

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Engineering Mechanics II
 Time: 3.0 hr

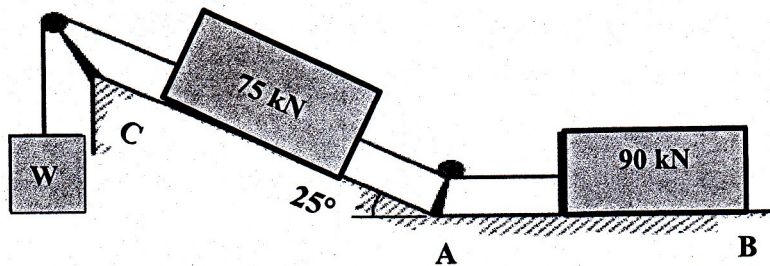
Course Code: CE 103
 Full Marks: 100

[Answer any ten (10) out of the following fourteen (14) questions]

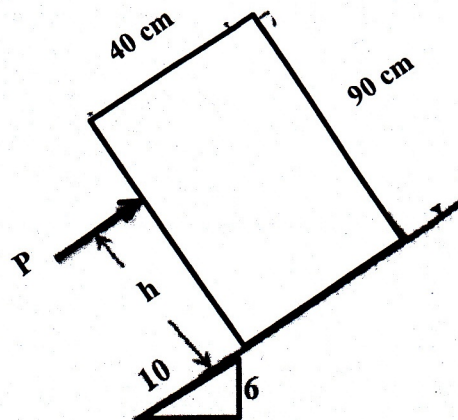
Full Marks: 100 [=10*10]

[Assume reasonable values for any missing data]

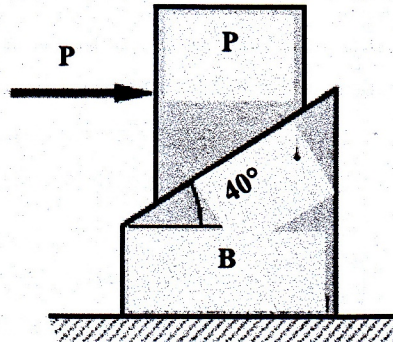
1. What weight W is necessary to start the system of blocks shown in the figure below moving to the left? The co-efficient of friction for Plane AB is 0.3 and AC is 0.5 and the pulleys are smooth.



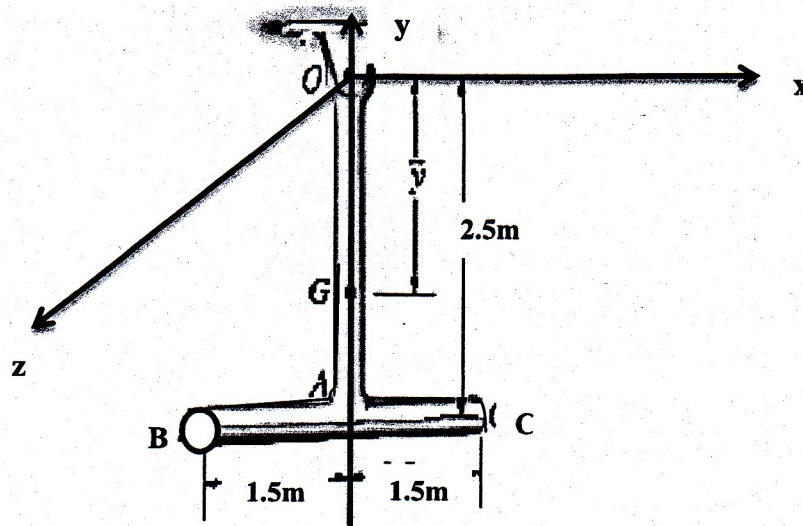
2. A homogeneous block of weight W rests upon the incline shown below. If the co-efficient of friction is 0.25, determine the greatest height h at which a force P parallel to the incline may be applied so that the block will slide up the incline without tipping over. Also calculate the value of P when $W = 50$ kN.



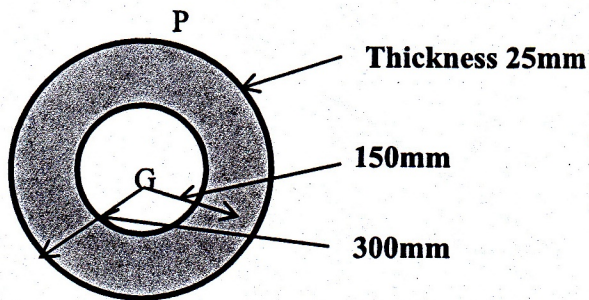
3. In the following figure, determine the minimum weight of block B that will keep it at rest while a force P starts block A up the inclined surface of B. $W_A = 250 \text{ lb}$ and angle of friction for all surfaces in contact is 32° , what is the value of P ?



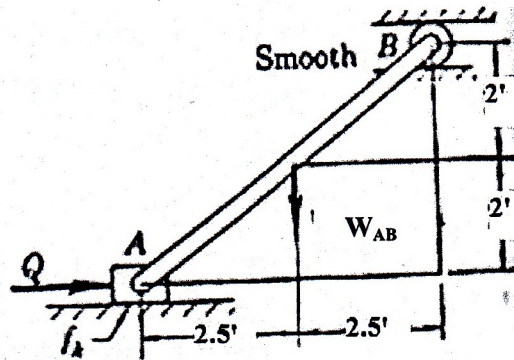
4. The pendulum is suspended from point O and consists of two thin rods, each having a weight of 65 N . Determine the pendulum's moment of inertia about the z axis.



