Register No:

Dhanalakshmi Srinivasan Engineering College

(Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai)
(Accredited with 'A' Grade by NAAC)
Perambalur – 621 212

Model Exam

Department of Aeronautical Engineering

AE 8301 | Aero Engineering Thermodynamics

(Common to Aeronautical and Aerospace Engineering)

Year | Semester	: II | III	**Date**	: 12.10.2019
Duration	: 3 hours	**Max. Marks**	: 100 Marks

Answer all the Questions

Part – A (10 X 2 = 20)

1. What is meant by a thermal energy reservoir?
2. State: Zeroth law of thermodynamics. Also give its importance.
3. What are cyclic and non-cyclic heat engines? Give examples.
4. What is entropy? How is it defined and calculated?
5. What is an air standard efficiency and relative efficiency?
6. Draw the p-v and T-s diagram for Brayton cycle.
7. What is triple point? What are the values of temperature and pressure of water at triple point?
8. State the advantages of regenerative cycle/simple Rankine cycle.
9. What is specific impulse? Also state its significance.
10. What are the factors affecting the thermal conductivity?

Part – B (5 X 13 = 65)

11. a) 0.4 m^3 of air at 5 bar and 130 °C is contained in a system. A reversible adiabatic expansion takes place till the pressure falls to 1.02 bar. The gas is then heated at constant pressure till enthalpy increases by 72.5 kJ. Calculate: i) The work done, ii) The index of expansion, if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states.

(Or)

b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure and 0.95 m^3/kg volume and leaving at 5 m/s, 700 kPa and 0.19 m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW. i. Compute the rate of shaft work input to the air in kW. ii. Find the ratio of the inlet pipe diameter to outlet pipe diameter.

12. a) Two reversible heat engines A and B are arranged in series. A rejects heat directly to B. A receives 1200 kJ at 427 °C from the hot source while B rejects heat to cold sink at 15 °C. Work output of A is twice that of B. Find the intermediate temperature between A and B, efficiency of each engine and heat rejected to the sink.

(Or)

b) 1 kg of ice at 0 ºC is mixed with 10 kg of water at 30 ºC. Determine the net increase in the entropy and unavailable energy when the system reaches common temperature. Assume that surrounding temperature is 10 ºC. Take, specific heat of water is 4.18 kJ/kg.K, specific heat of ice is 2.1 kJ/kg.K, and latent heat of ice is 333.5 kJ/kg.

13. a) An engine works on Otto cycle. The initial pressure and temperature of the air is 1 bar and 40 ºC. 825 kJ of heat is supplied per kg of air at the end of the compression. Find the temperature and pressure at the salient points if the compression ratio is 6. Also find the efficiency and mean effective pressure for the cycle. Assume air is used as working fluid and take all ideal conditions.

(Or)

b) An ideal cycle using air as the working fluid has a compression ratio of 18 and cut off ratio of 3. The intake conditions are 150 kPa, 25 ºC and 2500 cm^3. Determine: i) The net work output, ii) Thermal efficiency of cycle, iii) The mean effective pressure.

14. a) In a steam turbine steam at 20 bar, 360 °C is expanded to 8 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 of steam, the network and the cycle efficiency.

(Or)

b) In a regenerative cycle, the inlet conditions are 40 bar and 400 °C. Steam is bled at 10 bar in regenerative heating. The exit pressure is 0.8 bar. Neglecting pump work. Determine the efficiency of the cycle.

15. a) A turbojet engine, flying at an altitude, receives air at 0.6 bar and 255 K and it is compressed through a compression ratio of 8, with an isentropic efficiency of 80 %. Fuel with heating value of 40 MJ/kg is used to raise the temperature to 1200 K before entering the turbine with isentropic efficiency of 95 %. The mechanical transmission efficiency is 97 %. A convergent nozzle with an exit area of 0.5 m2 is used to produce a gas jet. Determine the jet velocity, thrust, and specific fuel consumption.

(Or)

b) Write short notes on Convective and Radiative heat transfer.

Part – C (1 X 15 = 15)

16. a) Metal block with m=5 kg, C= 0.4 kJ/kg.K at 40 ºC is kept in a room at 20 ºC. It is cooled in the following two ways: i) Using a Carnot engine (executing integral number of cycles) with the room itself as the cold reservoir; ii) Naturally. In each case, calculate the changes in entropy of the block, of the air of the room and of the universe. Assume that the metal block has constant specific heat.

