

**B.E. DEGREE EXAMINATIONS: APRIL / MAY 2009**

Third Semester

**AERONAUTICAL ENGINEERING**

**U07AR301 Aero Engineering Thermodynamics**

**Time: Three Hours**

**Maximum Marks: 100**

(Use of steam tables and Gas tables permitted)

**Answer ALL the Questions:-**

**PART A (20 x 1 = 20 Marks)**

1. The system is free from any chemical reactions then it is said to be in a state of
  - (a) Mechanical equilibrium
  - (b) isolated system
  - (c) quasi-static
  - (d) chemical equilibrium
2. When temperature is constant through out the process then it is known as
  - (a) isobaric
  - (b) isothermal
  - (c) adiabatic
  - (d) isentropic
3. The following law is used to produce thermometers
  - (a) Avogadro's law
  - (b) Joules law
  - (c) Zeroth law
  - (d) First law
4. The entropy change of reversible isothermal process is
  - (a) greater than one
  - (b) greater than 100
  - (c) Equal to zero
  - (d) Less than zero
5. If petrol is used in a diesel engine, then
  - (a) low power will be produced
  - (b) efficiency will be low
  - (c) higher knocking will occur
  - (d) black smoke will be produced
6. The thermodynamic cycle on which the petrol engine works, is
  - (a) Otto cycle
  - (b) Joule cycle
  - (c) Rankine cycle
  - (d) Stirling cycle
7. Mean effective pressure is the pressure available on the
  - (a) piston
  - (b) cylinder head
  - (c) silencer
  - (d) crank shaft.
8. Dual cycle consists of
  - (a) two constant volume processes
  - (b) two constant pressure processes
  - (c) two constant volume and one constant pressure process
  - (d) two constant pressure and one constant volume process.
9. The temperature of the gas when it is adiabatically decelerated to zero velocity at zero elevation is called
  - (a) Stagnation temperature
  - (b) Normal temperature
  - (c) Standard temperature
  - (d) Absolute temperature

10. Fluid dynamics of compressible flows is referred to as  
 (a) Liquid dynamics (b) Gas dynamics (c) Statics (d) Dynamics
11. The flow of fluid over a body is in a random fashion with components of fluctuations in three directions is known as  
 (a) Laminar flow (b) Turbulent flow (c) Stream flow (d) Parallel flow
12. The ratio of the velocity of object and the velocity of sound of the medium is known as  
 (a) Mach Number (b) Crocco number (c) Reynolds Number (d) Webber Number
13. The difference between dry bulb temperature and wet bulb temperature at any point is known as  
 (a) Wet bulb depression (b) Dew point depression  
 (c) Dry bulb temperature (d) Wet bulb temperature
14. Refrigeration is used to control  
 (a) Humidity (b) Air velocity (c) Temperature (d) None of these
15. In a mixture of dry air and water vapour, when the air has diffused the maximum amount of water vapour into it, is called  
 (a) Dry air (b) Moist air (c) Saturated air (d) Hot air
16. During a refrigeration cycle, heat is rejected by the refrigerator in a  
 (a) Compressor (b) Condenser (c) Evaporator (d) Expansion valve
17. The volume of air delivered by the compressor is called  
 (a) free air delivery (b) compressor capacity (c) swept volume (d) mean volume
18. The inter cooling in multi-stage compression is done  
 (a) to cool the air during compression (b) to cool the air at delivery  
 (c) to enable compression in two stages (d) to minimize the work of compression
19. The ratio of work done per cycle to the stroke volume of the compressor is known as  
 (a) compressor capacity (b) compression ratio  
 (c) compressor efficiency (d) mean effective pressure
20. In a single stage, single acting reciprocating air compressor without clearance volume, the work done is minimum during  
 (a) isothermal compression (b) isentropic compression  
 (c) adiabatic compression (d) polytropic compression

**PART B (5 x 16 = 80 Marks)**

- 21.(a) (i) Derive the general energy equation for a steady flow system. (6)  
 (ii) Apply the steady flow energy equation to (a) nozzle and (b) turbine and derive an equation for velocity at exit in the case of nozzle and work done in the case of turbine. (10)

(OR)

21.(b) The velocity and enthalpy of fluid at the inlet of a certain nozzle are 50m/s and 2800 kJ/kg respectively. The enthalpy at the exit of nozzle is 2600 kJ/kg. The nozzle is horizontal and insulated so that no heat transfer takes place from it. Find (a) velocity of fluid at exit of the nozzle (b) mass flow rate, if the area at inlet of nozzles is  $0.09\text{m}^2$  and the specific volume is  $0.185\text{ m}^3/\text{kg}$  and (iii) exit area of the nozzle, if the specific volume at the exit of nozzle is  $0.495\text{ m}^3/\text{kg}$ . (16)

