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University Examinations 2013/2014

SECOND YEAR, SECOND SEMESTER EXAMINATION FOR DIPLOMA IN CIVIL ENGINEERING

EMC 0225: INTRODUCTION TO THERMODYNAMICS

DATE: APRIL 2014 **TIME: 1 ½ HOURS**

INSTRUCTIONS: **(i)** *Answer question **one** and any other **two** questions*

(ii) Use the provided thermodynamic tables

QUESTION ONE – (30 MARKS)

(a) Define each of the following thermodynamic terms:
- (i) Working fluid
- (ii) Temperature
- (iii) Specific property
- (iv) Degree of superheat
- (v) Dryness fraction (5 Marks)

(b) A turbine operating under steady flow conditions receives steam at the following state; pressure 13.8 bar; specific volume 0.143m^3/kg; internal energy 2590 kJ/kg; velocity 30m/s. The state of the steam leaving the turbine is; pressure 0.35 bar; specific volume 4.37$m^{3/}$kg ; internal energy 2360kJ/kg; velocity 90m/s. Heat is lost to the surrounding at the rate of 0.25kJ/s. if the rate of steam flow is 0.38kg/s, what is the power developed by the turbine. (12 Marks)

(c) When a certain perfect gas is heated at constant pressure from $15°C$ to $95°C$, the heat required is 1136kJ/kg. when the same gas is heated at constant volume between the same temperatures the heat requires is 808kJkg. Calculate:
- (i) Specific heat at constant pressure
- (ii) Specific heat at constant volume
- (iii) Isentropic index

(iv) Specific gas constant
(v) Relative molecular mass (13 Marks)

QUESTION TWO – (15 MARKS)

Steam at 17 bar, dryness fraction 0.95, expands slowly in a cylinder behind a piston until the pressure is 4 bar.

Calculate

(a) The final specific volume and the final temperature of the steam when the expansion follows the law pv = constant. (7 ½ Marks)
(b) The final specific volume and the final temperature when the working substance is air expanding according to the law pv = constant between the same pressures as in part (a) and from the same initial temperature. (7 ½ Marks)

QUESTION THREE – (15 MARKS)

(a) Oxygen (molar mass 32Kg/kmol) is compressed reversibly and polytropically in a cylinder from 1.05bar, $15°C$ to 4.2 bar in such a way that one third of the work input is rejected as heat to the cylinder walls. Calculate the final temperature of the oxygen. Assume Oxygen to be a perfect gas and take c_v = 0.649kJ/kgK. (7 ½ Marks)
(b) 1 kg of steam in a cylinder expands reversibly behind a piston according to a law pv = constant, from 7 bar to 0.75 bar. If the steam is initially dry saturated find the temperature finally, the work done by the steam, and the heat flow to and from the cylinder walls. (7 ½ Marks)

QUESTION FOUR – (15 MARKS)

1 kg of a fluid at 30 bar, $300°C$, expands according to a law pv = constant to a pressure of 0.75 bar. Calculate the heat flow and the work done,

(a) When the fluid is air. (7 ½ Marks)
(b) When the fluid is steam. (7 ½ Marks)

Sketch each process on a T-s diagram.