Document No : UniKL MFI_SD_AC41
Revision No: 02
Effective Date: 01 December 2008

CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR

MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE	:	FCB 16102
SUBJECT TITLE	:	FLUID MECHANICS
LEVEL	:	BACHELOR
TIME/DURATION	:	12.30pm – 2.30pm (2 HOURS)
DATE	:	09 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer THREE (3) question only.
6. Answer all questions in English.

THERE ARE 12 PRINTED PAGES OF QUESTIONS.

SECTION A

INSTRUCTION: Answer ALL questions.

Question 1-10 are multiple choice questions: choose the best possible answer/answers for each of the following question.
Use the answer table, provided in appendix to mark your answers. Do not forget to attach answer table with your answer booklet

Question 1

A uniform solid body weighs 4 kg in air and 3.5 kg in water. What is its specific gravity?

A. 4.
B. 7.5.
C. 8.
D. 0.5
E. Can not be determined

(1 mark)

Question 2

A beaker of 7inch inside diameter and 9 inch inside height weighs 13 oz when empty and 190 oz when filled with a liquid. What is the density of the liquid in SI units? (You may use unit conversion tables given in Appendix 1)

A. 607.5 kg/m^3
B. 884.1 kg/m^3
C. 230 kg/m^3
D. 177 kg/m^3
E. None of the above

(1 mark)

Question 3

The absolute viscosity μ of a fluid is primarily a function of :

A. density
B. temperature
C. pressure
D. viscosity
E. none of the above

(1 mark)

Question 4

An oil has a kinematic viscosity of 1.25E-4 m^2/s and a specific gravity of 0.8. What is the absolute viscosity in kg/m-s units?

A. 0.08 kg/m-s
B. 0.10 kg/m-s
C. 0.125 kg/m-s
D. 1.00 kg/m-s
E. none of the above

(1 mark)

Question 5

Two parallel plates, one moving at 4m/s and the other stationary, are separated by a 5 mm thick layer of oil with specific gravity 0.80 and kinematic viscosity 1.25 E -4 m^2/s. What is the average shear stress in the oil

A. 80 Pa
B. 100 Pa
C. 125 Pa
D. 160 Pa
E. none of the above

(1 mark)

Question 6

As long as there is no shear stress, the pressure is independent of direction. This statement is known as:

A. Newton's law
B. Chanrles' law
C. Boyle's law
D. Pascal's law
E. None of the above

(1 mark)

Question 7

Gauge pressure is negative when

A. Atmospheric pressure is less than Absolute pressure
B. Absolute pressure is less than Atmospheric pressure
C. Atmospheric pressure is same as Absolute pressure
D. Gauge pressure cannot be negative

(1 mark)

Question 8

A flow in which velocity or pressure at a point does no change with time is called:

A. Uniform flow
B. Non-uniform flow
C. steady flow
D. unsteady flow
E. none of the above

(1 mark)

Question 9

Which is true for streamline of a flow?

A. they are lines joining points of equal velocity
B. fluid cannot cross a streamline
C. Streamlines cannot cross each other
D. All of the above are correct

(1 mark)

Question 10

How is friction accounted in the usual calculations involving principle of conversion of energy?

A. As 10% of total energy
B. As 10% of total energy
C. As 10% of total energy
D. Neglected

(1 mark)

SECTION B

Answer any 3 questions in this section.

Question 11

a) The mean free path of a gas, ℓ, is defined as the average distance traveled by molecules between collisions. A proposed formula for estimating ℓ of an ideal gas is

$$\ell = 1.26\frac{\mu}{\rho\sqrt{RT}}$$

What are the dimensions of the constant 1.26?

Use the formula to estimate the mean free path of air at 20°C and 7 kPa

Please refer to Appendix 2 for the properties of air

b) A near ideal gas has a molecular weight 44 and a specific heat c_v=610 J/kg K.

