

FINAL
Examination Paper

(COVER PAGE)

Session : August 2019

Programme : Diploma In Mechanical Engineering (DMEN)

Course : EGM2181 : Engineering Thermodynamics 2

Date of Examination : December 12, 2019 (Thursday)

Time : 8:00 am – 10:00 am Reading Time: Nil

Duration : 2 Hours

Special Instructions :

This paper consists of SIX (6) questions. Answer any FOUR (4) questions in the answer booklet provided. All questions carry equal marks.

Materials permitted : Non-Programmable Calculator

Materials provided :

Appendix 1 (Property Tables and Charts (SI UNITS))

Examiner (s) : Nur Hafizah Habideen and Soo Swee Yoong

Moderator : Dr Ing Al-Hassan Salami Tijani

This paper consists of 4 printed pages, including the cover page.

DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
EGM2181: ENGINEERING THERMODYNAMICS 2
FINAL EXAMINATIONS: AUGUST 2019 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

A gas turbine unit has a pressure ratio of 10 and a maximum cycle temperature of 700°C. The isentropic efficiencies of the compressor and turbine are 0.82 and 0.85 respectively. Take $C_{p,compressor} = 1.005$ kJ/kg.K and specific heat ratio, $k_{compressor} = 1.4$ for the compression process, and take $C_{p,turbine} = 1.11$ kJ/kg K and specific heat ratio, $k_{turbine} = 1.333$ for the expansion process. Utilizing the cold air standard assumptions, sketch the T-s diagram for the cycle mentioned above and determine:

- (a) The compressor exit temperature (8 marks)
- (b) The turbine exit temperature (5 marks)
- (c) The net power output (9 marks)
- (d) the power output of the electric generator geared to the turbine when the air enters the compressor at 15°C at the rate of 15 kg/s. (3 marks)

Question 2

Consider a steam power plant that operates on a simple ideal Rankine cycle and has a net power output of 45 MW. Steam enters the turbine at 7 MPa and 500°C and is cooled in the condenser at a pressure of 10 kPa by running cooling water from a lake through the tubes of the condenser at a rate of 2000 kg/s. Show the cycle on a T-s diagram with respect to saturation lines and determine:

- (a) the thermal efficiency of the cycle (18 marks)
- (b) the mass flow rate of the steam (2 marks)
- (c) the temperature rise of the cooling water (5 marks)

Question 3

- (a) Consider a 300 kJ/min refrigeration system that operates on an ideal vapor-compression refrigeration cycle with refrigerant-134a as the working fluid. The refrigerant enters the compressor as saturated vapor at 140 kPa and is compressed to 800 kPa. Show the cycle on a T - s diagram with respect to saturation lines and determine:
- (i) the quality of the refrigerant at the end of the throttling process (10 marks)
 - (ii) the coefficient of performance (3 marks)
 - (iii) the power input to the compressor (3 marks)
- (b) A 2 m long, 0.3 cm diameter electrical wire extends across a room at 15°C. Heat is generated in the wire as a result of resistance heating and the surface temperature of the wire is measured to be 152 °C. The voltage and electric current through the wire is 60 V and 1.5 A respectively. Determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room. (9 marks)

Question 4

Air enters a heating section at 95 kPa, 12°C, and 30 percent relative humidity at a rate of 6 m³/min, and it leaves at 25°C. Determine:

- (a) Sketch the schematic diagram and the psychrometric chart for the above (5 marks)
- (b) the rate of heat transferred in the heating section (16 marks)
- (c) the relative humidity of the air at the exit. (4 marks)

Question 5

A single stage, single-acting, reciprocating air compressor has a bore of 200 mm and a stroke of 300 mm. It runs at a speed of 500 rev/min. The clearance volume is 5% of the swept volume and the polytropic index is 1.3 throughout. Intake pressure and temperature are 97 kPa and 20°C, respectively, and the compression pressure is 550 kPa. Sketch the P-v diagram and determine:

- (a) The free air delivered in m³/min (free air condition 101.325 kPa and 15 °C) (15 marks)
- (b) The volumetric efficiency referred to the free air conditions (2 marks)
- (c) The air delivery temperature (2 marks)
- (d) The cycle power (3 marks)
- (e) The isothermal efficiency (3 marks)

Question 6

- (a) An analysis of A-type Coal gave the following values: C=75%; H=18%; O=2.5%; N=1%; S=0.5% ash=3%. Calculate the stoichiometric A/F ratio. (13 marks)
- (b) Acetylene (C₂H₂) is burned with stoichiometric amount of air during a combustion process. Assuming complete combustion, determine the air–fuel ratio on a mass and on a mole basis. (12 marks)

-THEEND-

EGM2181(f)/Aug2019/formatted