TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

DIPLOMA IN MECHANICAL ENGINEERING (DMEN)

EME 2303
THERMODYNAMICS III

END OF SEMESTER EXAMINATIONS

YEAR 3 SEMESTER 1

SERIES: DECEMBER, 2013

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) The readings taken in a room from a sling psychrometer were as follows:

Dry bulbs temperature 26.5°C
Wet bulb temperature 21.1°C

Using a psychrometic chart taking the barometric pressure as 1.013bar determine:

(i) The specific humidity
(ii) The percentage saturation
(iii) The dew point
(iv) The specific enthalpy of the mixture

(4 marks)

(b) Briefly explain the following analyses as applied in combustion of fuels:

(i) Gravimetric
(ii) Ultimate

(4 marks)

(c) List **FOUR** uses of compressed air in engineering. **(4 marks)**

(d) Show that the indicated work input per cycle for single stage-single acting reciprocating compressor is given by:

$$I.W = \frac{n}{n-1} P_1 V \left\{ \left(\frac{P_2}{P_1} \right)^{(n-1)/n} - 1 \right\}$$

Where: n = Polytropic index
P_1 = Admission pressure
V = Induced volume per cycle
P_2 = Delivery pressure

(8 marks)

Question TWO

The sensible and latent heat gains in a room served by a single zone air conditioner are 106.80kw and 43.44kw respectively. The room is to be maintained at 24°C and 45% saturation. The design conditions of outdoor air are 32°C dry bulb and 25°C wet-bulb temperatures for ventilation purposes outdoor air is mixed with recalculated air in a certain proportion, the rest being expelled through a

central conditioning station consisting of a cooler battery, reheat battery and a fan before it is supplied to the room through ducts.

The air entering the room is at 12°C, the air temperature rise in the fan and entering the reheat battery is at 9°C. The cooler coil apparatus dew point is 1.5°C.

(9 marks)

(a) Draw a sketch of the plant layout

(b) Determine:

(i) The proportion of mass flow rate of outdoor air to that supplied to the room.
(ii) The cooler battery load
(iii) The reheat battery load
(iv) The cooler coil contact factor

(20 marks)

Question THREE

(a) Outline the **THREE** advantages of multi-stage air compressor over single stage machines.

(3 marks)

(b) State **TWO** conditions required for minimum work input in multi-stage air compressors.

(2 marks)

(c) A three-stage, single-acting air compressor running in an atmospheric condition of 1.013bar and 15°C, is designed for minimum work and compresses air to 66.8bar and has a free air delivery of 5.8m^3/min. The suction pressure and temperature are 0.99 bar and 28°C respectively. The clearance volume for each cylinder is 4% of its stroke volume and the compressor runs at 750rpm. Assuming compression and re-expansion to follow the law $PV^{1.3} = C$, determine:

(i) The indicated power
(ii) The intermediate pressure
(iii) The swept volume of each cylinder (R = 0.287kJ/kgk).

(15 marks)

Question FOUR

(a) Define the following terms as applied in combustion:

(i) Calorific value
(ii) Mixture strength

(2 marks)

(b) Explain any **TWO** factors which affect the choice of a fuel. **(4 marks)**

(c) The ultimate analysis of a sample of petrol was 85.5% C and 14.5%H. If the mixture strength is 120%, determine:

(i) The actual A/f ratio
(ii) The analysis of the dry products of combustion

(14 marks)

Question FIVE

(a) Explain the advantages of compounding steam engines. **(2 marks)**

(b) A double-acting compound steam engine consists of one HP and one L.P cylinder. The admission pressure for the H.P cylinder is 13.5 bars and the condenser pressure is 0.25 bars. The engine is required to develop 250KW. The total expansion ratio referred to the L.P cylinder is 15 and the overall diagram factor is 0.8. The diameter of the L.P cylinder is 500mm and the stroke of both cylinders is 600mm. The expansion ratio of the H.P cylinder is 3. Assuming hyperbolic expansion in both cylinders and a mechanical efficiency of 0.86, determine:

(i) The speed of the engine in rev/min.
(ii) Diameter of the H.P cylinder
(iii) Ratio of work done in HP cylinder to L.P cylinder

(10 marks)