Your are reminded the following equations (with its usual notations)

$c_p - c_v = R$

$c_p/c_v = k$

$R = R_u/M$ where R_u =8314 $m^2/(s^2K)$/ 49700 $ft^2/(s^2\ °R)$

$a = (kRT)^{1/2}$

i) What are its specific heat ratio k and its speed of sound in SI units at 100°C?

ii) What are its specific heat ratio k and its speed of sound in imperial units at 100°C

(10 marks)

Question 12

a) The system in the following figure (Figure Q12-a) is at 20 °C. If the atmospheric pressure is 101.33 kPa and the pressure at the bottom of the tank is 260 kPa, what is the specific gravity of the fluid X

Densities:	SAE 30 oil	= 891 kg/m^3
	Mercury	= 13550 kg/m^3
	Water	= 998 kg/m^3

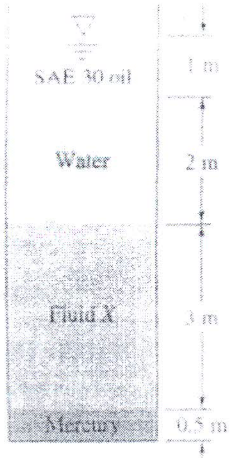

Figure Q12 -a

b) The U-tube in the following figure (Figure Q12-b) has a 2 cm ID and contains mercury as shown. If 30 cm^3 of water is poured into the right-hand leg, what will be the free –surface height in each leg from the bottom of the U-tube.

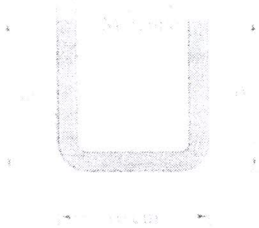

Figure Q12-b

(10 marks)

Question 13

a) The pressure head in a gas main at a point 100 m above sea level is equivalent to 200 mm of water. Assuming that the densities of the air and gas remain constant and equal to 1.202 kg m^{-3} and 0.561 kg m^{-3}, respectively, what will be the pressure head in mm of water at sea level?

b) In the following figure (Figure Q13-b) fluid P is water and fluid Q is mercury. If the specific weight of mercury is 13.6 times that of water, and atmospheric pressure is 101.3 kN m^{-2} what is the absolute pressure at A in kPa when h_1=20 cm and h_2 = 10 cm?

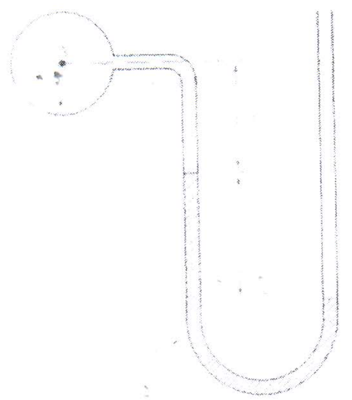

Figure Q13-b

(10 marks)

Question 14

a) Water flows though a pipe AB 1.0 m in diameter at 3 ms^{-1} and passes through a pipe BC which is 1.2 m in diameter. At C the pipe forks. Branch CD is 0.6 m in diameter and carries one third of the flow in AB. The velocity in the other branch CE is 2.5 ms^{-1} Find

i. Volume flow rate of flow in AB
ii. The velocity in BC
iii. The velocity in CD

iv. The diameter of CE

b) A Pitot- tube is used to measure air velocity. If a manometer is connected to the instrument indicates a difference in pressure head between tapings of 1.8 mm of water calculate the air velocity assuming the coefficient of Pitot tube to be unity. Density of air = 1.2 kgm^{-3}

(10 marks)

Question 15

a) Air flows thorough a rectangular duct which is 400 mm wide by 300 mm deep in cross section. To determine the volume flow rate of flow experimentally the cross section is divided into a number of imaginary rectangular elements of equal area and the velocity measured at the centre of each element (ms^{-1}) with the following result

Distance from bottom of duct (mm)	Distance from side of duct (mm)				
	40	120	200	280	360
30	1.5	1.9	2.1	1.9	1.6
90	1.8	3.3	6.8	3.6	1.9
150	2.0	6.7	9.9	6.9	2.2
210	1.9	3.4	6.9	3.7	2.0
270	1.7	1.9	2.2	2.0	1.8

Table Q15- Velocity measurements at various points in a duct

Calculate the volume flow rate of flow and the mean velocity in duct.

b) The suction pipe of a pump rises at a slope of 1 vertical in 5 along the pipe and water passes through it at 2.2 ms^{-1}. If dissolved air is released when the pressure falls to more than 68 kNm^{-2} below atmospheric pressure, find the greatest practical length of suction pipe. Neglect friction and assume water in the sump is at rest.

