UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

FIRST SEMESTER EXAMINATIONS

2010 ACADEMIC YEAR

1. CE 219 - Statistics and introduction to strength of materials
2. CE 219 - Statistics and introduction to strength of materials
3. EA 311 - Farm power and machinery
4. EA 401 - Farm power
5. EE 209 - Principles of electricity I
6. EE 209 - Principles of electricity I
7. EE 309 - Principles of electricity II
8. EE 321 - Electro mechanics and machines
9. EE 581 - Telecommunication theory
10. EG 211 - Engineering workshop technology
11. EM 211 - Engineering mathematics I
12. EM 311 - Engineering mathematics III
13. EM 411 - Engineering mathematics V
14. GE 481 - Introduction to surveying
15. GG 311 - Crystallography and optical mineralogy
16. GG 361 - Engineering geology paper 2 practical
17. GG 361 - Engineering geology paper 1 theory
18. ME 341 - Thermodynamics
19. MI 469 - Investment analysis

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

2009 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS

CE219: STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS

TIME: THREE HOURS

INSTRUCTIONS: 1. ANSWER ANY **FIVE (5)** QUESTIONS
2. EACH QUESTION CARRIES **20 MARKS**
3. USEFUL FORMULAE ARE PROVIDED AT THE END PAGE

Question 1

a) State and briefly define **Three (3)** branches of mechanics. [3 marks]

b) The crane in Fig. Q1 is used to lift pre-cast concrete panels as indicated. The cable ABC passes through frictionless pulley systems at A and B. Given that the height of the crane DA is 25m and the maximum lifting height (position of B from the ground) is 30m, determine the following at this position:

i) The vector of the tension in the cable AB, given that the density of concrete is $24kN/m^3$. [5 marks]

ii) The unit vector $\overline{T}_{AB}$ [3 marks]

iii) The angles the tension make, with the coordinate axes θ_x, θ_y, and θ_z [3 marks]

iv) The moments the tension makes with the ***x –axis*** and the ***y- axis***. [6 marks]

