THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF MINING ENGINEERING

FIRST SEMESTER EXAMINATION – 2021

2ND YEAR MINING ENGINEERING & 2ND YEAR MINERAL PROCESSING ENGINEERING

MN212 – THERMO-FLUIDS

DATE:	WEDNESDAY 9TH JUNE 2021
TIME:	12:50 PM
TIME ALLOWED:	3 HOURS

INSTRUCTION TO CANDIDATES:

1. YOU HAVE **10 MINUTES** TO READ THE PAPER. **DO NOT** WRITE DURING THIS PERIOD

2. THERE ARE FOUR QUESTIONS. **ATTEMPT ALL.** WRITE ANSWERS IN THE ANSWER BOOKLET PROVIDED.

3. WRITE YOUR **NAME** AND **NUMBER** CLEARLY ON THE **ANSWER BOOK.** DO THIS **NOW.**

MARKING SCHEME:

THE QUESTIONS CARRY EQUAL MARKS. TOTAL MARK IS 100

QUESTION ONE

(a) **Choose any of the correct answer (s). Some question will have more than 1 answers (1 mark each)**

I. Which of the following statement(s) is/are not true about Thermo-fluids

(a) mass, momentum, and heat transfer constitute the fundamentals of thermo-fluids
(b) the subject of thermo-fluids combines fluid mechanics and thermodynamics

(c) thermo-fluids is a subject that analyses systems and processes involved in energy, various forms of energy, and transfer of energy in fluids
(d) Thermal systems does not deal with the storage, conversion, and transportation of energy in its many forms.

II. Forms of energy are

(a) Electrical, mechanical and chemical energy only
(b) Mechanical, electrical, chemical and nuclear energy only
(c) Electrical, mechanical, chemical, thermal, radiant and nuclear energy only
(d) Electrical, potential, kinetic, mechanical, stored energy only

III. Which of the following is not a fundamental dimension with the standard unit

(a) Length – meter (m)
(b) Mass – kilogram (kg)
(c) Time – seconds (s)
(d) Density – kilogram per cubic meter (kg/m^3)
(e) Temperature – Kelvin (K)

IV. Which of the following is not a common property of fluids?

(a) pressure
(b) viscosity
(c) temperature
(d) mass
(e) surface tension

V. The property that represents the internal resistance of a fluid to motion is called
(a) Thermal conductivity
(b) Surface tension

(c) rheology
(d) viscosity
(e) friction force

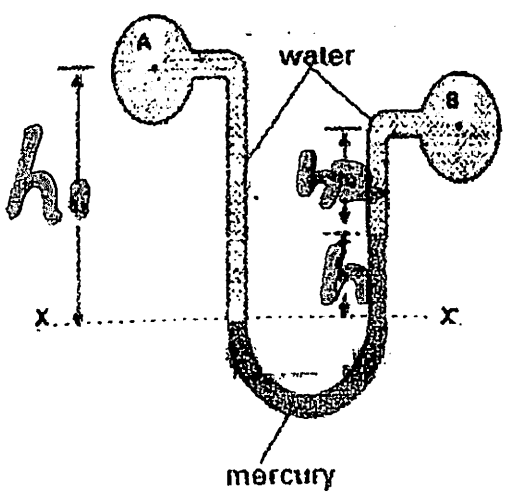
VI. If the atmospheric pressure is 101.4kPa, what will be the height of the mercury column in a barometer if s.g. of mercury is 13.6

(a) 0.760mm
(b) 760mm
(c) 760m
(d) Cannot calculate

VII. Which of the following statement(s) is/are correct?

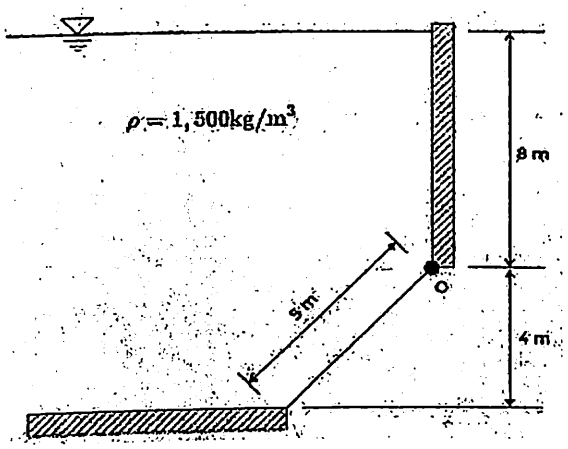
(a) Hydrostatic force always acts tangential to the surface
(b) Hydrostatic force always acts perpendicular to the surface
(c) In a submerged plane surface, hydrostatic force acts on the geometrical centre of the submerged body
(d) In a submerged plane surface, hydrostatic force acts at a depth below the geometrical centre of the submerged body

(b) Below is a differential manometer used to measure pressure difference between two points A and B in water of density 1000kg/m^3. The u-tube contains mercury (Hg) of density 13600kg/m^3



Calculate the difference in pressure (P_A-P_B) if h=0.5m, h_1 = 1.5m and h_2 = 0.75m
(8 marks)

(c) The 5m long, 1m wide slanted gate has a hinge at point O as shown below. The fluid on the left hand side has a density of 1500kg/m3.