(Or)

b) A steel tube k=43.26 W/m.K of 5.08 cm ID and 7.62 cm OD is covered with 2.54 cm of asbestos insulation k=0.208 W/m.K. The inside surface of the tube receives heat by convection from a hot gas at a temperature of 316 °C with heat transfer coefficient of 284 $W/m^2.K$ while the outer surface of insulation is exposed to atmosphere air at 38 °C with heat transfer coefficient of 17 $W/m^2.K$. Calculate heat loss to atmosphere for 3 m length of the tube and temperature drop across each layer.

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Part – A (10 X 2 = 20)

1. Define: Internal energy.
2. What is Nozzle? Write its energy flow equation.
3. Prove that $COP_{HP}=COP_R+1$.
4. What do you know about increase of entropy?
5. Compare the combustion process of Otto, Diesel and Dual cycles.
6. What is mean effective pressure? How is it calculated?
7. What is the difference between the critical point and the triple point?
8. Name the different process of Rankine's cycle in T-s diagram.
9. How will you classify propulsive engine?
10. Mention some applications of radiation heat transfer.

Part – B (5 X 13 = 65)

11. a) A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 MPa to a final state of 0.15 m^3 and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the Gas change.

(Or)

b) In an air compressor, air flows steadily at the rate of 0.5 kg/s. At entry to the compressor, air has a pressure of 105 kPa and specific volume of 0.86 m^3/kg and at exit of the compressor those corresponding values are 705 kPa and 0.16 m^3/kg. Neglect kinetic and potential energy change. The internal energy of air leaking the compressor is 95 kJ/kg greater than that of air entering. The cooling water in the compressor absorbs 60 kJ/s of heat from the air. Find power required to drive the compressor.

12. a) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300 K at a rate twice that at which the engine rejects heat to it. If the efficiency of the engine is 40 % of the maximum possible and the COP of the heat pump is 50 % of the maximum possible, what is the temperature of the reservoir to which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW?

(Or)

b) A particular gas having a specific heat at constant volume of 1.25 kJ/kg-K, is expanded reversibly and adiabatically from a specific volume of 0.06 m^3/kg and a temperature of 600 K to a specific volume of 0.18 m^3/kg, while its temperature drops by 165 K. when the gas is expanded into an evacuated space from its same initial state to the same final

specific volume, the temperature drop is only 50 K. Calculate the entropy change in each of the two processes.

13. a) An air standard Diesel cycle has a compression ratio of 18 and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression stroke, the pressure is 1 bar and the temperature is 300 K. Calculate: i) Thermal efficiency, ii) The mean effective pressure.

(Or)

b) An air standard cycle is executed in a closed system and consists of the following four process: 1-2 isentropic compression from 102 kPa and 15 °C to 612 kPa; 2-3 constant pressure heat addition of 485 kJ/kg; 3-4 isentropic expansion to 102 kPa; 4-1 constant pressure heat rejection to the initial state. Calculate the net work output per unit mass and the thermal efficiency.

14. a) Write short notes on the following: i) p-T diagram and pVT surface for pure substances, ii) Ideal and Actual vapour power cycles.

(Or)

b) A steam power plant operates between a boiler pressure of 4 MPa and 300 °C and a condenser pressure of 50 kPa. Determine the thermal efficiency of the cycle assuming the cycle to be a simple ideal Rankine cycle.

15. a) An aircraft flies at 90 km/hr. one of its turbojet engines takes in 40 kg/s of air and expands the gases to the ambient pressure. The air-fuel ratio is 50 and the lower calorific value of the fuel is 43 MJ/kg. for maximum thrust power, determine: jet velocity, thrust, specific thrust, thrust power, propulsive and thermal efficiencies.

(Or)

b) Explain the modes of heat transfer and derive the heat flow equations of conduction in parallel and radial flow.

Part – C (1 X 15 = 15)

16. a) In a single heater regenerative cycle, the steam enters the turbine at 30 bar, 400 °C and the exhaust pressure is 0.1 bar. The feed water heater is a direct contact type which operates at 5 bar. Find: i) The efficiency and the steam rate of the cycle, and ii) The increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without regeneration) neglect pump work.

(Or)

b) A cold storage room has walls made of 0.23 m of brick on the outside, 0.08 m of plastic foam, and finally 15 mm of wood on the inside. The outside and inside air temperature are 22 °C and -2 °C respectively. If the inside and outside heat transfer coefficients are respectively 29 and 12 $W/m^2.K$ and the thermal conductivities of brick, foam and wood are 0.98, 0.02 and 0.17 W/m.K respectively, determine (i) the rate of heat removal by refrigeration if the total wall area is 90 m, and (ii) the temperature of the inside surface of the brick.

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