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Reg. No. : ....

Name : ....

Third Semester B.Tech. Degree Examination, April 2015
(2013 Scheme)
13.307 : THERMAL ENGINEERING (MU)

Time : 3 Hours Max. Marks : 100

Instruction : ***Use*** *of approved Steam Tables* ***permitted.***

PART – A

Answer **all** questions. **Each** question carries **2** marks.

1. Sketch simple regenerative cycle using one feed water heater on T-S diagram. Explain why regenerative cycle is not practical.

2. Explain the function of economizer in steam boilers.

3. What are the important effects of supersaturated steam flow through nozzles ?

4. Explain any two advantages and disadvantages of velocity compounded impulse turbine.

5. What is adiabatic flame temperature ? How it is vary with equivalence ratio ?

6. Discuss crevice effects and leakage in real SI engine cycle.

7. Differentiate between normal and abnormal combustion in SI engine.

8. Explain the phenomenon of diesel knock.

9. Explain the defects in performance of a practical gas turbine cycle.

10. Why a regenerator is necessary in a simple gas turbine unit ? Sketch the T-S diagram of an open gas turbine cycle with regenerator. **(2×10=20 Marks)**

P.T.O.

PART – B

Answer **any one full** question from **each** Module. **Each full** question carries **20** marks.

Module – I

11. a) Explain why the blow-off cock is operated periodically when the boiler is working. Where it is located ? Explain its working with a neat sketch. 10

b) Determine the efficiency of a Rankine cycle using steam as the working fluid in which the condenser pressure is 20 kPa. The pressure in the boiler is 3 MPa. The steam leaves the boiler as saturated vapour. 10

12. a) Prove that the maximum diagram or blade efficiency of a single stage parsons reaction turbine is $2\cos^2\alpha_1 \times (1+\cos^2\alpha_1)^{-1}$, where α_1 = outlet angle of the fixed blade. 10

b) A convergent – divergent nozzle is to be designed in which steam initially at 15 bar and 275°C of superheat is to be expanded down to back pressure of 1 bar. Determine the necessary throat and exit diameters of the nozzle for a steam discharge of 900 kg/hr, assuming that the expansion is in thermal equilibrium throughout and frictional reheat amounting 15% of the total isentropic enthalpy drop to be effective in the divergent part of the nozzle. Assume index of expansion is 1.3. 10

Module – II

13. a) Explain what do you understand by "Air-Standard analysis" as referred to IC engine cycles. "The actual efficiencies of the IC engines are less than air standard efficiencies". Explain the causes. 10

b) An air standard cycle consists of the following process : isentropic compression from 18°C, 1 bar through a compression ratio of 6; heat addition at constant volume of 2850 kJ/kg; isentropic expansion to the initial volume; heat rejection at constant volume. Sketch the cycle on P-V and T-S diagram, and calculate its ideal efficiency, mean effective pressure and peak pressure. Assume Y = 1.4 and R = 287 kJ/kgK, C_v = 0.71 kJ/kgK. 10

14. a) Describe with a sketch the method commonly used in the laboratory for measuring the air supplied to an IC engine. 8

b) During the test on four cylinder, four stroke petrol engine the following readings are observed : Diameter of cylinder = 10 cm, piston stroke = 12 cm, engine speed in rpm = 2800, load on the hydraulic diameter = 150 N, dynamometer constant = 20420 when the speed is in rpm, fuel consumption = 6.5 kg/hr, Calorific Value of fuel used = 42000 kJ/kg, air/fuel ratio = 14 : 1, The temperature and pressure of the charge at the end of suction stroke = 15 $^{\circ}$C and 1 bar. For the determination of the mechanical efficiency a Morse test was carried out by successively shorting the spark plugs of four cylinders without change in speed. The corresponding brake powers of the engine are 13, 13.5, 14.3, 15.5 kW, respectively. Determine :

i) The brake power

ii) Brake mean effective pressure

iii) Brake thermal efficiency of the engine

iv) Mechanical efficiency of the engine

v) Indicated thermal efficiency

vi) Volumetric efficiency of the engine at suction condition. Assume R = 287 J/kgK. **12**

Module – III

15. a) Explain the following :

i) Flash and fire point

ii) Adiabatic flame temperature

iii) Equivalence ratio

iv) Higher and lower calorific values

v) Stoichiometric combustion. **10**

b) The products of combustion of an unknown hydrocarbon C_xH_y have the following measured composition : 8% CO_2, 0.9 % CO, 8.8 % O_2 and 82.3% N_2. Determine the composition of fuel, air fuel ratio and percentage excess air used. **10**

16. a) Explain the following :

i) Pre-ignition

ii) Auto-ignition

iii) Detonation

iv) Rating of IC engine fuels

v) Knock in CI engines. **10**

b) What actions can be taken with regard to the following variables, in order to reduce the possibility of detonation in SI engines ? Why ?

i) Compression ratio

ii) Spark timing

iii) Turbulence

iv) Engine speed

v) Mass of charge inducted. 10

Module – IV

17. a) Prove that the pressure ratio for the maximum specific output is the square root of the pressure ratio for the maximum thermal efficiency. Explain why a low pressure ratio is used in gas turbines compared with IC engines ? 8

b) In a simple gas turbine plant, air is taken at atmospheric pressure (1.013 bar) and temperature 15°C and compressed to 6 bar. The maximum temperature in the plant is limited to 750°C. The heated gases expand to atmospheric pressure. Assume isentropic efficiency of the compressor is equal to isentropic efficiency of the turbine and is 80%. The pressure loss through the combustion chamber is 0.1 bar. Calculate the flow of air if the plant develops 1100 kW. Also find the heat supplied/min and work ratio. Take C_p for air and gas as 1.005 kJ/kgK and y = 1.4. 12

18. a) What are the problems encountered in the design of gas turbine combustion chambers ? Draw a neat sketch of a combustion chamber used for an open-cycle plant and name the parts. 8

b) In a gas turbine unit, the HP stage turbine drives the compressor and an LP stage turbine drives the propeller through suitable gearing for marine drive application. The following specifications are to be followed for the calculations.

Over all pressure ratio = 5:1, the mass flow rate = 50 kg/sec, Maximum temperature = 625°C, Air intake pressure and temperature are 1.013 bar and 20°C respectively. Isentropic efficiency of the compressor = 0.80, Isentropic efficiency of the HP turbine = 0.83, Isentropic efficiency of he LP turbine = 0.95, Mechanical efficiency of the shaft = 0.98. Neglecting kinetic energy change and the pressure loss in combustion chamber, calculate :

i) The pressure between turbine stages

ii) The cycle efficiency

iii) The shaft power. 12

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