Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	THERMOFLUIDS
COURSE CODE	:	BDU 10403
PROGRAMME	:	1 BDC / 1 BDM
EXAMINATION DATE	:	JUNE 2016 / JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **SECTION A** AND **TWO (2)** QUESTIONS IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

SECTION A

Q1 (a) Define Newtonian fluid and give an example of non-Newtonian fluids. (5 marks)

(b) A 1.2 mm diameter tube is inserted into an unknown liquid whose density is 960 kg/m^3, and it is observed that the liquid rises 5-mm in the tube, making a contact angle of 15°. Determine:

(i) the surface tension of the liquid; and (7 marks)

(ii) the capillary rise of the liquid, if the liquid is kerosene with surface tension 0.028 N/m and density is 820 kg/m^3. (8 marks)

Q2 (a) Sketch *P-v* diagrams for steam and label the pressure, specific volume, temperature clearly, and then specify the phase of each state (on the diagrams) based on the following conditions:

(i) $P = 20$ bar, $T = 250°C$,
(ii) $T = 212.4°C$, $v = 0.09957$ m^3/kg,
(iii) $P = 10$ bar, $h = 2650$ kJ/kg, and
(iv) $P = 6$ bar, $h = 3166$ kJ/kg.

Note: You should sketch **four** (4) diagrams based on the above conditions. (15 marks)

(b) Discuss and sketch from state 1 to state 2 in either ***T-v***, or ***T-s*** diagram for the following processes:

(i) isentropic process,
(ii) isothermal process,
(iii) isobaric process, and
(iv) isochoric process.

Note: You should sketch **four** (4) diagrams based on the above processes. (5 marks)

SECTION B

Q3 (a) Describe:

(i) body forces; (1 mark)

(ii) surface forces. (1 mark)

Explain the net force acting on a control volume is determined? (2 marks)

(b) Fire fighters as shown in **FIGURE Q3 (b)** are holding a nozzle at the end of a hose while trying to extinguish a fire. If the nozzle exit diameter is 6 cm and the water flow rate is 5 m^3/min, determine:

(i) the average water exit velocity; (9 marks)

(ii) the horizontal resistance force required by the fire fighters to hold the nozzle. (7 marks)

Q4 (a) Someone claims that the average velocity in a circular pipe in fully developed laminar flow can be determined by simply measuring the velocity at $R/2$ (midway between the wall surface and the centerline).

(i) what is your opinion about the statement, do you agree or not; and (1 mark)

(ii) explain your opinion. (3 marks)

(b) Water at 10°C (ρ = 999.7 kg/m^3 and μ = 1.307 x 10^{-3} kg/m · s) is flowing steadily in a 0.20 cm diameter, 15 m long pipe. In the fully developed laminar flow region, the velocity at $R/2$ (midway between the wall surface and the centerline) is measured to be 1.8 m/s. Determine the velocity at the center of the pipe at the average velocity of the flow. (4 marks)

(c) Water at 10°C (ρ = 999.7 kg/m^3 and μ = 1.307 x 10^{-3} kg/m · s) is flowing steadily in a 5 cm diameter, 30 m long pipe horizontal pipe made of stainless steel at a rate of 9 L/s as shown in **FIGURE Q4 (c).** Determine:

(i) the pressure drop
(ii) the head loss and
(iii) the pumping power requirement to overcome this pressure drop

(12 marks)

Q5 (a) A household refrigerator with a COP of 1.7 removes heat from the refrigerated space at a rate of 80 kJ/min. Determine:

(i) the electric power consumed by the refrigerator in kW, and
(ii) rate of heat transfer to the kitchen air in kW.
(iii) sketch the schematic diagram of the refrigerator systems, and
(iv) explain how the refrigerator system works.

(14 marks)

(b) Refrigerant-134a enters the condenser of a residential heat pump at 800 kPa and 35°C at a rate of 0.018 kg/s, and leaves at 800 kPa as a saturated liquid. If the compressor consumes 1.2 kW of power, determine:

(i) COP of the heat pump, and
(ii) rate of heat absorption from the outside air.

(6 marks)

Q6 (a) Sketch a *P-v* diagram of a Carnot cycle, label accordingly and indicate the heat in (Q_{in}), heat out (Q_{out}) and net work done ($W_{net,\ out}$) during the process of Carnot cycle.

(4 marks)

(b) A Carnot heat engine receives heat at 1000 K and rejects the waste heat to the environment at 30°C. The entire work output from the heat engine is used to drive a Carnot refrigerator as shown in **FIGURE Q6 (b)**. The refrigerator operates by removing heat from cooled space at -10°C, at a

rate of 280 kJ/min and rejects the heat to the same environment at same temperature. Determine:

(i) the rate of heat supplied to the heat engine, and
(ii) the total rate of heat rejection to the environment.

(16 marks)

- END OF QUESTION -

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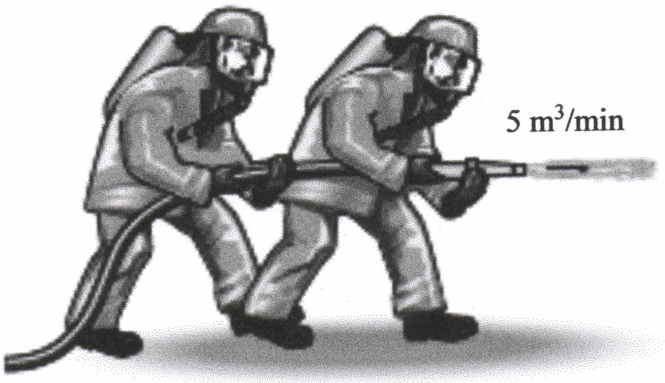

FIGURE Q3(b)

