Menoufiya University **Faculty of Engineering** **Shebin El-Kom** **1th Semester** **Academic Year: 2015-2016**	Minufiya University	**Year: 3th year** **Department:** *Mechanical Power* **Subject: External Combustion System** *(MPE314C)* **Time Allowed: 3 hrs** **Date: 14/1/2016**

Note: Assume any data required, state your assumption clearly. Answer all the following Questions

Question (1) **(25 Marks)**

(1.1) Define the followings: Adiabatic flame temperature, Excess air, power plant capacity factor, combustion efficiency, combustion tune up, air preheating factor and lower and higher heating values? **[7 marks]**

(1.2) Describe the main boiler types and reasons for heat loss from the boiler? **[4 marks]**

(1.3) Estimate the flame temperature by using the Energy balance of the combustion process? **[5 marks]**

(1.4) Explain the main difference between, recuperators and regenerators? **[4 marks]**

(1.5) A fuel contains 84 % Carbon and 16 % H_2 by mass, after burning it with air, the Orsat analysis of the flue gases gives: 10 % CO_2, 1 % CO, and 5.35 % O_2. Determine the percentage of excess air supplied and the mass of the flue gases per 1 kg_{fuel}. **[5 marks]**

Question (2) **(25 Marks)**

(2.1) Describe the function of combustion control systems and its types, explain the circuits, advantages and disadvantages of **two** types only? **[7 marks]**

(2.2) Discuss **three** main factors affecting on the combustion efficiency? **[6 marks]**

(2.3) Discuss in detail the different modes for heat transfer in combustion zone from the flame to the surrounding wall? **[6 marks]**

(2.4) A boiler power station has the following data. Fuel flow rate: 0.867 t/hr where the fuel is residual fuel oil. Exit flue temperature is 165 C and the actual A/F is 13.5937 kg/kg_{fuel}. The ash content is 1% of fuel by weight. The flue gases contain 8% CO_2 and 10% H_2O, pass through a cylindrical furnace with 0.6 m in diameter. The mean flue gas temperature is 800 C, the wall temperature is 500 C and the wall emissivity is 0.8. The pressure of the flue gases is 1 bar. Determine the rate of total heat transfer to the wall per 1 m^2 of the wall area. The combustion chamber is cooled by water of temperature 20 C and the wall thickness and thermal conductivity are 10 mm and 170 W/m.K, respectively. **Take the values of absorptivities of CO_2 and H_2O are 0.09 and 0.1, respectively. [6 marks]**

Question (3) **(17 Marks)**

(3.1) What are the different uses of gas turbines? **[3 marks]**

(3.2) What are the different essential design criteria that any gas turbine must meet? **[3 marks]**

(3.3) Define the availability and reliability of a gas turbine. **[3 marks]**

(3.4) An open cycle gas turbine has a single stage compressor and a single stage expander incorporating a heat exchanger. The suction air temperature is 17°C and the pressure 1 bar. For an overall pressure ratio of 4.5 and shaft output of 4000 kW, the mass flow is 40 kg/s. If the thermal ratio of the heat exchanger is 0.6 and the isentropic efficiency of compressor is 0.84,

calculate the isentropic efficiency of the gas turbine for a plant thermal efficiency of 0.29. Take for air: γ =1.4, cp=1.005 kJ/kg.K; for gas: γ =1.365, cp=1.07 kJ/kg.K. **[8 marks]**

Question (4) **(18 Marks)**

(4.1) Explain with drawing one modification to the standard Brayton Cycle to achieve maximum thermal efficiency of the cycle. **[2 marks]**

(4.2) Explain with drawing the basic types of combustion chamber systems used in gas turbine engines. **[2 marks]**

(4.3) What are the different requirements for a gas turbine engine combustion chamber system? **[3 marks]**

(4.4) Explain with drawing the different types of propulsion engines. **[4 marks]**

(4.5) A gas turbine unit receives air at 1 bar and 300 K and compresses it adiabatically to 6.2 bars. The compressor efficiency is 0.88. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is 0.17 kg_{fuel}/kg_{air}. The turbine internal efficiency is 90%. Calculate the turbine work, the compressor work and the thermal efficiency. For air cp=1.005 kJ/kg.K, γ = 1.4 and for products of combustion cp =1.147 kJ/kg.K, γ = 1.333. **[7 marks]**

GOOD LUCK

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