CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2016 SEMESTER

COURSE CODE	:	LMD10602
COURSE NAME	:	FLUID MECHANICS
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	DIPLOMA OF ENGINEERING TECHNOLOGY IN MARINE ENGINEERING
DATE	:	25 MAY 2016
TIME	:	02.00 PM – 04.30 PM
DURATION	:	2 HOURS 30 MINUTES

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of TWO (2) sections; Section A and Section B.
4. Answer ALL questions in Section A. For Section B, answer TWO (2) questions only.
5. Please write your answers on the answer booklet provided.
6. Answer all questions in English language ONLY.

THERE ARE 6 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) Convert the following physical quantities to S.I unit.

i. Volume Flow rate = 600L/min

(3 marks)

ii. Mass Flow rate = 7200 g/h

(3 marks)

(b) A steel tank of weight 7000 N as shown in Figure 1b below has a dimension of 1.6 m x 2.0 m x 3.0 m and contains oil of relative density of 0.78 to a depth of 2.0 m. The tank is supported by four pads such that the load is equally distributed. Determine:

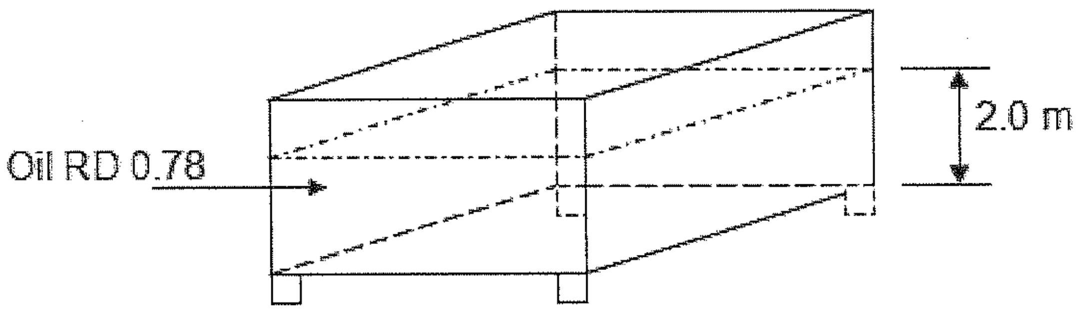


Figure 1b Steel Tank

i. mass of the steel tank

(2 marks)

ii. the force on each supporting pad

(8 marks)

iii. the pressure on the tank base

(4 marks)

Question 2

(a) With the aid of suitable diagram, explain briefly the definition of the continuity equation.

(6 marks)

(b) Water enters the UPVC pipe as shown in Figure 2b below at 30 L/s and then branches into two. The main pipe diameter is 100 mm (point 1) and the branch pipes are 80 mm (point 2) and 100 mm (point 3) in diameter respectively. The volume flow rate for branch 3 is 60% of the total rate. Determine the

i. velocity in the main pipe.

(2 marks)

ii. volume flow rate in each branch in L/s.

(6 marks)

iii. weight flow rate in main pipe and in each branch.

(6 marks)

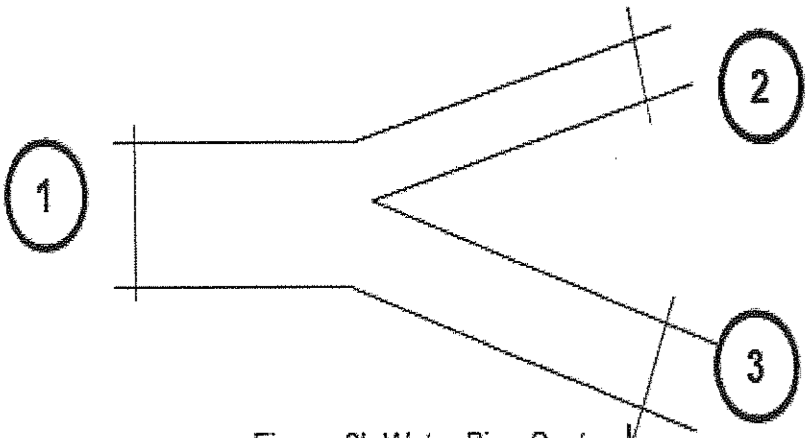


Figure 2b Water Pipe System

Question 3

Water flows at a rate of 1000 *L/s* through a pipe system which lies in a horizontal plane then bends at 45° pipe reducer. The diameter at the bend entrance is 400*mm* and at the exit 200*mm* as shown in Figure 3 below.