5. If the plate shown below has a density of 9000 kg/m^3 and a thickness of 25 mm , determine its moment of inertia about an axis directed perpendicular to the page and passing through point P.

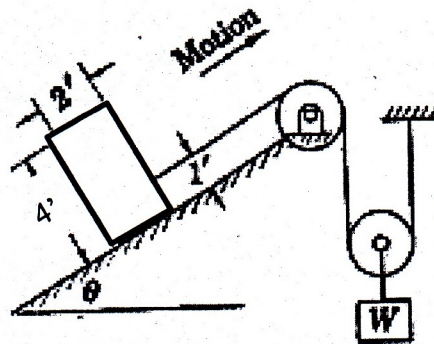


6. In the figure below, weight of rod, $W_{AB} = 250\text{lb}$. If the reaction at B is 25lb upward and $f_k = 0.3$, find resultant acceleration of the mass center of slender rod, \ddot{a} and force Q.



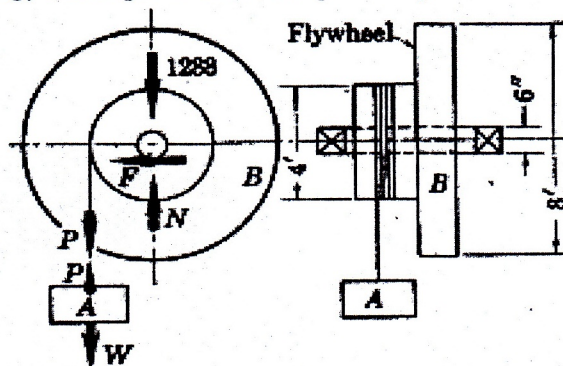
7. In the figure below, the body A weighs 1500lb. Let $\theta = 36^\circ$ and $f_A = 0.25$. The pulleys are weightless and frictionless.

- Determine the weight W when body A is on the point of turning over.
- Determine corresponding tension in the weightless cord.

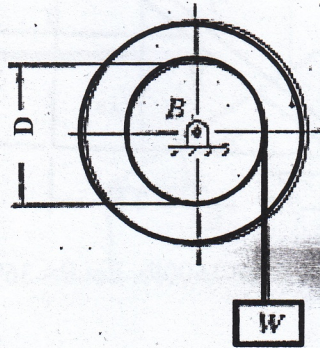


8. In the figure, Weight A is supported from a cable which is wound about a 4-ft drum. An 8ft flywheel turns with the drum. The total weight of the rotating drum is 1288lb and the radius of gyration is 3 ft. While A travels 65ft vertically downward, the speed of the rotating parts changes from 20rpm to 180 rpm. The frictional force in the bearings acting tangentially to the 6 in shaft is $F = 70\text{lb}$. What is the weight W of A?

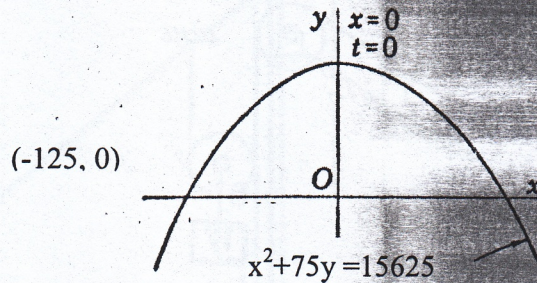
(Note: Use Work Energy Principle to solve the problem)



9. The weight of the rotating drum assembly B is 3000 lb and its radius of gyration with respect to the axis is 14 inch. The weight is suspended from a cable which wraps about the $D = 40$ inch in diameter. While W moves downward through a distance of 55ft, the speed of the drum is increased from 20 rpm to 60 rpm. If the frictional effects are negligible, what is the weight of W ? (Note: Use Work Energy Principle to solve the problem.)

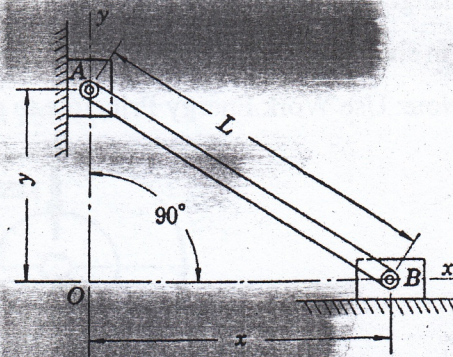


10. A point P moves in the path of the parabola, $x^2 + 75y = 15625$, so that $V_x = a$ constant and $a_y = -g$. Determine the magnitude and direction of its velocity when the point is at the position $(-125, 0)$.



