NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

THERMODYNAMICS

TIE 2101

First Semester Supplementary Examination Paper

August 2015

This examination paper consists of four (4) printed pages.

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Steam tables

Examiner's Name: Mr. W. Tumbudzuku

INSTRUCTIONS AND INFORMATION TO CANDIDATE:

1. Answer any five (5) questions
2. Each question carries 20 marks
3. Use of calculators is permissible

Question 1

a) Describethe following processes:

i) Isothermal process, . [2]
ii) Isochoric process, [2]
iii) Isobaric process, [2]
iv) Adiabatic process. [2]

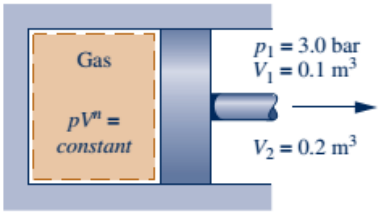

Figure Q1: Piston-cylinder assembly

b) A gas in a piston–cylinder assembly undergoes an expansion process for which the relationship between pressure and volume is a polytropic process given by $pV^n = C$. Given that the initial pressure is 3 Bar, the initial volume is 0.1 m^3, and the final volume is 0.2 m^3

Determine the work for the process, in kJ, if:

i) $n = 1.5$, [3]
ii) $n = 1.0$, [3]
iii) $n = 0$, [3]
iv) Draw a $p \cdot V$ diagram showing the three processes. [3]

Question 2

a) Explain the following thermodynamics terms;

i) Surroundings, [2]
ii) Boundary, [2]
iii) Heat and Temperature. [2]

b) Distinguish between the Otto cycle and the Diesel cycle [4]

c) A petrol engine cylinder has diameter of 10 cm and stroke 20 cm, clearance volume 250 cm^3. If the temperature at the beginning of the compression is 65^oC, Find the temperature at the end of compression and the work done during the compression stroke if the law of compression is $pV^{1.33} = C$. Take the initial pressure as 195 kN/m^2. [10]

Question 3

Steam is supplied to the turbine at a rate of 60 kg/s; and dry saturated at 40 Bar. The steam exits the turbine into the condenser at a pressure of 0.04004Bar where it is condensed to wet saturation before being pumped into the boiler. If the plant operates on the Rankinecycle, calculate:

a) The power input of the feed pump given that the specific volume of the saturated water is 0.001 m^3 . [4]
b) The net power output of the plant. [4]
c) The heat lost in the condenser. [4]
d) The thermal efficiency of the plant. [4]
e) The ration of the feed pump work to the turbine work. [4]

Question 4

(a) Outline the evolution of thermodynamics as a field of study. [10]
(b) Discuss the relevance of engineering thermodynamics to Industrial and Manufacturing Engineering. [10]

Question 5

a) Entropy is defined as the multiplicity of the system, the disorder of the system or the energy which is unavailable to do work . Discuss. [8]

b) 0.5kg of air at a pressure of $40\,MN/m^2$ and a temperature of $40\,^oC$ receives heat energy at constant volume until its pressure becomes $80\,MN/m^2$. It then receives heat energy at constant pressure until its volume becomes $0.5\,m^3$.
Determine the change of entropy during each process. [12]
Take Cp=1.005kJ/kgK andCv=0.717kJ/kgK
Where Cp is the coefficient of heat at costant pressure and Cv is the coefficient of heat at constant volume.

Question 6

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

b) A petrol engine cylinder has a diameter of 10 cm and stroke of 15 cm, clearance volume 300 cm^3. If the temperature at the beginning of the compression is 70^0C, Find the temperature at the end of compression and the work done during the compression stroke if the law of compression is $pV^{1.11} = c$.
Take the initial pressure as 156 kN/m^2. [10]

Question 7

Determine the specific volume of steam at a pressure of 8 Mpa for the following conditions with the aid of steam tables.

(a) Dryness fraction x=0.2, [5]
(b) Dryness fraction x=0.6, [5]
(c) It's temperature is 450 ^{o}c, [5]
(d) It's temperature is 750 ^{o}c. [5]

End of examination