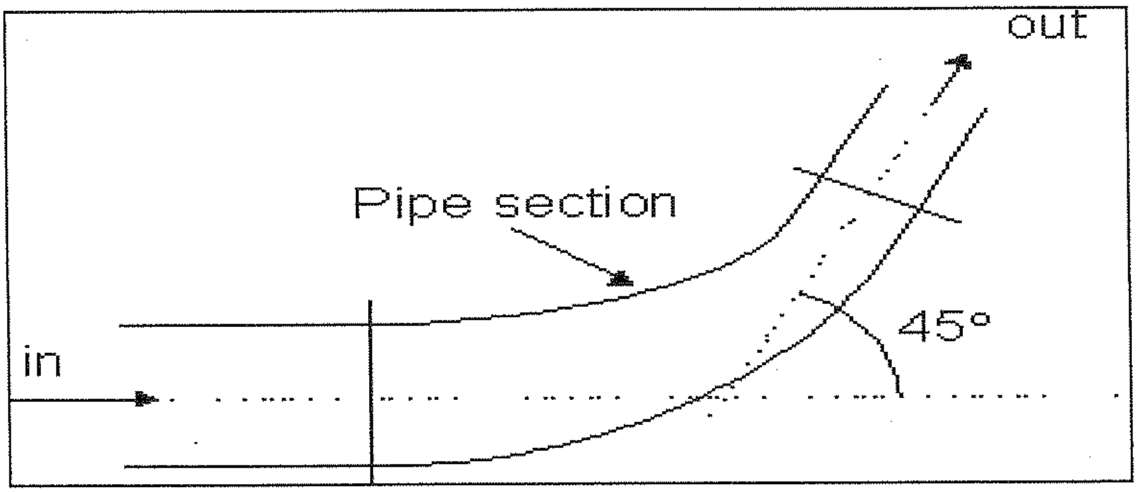


Figure 3: Pipe Reducer

(a) Calculate the magnitude and direction in horizontal direction.

(5 marks)

(b) Calculate the magnitude and direction of the fluid in vertical direction.

(5 marks)

(c) Determine the resultant force on the pipe if friction is neglected.

(5 marks)

(d) Sketch the resultant force diagram on the pipe and on the fluid respectively.

(5 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions.
Please use the answer booklet provided.

Question 4

(a) Draw a neat diagram showing the flow of a fluid through a close elbow and a large radius elbow. Use these diagrams to explain which elbow has the highest head loss.

(6 marks)

(b) Briefly explain the reasons why close elbows (or bends) are often used in the preference to large radius ones, even though the head loss is higher.

(2 marks)

(c) A galvanized steel pipe of diameter 150 mm and length 200 m carries water at a temperature of 20°C with flow rate 30 L/s. Evaluate:

i. The friction factor
ii. The head loss
iii. The pressure drop due to friction

(Hint: find the dynamic viscosity, density for water at 20°C and absolute roughness of galvanized steel pipe using appendix given)

(12 marks)

Question 5

Water at 20° C is pumped at a rate of 20 L/s from a pond to a tank as shown in Figure 5. The tank is under pressure. The pipe is galvanized steel with 100 mm diameter and 6 m length. The elbow used is 90° standard and the additional fittings are 6 screwed sockets. For design purposes the globe valve is taken to be in the ¾ opened. To allow for clogging, the K factor of the foot valve and strainer has to be increased by two-third. Assume that friction factor throughout the piping system to be at constant value of 0.015.