22.(a) (i) Derive an expression for the efficiency of a dual cycle (8)

(ii) An oil engine working on the dual combustion cycle, has a compression ratio of 10 and cut-off takes place at  $1/10$  of the stroke. If the pressure at the beginning of compression is 1 bar and maximum pressure is 40 bar. Determine the air standard efficiency of the cycle. Take  $\gamma=1.4$ . (8)

(OR)

22.(b) Two engines are to operate an Otto and Diesel cycles with the following data: Maximum temperature = 1500 K, Exhaust temperature = 700 K, Ambient conditions = 1 bar and 300 K. Compare the compression ratios, maximum pressures and efficiencies of two engines. (16)

23.(a)(i) The jet of a gas at 593 K ( $\gamma=1.3$ ,  $R=469\text{ J/kgK}$ ) has a Mach number of 1.2. Determine for local and stagnation conditions velocity of sound and enthalpy. What is the maximum attainable velocity of this jet? (8)

(ii) What are the main components of a gas turbine engine used for turbojet aircrafts? Show that the various processes occurring in the engine on a T-S diagram. (8)

(OR)

23.(b)(i) Explain how the wet steam, dry saturated steam and superheated steam is produced? (6)

(ii) Determine the quantity of heat required to produce 1 kg of steam at a pressure of 6 bar at a temperature of  $25^\circ\text{C}$  under the following conditions. (a) when the steam is wet having a dryness fraction 0.9 (b) when the steam is dry saturated and (c) when it is superheated at a constant pressure at  $250^\circ\text{C}$ . Assuming the mean specific heat of superheated steam to be  $2.3\text{ kJ/kgK}$ . (10)

24.(a)(i) What is difference between a refrigerator and a heat pump? Derive an expression for the performance factor for both if they are running on reversed Carnot cycle. (6)

(ii) The temperature limits of an ammonia refrigerating system are  $25^\circ\text{C}$  and  $-10^\circ\text{C}$ . If the gas is dry at the end of compression. Calculate the coefficient of performance of the cycle assuming no under cooling of the liquid ammonia. Use the following table for properties of ammonia. (10)

Temperature, °C	Liquid heat, Kj/Kg	Latent heat, Kj/Kg	Entropy, Kj/Kg K
25	298.9	1166.94	1.1242
-10	135.37	1297.68	0.5443

(OR)

- 24.(b)(i) The capacity of refrigerator is 200 TR when working between  $-6^{\circ}\text{C}$  and  $2^{\circ}\text{C}$ . Determine the mass of ice produced per day from water at  $25^{\circ}\text{C}$ . Also find the power required to drive the unit. Assume that the cycle operates on reversed Carnot cycle. Latent heat of ice is  $335\text{ KJ/Kg}$ . (8)
- (ii) The atmosphere air has a dry bulb temperature of  $21^{\circ}\text{C}$  and wet bulb temperature of  $18^{\circ}\text{C}$ . If the barometer reads  $750\text{ mm of Hg}$ , determine (a) Partial pressure of water vapour (b) Relative humidity and (c) Dew point temperature. (8)
- 25.(a)(i) Explain the function of various types of compressors with neat sketches. (6)
- (ii) A single acting reciprocating air compressor has cylinder diameter and stroke of  $150\text{ mm}$  and  $300\text{ mm}$  respectively. The compressor sucks air at  $1\text{ bar}$  and  $27^{\circ}\text{C}$  and delivers at  $8\text{ bar}$  while running at  $100\text{ rpm}$ . Find (a) indicated power of the compressor (b) mass of air delivered by the compressor per minute and (c) temperature of the air delivered by the compressor. The compression follows the law  $PV^{1.25}=C$ . Take  $R$  as  $287\text{ J/Kg}$ . (16)

(OR)

- 25.(b)(i) Derive the expression for the work done by a single stage reciprocating air compressor without clearance volume when compression is (a) isothermal and (b) isentropic. (8)
- (ii) A single stage reciprocating air compressor is required to compress  $1\text{ kg}$  of air from  $1\text{ bar}$  to  $4\text{ bar}$ . The initial temperature is  $27^{\circ}\text{C}$ . Compare the work requirement in the following cases (a) isothermal compression (b) Compression with  $PV^{1.2}=\text{constant}$  and (c) Isentropic compression. (8)

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