Take Cv = 0.718 kJ/kg K, R = 0.287 kJ/kg K.**
   ➤ Appeared in: W23 (Q4c, 07 marks)
5. **An engine working on the Otto cycle is supplied with air at 0.1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100 kJ/kg. Calculate the maximum pressure and temperature of the cycle, the cycle efficiency and mean effective pressure (for air, Cp = 1.005, Cv = 0.718 and R = 0.287 kJ/kg K).**
   ➤ Appeared in: S23 (Q4c, 07 marks)
6. **In an engine operated on Otto cycle, the compression ratio is 6 and the compression starts at 30°C and 100 kPa. The maximum temperature of the cycle is 1250°C. Determine: (i) heat supplied per kg of air, (ii) air standard efficiency of the cycle, (iii) Mean effective pressure of the cycle. Take Cv = 0.716 and γ = 1.4.**
   ➤ Appeared in: W23 (Q4c, 07 marks)
7. **A diesel engine has compression ratio of 20. The compression begins at 0.1 MPa and 35°C. The heat added is 1700 kJ/kg. Calculate maximum pressure and temperature of cycle, work done per kg of air and cycle efficiency.**
   ➤ Appeared in: S25 (Q4c, 07 marks)
8. **An oil engine working on the dual combustion cycle has a compression ratio of 14 and the explosion ratio obtained from an indicator card is 1.4.**

If the cut-off occurs at 6 per cent of the stroke, find the ideal efficiency. Take γ for air = 1.4.

➤ Appeared in: S24 (Q3b, 04 marks)

9. **The air standard efficiency of an Otto cycle is 60% and γ = 1.4. Calculate the compression ratio.**

   ➤ Appeared in: S24 (Q3b, 04 marks)