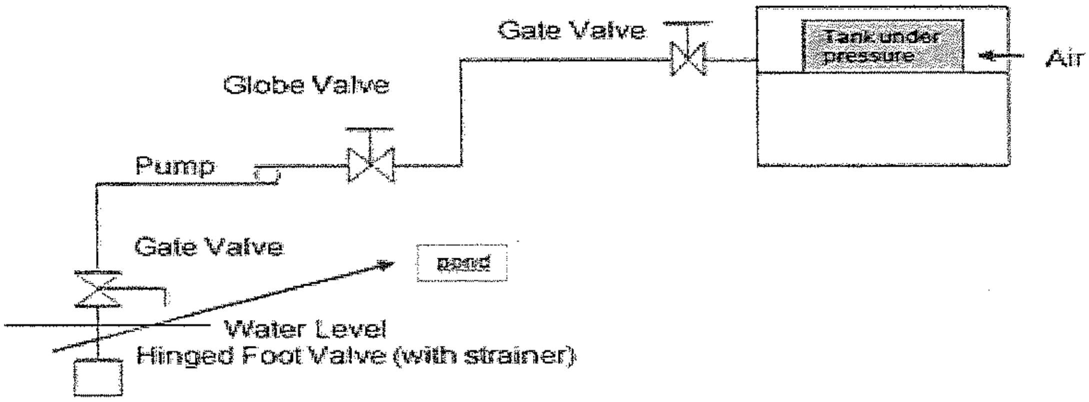


Figure 5: Water Pumping System

Solve:

(a) the density and viscosity of the water at 20° C

(2 marks)

(b) the Reynolds Number and the flow regime

(6 marks)

(c) the total K factors

(5 marks)

(d) the relative roughness

(2 marks)

(e) the total head loss

(5 marks)

Question 6

TWO (2) commercial steel pipes are connected in series as shown in Figure 6 below. Pipe A is 150 mm in diameter and 200 m long. Pipe B is 200 mm in diameter and 250 m long. Water at 20°C is pumped through the pipes with the velocity in pipe A being 5 m/s. Assume that minor losses are so small due to enlargement and may be negligible. Friction factor may be determined using Moody diagram or Moody formula.

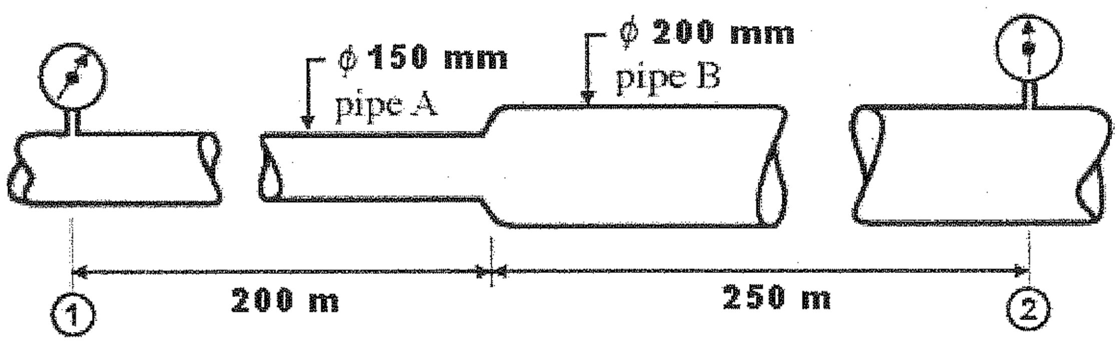


Figure 6: Commercial Steel Pipes in Series

Based on the data mentioned above, evaluate:

(a) the required viscosity and density for the water at 20° C

(2 marks)

(b) the head loss in pipe A

(6 marks)

(c) the head loss in pipe B

(6 marks)

(d) the total head loss

(2 marks)

(e) the difference between the friction factor for both pipes

(4 marks)

END OF QUESTIONS

FLUID MECHANICS

LMD 10602

TABLES, FORMULAE AND CHARTS

APPENDIX 1: WATER PROPERTIES
APPENDIX 2: ABSOLUTE ROUGHNESS
APPENDIX 3: SIMPLIFIED K FACTORS
APPENDIX 4: MOODY DIAGRAM CHART
APPENDIX 5: LIST OF FORMULAE

