AERO ENGINEERING THERMODYNAMICS

DEPARTMENT OF AERONAUTICAL ENGINEERING

SEMESTER & YEAR: III & II

PART-A [10*2=20]

1. Write the first law of thermodynamics for a cycle and a process.
2. Differentiate between point and path function.
3. Draw the otto cycle on a p – v diagram and mark the processes.
4. What are the assumptions made in air standard cycle analysis?
5. What is meant by quality of steam? Does it have any meaning in the superheated vapour region?
6. Define the terms: thrust and specific impulse.
7. What is a ton of refrigeration?
8. What are the desirable properties of a refrigerant?
9. What is Fourier's law of heat conduction?
10. Define the terms: Black body and Opaque body.

PART-B [5*16=80]

1. (a) A centrifugal air compressor delivers 15 kg of air, per minute. The inlet and outlet conditions of air are V1 = 10m/s, p1 = 1 bar vs1 = 0.5 m3/kg and V2 = 80 m/s, p2 = 7 bar, vs2 = 0.15 m3/kg. The increase in enthalpy of air passing through the compressor is 160 kJ/kg and heat loss to the surroundings is 720 KJ/min. Find the power required to drive the compressor. Assume that inlet and discharge lines are at the same level.
Or
(b) Two Carnot engines work in series between the sources and sink temperature of 500 K and 300 K. If both engines develop equal power. Determine the intermediate temperature.

2. (a) In an air standard otto cycle the compression ratio is 6. The compression begins 400C and 0.1 MPa. The heat supplied per kg of air at the end of the compression is 852 KJ. Find the temperature and pressure at all salient points and the efficiency.
Or
(b) A single stage double acting air compressor of 62.5 kW I.P. running at 120 r.p.m. takes air at 1 bar and delivers at 10 bar. Assuming the law of expansion and compression as pv 1.35 = constant, find the diameter and stroke of the cylinder.

3. (a) A steam power plant operating on Rankine cycle works between 40 bar and 0.05 bar. If the steam supplied is dry saturated, find the cycle efficiency and specific steam consumption.
Or
(b) An aircraft flies at 960 kmph. 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

(i) Jet velocity
(ii) Thrust
(iii) Specific thrust
(iv) Thrust power
(v) Propulsive, thermal and overall efficiencies and
(vi) TSFC

4. (a) A refrigerating machine using R12 works between – 180 C and 370 C. the enthalpy of liquid at 370 C is 71 kJ/kg. The enthalpies of R12 entering and leaving the compressor are 183 kJ/kg and 210 kJ/kg respectively. The rate of circulation of refrigerant is 2 kg/min and efficiency of compressor is 0.85. Determine :
(i) Capacity of the plant in tons of refrigeration
(ii) Power required running the plant.
(iii) COP of the plant.

Or
(b) With neat sketches, explain the working of winter air –conditioning system.

5. (a) Show that in the case of reciprocating compressor, the work input is independent clearance ratio. Explain with the help of p – v diagrams.
Or
(b) Derive an expression for the volumetric efficiency of a two – stage reciprocating compressor in terms of clearance ratio and pressure ratio

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II YEAR/ III SEM - B.E AERONAUTICAL ENGINEERING
AE 2203 – AERO ENGINEEIRNG THERMODYNAMICS
MODEL EXAMINATION MARKS: 100

PART-A [10*2=20]

1. Differentiate between intensive and extensive properties giving examples.
2. What is meant by quasi – static process?
3. Briefly explain the term mean effective pressure.
4. What are the assumptions in air standard cycles?
5. What is meant by triple point of steam?
6. Define specific impulse and explain its importance.
7. How the cooling capacity of a refrigeration system is defined?
8. What are the important parameters to be considered in the selection of a refrigerant?
9. What is the advantage of multistage compression with intercooling?
10. Represent the processes in an idealized reciprocating compressor by P – V diagram.

PART-B [5*16=80]

1. (a) (i) Heat and work are the energy in transmit and inexact differentials. Explain.
(ii) A reversible heat engine in a satellite operates between a hot reservoir at T1 and a radiating panel at T2. Radiation from the panel is proportional to its area and to the fourth power of T2. For a given work output and values of T1 show that the area of the panel will be minimum when T2/ T1 = 0.75

(b) (i) State Kelvin-Planck and Clausis statement of second law of thermodynamics.
(ii) Show that both the above statements are equivalent in all respects.
(iii) A heat engine operates between a source at 6000C and a sink at
200 C. Determine the minimum rate of heat rejected if the work output is 2 kW. Estimate the same if the engine operates at 40% of ideal efficiency.

