1) A- Define: Auto Ignition Temperature, Flammability Limits, Smoke Point, Methane Number, Gibbs Function, Enthalpy of Formation, Chemical Kinetics, Quenching Distance, Calorific Value, and Minimum Ignition Energy. (10)  
B- Discuss the major parameters for boiler overall performance analysis? (5)

2) A- What are the major parameters needed to account the boiler heat balance? With the help of a flow diagram that shows the inputs and outputs of both heat and mass, into and out from the boiler respectively. (5)  
B- State briefly the factors affecting on the reaction rate? (5)  
C- State briefly how the combustion reaction proceed kinetically? (5)

3) A- State briefly the different devices used for flame studies? In this case state the flame classifications. (5)  
B- How burning velocity, quenching distance and minimum ignition energy are interrelated? In this case give brief description about the main factors affecting the quenching distance and minimum ignition energy. (5)  
C- Discuss the flame characteristics in terms of temperature and species distribution. (5)

4) A- A small gas turbine uses C₈H₁₈(L) for the fuel and 400% excess air, the air and fuel enter at 25 °C, and the products of combustion leave at 900 K. The output of the engine and the fuel consumption are measured, and it is found that the specific fuel consumption is 0.25 kg/s of fuel per megawatt output. Determine the heat transfer from the engine per kilomole of fuel, the entropy and Gibbs function changes. Assume complete combustion. (5)  
B- In a test of a gas-turbine combustor, saturated-liquid methane at 115 K is to be burned with excess air to hold the adiabatic flame temperature to 1600 K. It is assumed that the products consist of a mixture of CO₂, H₂O, N₂, O₂, and NO in chemical equilibrium. Determine the percent excess air used in the combustion, and the percentage of NO in the products. (10)