TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
Diploma in Mechanical Engineering
EME 2207 : Thermodynamics II
SPECIAL/ SUPPLEMENTARY EXAMINATION
SERIES: AUGUST 2019
TIME: 2 HOURS
DATE: Pick Date **Aug 2019**

Instruction to Candidates:

You should have the following for this examination

- *Student I.D. Card & Examination Pass*
- *Answer booklet*
- *Non-Programmable scientific calculator*
- *Thermodynamic and Transport Properties of Fluids by G. F. C. Rogers and Y. R. Mayhew*

This paper consists of **FIVE** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE

a. i) Show that heat flow Q, through a cylinder is given by; **(8 marks)**

$$Q = \frac{2\pi K(t_1 - t_2)}{\ln\left(\frac{r_2}{r_1}\right)}$$

Where K – thermal conductivity of the cylinder materials
t_1 & t_2 are inside and outside surface temperatures respectively
r_1 and r_2 are internal and external radii respectively

ii) Derive an expression for the logarithmic mean area for the cylinder.

b. A steel tube with 5 cm internal diameter, 7.6 cm external diameter has a value of k=15W/mK. The tube is covered with an insulative covering of thickness 2 cm whose k 0.2 W/m·K. A hot gas at 330^{o} C with α = 400 W/m^{2}K flows inside the tube. The outer surface of the insulation is exposed to cooler air at 30^{o}C with α = 60 W/m^{2}K. Determine;

(i) The heat loss from the tube to the air for 10 m of the tube and

(ii) The temperature drops resulting from the thermal resistances of the steel tube, the insulation layer and the outside air. **(12 marks)**

Question TWO

a. Explain the factors which influence the choice of a fuel for a particular application **(6 marks)**

b. Explain the following terms as applied to combustion

(i) Weak mixture
(ii) Rich mixture
(iii) Mixture strength
(iv) Stoichiometric mixture **(8marks)**

c. The percentage composition of a liquid fuel by mass is, C=84.8 % and H_2=15.2 %. Calculate:

(i) Stoichiometric A/F ratio,

(ii) The volumetric analysis of the products of combustion if 15 % excess air is supplied. **(6 marks)**

Question THREE

a. Describe any two types of irreversible processes. **(6 marks)**

b. Steam at a pressure of 20bar and 250^{o}C is expanded in a perfectly thermally insulated cylinder to 3.6 bar and it is then further expanded polytropically to a pressure of 0.6 bar. Determine;-

i) Final condition of the steam,
ii) Work done,
iii) Change of entropy during the two processes. **(14marks)**

Question FOUR

a. Explain with help of both p-v and t-s diagrams the air standard Dual combustion cycle. **($7\frac{1}{2}$ marks)**

b. An air standard dual combustion has a volume compression ratio of 15:1. The conditions at the beginning of compression are 1bar, 25^{o}C and 0.1m^{3}. The maximum pressure of the cycle is 1500^{o}C. Determine for the cycle;

   i) the conditions at the the corners of the cycle

   ii) Thermal efficiency. **($12\frac{1}{2}$marks)**

Question FIVE

a. i) The work done when a given mass of a perfect gas undergoes a non-flow reversible polytropic process in given by;

$$W = \frac{mR(T_1 - T_2)}{n - 1}$$

Hence or otherwise, show that the heat transfer for the same process is given by;

$$Q = \left(\frac{n - \gamma}{\gamma - 1}\right) W$$

(8 marks)

b. 0.45 m^{3} of air at 1 bar and 80°C contained in a cylinder behind a piston is compressed according to the law pv^n =constant to a volume of 0.13 m^{3}, the final pressure being 5 bar. Determine:

   (i) The mass of gas;

   (ii) The value of index 'n' for compression;

   (iii) The increase in internal energy of the gas;

   (iv) The heat transfer during the process. **(12 marks)**