VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

[Central Technological Institute, Maharashtra State]

Matunga, Mumbai-400 019

SEMESTER EXAMINATION:		*ESE – APRIL-MAY. 2014*	DATE OF EXAM:		30/04/2014
SEMESTER & PROGRAM	:	*Sem. IV S.Y.B.Tech (Mechanical)*	TIME	:	*1:30 to 4:30pm*
TIME ALLOWED	:	*3 Hrs.*	MARKS	:	*100*
COURSE (Course Code)	:	*ME 0207 (Applied Thermodynamics – II)*			

Instructions
1. **All questions are compulsory.**
2. Figures to the right indicate full marks.
3. Draw neat sketches wherever necessary.
4. Assume suitable data, if required.
5. Use of **Steam Table** is permitted.

Q.1. A. State the advantages of 'inter-cooling' and 'after cooling' of air compressors and derive the condition for maximum work for two stage compressor. 6

B. (i) Explain with neat sketches, working of roots and vanes type of blowers. 3

(ii) Compare centrifugal and axial flow compressors. 3

C. A two stage air compressor takes in air at 1.013 bar and 15°C and delivers at 43.4 bar. The intercooler pressure is 7.56 bar. The inter-cooling is perfect and the index of compression *n* is 1.3. Calculate the work done in compressing 1 kg of air. If both the cylinders have same stroke and piston diameters are 9cm and 3 cm and the volumetric efficiency of the compressor is 90%. Will the intercooler pressure be steady or will it rise or fall as compressor starts working? 8

Q.2. A. (i) Define and explain (i) LCV, (ii) HCV. 2

B. Compare in details the Bomb and Boy's calorimeter. 4

C Describe Orsat apparatus. OR 6

Write short note on Gas Chromatography. 6

D The following is the ultimate analysis of a sample of petrol by weight: Carbon = 85%, Hydrogen = 15%, Calculate the ratio of air to petrol consumption by weight if the volumetric analysis of the dry exhaust gas is : CO_2 = 11.5 %, CO = 1.2 %, O_2 = 0.9%, N_2 = 86 %. Also find the percentage of excess air. 8

Q.3. A. What are the ideal requirements of a boiler? 2

B. Compare water and fire tube boilers. 4

C. Explain construction and working of any three from the following. 6

(i) Super heater, (ii) Spring loaded safety valve, (iii)Water level indicator,

(iv) Fusible plug,(v) Green's Economiser.

D. When coal burns in a boiler, the equivalent evaporation from and at 100°C is 9 kg per kg of fuel. When oil burns in the same boiler, the equivalent evaporation from and at 100°C = 15.5 kg/kg of fuel. How many barrels of 300 litres of oil capacity are equivalent in heat to one tonne of coal? The specific gravity of the oil fuel is 0.8. Calculate the calorific value of the coal if the calorific value of the oil fuel is 41820 kJ/kg of fuel. Calculate the efficiency of the boiler which remains the same before and after the 8

Q.4. A. Define and explain (i) Steam nozzle efficiency, (ii) Nozzle velocity coefficient, 6

(iii)Critical pressure in the nozzle.

OR

Compare velocity with pressure compounding, and explain how both velocity and pressure compounding is combined.

B. Dry and saturated steam enters a nozzle at 2 bar and with negligible velocity. The mass flow rate is 0.03 kg/s. The discharge pressure is 1 bar and the expansion is isentropic. Find the throat pressure, dryness at the throat, throat area and exit area. 7

If the irreversible flow is taken into account the velocity co-efficient is found to be 0.96. What will be the discharge, dryness at the throat and increase in entropy during expansion.

C. The mean diameter of the blade of an impulse turbine with a single row wheel is 105 cm and speed is 3000 rpm. The nozzle angle is 18°, the ratio of blade speed to steam speed is 0.42, and ratio of the relative velocity at outlet of the blade to that at inlet is 0.84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow is 8 kg per second. Draw the velocity diagrams for the blade and calculate the following. 7

(a) Resultant thrust on the blades. (b) Tangential thrust on the blades (c) Axial thrust on the blades (d) Power developed by blades (e) Blading efficiency.

Q.5. A. Explain in details, all three methods to improve performance of Gas Turbine Power Plant. 6

B. A simple gas turbine takes in air at atmospheric pressure and 15°C and compresses air in compressor up to 16 bar. Then air enters the combustion chamber and is then heated up to a maximum temperature of 1350°C then it enters the turbine and expands to atmospheric pressure. The isentropic efficiency of the compressor and turbine is 0.88, combustion efficiency 0.97. Fall of pressures through the combustion chamber is 0.3 bar, *cp* for air and gases = 1.005kJ/kgK, $\gamma = 1.4$. Determine the flow of air and gases for net power of 200 MW developed. Calculate also the heat supplied per kg of air and work ratio. Also calculate thermal efficiency if mechanical and generator efficiency are each 96%. 7

C. The following data refers to a gas turbine using intercooling, regeneration and reheating arrangement. 7

Pressure ratio = 64, compressor inlet temperature = 3000K. Turbine inlet temperature = 1500K, compressor efficiency = 0.87, turbine efficiency = 0.88, Regenerator effectiveness = 0.8, inlet pressure to compressor =1bar.

Determine (a) cycle thermal efficiency (b) cycle work ratio (c) cycle air rate.