



B.E DEGREE EXAMINATIONS: JUNE 2015

(Regulation 2009)

Third Semester

AERONAUTICAL ENGINEERING

AER102: Aero Engineering Thermodynamics

(Use of Refrigerant table and psychrometric chart is permitted)

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. When a system has only heat and work transfer, but there is no mass transfer is known as
 - a) closed system
 - b) open system
 - c) isolated
 - d) Both a & b
2. A system is said to be consisting of a pure substance when
 - a) it is homogeneous in composition
 - b) it is homogeneous and invariable in chemical aggregation
 - c) it has only one phase
 - d) it has more than one phase
3. For the same temperature limits and heat input, the most efficient cycle is
 - a) Diesel cycle
 - b) Brayton cycle
 - c) Carnot cycle
 - d) Otto cycle
4. A cycle consisting of one constant pressure, one constant volume and two isentropic processes is known as
 - a) Carnot cycle
 - b) Stirling cycle
 - c) Otto cycle
 - d) Diesel cycle
5. Intercooling in multi-stage compressors is done to
 - a) cool the air during compression
 - b) cool the air at delivery
 - c) enable compression in two stages
 - d) minimize the work of compression
6. A second law of thermodynamics defines
 - a) heat
 - b) work
 - c) enthalpy
 - d) entropy
7. Refrigeration is generally produced by
 - a) melting of a solid
 - b) non-sublimation of a solid

- c) non-evaporation of a liquid d) treatment of metals
8. A refrigerating machine working on Reversed Carnot cycle takes out 2kW per minute of heat from the system while working between temperatures limits of 300K and 200K. COP and power consumed by the cycle will be
- a) 1, 1 kW b) 1, 2 kW
c) 2, 1 kW d) 2, 2 kW
9. The ambient air temperature as recorded by ordinary thermometer is called
- a) Wet bulb temperature b) Dew point temperature
c) Dry bulb temperature d) Saturation temperature
10. In Carnot vapour cycle, heat addition and rejection is
- a) isothermal b) isobaric
c) isochoric d) Both a & b

PART B (10 x 2 = 20 Marks)

11. Why does free expansion have zero work transfer?
12. What are intensive and extensive properties?
13. State the four processes of the Diesel cycle?
14. What is the physical significance of mean effective pressure?
15. Define: Adiabatic efficiency and Isothermal efficiency
16. What is the need of staging the compression process?
17. What is refrigerating effect? What is a tonne of refrigeration?
18. How is a reversed Brayton cycle used for refrigeration?
19. What is an adiabatic saturation process?
20. Define Dew point temperature

PART C (5 x 14 = 70 Marks)

21. a) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and - 20°C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360 kJ.
- (a) Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C.
- (b) Reconsider (a) given that the efficiency of the heat engine and the COP

of the refrigerator are each 40% of their maximum possible values.

(OR)

- b) (i) Derive the equation of Clausius inequality. (7)
(ii) Water flows through a turbine in which friction causes the water temperature rise from 35°C to 37°C. If there is no heat transfer, how much does the entropy of the water change in passing through the turbine. (7)

22. a) (i) Show that the efficiency of the Brayton cycle depends only on the pressure ratio. (10)
(ii) How does Brayton cycle compare with Rankine cycle (4)

(OR)

- b) An air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar, 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate (a) the pressures and temperatures at the cardinal points of the cycle, (b) the cycle efficiency, and (c) the m.e.p. of the cycle, $c_v = 0.718$ kJ/kgK, $c_p = 1.005$ kJ/kgK.

23. a) (i) A single-acting two-stage reciprocating air compressor with complete intercooling delivers 6 kg/min at 15 bar pressure. Assume an intake condition of 1 bar and 15°C and that the compression and expansion processes are polytropic with $n=1.3$. Calculate: (a) The power required, and (b) the isothermal efficiency (10)
(ii) Explain volumetric efficiency and free air delivery of a compressor (4)

(OR)

- b) Derive an expression for the optimum intermediate pressure to minimum work input in a two stage reciprocating compressor with perfect intercooling.

24. a) A vapour compression refrigeration system uses R-12 and operates between pressure limits of 0.745 and 0.15 MPa. The vapour entering the compressor has a temperature of -10°C and the liquid leaving the condenser is at 28°C. A refrigerating load of 2 kW is required. Determine the COP and the swept volume of the compressor if it has a volumetric efficiency of 76% and runs at 600 rpm.

(OR)

- b) (i) What are the effects of CFCs on the environment (4)
(ii) Explain in detail the vapour compression refrigeration cycle with neat sketches (10)

25. a) (i) The dry and the wet-bulb temperatures of atmospheric air at 1 atm (101.325 kPa) (8) pressure are measured with a sling psychrometer and determined to be 25 and 15°C, respectively. Determine (a) the specific humidity, (b) the relative humidity, and (c) the enthalpy of the air.
- (ii) Consider a room that contains air at 1 atm, 35°C, and 40 percent relative (6) humidity. Using the psychrometric chart, determine (a) the specific humidity, (b) the enthalpy, (c) the wet-bulb temperature, (d) the dew-point temperature, and (e) the specific volume of the air.

(OR)

- b) Air at 1 atm, 15°C, and 60 percent relative humidity is first heated to 20°C in a heating section and then humidified by introducing water vapor. The air leaves the humidifying section at 25°C and 65 percent relative humidity. Determine (a) the amount of steam added to the air, and (b) the amount of heat transfer to the air in the heating section.