(10 marks)

END OF QUESTION

Appendix 1

Unit Conversion Tables

Table 1 Equivalence of Miscellaneous Units

Lengths					
1 ft	= 0.3048 m	= 12 in	= 0.3333 yd		
1 m	= 3.28084 ft	= 39.37008 in			
1 mi	= 5,280 ft	= 1,760 yd	= 1,609.34 m	= 1.60934 km	= 320 rd
Areas					
1 ft^2	= 0.09290 m^2	= 144 in^2	= 0.11111 yd^2		
1 m^2	= 1550 in^2	= 10.7639 ft^2	= 1.19599 yd^2		
1 acre	= 43,560 ft^2	= 4,840 yd^2	= 0.40469 ha (hectare)	= 4046.87 m^2	= 0.001563 mi^2
1 mi^2	= 640 acres	= 3,097,600 yd^2	= 2,589,988 m^2	= 2.5899 km^2	= 258.99 ha
1 km^2	= 0.38610 mi^2	= 247.104 acre	= 100 ha		
Masses and weights					
1 lb	= 0.45359 kg = 0.000464 long ton	= 16 oz	= 14.5833 oz (troy)	= 0.0005	ton = 7000 grains
1 kg	= 2.2046 lb av = 0.001 m ton	= 2.6792 lb tr (troy)	= 35.274 oz av	= 15,432.4 grains	= 0.00110 ton
1 ton	= 2,000 lb	= 907.185 kg	= 32,000 oz	= 0.90722 m ton	
Volume and capacity					
1 ft^3	= 1728 in^3 = 6.229 Imp gal (Br)	= 0.03704 yd^3 = 0.80356 bu	= 0.028317 m^3	= 29.9221 qt (liq)	= 7.4806 gal (liq)
1 yd^3	= 46,656 in = 21.6962 bu (bushel)	= 27 ft^3	= 0.76456 m^3	= 807.896 qt (liq)	= 201.974 gal (liq)
1 gal (liq)	= 231 in^3	= 0.13368 ft^3	= 4 qt	= 0.83268 Imp gal	= 0.00378543 m^3
1 m^3	= 61,023 in^3 = 1.308 yd^3	= 35,314 ft^3	= 1056.7 qt (liq)	= 264.18 gal	= 28.38 bu

Table 2 Conversion Factors for Thermal Conductivity

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h·ft·°F	Btu·in/h·ft·°F	W/m·°C	W/cm·°C	cal/s·cm·°C	kcal/h·m·°C
Btu/h·ft·°F	1.0000	12.000	1.72958	0.017296	4.13378 x E-03	1.48816
Btu·in/h·ft^2·°F	0.0833	1.000	0.14413	1.441314 x E-03	3.44481 x E-04	0.124013
W/m°·C	0.57818	6.9381	1.000	0.001	2.39006 x E-03	0.860422
W/cm·°C	57.8175	693.810	100.000	1.000	0.23901	86.0422
cal/s·cm·°C	241.9090	2902.91	418.40	4.18400	1.000	360.000
kcal/h·m·°C	0.671971	8.06365	1.16222	0.011622	2.77778 x E-03	1.000

Table 3 Conversion Factors of Coefficients of Heat Transfer

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h·ft^2·°F	W/m^2·°C	W/cm^2·°C	kcal/h·m·°C	cal/s·cm^2·°C
Btu/h·ft^2·°F	1.0000	5.67446	5.67446 x E-04	4.88243	1.35623 x E-04
W/m^2·°C	0.17623	1.000	1.0 x E-04	0.86042	2.3900 x E-03
W/cm^2·°C	1762.28	1.0 x E+04	1.000	8604.20	0.2390
kcal/h·m^2·°C	0.20482	1.16222	1.16222 x E-04	1.000	2.77778
cal/s·cm^2·°C	7373.38	4.1840 x E-04	4.1840	3.6000	1.000

J	9.478 x E-04	1.0000	[illegible]	[illegible]	[illegible]
kWh	3414.43	3.6 x E+06	1.0000	860.420	2.6552 x E+06
kcal	3.9656	4184.0	1.16222 x E-03	1.0000	3086.54
hp-h	2547.16	2.6864 x E-06	0.7457	641.6	1.9808 x E-06
ft-lbf	1.28592 x E-03	1.355818	3.76616 x E-07	3.2405 x E-04	1.0000

Table 5 Conversion Factors for Energy in Relation to Time and Area

(Multiply units of left column by appropriate factor* in table to obtain results in units designated at top of vertical column)

