Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER-1 (OLD) EXAMINATION – WINTER 2016

Subject Code: 713904N Date:23/11/2016

Subject Name: Advanced Thermal Engineering

Time:10:30 am to 1:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of steam and property table is permitted.**

Q.1 **(a)** Explain Helmholtz function and Gibbs function. Discuss their importance in study of heat and work. **07**

(b) Derive the expression of Availability and Irreversibility for turbine, compressor and heat exchanger. **07**

Q.2 **(a)** Derive the equation for temperature distribution under one dimensional steady state heat conduction for plane wall. Also obtain the conditions for max. temperature distribution. **07**

(b) 30 kg of water at 98^0C mix with 40 kg of water at 38^0C, at constant pressure. The temperature of surrounding is 18^0C. The specific heat of water is 4.2 kJ/kgK. Determine: (i) change of entropy of water (ii) availability of water (iii) Irreversibility **07**

OR

(b) An M.S. sphere ($\phi = 15mm, k = 42W/m^0C$) is exposed to cooling airflow at 20^0C resulting in the convective co-efficient h = 120 W/m^2 ^{0}C. Determine: (i) time required to cool the sphere from 550^0C to 90^0C. (ii) Instantaneous heat transfer rate 2 minutes after the start of cooling (iii) total energy transferred from the sphere during the first 2 minutes. Take ρ = 7850 kg/m^3, c = 475 J/kg^{0}C , α = 0.045 m^2/h for M.S. **07**

Q.3 **(a)** Give a brief note on stoichiometry. **07**

(b) Determine the fuel gas analysis and air fuel ratio by weight when fuel oil with 84.9% carbon, 11.4% hydrogen, 3.2% sulphur, 0.4% oxygen and 0.1% ash by weight is burnt with 20% excess air, assume complete combustion. **07**

OR

Q.3 **(a)** Differentiate between Film-wise and Drop-wise Condensation. **07**

(b) A metal-clad heating element of 10mm diameter and emissivity 0,92 is submerged in a water bath horizontally. If the surface temp. of metal is 260^0C under steady boiling conditions, calculate power dissipation per unit length of heater. Assume that water is exposed to atmospheric pressure and is a uniform temperature. **07**

Q.4 **(a)** Derive the equation for effectiveness of parallel flow heat exchanger by NTU method. **07**

(b) A condenser is to be designed to condense 1800 kg/h of dry and saturated a steam at a pressure of 10kPa. A square array of 400 tubes each of 8mm in diameter is to be used. If the tube surface temperature is to be maintained at 24^0C, calculate (i) heat transfer co-efficient (ii) length of each tube assuming single pass. **07**

OR

Q.4 **(a)** Give comparison between conventional and compact het exchangers. **07**

(b) In a gas turbine power plant heat is being transferred in a cross flow heat exchanger (surface area is $50m^2$) from hot gases leaving the turbine at 450^0C to the air leaving the compressor at 170^0C. The air flow rate is 5000kg/h and air-fuel ratio is 0.015 kg/kg. The overall heat transfer co-efficient for the heat exchanger is $52.33W/m^2$. Determine: (i) temperature on the air and gas side (ii) rate of heat transfer in the exchanger. Take $C_{ph} = C_{pc} = 1.05$ kJ/kg ^0C. Assume $\varepsilon = 0.52$, correction factor = 0.76 **07**

Q.5 **(a)** Derive the equation of radiation heat exchange for two gray surfaces connected by single refractory surface using concept of irradiation and radiosity. **07**

(b) Write a short note on Gas Radiation. **07**

OR

Q.5 **(a)** Explain with neat sketch boiling regimes. **07**

(b) A thermocouple used to measure temperature of gas flowing through duct records 280^0C. If emissivity of junction is 0.4 and film co-efficient of heat transfer is 150 W/m^2K, Determine: (i) true gas temperature (ii) what should be the emissivity of junction in order to reduce the temperature error by 30%? The temperature of duct wall is 140^0C. **07**

****