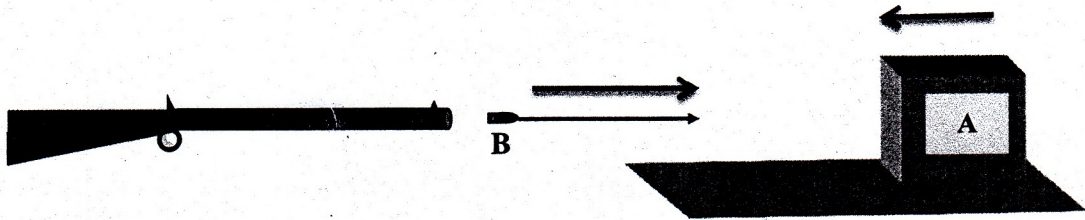
11. In the given figure, sliding members A and B are constrained to move at all times in the y and x directions respectively. They are connected by the rod whose length is, $L = 34$ ft. At the instant, when $x = 21$ ft, $V_B = 37$ fps towards the right and $a_B = -29$ fps^2 towards the left. Determine

- Value of y when $x = 21$ ft
- Velocity of A , V_A
- Acceleration of A , a_A at this instant.

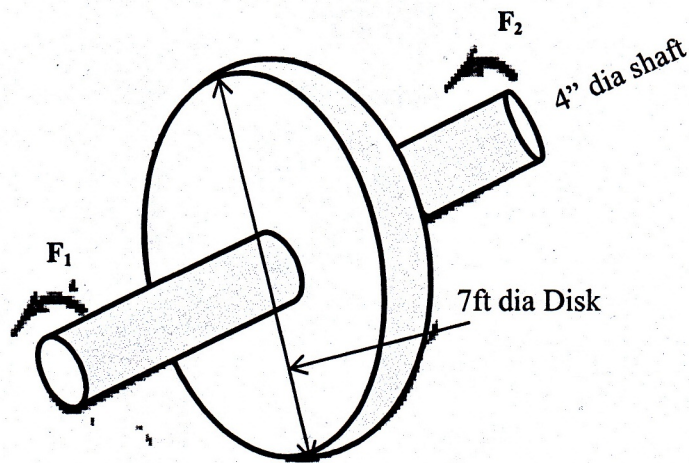


12. A box of sand A weighing 15lb is moving left on a horizontal plane, where $f=0.4$ with $V_A=6\text{fps}$. The box is struck by a bullet B weighing 0.5lb, moving right with $V_B=1500\text{fps}$. The bullet embeds itself in the box.

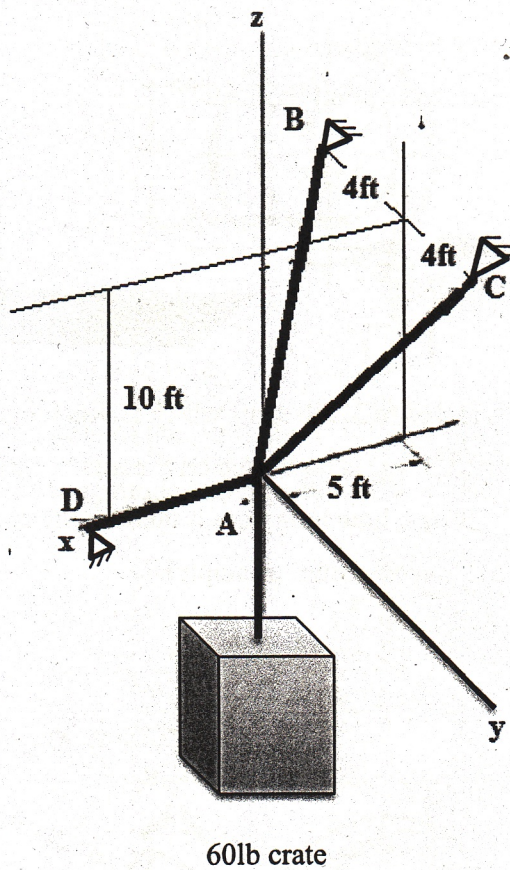
- What is the resulting velocity of the box?
- When does the box come to rest?
- How far does it move from the point of impact?



13. A 745 lb disk, 7ft diameter, is keyed to 322lb shaft which is 4inch in diameter. The shaft is turning 845 rpm, where $f=0.04$. If there is no torque on the rotating members except that due to the frictional force in the bearings, how long does it take for the angular speed to be reduced to 250rpm (Use Impulse-momentum principle).



14. Determine the force in each cable (AB, AC, AD) to support the 60lb crate shown in the figure below.



University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc. Engineering (Civil)

Course Title: Surveying
Time: 3 hours

Course Code: CE 105
Full Marks: 100

SECTION I

(There are **Four** questions in this section. Answer any **Three** of them.)

1. (a) What are the characteristics of contour lines? (03)
(b) Draw contour lines of 20m, 25m and 28m for the grid shown in Figure 1(b). (09)
(c) Draw simple, compound, reverse and broken-back curves. (04 $\frac{2}{3}$)
2. (a) What is transition curve? What are the functions of a transition curve? (04)
(b) Explain curve setting method by radial offset from the tangent. (with figure) (06)
(c) Define mid ordinate, apex distance, deflection angle, super-elevation and tangent distance. (06 $\frac{2}{3}$)
3. (a) Explain the working principle of GPS. (06 $\frac{2}{3}$)
(b) A roadway embankment with formation width of 10 m and side slope of 2H:1V is to be constructed. The ground level along the center line is as follows: (10)

Chainage	0	30	60	90	120
GL(m)	102	105	97	106	104

The embankment formation level has a rising gradient of 1 in 60 and the formation level at zero chainage is 100 m. Assuming the ground is level across the center line, compute the volume of earth works. (both cutting and filling)
4. (a) Draw level section, two level section and three level section. (03)
(b) The following offsets were taken from a chain line to an irregular boundary line at an interval of 10 ft (All offset values are in ft): (08)

0, 2.15, 3.05, 2.55, 1.55, 2.12, 3.15, 2.25, 1.25

Compute the area formed by the chain line, the irregular boundary line and the end offsets by

 - i. The mid ordinate rule
 - ii. The trapezoidal rule
 - iii. Simpson's rule
 - iv. Average ordinate rule
- (c) What is GPS? Write the name of different segments of GPS. (05 $\frac{2}{3}$)

SECTION II

(There are **Four** questions in this section. Answer any **Three** of them.)

