TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN MECHANICAL ENGINEERING (DMEN)

EME 2309
THERMODYNAMICS IV

SPECIAL/SUPPLEMENTARY EXAMINATIONS

YEAR 3 SEMESTER 2

SERIES: MARCH, 2014

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. You should have the following for this examination:
   - Answer Booklet
   - Scientific Calculator
   - Drawing Instruments

2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. All Questions carry equal marks.
5. **This paper consists of FOUR printed pages.**

Question ONE

(a) Define the following terms as applied in heat transfer:

(i) (I) Thermal conductivity

(II) Convection heat transfer coefficient

(ii) Show that the logarithmic mean area for a cylinder is given by:

$$A_m = \frac{4\pi(r_2 - r_1)}{In\, r_2 / r_1}$$

(10 marks)

(b) Explain using clear sketches the use of a reheater on the basic gas turbine, unit indicating its effect with help of a T-S diagram. **(4 marks)**

(c) Define the following terms as applied in engine trials:

(i) Indicated mean effective pressure
(ii) Specific fuel consumption
(iii) Brake thermal efficiency

(6 marks)

Question TWO

(a) Show that the logarithmic mean radius, r_m, for a cylinder is given by:

$$r_m = \frac{r_1 - r_2}{In\, r_2 / r_1}$$

Where r_1 and r_2 are the internal and external radii respectively.

(b) Water at 80°C flows through a 50mm bore steel pipe of 6mm thickness, and the atmospheric temperature is 15°C. The thermal conductivity of steel is 48W/mk and the inside and outside heat transfer coefficients are 2800 and 17W/m^{2}k respectively. Neglecting radiation determine the rate of heat loss per unit length of pipe. **(10 marks)**

Question THREE

(a) State **FIVE** ways classifying engines. **(5 marks)**

(b) Plot a graph o the specific fuel consumption against speed and explain the general shape of the graph. **(4 marks)**

(c) A four cylinder petrol engine has an output of 52kw at a speed of 2000rpm. A morse test is carried out and the brake Torque readings are 177, 170, 168 and 174Nm respectively. For normal running at this speed the specific fuel consumption is 0.364Kg/Kwh. The calorific value of the fuel is 44200kJ/kg. Determine:

(i) The mechanical efficiency
(ii) The brake thermal efficiency

(11 marks)

Question FOUR

In an open gas turbine unit the air from the compressor passes through a heat exchanger where it is heated by the gas from the L.P. turbine. The H.P turbine drives the compressor only. The exhaust gases from the H.P turbine pass through the L.P combustion chamber, then into the L.P turbine which drives the external load. Given the following information:

Overall pressure ratio	9/1
Compressor Isentropic Efficiency	0.88
H.P turbein isentropic efficiency	0.86
L.P turbine isentropic efficiency	0.9
Heat exchanger effectiveness	0.75
Temperature of gases entering the H.P turbine	700^{o}C
Temperature of gases entering the L.P turbine	650^{o}C
Atmospheric pressure	1.0132S
Atmospheric temperature	25^{o}C

Taking Cp for air and gases as 1.005kJ/KgK and r as 1.4 for both working fluids.

(a) Sketch the plant layout and T-S diagram. **(5 marks)**

(b) Determine:

(i) Pressure of gas entering the L.P turbine
(ii) Overall thermal efficiency

(15 marks)

Question FIVE

(a) Explain the principle of operations of two main types of steam Turbines:

(i) Impulse
(ii) Reaction

(2½ marks)

(b) Explain 'Pressure Compounding' with the help of a sketch as used in steam turbines and illustrate the variation of steam velocity with pressure through a stage of the wheel.

(4½ marks)

(b) The following data applies to the first stage of an impulse turbine which is a two-row velocity compounded wheel:

Turbine speed	=	2000rpm
Mean blade radius	=	600mm
Nozzle angle	=	20^o
Exit angle from 1st row of moving blades	=	22^o
Exit angle from 2nd row of moving blades	=	34^o
Blade velocity coefficient for all blades	=	0.9
Mass flow rate of steam	=	6kg/s
Absolute velocity of steam at discharge from the nozzle	=	700m/s
Exist angle from fixed blades	=	27^o

Determine:

(i) Blade inlet angle for each row
(ii) Diagram power

(13 marks)