	Btu/h-ft²	Btu/h-m²	W/ft²	W/m²	kcal/h-m²	Btu/s-ft²
Btu/h-ft²	1.0000	10.7639	0.29288	3.15248	2.71428	2.77778 x E-04
Btu/h-m²	0.092903	1.0000	0.027209	0.29288	0.251996	2.58064 x E-05
W/ft²	3.41443	36.7526	1.0000	10.76391	9.26142	9.48453 x E-04
W/m²	0.31721	3.41442	0.092903	1.0000	0.86042	8.81138 x E-05
kcal/h-m²	0.36867	3.96832	0.10797	1.16222	1.0000	1.02408 x E-04
Btu/s-ft²	3600.0	38750.0	1054.35	11348.9	9764.85	1.0000

Table 6 Miscellaneous Conversion Equivalents

	(lb/ft³)	(g/cm³)	(kg/m³)	(lb/gal)
lb/ft³	1.000	= 0.0160185	= 16.01846	= 0.133680
g/cm³	62.428	= 1.000	= 1000.0	= 8.34538
kg/m³	0.062428	= 0.001	= 1.000	= 0.008345
lb/gal	7.4805	= 0.11982	= 119.82	= 1.000
Enthalpy and energy per unit mass				
	(Btu/lb)	(kcal/kg)	(J/g)	(w-h/kg)
Btu/lb	1.000	= 0.555556	= 2.32444	= 0.645679
kcal/kg	1.799	= 1.000	= 4.184	= 1.16222
J/g	0.430210	= 0.239006	= 1.000	= 0.277778
w-h/kg	1.54876	= 0.860422	= 3.600	= 1.000
Specific heat and entropy				
	(Btu/lb-°R)	(kcal/kg-°K)	(kJ/kg-°K)	(w-h/kg-°K)
kcal/kg-°K	1.000	= 1.000	= 4.184	= 1.16222
kJ/kg-°K	0.239006	= 0.239006	= 1.000	= 0.277778
w-h/kg-°K	0.860422	= 0.860422	= 3.600	= 1.000

Appendix 2

Properties of Air

T, °C	ρ, kg/m³	μ, N · s/m²	ν, m²/s	T, °F	ρ, slug/ft³	μ, lb · s/ft²	ν, ft²/s
−40	1.52	1.51 E-5	0.99 E-5	−40	2.94 E-3	3.16 E-7	1.07 E-4
0	1.29	1.71 E-5	1.33 E-5	32	2.51 E-3	3.58 E-7	1.43 E-4
20	1.20	1.80 E-5	1.50 E-5	68	2.34 E-3	3.76 E-7	1.61 E-4
50	1.09	1.95 E-5	1.79 E-5	122	2.12 E-3	4.08 E-7	1.93 E-4
100	0.946	2.17 E-5	2.30 E-5	212	1.84 E-3	4.54 E-7	2.47 E-4
150	0.835	2.38 E-5	2.85 E-5	302	1.62 E-3	4.97 E-7	3.07 E-4
200	0.746	2.57 E-5	3.45 E-5	392	1.45 E-3	5.37 E-7	3.71 E-4
250	0.675	2.75 E-5	4.08 E-5	482	1.31 E-3	5.75 E-7	4.39 E-4
300	0.616	2.93 E-5	4.75 E-5	572	1.20 E-3	6.11 E-7	5.12 E-4
400	0.525	3.25 E-5	6.20 E-5	752	1.02 E-3	6.79 E-7	6.67 E-4
500	0.457	3.55 E-5	7.77 E-5	932	0.89 E-3	7.41 E-7	8.37 E-4

Suggested curve fits for air:

$$\rho = \frac{p}{RT} \qquad R_{air} \approx 287\ \text{J/(kg} \cdot \text{K)}$$

Power law: $$\frac{\mu}{\mu_0} \approx \left(\frac{T}{T_0}\right)^{0.7}$$

Sutherland law: $$\frac{\mu}{\mu_0} \approx \left(\frac{T}{T_0}\right)^{3/2}\left(\frac{T_0 + S}{T + S}\right) \qquad S_{air} \approx 110.4\ \text{K}$$

with $T_0 = 273$ K, $\mu_0 = 1.71$ E-5 kg/(m · s), and T in kelvins.