5. (a) Explain plan table survey basics. (05)
(b) Explain intersection method of plane table surveying. (07)

- (c) Briefly explain remote sensing. (04 $\frac{2}{3}$)
6. (a) What is project survey? Briefly explain reconnaissance and detail engineering survey. (06 $\frac{2}{3}$)
- (b) What is astronomical surveying? What are the applications of astronomical surveying? (05)
- (c) Define latitude and longitude. Show tropic of cancer and tropic of capricorn in a qualitative figure. (05)
7. (a) What do you mean by scale of photograph? What are the reasons of overlapping? (04 $\frac{2}{3}$)
- (b) Differentiate between terrestrial and aerial photogrammetry. (03)
- (c) The scale of an aerial photography is 1 cm = 50 m. The photograph size is 15 cm x 10 cm. Determine the number of photographs required to cover an area of 200 sq. km if the longitudinal lap is 60% and the side lap is 40%. (09)
8. (a) Determine the values of stadia constants from the following observation (13)

Instrument station	Staff reading on	Distance (m)	Stadia readings (cm)	
			Upper	Middle
O	P	50	25.5	20.5
	Q	35	30.5	27.5
	R	80	25	15

- i. Determine the values of stadia constants.
- ii. A staff is placed at point S where upper and lower stadia readings were found to be 55 cm and 30 cm respectively. Find the distance between point O and S.
- (b) What is the principle of tacheometric surveying? (03 $\frac{2}{3}$)

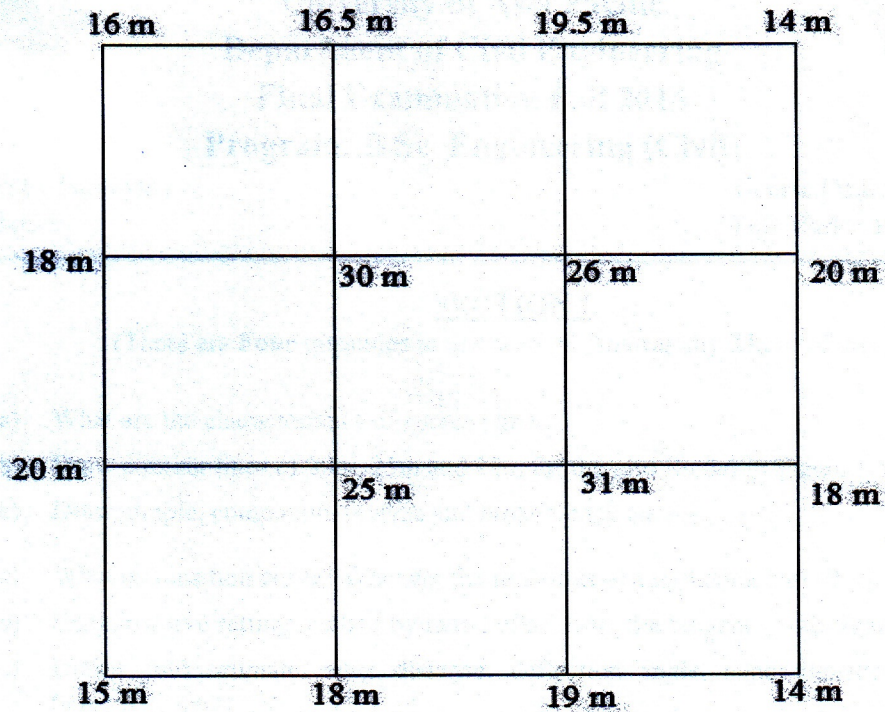


Figure 1(b)

Formula:

For a level Section,

$$A = (b+sh)h$$

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc Engineering (Civil)

Course Title: Surveying
 Time: 3 Hours

Course Code: CE 105
 Full Marks: 120

Section- A :Answer any 3 (Three) out of 4 (Four)

1. (a) Define Chain Survey. Write down the name of different instruments used for chain survey. (05)
- (b) Define check line, tie station and tie line with a figure. (04)
- (c) A distance measured by using a 100 ft chain was 1840 ft. Standard pull and standard temperature for the chain was 30 lb and 85° F respectively. However, the force pulled to pull the chain was a 20 lb and field temperature was 75° F. Calculate the correct distance. Given $A=0.05 \text{ cm}^2$, $E= 2.109 \times 10^6 \text{ kg/cm}^2$. (neglect correction for sag) (11)
2. (a) Define true meridian and magnetic meridian. (04)
- (c) A line has true bearing of $N 25^\circ W$ and magnetic bearing of $N 45^\circ W$. Find the declination angle of the line. (06)
- (d) A closed traverse was conducted and following observations were made. Find out the missing quantities. (10)

