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Question Paper Code : 21567

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Mechanical Engineering

ME 2301/ME 51/ME 1351 A/10122 ME 402 — THERMAL ENGINEERING

(Regulation 2008/2010)

(Common to PTME 2301 – Thermal Engineering for B.E. (Part – Time) Fourth Semester – Mechanical Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Use of Steam Tables, R and AC Tables, Mollier chart and Humidity charts permited.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name any four assumptions made for air standard cycle analysis.
2. Sketch the dual cycle on p-V and T-s co-ordinates.
3. Define Scavenging.
4. What is the use of a catalytic converter?
5. What is metastable flow?
6. What are the different methods of governing steam turbine?
7. Give the expression for work done for a two stage reciprocating compressor with intercooler.
8. Define volumetric efficiency of a reciprocating compressor.
9. What is meant by subcooling in vapour compression system?
10. Define Relative Humidity.

PART B — (5 × 16 = 80 marks)

11. (a) Derive an expression for air the air standard efficiency of diesel cycle. Explain why the efficiency of Otto cycle is more than that of the diesel cycle for the same compression ratio. (16)

Or

(b) In an oil engine working on dual cycle, the heat supplied at constant pressure is twice that of heat supplied at constant volume. The compression and expansion ratios are 8 and 5.3. The pressure and temperature at the beginning of cycle are 0.93 bar and 27° C. Find the efficiency of the cycle and mean effective pressure. Take C_p = 1.005 kJ/kgK and C_v = 0.7 18 kJ/kgK. (16)

12. (a) (i) Explain the construction and working of a fuel Injector with a neat sketch. (8)

(ii) Draw and explain the Port Timing diagram of two stroke cycle diesel engine. (8)

Or

(b) The following observations were taken during a test on a single cylinder four – stroke cycle engine having a bore of 300 mm and stroke of 450mm.

Ambient air temperature	=	22°C
Fuel Consumption	=	11 kg/hr
CV of fuel	=	42,000 kJ/kg
Engine speed	=	300 rpm
Mean effective pressure	=	6 bar
Net brake load	=	1.0 kN
Brake drum diameter	=	2 m
Quantity of Jacket cooling water	=	590 kg/hr
Temperature of entering cooling water	=	22°C
Temperature of leaving cooling water	=	70°C
Quantity of air as measured	=	225kg/hr
Specific heat of exhaust gas	=	1.005kJ/kgK
Exhaust gas temperature	=	405°C
Rope diameter	=	2 cm

Determine indicated power, brake power, mechanical efficiency and draw a heat balance sheet on hour basis. (16)

13. (a) (i) What are the effects of friction in a nozzle? Explain. (8)

(ii) A convergent — divergent nozzle is required to discharge 2kg of steam per second. The nozzle is supplied with steam at 7 bar and 180° C and discharge takes place against a back pressure of 1 bar. The expansion up to throat is isentropic and the frictional resistance between the throat and exit is equivalent to 63kJ/kg of steam. Taking approach velocity of 75m/s and throat pressure of 4 bar, estimate:

(1) Suitable areas for the throat and exit and

(2) Overall efficiency of the nozzle based on the enthalpy drop between the actual inlet pressure and temperature and the exit pressure. (8)

Or

(b) (i) The velocity of steam, leaving the nozzle of an impulse turbine is 1000 m/s and the nozzle angle is 20°. The blade velocity is 350m/s and the blade velocity of coefficient is 0.85. Assuming no losses due to shock at inlet, calculate for a mass flow of 1.5kg/s and symmetrical blading

(1) Blade inlet angle (3)

(2) Driving force on the wheel (3)

(3) Axial thrust on the wheel and (3)

(4) Power developed by the turbine. (3)

(ii) Differentiate between impulse and reaction turbine? (4)

14. (a) A single acting reciprocating air compressor has a piston diameter of 200mm and a stroke of 300mm and runs at 350rpm. Air is drawn at 1.1 bar pressure and is delivered at 8 bar pressure. The law of compression is $pV^{1.35}$ = constant and clearance volume is 6% of the stroke volume. Determine the mean effective pressure and the power required to drive the compressor. (16)

Or

(b) Derive the work done by a two stage reciprocating air comnpressor with intercooler and derive the condition for minimum work input and the expression for minimum work required for two stage reciprocating compressor? (16)

15. (a) (i) What are the properties of a good refrigerant? (4)

(ii) An Ammonia refrigerator produces 30 tons of ice at 0°C in a day of 24 hours. The temperature range in the compressor is from 25° C to -15°C. The vapour is dry saturated at the end of compression. Assume a COP of 60% of Theoretical value. Calculate the power required to drive the compressor. Assume latent heat of ice is 335kJ/kg. For properties of NH_3, refer the table below. (12)

Temperature (°C)	h_f kJ/kgk	h_g kJ/kgk	S_f kJ/kgk	S_g kJ/kgk
25	298.9	1465.8	1.124	5.039
–15	112.34	1426.5	0.4572	5.549

Or

(b) (i) An office is to be air-conditioned for 50 staff when the outdoor conditions are 30°C DBT and 75% RH if the quantity of air supplied is 0.4m³/min/person, find the following:

(1) Capacity of the cooling coil in tones of refrigeration. (4)

(2) Capacity of the heating coil in kW .(4)

(3) Amount of water vapour removed per hour. (4)

Assume that required air inlet conditions are 20°C DBT and 60% RH. Air is conditioned first by cooling and dehumidifying and then by heating.

(ii) Describe the factors that affect human comfort. (4)