Calculate;

(1) The hydrostatic force required to keep the gate closed **(6 marks)**

(2) The location of the hydrostatic force **(6 marks)**

QUESTION TWO

(a) Water flows through a pipe AB of diameter, D_1 = 100 mm, which is in series with a pipe BC of diameter, D_2 = 150mm in which the mean velocity is 1.5 m/s. At C the pipe forks and one branch CD is of diameter, D_3 such that the mean velocity is 3m/s. The other branch, CE of diameter, D_4 = 50mm and conditions such that the discharge Q_2 at BC divides that $Q_3 = 2Q_4$

Apply continuity principle and determine the following **(10 marks)**;

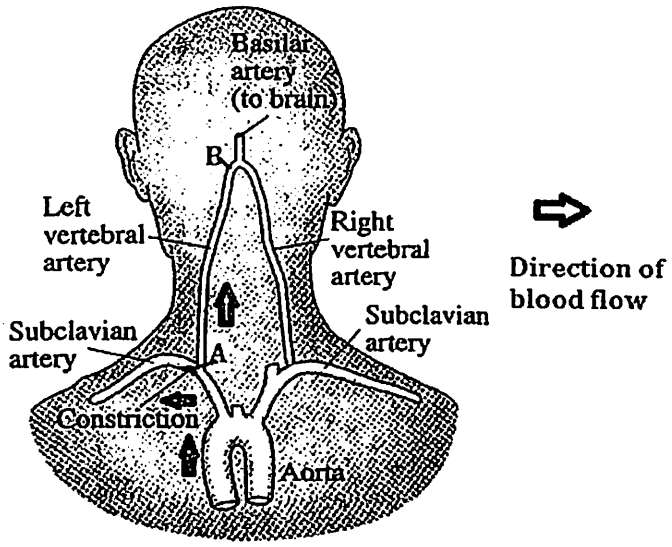
i. Flow rates at each point, Q_1, Q_2, Q_3 and Q4

ii. The inlet mean velocity, V_1 and outlet velocity, V_4 at point E

iii. The diameter, D_3 of pipe CD

(b) Shown below is an illustration of blood flow system from the heart to the brain and back. Normal flow of blood to the brain must be maintained to avoid serious health consequences such as attack of the brain.

At point A in the diagram, there is a constriction that is narrowing the effective cross-sectional area of the subclavian artery.



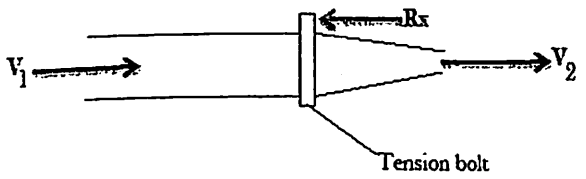
(i) Will the pressure at point A high or low compared with the pressure at point B. Explain the reason for your answer **(4 marks)**

(ii) Will normal blood flow to the brain occur through the left vertebral artery with the constriction of subclavian artery? Provide explanation for your answer **(4 marks)**

(c) A nozzle attached to a pipeline of diameter 64mm discharges water to the atmosphere at a jet of 30 m/s. the nozzle diameter is 19mm.

Determine the tension forces on the flanged connection between the pipe and the nozzle when; **(7 marks)**

(i) The nozzle diameter is placed along the horizontal axis as shown



(ii) The nozzle is elevated up to a height of 10m

QUESTION THREE

(a) Differentiate between laminar and turbulent flows in pipes (**4 marks**)

(b) What is the main driving force for fluid flow in (1) horizontal pipes (2) channel flows and (3) pipes inclined at angle? (**6 marks**)

(c) Water of density 1000kg/m^3 and viscosity of 0.001 N.s/m^2 is flowing steadily in a 0.051m diameter horizontal pipe made of stainless steel of roughness, $\varepsilon = 2.13 \times 10^{-6}$ m at a rate of 0.0057 m^3/s. Determine (**15 marks**);

(i) The pressure drop, Δp
(ii) Head loss and
(iii) Required power input, $\dot{W}$ for flow over 61 meter long section of the

QUESTION FOUR

(a) Define the following terminologies with examples or equations where necessary