Side	Length(m)	Bearing(W.C.B)
AB	500	$98^\circ 30'$
BC	620	$30^\circ 20'$
CD	468	$298^\circ 30'$
DE	?	$230^\circ 0'$
EA	?	$150^\circ 10'$

3. (a) Draw the figure of a circular curve and show its various components. Write down the factors affecting the location and configuration of horizontal alignment of a curve. (10)

(b) Define contouring. Write down the characteristics of a contour. (10)

4. (a) What are the differences between chain survey and traverse survey? (05)

(b) The following figures were extracted from a levelling field book, some of the entries being illegible due to exposure to rain. Insert the missing figures and check your results. Rebook all the figures by the rise and fall method. (15)

Station	B.S.	I.S.	F.S.	Rise	Fall	RL	Remarks
1	2.285					232.46	B.M. 1
2	1.650		?	0.020			
3		2.105			?		
4	?		1.960	?			
5	2.050		1.925		0.300		
6		?		?		232.255	B.M. 2
7	1.690		?	0.340			
8	2.865		2.10		?		
9			?	?		233.425	B.M. 3

Section- B: Answer any 3 (Three) out of 4 (Four)

5. (a) What do you mean by tacheometric survey? What are the characteristics of tacheometer? (08)

(b) The following data is found from reciprocal levels. (12)

Instrument At	Staff readings on		Remarks
	P	Q	
P	2.824	1.748	Distance PQ=2050 m
Q	1.928	1.006	RL of P=125.000

Find the angular error in the collimation adjustment of the instrument. Also find the elevation of Q.

6. (a) Write down the steps in levelling with figure. (06)

(b) Distance between two points A and B is 2.5 km. The level and staff are placed at A and B and staff reading is found to be 7.405 ft. Distance from point A to observer's eye is 3 ft and RL of point B is 558.59m. Find the elevation of A, considering error due to curvature and refraction only. (14)

7. (a) Write down the procedure of drawing perpendicular offset from tangent of a circular curve. (08)
- (b) What do you mean by transition curve? What are the primary functions of a transition curve? (12)
8. (a) What do you mean by photogrammetry survey? What are the functions of Oop (Office of Photogrammetry)? (08)
- (b) Determine the values of stadia constants from the following observations. (12)

Instrument Station	Staff reading on	Distance (m)	Stadia Reading	
			Lower	Upper
O	A	150	1.255	2.750
	B	200	1.000	3.000
	C	250	0.750	3.255

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program : B.Sc Engineering (Civil)

Course Title: Chemistry
Time: 3 hours

Course Code: CHEM111
Full Marks: 150

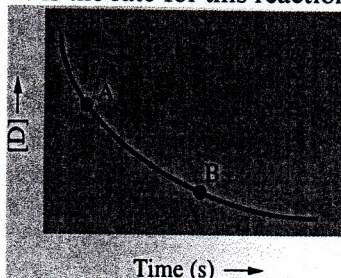
Section: A

There are FOUR questions in this section. Answer any THREE.

1. (a) What is solution? What are the different types of solution? [7]
(b) Explain the freezing point depression and boiling point elevation by drawing the phase diagram of water upon addition of a non-volatile solute. [10]
(c) An aqueous solution is 0.0222 *m* glucose. What are the boiling point and the freezing point of this solution? Boiling-point-elevation constant (K_b) and freezing-point-depression constant (K_f) of water are 0.512 and 1.858 °C/*m* respectively. [8]
2. (a) State and explain Raoult's law. Define ideal and non-ideal solution. [10]
(b) Camphor is a white solid that melts at 179.5 °C. It has been used to determine the molecular masses of organic compounds because of its unusually large freezing-point-depression constant (40 °C/*m*), which allows ordinary thermometers to be used. The organic substance is dissolved in melted camphor, and then the melting point of the solution is determined.
 - i. A 1.07-mg sample of a compound was dissolved in 78.1 mg of camphor. The solution melted at 176.0 °C. What is the molecular mass of the compound?
 - ii. If the empirical formula of the compound is CH, what is the molecular formula? [15]
3. (a) Define lattice energy and hydration energy. How do they play role in determining the solubility of an ionic solid in water? [12]
(b) Estimate the freezing point of a 0.010 *m* aqueous solution of aluminum sulfate, Al₂(SO₄)₃. Assume the value of 'i' based on the formula of the compound. Freezing-point-depression constant (K_f) of water is 1.858 °C/*m*. [13]
4. (a) Define rate of reaction. What are the parameters that influence the rate of a reaction? [8]
(b) Calculate the average rate of decomposition of N₂O₅, $-\Delta[N_2O_5]/\Delta t$, by the reaction $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ during the time interval from $t = 600$ s to $t = 1200$ s. Use the following data:

Time	[N ₂ O ₅]
600 s	$1.24 \times 10^{-2} M$
1200 s	$0.93 \times 10^{-2} M$

[9]
(c) Shown below is a plot of the concentration of a reactant D versus time.
 - i. How do the instantaneous rates at points A and B compare?
 - ii. Is the rate for this reaction constant at all points in time?



[8]

Section: B

There are FOUR questions in this section. Answer any THREE.

