NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

BACHELOR OF ENGINEERING (HONOURS) DEGREE IN INDUSTRIAL AND MANUFACTURING ENGINEERING

1ST SEMESTER EXAMINATION DECEMBER 2011

INTRODUCTION TO THERMAL SYSTEMS **COURSE CODE - TIE 3108**

DURATION: **3 HOURS**

INSTRUCTIONS TO CANDIDATE

1. **Answer Five Questions**
2. **Each Question Carries 20 marks**

QUESTION ONE

A boiler generates 5000kg of steam /h at 1.8MN/m^2 , the steam temperature is 325^0C and the feed water temperature is 49.4^0C . The efficiency of the boiler plant is 80% when using oil of calorific value 45 500kJ/kg. The steam generated is supplied to a turbine which develops 500KW and exhausts at 0.18MN/m^2 , the dryness fraction of the steam being 0.98. [6]

a) Estimate the amount of oil used/h and the fraction of the enthalpy drop through the turbine, which is converted into useful work. [6]

b) What are the two maintenance problems associated with boilers, and two possible solutions to them? [8]

QUESTION TWO

a) A two stage, single acting, reciprocating compressor takes air at the rate of 0.2m^3/s. Intake pressure and temperature are 0.1MN/m^2 and 16^0 C respectively. The air is compressed to a final pressure of 0.7MN/m^2. The immediate pressure is ideal and intercooling is perfect. The compression index is 1.25 and the compressor runs at 10rev/s.

Neglecting clearance, determine:

i) The immediate pressure [4]
ii) The total volume of each cylinder [4]
iii) The cycle power [4]

b) Identify the two maintenance problems associated with compressors and two possible solutions to them? [8]

QUESTION THREE

a) Identify and explain the principles of operation of any two types of recuperators [8]

b) A surface condenser operating at a pressure of 24KN/m^2 condenses 1.8 tonne of steam of 0.98 dryness fraction and is condensed, but not undercooled. Cooling water enters the condenser at a temperature of 21^0C and leaves at 57^0C. Determine the flow rate of the cooling water. [12]

QUESTION FOUR

Air is heated by passing it through a 25mm bore copper tube which is maintained at 280^0C. The air enters at 15^0C and leaves at 270^0C at a mean velocity of 30m/s. Using Reynold's analogy. Calculate:

a) The length of the tube [10]
b) The pumping power required [10]

For turbulent flow in the tube take $f = 0.0791(Re)^{-1/4}$ and all properties at mean film temperature.

QUESTION FIVE

Air is required to be delivered to a room at dry bulb temperature of 17^0C and with relative humidity of 60%. The calculation to be based on an air flow of 0.5m/s into the room and it can be assumed that the corresponding fan input is 1.125kW. Calculate the condition at which the air must leave the heater. Assume the pressure throughout the plant is constant at 1.013 bar [20]

QUESTION SIX

Exhaust gases flowing through a tubular heat exchanger at the rate of 3m/s are cooled from 400^0C to 120^0C by water initially at 10^0C. The specific heat of exhaust gases and water are given as1.13 and 4.19kJ/kgK respectively, and the overall heat transfer coefficient from gases to water is140W/m^2K. Calculate the surface area required when the cooling water flows at 0.4kg/s,

a) For parallel flow [10]
b) For counter flow [10]

QUESTION SEVEN

a) With the aid of sketches show the four fluid flow circuits in a steam power plant, explain their principles of operation. [10]
b) For each major equipment in the circuit above explain the maintenance problems associated and the possible solution. [5]
c) Identify the control mechanism in each equipment in the above circuit [5]

END OF EXAM