2. (a) An ideal diesel cycle using air as the working fluid has a compression ratio of 16 and a cut off ratio of 2. The intake conditions are 100 kPa, 200 C and 2000 cm3. Determine
(i) The net work output
(ii) Thermal efficiency of cycle
(iii) The mean effective pressure.
Or
(b) (i) Represent the processes of Brayton cycle by P-V and T – S diagram.

(ii) Derive an expression for thermal efficiency of Brayton cycle as a function of pressure ratio.

(iii) A gas turbine plant operates on the Brayton cycle between Tmin = 300 K and Tmax = 1073 K. Find the maximum work done per kg of air and the corresponding cycle efficiency. Compare the efficiency with carnot efficiency operating between the same two temperature.

3. (a) Consider a steam power plant operating on the ideal regenerative Rankine cycle with one open feed water heater. Steam enters the turbine at 3 MPa and 4000 C and is condensed in the condenser at a pressure of 10 kPa. Some quantity of steam leaves the turbine at a pressure of 0.6 MPa and enters the open feed water heater. Compute the fraction of the steam extracted from the turbine and the thermal efficiency of the cycle.
Or
(b) An aircraft flies at 960 kmph. 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

(i) Jet velocity
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4. (a) With a neat sketch explain the function of an ideal vapour – compression Refrigeration cycle. Represent the process by T – S and p – h diagrams and derive the expression for C.O.P.
Or
(b) In an aircraft cooling system, air enters the compressor at 0.1 MPa, 40C and is compressed to 0.3 MPa with an isentropic efficiency of 72%. After being cooled to 550C at constant pressure in a heat exchanger the air then expands in a turbine to 0.1 MPa with an isentropic efficiency of 78%. The low temperature air absorbs a cooling load o 3 tonnes of refrigeration at constant pressure before reentering the compressor which is driven by the turbine. Assuming air to be ideal gas determine the C.O.P of refrigerator. Represent the system schematically and by T – S diagram. Also estimate the driving power required and the air mass flow rate.

5. (a) Discuss in detail various types of Air Compressors with suitable diagrams.
Or
(b) A two stage air compressor with inter cooling takes in air at 1 bar and 270C. The compression process is polytropic of index 1.3. The compressed air is delivered at 9 bar. Calculate per kg of air, the maximum work done and heat rejected to the intercooler.

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PART-A [10*2=20]

1. State the Kelvin – Planck statement of the second law of thermodynamics
2. A Carnot heat engine operates between the temperatures of 300 K and 900 K. If the heat received from the higher temperature source is 1000 kJ, calculate the works output.
3. Compare Otto and Diesel cycles on the basis of compression ratio and maximum temperature in the cycle.
4. What is the physical significance of mean effective pressure?
5. Define compression ratio used in Otto cycle analysis and pressure ratio used Brayton cycle analysis.
6. Write the area – velocity relation for an isentropic flow in a variable area duct. What is the mean effect of Mach number on area – velocity relation?
7. Distinguish between simple vapour compression and vapour absorption refrigeration's systems.
8. What are the differences between Heat pump and Refrigerator?
9. Why is clearance provided in a reciprocating compressor?
10. Explain the difference in the operation of valves of an I.C engine and a reciprocating compressor.

PART-B [5*16=80]

1. (a) Air is compressed in a reversible process in a cylinder from 100 kPa, 293 K to 500 kPa, according to PV1.3 = constant. Calculate the work done and heat transfer per kilogram. Also calculate the change in the entropy. Assume air to be an ideal gas Cpair = 1.005 kJ/kgk ? = 1.4

Or

(b) Two reversible heat engines A and B are arranged in series. A rejecting heat directly to B. Engine A receives 200 KJ at a temperature of 4210 C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.40 C. If the work output of A is twice that of B, find the efficiency of the each engine.

2. (a) Show the Otto cycle on P – V and T –S diagrams. Derive expressions for the efficiency and mean effective pressure and plot their variation with compression ratio.

Or

(b) In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 288 K, and the pressure is 0.1 MPa. The maximum temperature in the cycle is 1753 K. Calculate

(i) The pressure and temperature at all the four important points in the cycle.

(ii) The cycle efficiency.

3. (a) Steam at 20 bar, 633 K 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 their boiler. Assuming ideal processes, find per kg of steam, the network and cycle efficiency.

Or

(b) An aircraft flies at 960 kmph. 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

(i) Jet velocity

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4. (a) With the help of a block diagram, explain the working of the simple vapour compression refrigeration system. Show the cycle on T-S and p-V diagrams. Derive expression for C.O.P in terms of the enthalpy.

Or

(b) Write notes on properties of Refrigerants.

5. (a) With the help of a neat sketch explain the construction and working of a reciprocating air compressor. Derive an expression for the work of compression in terms of pressure ration and clearance ratio.

Or

(b) Derive an expression for the optimum intermediate pressure of two stage reciprocating compressor with perfect intercooling.