5. (a) Define equilibrium constant. [5]
(b) Write down the equilibrium constant expression for the following chemical reactions:
$$\text{CO}(g) + 3\text{H}_2(g) \rightleftharpoons \text{CH}_4(g) + \text{H}_2\text{O}(g)$$
$$\text{CH}_4(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}(g) + 3\text{H}_2(g)$$
$$\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$$
$$\frac{1}{2}\text{N}_2(g) + \frac{3}{2}\text{H}_2(g) \rightleftharpoons \text{NH}_3(g)$$
 [10]
(c) Carbon monoxide and hydrogen react according to the following equation:
$$\text{CO}(g) + 3\text{H}_2(g) \rightleftharpoons \text{CH}_4(g) + \text{H}_2\text{O}(g)$$

When 1.000 mol CO and 3.000 mol H₂ are placed in a 10.00-L vessel at 927°C (1200 K) and allowed to come to equilibrium, the mixture is found to contain 0.387 mol H₂O. What is the molar composition of the equilibrium mixture? That is, how many moles of each substance are present? [10]
6. (a) What is the relationship between the equilibrium constants K_p and K_c ? What will be K_p for the methanation reaction if $K_c = 3.92$? The reaction is:
$$\text{CO}(g) + 3\text{H}_2(g) \rightleftharpoons \text{CH}_4(g) + \text{H}_2\text{O}(g)$$
 [4+6]
(b) Define reaction quotient, Q_c . Predict the direction of the above methanation reaction if
i. $Q_c > K_c$, ii. $Q_c = K_c$, iii. $Q_c < K_c$. [6]
(c) A 50.0-L reaction vessel contains 1.00 mol N₂, 3.00 mol H₂, and 0.500 mol NH₃. Will more ammonia, NH₃, be formed or will it dissociate when the mixture goes to equilibrium at 400°C? The equation is:
$$\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$$

 K_c is 0.500 at 400°C. [9]
7. (a) Define enthalpy. Explain why enthalpy is an extensive property and why it is a state function. [8]
(b) What is internal energy? Derive a relationship between enthalpy change and internal energy change. [9]
(c) Use values of ΔH°_f (ΔH°_f for CS₂(g) is 116.9 kJ/mol and CS₂(l) is 89.70 kJ/mol) to calculate the heat of vaporization, ΔH°_{vap} , of carbon disulfide at 25°C. The vaporization process is:
$$\text{CS}_2(l) \longrightarrow \text{CS}_2(g)$$
 [8]
8. (a) Describe a coffee-cup calorimeter. [8]
(b) What is the enthalpy of reaction, ΔH , for the formation of tungsten carbide, WC, from the elements?
$$\text{W}(s) + \text{C}(\text{graphite}) \longrightarrow \text{WC}(s)$$

The enthalpy change for this reaction is difficult to measure directly, because the reaction occurs at 1400°C. However, the heats of combustion of the elements and of tungsten carbide can be measured easily using the following thermochemical equation:
$$2\text{W}(s) + 3\text{O}_2(g) \longrightarrow 2\text{WO}_3(s); \Delta H = -1685.8 \text{ kJ} \quad (1)$$
$$\text{C}(\text{graphite}) + \text{O}_2(g) \longrightarrow \text{CO}_2(g); \Delta H = -393.5 \text{ kJ} \quad (2)$$
$$2\text{WC}(s) + 5\text{O}_2(g) \longrightarrow 2\text{WO}_3(s) + 2\text{CO}_2(g); \Delta H = -2391.8 \text{ kJ} \quad (3)$$
 [11]
(c) Define heat of formation. Explain why it is important in thermochemistry. [6]

University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2014
Program: B.Sc Engineering (Civil)

Course Title: English Language II

Course Code: HSS 103

Time: 3.00 Hours

Full Marks: 50

* Marks are indicated in the right margin

1. Read the following passage and answer the questions that follow:

The **Bangladesh Army** is the land forces branch and the largest of the three uniformed service of the Bangladesh Armed Forces. The primary mission of the Army is to provide necessary forces and capabilities in support of Bangladesh's security and defence strategies including defence of the nation's territorial integrity against external attack. Control and operations are administered by the Department of the Army of the Armed Forces Division. The civilian head is the Prime Minister, who by law also holds the defence ministry portfolio. Presently the size of the army is 180,000 and the Headquarters is in Dhaka Cantonment. The motto of Bangladesh Army is "*In War, In Peace, We are Everywhere for our Country*". The Bangladesh Army has been actively involved in a number of United Nations Peace Support Operations (UNPSO) since its formation in the 1970s. Its first deployments came in 1988, when it participated in two operations – UNIIMOG in Iraq and UNTAG in Namibia. Later, as part of the UNIKOM force deployed to Kuwait and Saudi Arabia following the Gulf War, the Bangladesh Army sent a mechanised infantry battalion (approx. 2,193 personnel). Since then, the Bangladesh Army has been involved in up to thirty different UNPKOs (United Nations Peace Keeping Operations) in as many as twenty five countries. As a result of its contributions to various UN peacekeeping operations, up to 88 Bangladeshi soldiers have lost their lives (as of February 2009). However, the performance of Bangladesh's contingents has been described as being of the "highest order" and the appointment of several senior Bangladesh military officers as the Commander of UN peacekeeping missions and Senior Military Liaison Officers. In January 2004, BBC described the Bangladeshi UN Force as "**Cream of UN Peacekeepers**". UN peacekeepers are often referred to as **Blue Berets** or **Blue Helmets** because of their light blue berets or helmets. Bangladesh Armed Forces participated in the Gulf war in 1991 in *Operation Desert Storm*.

