Register Number……

B.E. DEGREE EXAMINATIONS: NOVEMBER 2009

Third Semester

AERONAUTICAL ENGINEERING

U07AR301: Aero Engineering Thermodynamics

Time: Three Hours **Maximum Marks: 100**

Answer ALL the Questions:-

PART A (10 × 1 = 10 Marks)

1. The expression $\int pdV$ may be applied for obtaining work of

   a. Non – flow reversible process

   b. Steady flow reversible process

   c. Steady flow adiabatic irreversible process

   d. Steady flow adiabatic reversible process.

2. A perfect gas at 27°C is heated till its volume is doubled. The pressure is unchanged. The final temperature is

   a. 54°C b.540°C c. 327°C d. 600°C

3. For the same compression ratio

   a. otto cycle is more efficient than diesel cycle

   b. diesel cycle is more efficient then otto cycle

   c. otto cycle & diesel cycle have the same efficiency

   d. efficiency is independent of compression ratio

4. Compression ratio of spark ignition engines normally varies from

   a. 4 to 6 b.6 to 12 c.10 to 18 d.14 to 22

5. The main function of condenser is

   a. To create vacuum b. To maintain vacuum

   c. To condense steam to water to be re-used d. To avoid pollution

6. Turboprop engines are limited to

   a. Low speed & low altitude b. Low speed & high altitude

   c. High speed & high altitude d. High speed & low altitude

7. Which of the following is not a desirable property of a refrigerant?

   a. Low boiling point b. Low freezing point

   c. Low latent heat d. Low specific volume

8. Sub – cooling is a process of cooling the refrigerant in vapour compression refrigeration system

   a. After compression b. Before compression

   c. Before throttling d. After throttling

9. The work input to reciprocating air compressor is minimum if the compression follows the law

   a. $pV^{\gamma} = C$ b. $pV = C$ c. $pV^{1.2} = C$ d. $pV^{n} = C$

10. In a positive displacement rotary air compressor namely roots blower, how many times the high pressure air is delivered per revolution

    a. Once b.Twice c.Thrice d. Four times

PART B (10 x 2 = 20 Marks)

11. Give the Clausius statement of second law.
12. What is PMM2? Why is it impossible?
13. In what way Brayton cycle is differing from Otto cycle?
14. Define compression ratio & mean effective pressure?
15. Define specific impulse of a rocket.
16. Show the throttling process & isentropic expansion process on h-s diagram for steam.
17. Show the simple vapour compression refrigeration cycle (with dry saturated vapour entering the compressor & no sub – cooling) on T-s & p-h diagrams.
18. What is the difference between a refrigerator and a heat pump?
19. Classify the various types of air compressors.
20. Compare axial & centrifugal compressors.

PART C (5 x 14 = 70 Marks)

21(a) (i) Derive the equation of Clausius inequality. (8)

(ii) Define flow work and derive the expression for the same. (6)

(OR)

(b) A certain gas has c_p=1.968 and c_v=1.507 kJ/kgK. Find its molecular weight and the gas constant. A constant volume chamber of 0.3 m^3 capacity contains 2 kg of this gas at 5°C. Heat is transferred to the gas until the temperature is 100°C. Find the work done, the heat transferred and the changes in internal energy, enthalpy and entropy.

22 (a)A petrol engine is supplied with fuel which has a calorific value of 4200 kJ/kg. The pressures in the cylinder at 30% and 70% of the compression strokes are 1.3 bar and 2.6 bar respectively. Assuming that the compression follows the law $pV^{1.4}$=C, find the air standard efficiency of the cycle.

(OR)

(b)In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 Mpa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate (i) the cut-off ratio (ii) the heat supplied per kg of air, (iii) the cycle efficiency and (iv) the mean effective pressure.

23(a) 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 of steam the net work and the cycle efficiency.

(OR)

(b)Show that for isentropic flow in a duct of varying cross-section $\frac{dA}{A} = vdp\left(\frac{1}{c^2} - \frac{1}{a^2}\right)$ where c is the fluid velocity and a is the local sonic velocity. Explain the physical significance of this equation by considering subsonic, sonic and supersonic flow in nozzles and diffusers.

24 (a) A vapour compression refrigeration system using R12 has condensing temperature of 50°C and evaporating temperature of 0°C. the refrigeration capacity is 7 tons. The liquid leaving the condenser is saturated liquid and compression is isentropic. The vapour leaving the evaporator is dry saturated. Assume that enthalpy at the end of

isentropic compression = 210 kJ/kg. Determine (i) the refrigerant flow rate, (ii) power required to run the compressor, (iii) heat rejected in the plant and (iv) COP of the system.

The properties of R12 are listed below:

Temp (°C)	Pressure(bar)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kgK)	s_g (kJ/kgK)
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

(OR)

(b) Discuss the working of vapour absorption refrigeration system with neat sketches.

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

(OR)

(b) A single stage single acting compressor delivers 15 m^3 of free air per minute from 1 bar to 8 bar. The speed of compressor is 300 rpm. Assuming that compression and expansion follows the law $pV^{1.3}$=constant and clearance is 1/16 th of swept volume, find the diameter and stroke of the compressor. Take L / D = 1.5. Also find the power required to run the compressor.

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