Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDX 20203
PROGRAMME CODE	:	2 BDX
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **SIX (6)** QUESTIONS **ONLY**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

SECTION A

Q1 (a) Under what conditions is the ideal-gas assumption suitable for Real Gases? Write down few formula that related with Real Gases.

(8 marks)

(b) An elastic air balloon having a diameter of 30 cm is attached to the base of a container partially filled with water at +4°C, as shown in Figure Q1(b). If the pressure of air above water is gradually increased from 100 kPa to 1.6MPa. **Examine** if the force on the cable will change? If so, what is the percent change in the force? Employ the pressure on the free surface and the diameter of the balloon are related by $P = CD^n$, where C is a constant and $n = -2$. The weight of the balloon and the air in it is negligible.

(12 marks)

Q2 (a) A 1.9 mm diameter tube is inserted into an unknown liquid whose density is 960 kg/m3, and it is observed that the liquid rises 5 mm in the tube, making a contact angle of 15°. Determine the surface tension of the liquid. **Compare** the unknown liquid with an oil.

(8 marks)

(b) A steady, incompressible, two-dimensional velocity field is given by the following components in the xy-plane:
$u = 0.20 + 1.3x + 0.85y$ and $v = -0.50 + 0.95x - 1.3y$
Calculate the acceleration field (find expressions for acceleration components a_x and a_y) and **distinguish** the acceleration at the point $(x, y) = (4, 7)$.

(12 marks)

Q3 (a) An airplane is flying at an altitude of 12,000 m. Determine the gage pressure at the stagnation point on the nose of the plane if the speed of the plane is 700 km/h. How would you solve this problem if the speed were 1050 km/h? Examine what condition happen for both situation.

(10 marks)

(b) The air velocity in the duct of a heating system is to be measured by a Pitot-static probe inserted into the duct parallel to flow. If the differential height between the water columns connected to the two outlets of the probe is 2.4 cm, examine a few perimeter below when the air temperature and pressure in the duct are 45°C and 98 kPa, respectively.
i the flow velocity, and
ii the pressure rise at the tip of the probe. **Appraise** flow rate and water level.

(10 marks)

SECTION B

Q4 (a) The pilot of an airplane reads the altitude 9000 m and the absolute pressure 25 kPa when flying over a city as in **Figure 4(a)**. Calculate the local atmospheric pressure in that city in kPa and in mm Hg. Take the densities of air and mercury to be 1.15 kg/m^3 and 13,600kg/m^3, respectively.

(6 marks)

(b) A turbojet aircraft flies with a velocity of 900 km/h at an altitude where the air temperature and pressure are -35 °C and 40 kPa. Air leaves the diffuser at 50 kPa with a velocity of 15 m/s, and combustion gases enter the turbine at 450 kPa and 950 °C. The turbine produces 500 kW of power, all of which is used to drive the compressor. Assuming an isentropic efficiency of 83 percent for the compressor, turbine, and nozzle, and using variable specific heats, determine:

(i) the pressure of combustion gases at the turbine exit,
(ii) the mass flow rate of air through the compressor,
(iii) the velocity of the gases at the nozzle exit, and
(iv) the propulsive power and the propulsive efficiency for this engine

(14 marks)

Q5 (a) Describe the ideal process and define the isentropic efficiency for an:

(i) adiabatic turbine,
(ii) adiabatic compressor, and
(iii) adiabatic nozzle.

(6 marks)

(b) Refrigerant-134a enters an adiabatic compressor as saturated vapor at 100 kPa at a rate of $0.7 m^3/min$ and exits at 1-MPa pressure as shown in **FIGURE Q5(b)**. If the isentropic efficiency of the compressor is 87 percent, examine:

(i) the temperature of the refrigerant at the exit of the compressor, and
(ii) the power input, in kW.

(14 marks)

Q6 (a) From a work-production perspective, distinguish which are more valuable:

(i) thermal energy reservoirs at 675 K and 325 K, or
(ii) thermal energy reservoirs at 625 K and 275 K.

(6 marks)

(b) An air-conditioner with refrigerant-134a as the working fluid is used to keep a room at 23 °C by rejecting the waste heat to the outdoor air at 37 °C. the room gains heat through the walls and the windows at a rate of 250 kJ/min while the heat generated by the computer, TV, and lights amounts to 900 W. The refrigerant enters the compressor at 400 kPa as a saturated vapor at a rate of 100 L/min and leaves at 1200 kPa and 70 °C, as shown in **FIGURE Q6(b)**. Determine:

(i) the actual COP,
(ii) the maximum COP, and
(iii) the minimum volume flow rate of the refrigerant at the compressor inlet for the same compressor inlet and exit conditions.

(14 marks)

- END OF QUESTION -

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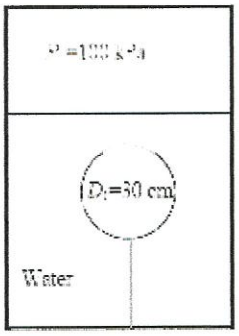

FIGURE Q1 (b)

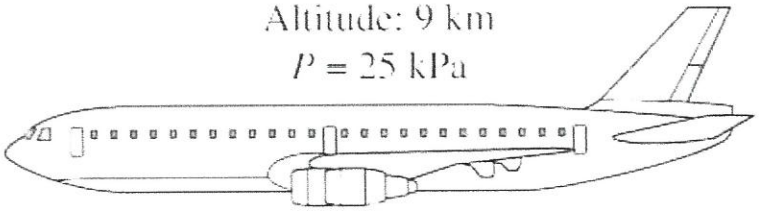

FIGURE Q4 (a)

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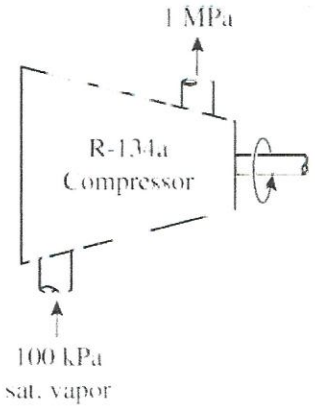

FIGURE Q5(b)

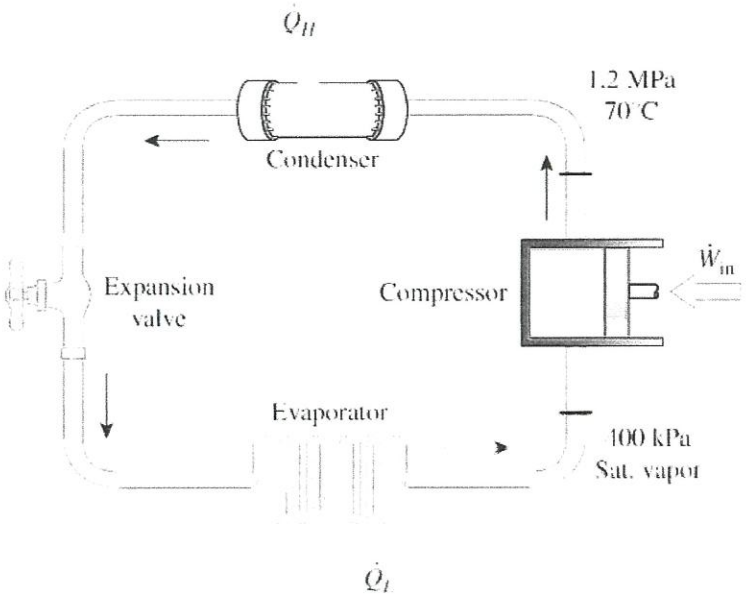

FIGURE Q 6(b)