Bangladesh Military Academy (BMA) is the training institute for the officer cadets of Bangladesh Army. It is located in Bhatiary, near **Chittagong Hill Tracts**, in **Chittagong** of south-east Bangladesh, about 13 kilometres north of Chittagong city. The Academy is situated on the slopes of the Sitakunda hill ranges and the shore of the Bay of Bengal. The Academy was initially established at Comilla Cantonment on 11 January 1974 and later relocated at Bhatiary in 1976. This Academy was awarded National Standard in the year 1979. BMA is the only academy for training commissioned officers and transforming a civilian into one of the finest and most professional military officers in the world. It has a rich tradition of leadership training and excellence.

Now, answer the following questions:

01 x 07 = 07

- a) What do the passages primarily discuss about?
- b) What is the chief duty of Bangladesh Army?
- c) By law, who is the defence minister of Bangladesh?
- d) Why did BBC describe Bangladesh UN Force as the "**Cream of UN Peacekeepers**"?
- e) In how many missions did the Bangladesh Armed Force participate?
- f) What were the first two missions of Bangladesh Army as UN peacekeepers?
- g) Where was BMA originally located?

2. Complete the following sentence using appropriate Modal verbs:

0.5 x 10 = 05

- a) You seem to be having trouble there. _____ I help you?
- b) I don't have enough money to buy lunch. _____ you lend me a couple of dollars?
- c) That ice is dangerously thin now. You _____ go ice-skating today.
- d) It's way past my bedtime and I'm really tired. I _____ go to bed.
- e) He _____ have committed this crime. He wasn't even in the city that night.
- f) Jamil is over two hours late already, He _____ missed the bus again.
- g) If you don't start working harder you _____ repeat the course next year.
- h) That bus is usually on time. It _____ to be here any time now.
- i) I read about your plane's near disaster. You _____ terrified!

j) Professor Rahman, we've finished our work for today. _____ we leave now, please?

3. Join any ten of the following pairs of sentences with appropriate conjunctions or relative pronouns
0.5 x 10 = 05

- a) I used torchlight. It was very dark by then.
- b) She went to see the manager personally. She had a very serious complaint to make.
- c) We had waited for you for a long time. You did not turn up at all.
- d) He was very pleased with himself. He had won first prize in the competition.
- e) You must come early. We will have time to make all the arrangements.
- f) The boys are afraid to go near that place. They have heard that it is haunted.
- g) I could not find him in his own house. I went over to Tomal's house to see if he was there.
- h) The bull rushed straight at the little boy. He quickly moved to one side.
- i) I shouted for help as loudly as I could. No one heard me.
- j) The girl did not buy that expensive pair of shoes. She liked them very much.
- k) He walked out of the room very angrily. He slammed the door hard.
- l) Shapon locked himself in my bedroom. He would not be disturbed by the children.

4. Write single sentence definitions of any five (5) of the following: 01 x 05 = 05

- a) Dictatorship (class)
- b) Liberty (negation)
- c) Plagiarism (synonym)
- d) Fridge (function)
- e) Pediatrician (class)
- f) Mentor (synonym)

5. Write a letter to your friend describing a recent farewell program of the outgoing batch in your department that you have attended. 05

6. UAP will take part in the 'International Math Olympiad 2015' to be held at Bangabandhu International Conference Centre, Agargaon. As the convener of UAP co-curriculum activities committee, write a memorandum to this effect. 05

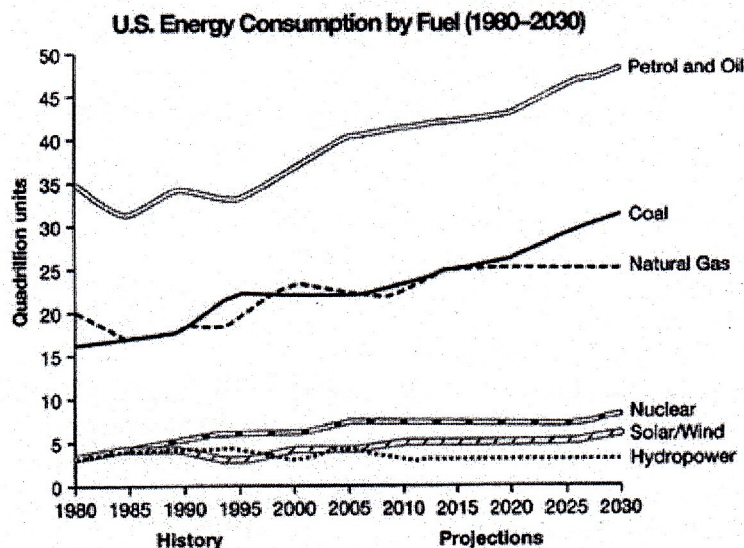
7. The 'Dhaka International Trade Fair (DITF) 2015' took place at Sher-e-Bangla Nagar, Dhaka. As a reporter of *The Daily Star*, write a news-report on the event for publication in your newspaper. 05

