# EAST AFRICAN SCHOOL OF AVIATION EXAMINATION

# END TERM I EXAMS

**DIPLOMA IN AERONAUTICAL ENGINEERING**

Mechanical Technology II

**STREAM: Module III (Airframes & Engines)** **Duration: 3Hrs**

**DAY/DATE: 3rd April, 2017** **TIME: 9.00-12.00 pm**

---

**INSTRUCTION TO CANDIDATES**

*You should have the following for this examination:*

*Answer booklet;*

*Mathematical tables / Electronic calculator.*

*Answer* ***ALL QUESTIONS IN SECTION A*** *and* ***SECTION B*** *in this paper*

*All questions carry equal marks.*

*Maximum marks for each part of a question are as shown*

**This paper consists of -3- printed pages.**

**Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing**

**SECTION A: THERMODYNAMICS**

Answer **ALL** questions from this section.

1. (a) Define the term thermodynamic system. **(2 marks)**

(b) Differentiate between open system and closed system as applied in thermodynamics.

**(4 marks)**

(c) Briefly explain the following. **(4 marks)**

i. Zeroth law of thermodynamics
ii. First law of thermodynamics

(d) Show that work done (W) during an isothermal process is given by: **(10 marks)**

$W = p_1 v_1 \ln\frac{v_2}{v_1}$ where $p_1$- pressure at state 1, $v_1$- volume at state 1 and

$v_2$- volume at state 2.

2. (a) Briefly explain using p-v diagrams the following thermodynamic processes.

i. Isobaric process
ii. Isochoric process
iii. Polytropic process
iv. Adiabatic process **(8 marks)**

(b) A unit mass of a certain fluid is contained in a cylinder at an initial pressure of 10 bar. The fluid is allowed to expand reversibly behind a piston according to a law $pv^2$ = constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 10 bar. Calculate the net work done by the fluid for an initial volume of 0.1 $m^3$. **(12 marks)**

3. (a) Show that for a perfect gas.

$c_p - c_v = R$ where $c_p$- specific heat capacity at constant pressure, R- specific gas constant, $c_v$- specific heat capacity at constant volume (**10 marks**)

(b) 0.3 kg of nitrogen gas at 100 kPa and $40^0$ C is contained in a cylinder. The piston is moved compressing nitrogen until its pressure becomes 1 MPa and temperature becomes $160^0$ C. The work done during the process is 30 kJ. Calculate the heat transferred from the nitrogen to the surroundings. (**10 marks**)

**SECTION B: FLUID MECHANICS**

Answer **ALL** questions from this section

4. a). State TWO uses of dimensional analysis. **(2 Marks)**

b). Briefly explain the following methods as applied in dimensional analysis. **(6 Marks)**

i. Rayleigh's method
ii. Buckingham's Π-theorem

c). The thrust (P) of an aircraft propeller depends upon the diameter (D), speed (V), mass density (ρ), revolutions per minute (N) and coefficient of viscosity (μ). Show that:

$$P = PD^2V^2f\left(\frac{\mu}{\rho VD}, \frac{DN}{V}\right)$$

**(12 Marks)**

5. a). State any **FIVE** non-dimensional constants used in fluid analysis. **(5 Marks)**

b). Briefly explain the following types of hydraulic similarity.

i. Geometric similarity
ii. Kinematic similarity
iii. Dynamic similarity

**(6 Marks)**

c). Show that the discharge of the prototype for the given discharge of a distorted model is given by:

$Q = q \times s_h \times s_v^{1.5}$ where Q- discharge of prototype, q- discharge of model, $s_h$- horizontal scale ratio, $s_v$- vertical scale ratio **(4 marks)**

d). The resistance on a ship is to be found out from model tests on 1:60 model in a wind tunnel. If the drag on the model was found to be 0.005 N, what will be the drag on the prototype. Take density of air = 1.2 kg/m$^3$ and density of sea water = 1030 kg/m$^3$ **(5 marks)**