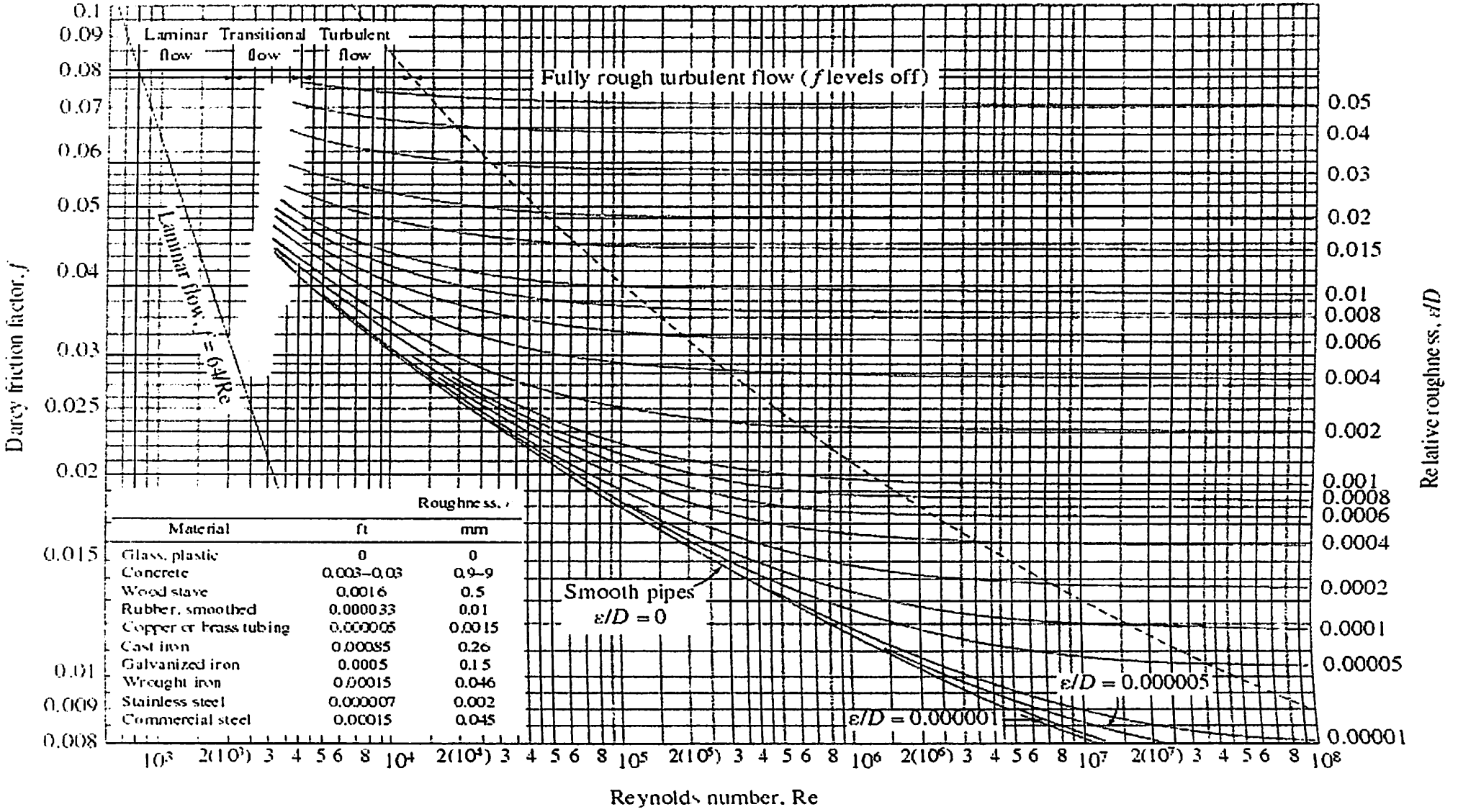
(1) State properties (**2 marks**)
(2) 1st Law of thermodynamics (**2 marks**)
(3) 2nd law of thermodynamics (**2 marks**)
(4) Heat engine (**2 marks**)

(b) Sketch a P-V diagram showing the following processes in a cycle (**17 marks**)

Process 1 – 2: *Isobaric work output of 10.5kJ from an initial volume of 0.028m^3 and pressure 140kPa,*
Process 2 – 3: *Isothermal compression and*
Process 3 - 1: *Isochoric heat transfer to its original volume of 0.028m^3 and pressure at 140kPa.*

Calculate;
(1) The maximum volume (m^3) of the cycle
(2) The isothermal work in kJ and
(3) The net work in kJ

.....GOOD LUCK....END OF EXAM.....



Roughness, ε

Material	ft	mm
Glass, plastic	0	0
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045