Appendix 1: Density, Viscosity and Saturation Vapour Pressure of Water

Temperature (°C)	*Density* (kg/m^3)	*Dynamic viscosity* (Pas)	*Vapour pressure* (kPa (abs.))
0	1000	1.80×10^{-3}	0.61
5	1000	1.52×10^{-3}	0.87
10	1000	1.31×10^{-3}	1.23
15	999	1.15×10^{-3}	1.71
20	998	1.00×10^{-3}	2.34
25	997	0.90×10^{-3}	3.18
30	996	0.80×10^{-3}	4.25
35	994	0.72×10^{-3}	5.64
40	992	0.66×10^{-3}	7.38
45	990	0.60×10^{-3}	9.60
50	988	0.55×10^{-3}	12.3
55	986	0.51×10^{-3}	15.7
60	983	0.47×10^{-3}	20.0
65	980	0.44×10^{-3}	25.0
70	977	0.41×10^{-3}	31.2
75	974	0.38×10^{-3}	38.6
80	971	0.36×10^{-3}	47.4
85	968	0.34×10^{-3}	57.8
90	965	0.32×10^{-3}	70.1
95	962	0.30×10^{-3}	84.6
100	958	0.28×10^{-3}	101.3

Appendix 2: Absolute Roughness of Various Common Pipe Materials

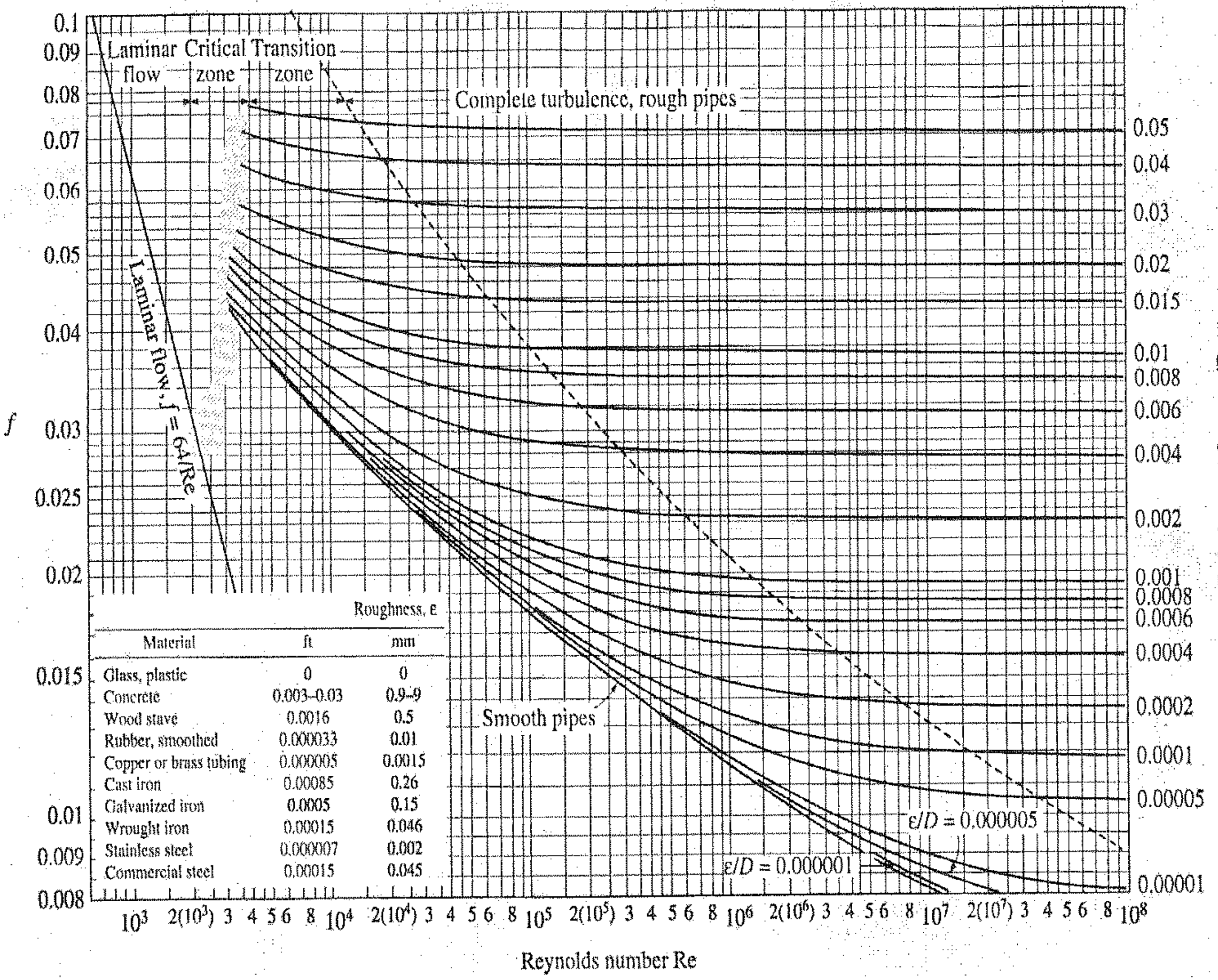
Absolute roughness	mm
Cast iron	0.25
Commercial steel or wrought iron	0.045
Galvanised iron or steel	0.15
Concrete (cast on steel forms)	0.2
Concrete (spun)	0.1
Drawn tube	0.0015
Extruded tube made of metal, glass or plastic	0 (smooth)

