NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial & Manufacturing Engineering

1st SEMESTER EXAMINATIONS APRIL 2009

THERMODYNAMICS – TIE 2101

ANSWER ANY <u>FIVE (5)</u> QUESTIONS
TIME ALLOWED: 3 HRS
ADDITIONAL MATERIAL – STEAM TABLES

<u>Question 1</u>

0.35kg of air at a pressure of $140\,{}^{kN}\!/_{m^2}$ occupies $0.4\,m^3$ and from this condition is compressed to 1.4 ${}^{MN}\!/_{m^2}$ according to the law $PV^{1.34} = C$.

Determine:

(a) the change of internal energy of the air **[10]**
(b) the work done on or by the air **[5]**
(c) the heat received or rejected by the air **[5]**

Take $c_p = 1.005kJ/kgK$ and $c_v = 1.005kJ/kgK$

<u>Question 2</u>

(a) Show from the first law of thermodynamics that the change of entropy for a gas is given by $s_2 - s_1 = c_p \ln(T_2/T_1) + R\ln(P_2/P_1)$ **[8]**

(b) Describe with the aid of a diagram the stages in the formation of superheated steam. **[8]**

(c) A perpetual motion machine of its own kind is impossible. Discuss. **[4]**

<u>Question 3</u>

Determine the saturation temperature, Specific liquid enthalpy, specific enthalpy of evaporation and specific enthalpy of dry saturated steam at a pressure of 2.08 ${}^{MN}\!/_{m^2}$. **[20]**

Question 4

In an ideal Diesel cycle the volume ratios of the adiabatic expansion and compression are 8:1 and 12:1 respectively. The pressure and the temperature at the beginning of compression are 90 kN/m^2 and 44 ^oC respectively. The pressure at the end of the adiabatic expansion is 258 kN/m^2 . Determine:

(a) the maximum temperature attained during the cycle **[10]**

(b) the thermal efficiency of the cycle **[10]**

(c) Take γ =1.4

Question 5

(a) Describe the major components of a steam power plant **[10]**

(b) A closed gas turbine unit operating with maximum and minimum temperatures of 760 ^oC and 20 ^oC has a pressure ratio of 7:1. Calculate the ideal cycle efficiency and the work ratio. **[10]**

Question 6

(a) A furnace wall consists of 300mm firebrick, 150mm insulating brick, and 300mm building brick. The inside wall is at a temperature of 500 o/c and the atmospheric temperature is 30 ^oC .The heat transfer coefficient for the outside surface is 10 $W/m2K$, and the thermal conductivities of the firebrick, insulating brick, and the building brick are 1.4, 0.2, and 0.7W/mK, respectively. Calculate

(i) the rate of heat loss per unit wall surface area and **[10]**

(ii) the temperature of the outside wall surface of the furnace **[10]**

End of examination