

MEL 241 ENERGY SYSTEMS & TECHNOLOGIES

MAJOR EXAMINATION

Time: 60 min

Max. Marks: 70

(Open Hand-written Notes Examination)

**Problem 1:** Draw *Mine-to-Wheels* diagrams for combustion engine vehicles and electric vehicles.

(5 marks)

**Problem 2:** Prove that energy systems are biological need of humans.

(5 marks)

**Problem 3** A company is developing a petrol-diesel engine. The preliminary tests show following results:

- Flow rate of petrol ( $C_7H_{17}$ ) = 14.2 kg/hr
- Flow rate of Diesel ( $C_{144}H_{249}$ ) = 14.5 kg/hr
- Flow rate of air = 516.6 kg/hr

The air with 65% RH and fuel enter at 25 °C. In the engine 95% of the carbon burns to  $CO_2$ , 3% burns to CO and remaining leaves as  $CH_4$  emissions. Determine the composition and the dew point of the products of combustion.

(10 marks)

**Problem 4:** An air-conditioning system is to be designed for a Shopping mall in Delhi Based on Summer conditions:

- Out-door conditions: 42 °C & 20 % of RH.
- Required Indoor conditions: 22 °C & 55% of RH.

Develop a psychrometric duct & draw the processes on psychrometric chart for this system. Specify approximate properties of air after each process.

(10 marks)

**Problem 5:** Draw a neat sketch of an ECO-FRIENDLY AIR DISTRIBUTION System for PC Combustion and explain the need for coal mill.

(5 marks)

**Problem 6:** Derive an expression for Total thrust of a turbofan engine.

Following are the details of a turbojet engine.

- Total Thrust = 76.4 kN
- Compressor Pressure ratio: 25.5
- Turbine inlet temperature: 1,400 °C
- Cruising conditions: 223K, 26.4 kPa & 0.413kg/m<sup>3</sup>
- Cruising Mach Number : 0.92

Calculate mass flow rate of air required to generate the required total thrust. Also compute TSFC of turbojet engine.

Heating value of fuel = 41,400 kJ/kg; Properties of air:  $c_p=1.005$  kJ/kg &  $\gamma=1.4$ ; Properties of combustion gas:  $c_p=1.230$  kJ/kg &  $\gamma=1.3$ .

(15 marks)

**Problem 7:** Draw a neat sketch of Solar PV panel test setup and explain the working principle of the same. Also explain the reason for drop in efficiency at higher cell temperatures.

(5 marks)

**Problem 8:** Draw neat sketch of Diesel Engine Test Setup. A constant speed test on a Diesel engine generates following equation for fuel consumption Vs Brake Power.

$$\dot{m}_{fuel} (gms / s) = 0.0532 + 0.0951 \times BP(kW)$$

Estimate Friction Power developed by this engine.

**Following are the specifications of the engine:**

Engine Speed: 1500 rpm & four stroke.

Max. Brake Power = 6.2 kW

Compression ratio = 17.2

Cut-off ratio = 1.8

Heating value of fuel = 44,800 kJ/kg.

Develop an air standard Diesel cycle for this engine.

(Ambient conditions : 310K & 100kPa.)

(15 marks)