PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINERING

EXAMINATION QUESTION PAPERS

ME 211
BASIC THERMODYNAMICS AND CYCLES

SEMESTER ONE – 2024

BY GK

THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

SCHOOL OF MECHANICAL ENGINEERING – 2nd YEAR DEGREE

FIRST SEMESTER EXAMINATIONS - 2024

ME 211 – BASIC THERMODYNAMICS AND CYCLES

TIME ALLOWED: 2.5 HOURS

INSTRUCTIONS:

1. You have 10 minutes to read the paper. You **must not** begin writing this time.
2. Answer **All the** questions.
3. **Use only ink**. Do not use pencil for writing except for drawings and sketches.
4. Start each question on a new page and show all your calculations in the answer book provided. No other written will be accepted.
5. Write down your **FULL NAME** and **STUDENT NUMBER** clearly on the front page.
6. Calculator is permitted in the examination room. Notes, textbooks or smart phones are not allowed.
7. Any candidate cheating the examinations will be disqualified.

MARKING SCHEME:

Subject Learning Outcomes (SLOs)		Marks
1	Solve thermodynamic problems through the application of the basic equations derived from the first law, gas laws and vapour tables.	8
2	Describe the principles of steam power plant, heat engines and refrigeration systems.	8
3	Summarise the construction and performance of internal combustion engines.	6
4	Employ the second law of thermodynamics and the concept of entropy.	10
5	Workout the basic models to study, analyse and design thermal systems and to comprehend methods to increase the thermal efficiency.	8
Total		40

Question No. 1

(a) A force of 1600 N is applied uniformly on a piston of 8 cm diameter. Determine the pressure on the piston. [2]

(b) How does heat pump differ from a refrigerator? [2]

(c) State the Clausius statement for second law of thermodynamics with sketch. [2]

(d) Prove that entropy is a property of a system. [2]

(e) Explain "Air standard analysis" which has been adopted for I.C. engine cycles. State the assumptions made for air standard cycles. [2]

Question No. 2

Two tanks contain methane. For the given conditions, methane can be treated as an ideal gas. Tank 1 has a volume of 0.3 m^3, and is at a temperature of 20°C and a pressure of 300 kPa. Tank 2 contains 1.5 kg of methane, and is at a temperature of 30°C and a pressure of 800 kPa. The partition between the two tanks is removed to allow methane in the tanks to mix and reach equilibrium. What is the equilibrium pressure if the temperature of the two tanks is 25°C at equilibrium? (Take R=0.5182 kJ/kgK for methane.) [6]

Question No. 3

Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ removed from the cold body by the refrigerator? If this system is used as a heat pump, how many MJ of heat would be available for heating for each MJ of heat input to the engine? [6]

Question No. 4

Calculate the amount of theoretical air required for the combustion of 1 kg of acetylene (C_2H_2) to CO_2 and H_2O. [6]

Question No. 5 (Answer any one)

(a) 1 kg of air initially at 8 bar pressure and 380 K expands polytropically ($pv^{1.2}$ = constant) until the pressure is reduced to one-fifth value. Calculate: (i) Final specific volume and temperature. (ii) Change of internal energy, work done and heat interaction. (iii) Change in entropy. Take: R = 0.287 kJ/kg K and $\gamma = 1.4$. [6]

(b) A closed system contains air at a pressure 1 bar, temperature 300 K and volume 0.018 m^3. This system undergoes a thermodynamic cycle consisting of the following three processes in series: (i) Constant volume heat addition till pressure becomes 5 bar, (ii) Constant pressure cooling, and (iii) Isothermal heating to initial state. Represent the cycle on T-S and p-V plots and evaluate the change in entropy for each process. (Take C_p = 0.718 kJ/kg K and R = 0.287 kJ/kg K)

Question No. 6 (Answer any one)

(a) Explain with the help of neat diagram a 'Regenerative Cycle'. Derive also an expression for its thermal efficiency. [6]

(b) The minimum pressure and temperature in an Otto cycle are 100 kPa and 27°C. The amount of heat added to the air per cycle is 1500 kJ/kg.

(i) Determine the pressures and temperatures at all points of the air standard Otto cycle.

(ii) Also calculate thermal efficiency of the cycle for a compression ratio of 8 : 1.

Take for air: c_v = 0.72 kJ/kg K, and $\gamma = 1.4$.

****Best of Luck****