

B.E. DEGREE EXAMINATIONS: APRIL / MAY 2010

Fourth Semester

MECHANICAL ENGINEERING

U07ME403: Thermal Engineering

Time: Three Hours

Maximum Marks: 100

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

1. Constant volume cycle is also called -----
(a) otto cycle (b) diesel cycle (c) dual cycle (d) pressure cycle
2. Dual cycle is -----
(a) partly at constant volume and partly at constant pressure (b) diesel cycle
(c) brayton cycle (d) air cycles
3. A petrol engine has compression ratio from
(a) 6 to 10 (b) 10 to 15 (c) 15 to 25 (d) 25 to 40
4. The knocking tendency in spark ignition engine may be decreased by
(a) controlling the air fuel mixture (b) controlling the ignition timing
(c) reducing the compression ratio (d) all of these
5. The critical pressure ratio of initially dry saturated steam is -----
(a) $P_2/P_1 = 0.577$ (b) $P_2/P_1 = 0.544$ (c) $P_2/P_1 = 0.6$ (d) $P_2/P_1 = 0$
6. The function of Compounding of a steam turbine is
(a) to reduce the rotor speed (b) to reduce the velocity
(c) to reduce the pressure (d) none of this
7. If the flow of air through the compressor is perpendicular to its axis, then it is a
(a) reciprocating compressor (b) centrifugal compressor
(c) axial flow compressor (d) turbo compressor
8. The positive displacement compressor is
(a) roots blower (b) vane blower (c) centrifugal compressor (d) both 'a' and 'b'
9. The boiling point of ammonia is
(a) -10.5°C (b) -30°C (c) -33.3°C (d) -77.6°C
10. Which of the following refrigerant is highly toxic and flammable?
(a) ammonia (b) CO_2 (c) SO_2 (d) F-12

PART B (10 x 2 = 20 Marks)

11. Define cut off ratio and compression ratio in gas power cycles.
12. Sketch the schematic arrangement of open cycle gas turbine plant and name the components.
13. What is meant by scavenging?
14. List out the causes for knocking in an IC engine.
15. What is meant by convergent-divergent nozzle?
16. Define supersaturated flow of steam nozzle.
17. Write any two advantages of rotary air compressors.
18. Define free air delivered (FAD) in air compressors.
19. What do you mean by sub cooling in vapour compression refrigeration cycle?
20. Differentiate between vapour compression and vapour absorption refrigeration system.

PART C (5 x 14 = 70 Marks)

21. (a) In a gas turbine plant working on the Brayton cycle, the air at the inlet is at 23 °C, 0.1 MPa. The pressure ratio is 6.75 and the maximum temperature is 750 °C. The turbine expansion is divided into two stages with reheat to 750 °C. The efficiency of compressor and two turbines are 82% and 86% each respectively. Determine the maximum power that can be obtained from this plant, if the mass flow rate of air is 5 kg/sec.

(OR)

- (b) Derive the expression for Air standard efficiency of Dual cycle in gas power cycles.

22. (a) A diesel engine consumes 17 kg of oil per hour and gives 80 kW of power. The CV of fuel oil is 43500kJ/kg. The water supplied to the jackets also passes subsequently through the exhaust calorimeter. The following observations were made

Mass of water supplied /min	= 1200kg
Temperature of water entering the jackets	= 23°C
Temperature of water leaving the jackets	= 59°C
Temperature of exhaust gas leaving exhaust calorimeter	= 170°C
Temperature of engine room	= 23°C
Temperature of exhaust gas leaving the engine	= 425 °C
Specific heat of exhaust gas	=1.05 kJ/sec

Draw up a heat balance sheet for the engine in kJ/sec

(OR)

- (b) (i) Explain with a neat sketch the operation of a wet sump lubrication systems. (8)
- (ii) Write short notes on valve timing diagram of four stroke C.I engine. (6)
23. (a) (i) What is compounding? Briefly explain with neat sketch pressure – velocity compounding in a steam turbine. (9)
- (ii) List the types of reaction turbines, also differentiate between impulse and reaction turbine. (5)

(OR)

- (b) Steam at a pressure of 15 bar saturated is discharged through a convergent-divergent nozzle to a backpressure of 0.2 bar. The mass flow rate is 9kg/kW.hr. If the power developed is 220kW, determine number of nozzle required if each nozzle has a throat of rectangular cross section of 4mmx8mm. If 12% of overall isentropic enthalpy drop occurs in the divergent portion due to friction, find the cross section of the exit nozzle?
24. (a) A two stage double acting air compressor operating at 220 r.p.m. takes in air at 1 bar and 27°C. The size of L.P. cylinder is 360x400mm. The size of the H.P.cylinder is same as that of L.P.cylinder. Clearance of both the cylinders is 4%. The L.P.cylinder discharges the air at a pressure of 4 bar. The air passes through the inter-cooler so that it enters the H.P.cylinder at 27°C and 3.8 bar. Finally it is discharged from the compressor at 15.2 bar. The value of “n” for both the cylinders is 1.3, $C_p = 1.0035 \text{ kJ/kg.K}$, $R = 0.287 \text{ kJ/kg.K}$. Calculate (i) the heat rejected in the intercooler (ii) Diameter of H.P. Cylinder (iii) The power required to drive the H.P. cylinder.

(OR)

- (b) (i) With a neat sketch explain the principles of operation of a centrifugal compressor.(10)
- (ii) Enumerate the difference between rotary air compressor and reciprocating air compressor. (4)
25. (a) A 5 tonne of refrigeration plant uses R12 as refrigerant. It enters the compressor at -5°C as saturated vapour. Condensation takes place at 32°C and there is no under cooling of refrigerant liquid. Assuming isentropic compression, determine COP of the plant, Mass flow of refrigerant, power required to run the compressor in KW. The properties of R-12 are given in table; $C_p(\text{vapour}) = 0.65 \text{ kJ/kgK}$; $C_p(\text{liquid}) = 0.94 \text{ kJ/kgK}$

T°C	P(bar)	Enthalpy KJ/Kg		Entropy
		hf	hg	KJ/Kg K
32	7.85	130.5	264.5	1.542
-5	2.61	-----	249.3	1.557

(OR)

(b) Briefly explain the following refrigeration systems with schematic diagram

(i) Ammonia - water absorption refrigeration cycle (7)

(ii) Lithium bromide – water vapour absorption refrigeration system. (7)