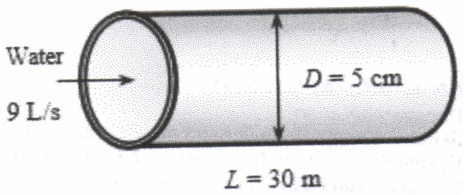

FIGURE Q4 (c)

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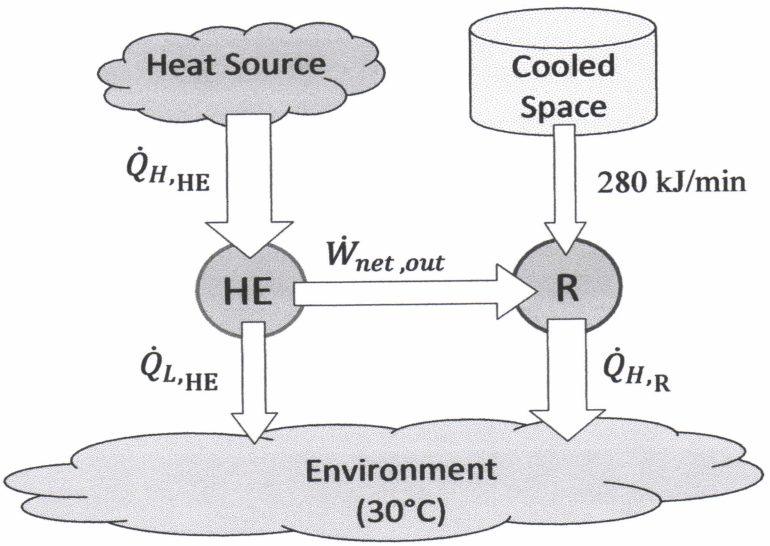

FIGURE Q6 (b)

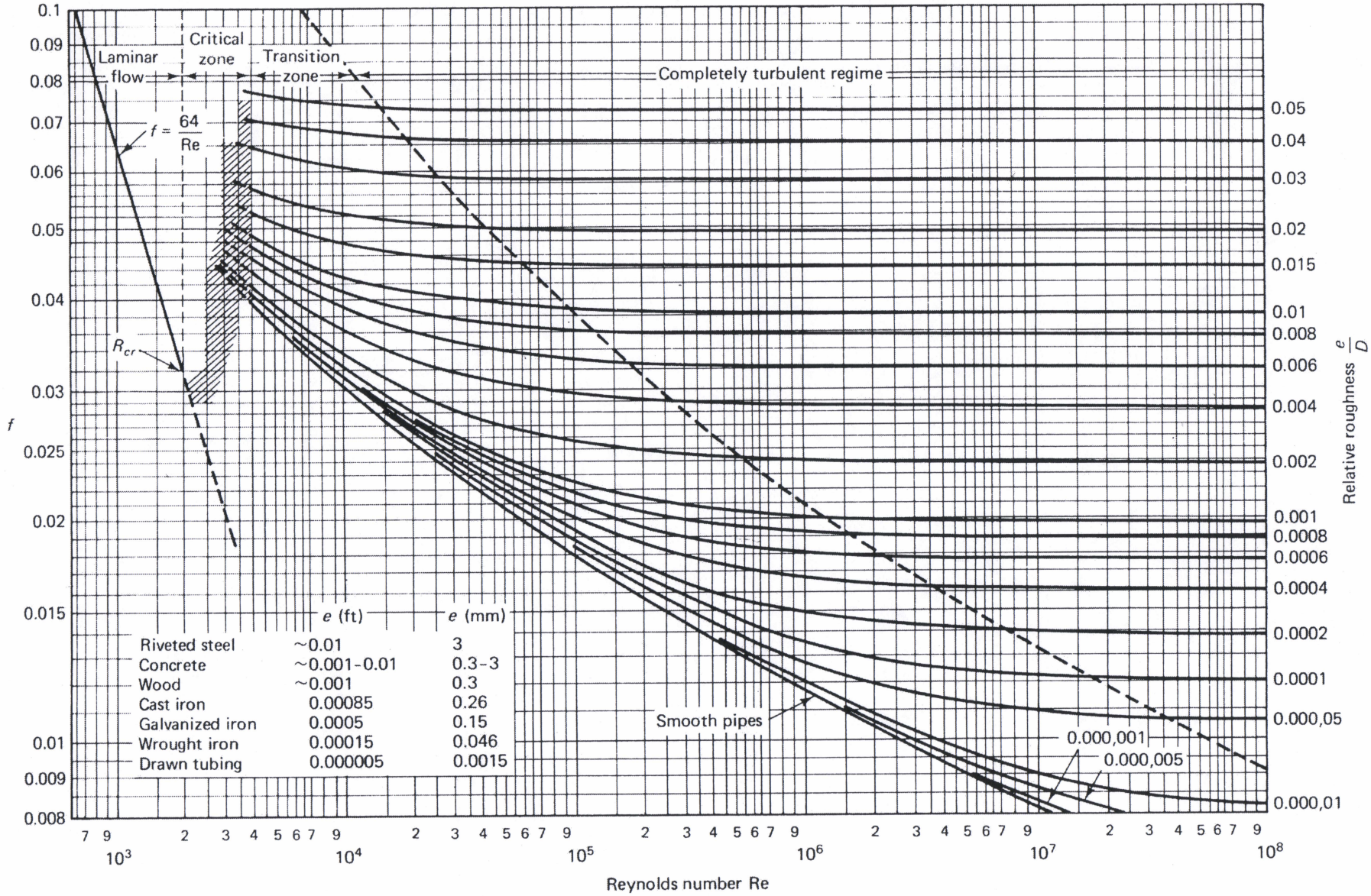

Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)