8. Write a paragraph on any one of the following (word limit 200) 08

a) CE Festival

b) The Best Restaurant You Have Experienced

9. The graph below shows information from a 2008 report about consumption of energy in the USA since 1980 with projections till 2030. Describe the information available in the graph in your own words. 05



University of Asia Pacific
Department of Basic Sciences & Humanities
Semester Final Examination, Fall-2014
Program: B. Sc. Engineering (Civil)
1st year/ 2nd semester

Course Title: Mathematics II
 Time: 3 hours

Course Code: MTH 103

Credit: 3.00
 Full Marks: 150

N.B: There are two sections in the question paper namely "**SECTION A**" and "**SECTION B**". You have to answer from both sections according to the instruction mentioned in each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Determine the angles which the vector $\mathbf{A} = 3\mathbf{i} - 6\mathbf{j} + 2\mathbf{k}$ makes with the coordinate axes. 12
- (b) Find a unit vector parallel to the resultant of vectors $\mathbf{r}_1 = 2\mathbf{i} + 4\mathbf{j} - 5\mathbf{k}$ and $\mathbf{r}_2 = \mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$. 8
- (c) Show that the addition of vectors is associative. 5
2. (a) If $\mathbf{A} = (2x^2y - x^4)\mathbf{i} + (e^{xy} - y\sin x)\mathbf{j} + (x^2\cos y)\mathbf{k}$, find 18

$$\frac{\partial A}{\partial x}, \frac{\partial A}{\partial y}, \frac{\partial^2 A}{\partial x^2}, \frac{\partial^2 A}{\partial y^2}, \frac{\partial^2 A}{\partial x \partial y}, \frac{\partial^2 A}{\partial y \partial x}$$
- (b) Find the unit tangent vector to any point on the curve $x = t^2 + 1, y = 4t - 3, z = 2t^2 - 6t$. Also determine the unit tangent at the point where $t = 2$. 7
3. (a) If $\mathbf{A} = A_1\mathbf{i} + A_2\mathbf{j} + A_3\mathbf{k}$; $\mathbf{B} = B_1\mathbf{i} + B_2\mathbf{j} + B_3\mathbf{k}$ and $\mathbf{C} = C_1\mathbf{i} + C_2\mathbf{j} + C_3\mathbf{k}$ then prove that 7

$$\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C}) = \mathbf{C} \cdot (\mathbf{A} \times \mathbf{B})$$
- (b) If $\mathbf{A} = 3\mathbf{i} - \mathbf{j} + 2\mathbf{k}$; $\mathbf{B} = 2\mathbf{i} + \mathbf{j} - \mathbf{k}$ and $\mathbf{C} = \mathbf{i} - 2\mathbf{j} + 2\mathbf{k}$ find $(\mathbf{A} \times \mathbf{B}) \times \mathbf{C}$. 6
- (c) If $\mathbf{A} = \sin u \mathbf{i} + \cos u \mathbf{j} + u \mathbf{k}$; $\mathbf{B} = \cos u \mathbf{i} - \sin u \mathbf{j} - 3\mathbf{k}$ and $\mathbf{C} = 2\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ find $(\mathbf{A} \times (\mathbf{B} \times \mathbf{C}))$ at $u = 0$. 12

4. (a) Define Gradient, Divergence and Curl. 9
- (b) i. Find $\text{grad } \phi$ if $\phi = \frac{1}{r}$. 16
 ii. Prove $\nabla \times (\nabla \times \mathbf{A}) = -\nabla^2 \mathbf{A} + \nabla(\nabla \cdot \mathbf{A})$.

SECTION B

There are FOUR questions in this section. Answer any THREE.

5. (a) To find the condition that the general equation of the second degree $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ may represent a pair of straight lines and also find the value of their point of intersection. 17
- (b) Show that the equation $2x^2 - 2xy + x + 2y - 3 = 0$ represents a pair of straight lines; also find their point of intersection and the angle between them. 8
6. (a) Determine the angle between two lines whose direction cosines are given by the equations relations $l + m + n = 0$ and $l^2 + m^2 - n^2 = 0$. 10
- (b) Find the equation of the plane through $(2, -1, 0)$ and $(3, -4, 5)$ and perpendicular to the plane $2x + y - z + 6 = 0$. 8
- (c) Compute the projection of the join of points $(-1, -1, 3)$ and $(2, 0, 1)$ on the line through the points $(-7, 5, 3)$ and $(2, 6, 8)$. 7
7. (a) Define Direction Cosines of a line. 5
- (b) If P & Q are $(1, -5, 7)$ and $(-3, 6, -2)$ and O be the origin, find the direction cosines of OP, OQ and PQ. Also find the angle POQ. 10
- (c) Find the equation of the plane through the points $(2, 1, -3)$, $(3, -1, 4)$, $(7, 5, 6)$. 10
8. (a) Find for what value of δ the equation $x^2 - 4xy - y^2 + 6x + 8y + \delta = 0$ represents a pair of straight lines. 8
- (b) Find the equation of the plane through the line of intersection of the planes $x + 2y + 3z - 4 = 0$ and $2x + y - z + 5 = 0$ that is perpendicular to the plane $5x + 3y + 6z + 8 = 0$. 8
- (c) Find the equation of the plane through the point $(4, 0, 1)$ and parallel to the plane $4x + 3y - 12z + 6 = 0$. 9