Note The roughness values quoted are for pipes in the as-manufactured condition. The values are likely to increase with time, owing to the effects of corrosion, erosion and fouling.

Appendix 3: Simplified K Factors for Common Fittings

Fitting	*K factor*
45° elbow (standard radius)	0.3
90° elbow: standard radius	0.6
long radius	0.3
Return bend	0.8
Socket or coupler (screwed)	0.03
Tee: along line of flow	0.3
through side	0.8
Gate valve (fully open)	0.2
Globe valve: fully open	6.0
3/4 open	8.0
1/2 open	12.0
1/4 open	24.0
Check valve: hinged or swing disc	1.7
ball or poppet type	4.0
Foot valve with strainer:	
hinged or swing disc	3.0
ball or poppet type	7.0
Gradual transition: contracting	0 (negligible)
enlarging	0.75
Sudden contraction in a pipe	0.25
Sudden enlargement in a pipe	1.0
Sudden entrance (from tank to pipe)	0.5
Sudden exit (from pipe to tank)	1.0

Appendix 4: Moody Diagram Chart



	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

FIGURE A-27

The Moody chart for the friction factor for fully developed flow in circular tubes.

Appendix 5: List of Formulae

$$\mathrm{Re} = \frac{\rho v d}{\mu}$$

$$\mathrm{Re} = \frac{v d}{\upsilon}$$

$$h_f = \frac{f L v^2}{2 g d}$$

$$h_f = \frac{4 f L v^2}{2 g d}$$

$$h_L = K \frac{v^2}{2g}$$

$$h_L = \frac{(v_1 - v_2)^2}{2g}$$

$$f = 0.0055\left[1 + \left(20000\varepsilon_r + 10^6 / \mathrm{Re}\right)^{1/3}\right]$$

$$H_L = \left(fL/d + \Sigma K\right)\frac{v^2}{2g}$$

$$\frac{f_E L_E}{d_E^{\,5}} = \frac{f_A L_A}{d_A^{\,5}} + \frac{f_B L_B}{d_B^{\,5}} + \ldots\ldots$$

$$\left(\frac{d_E^{\,5}}{f_E L_E}\right)^{1/2} = \left(\frac{d_A^{\,5}}{f_A L_A}\right)^{1/2} + \left(\frac{d_B^{\,5}}{f_B L_B}\right)^{1/2} + \ldots\ldots$$

$$F = \dot{m}(v_2 - v_1)$$

$$p_1 A_1 - p_2 A_2 \cos\theta + F_x = \dot{m}\left(v_2 \cos\theta - v_1\right)$$