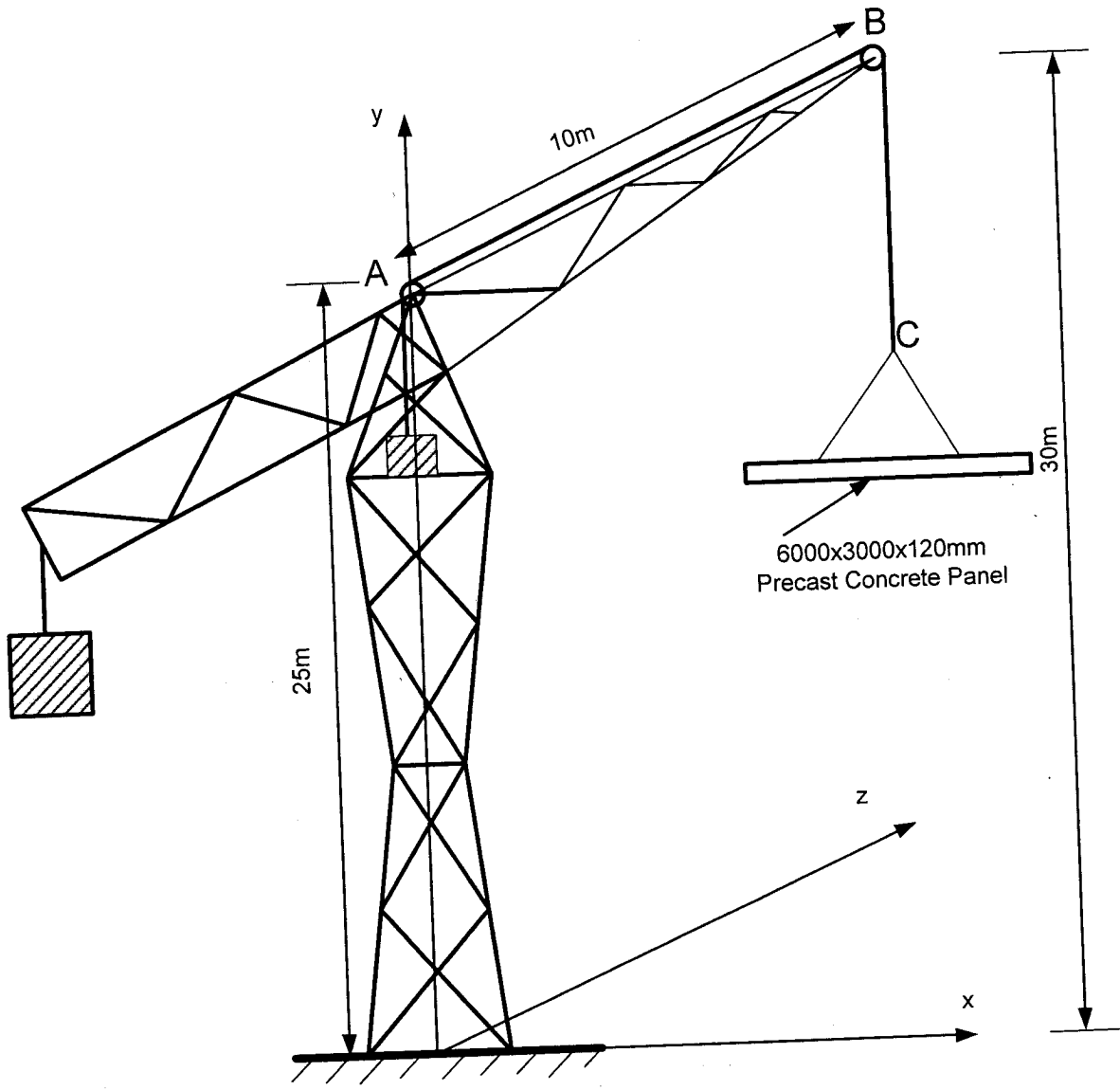

B
y
10m
A
C
30m
6000x3000x120mm
Precast Concrete Panel
25m
z
x

Fig. Q1

Question 2

a) Define the following terms as applied in mechanics:

i) Vector quantity [2 mark]

ii) Moment of force about a point [2 mark]

b) The 4m x 4m rectangular flat plate in Fig. Q2 has a system of forces acting on its flat surface OABC. The forces act on the mid positions of the edges and the couple (moment) acts from point O to B, as shown

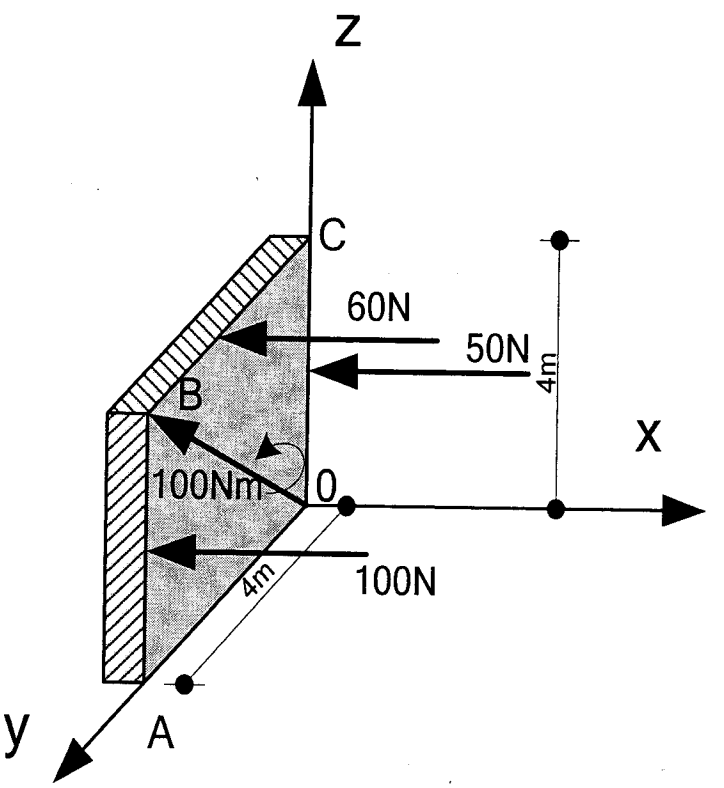


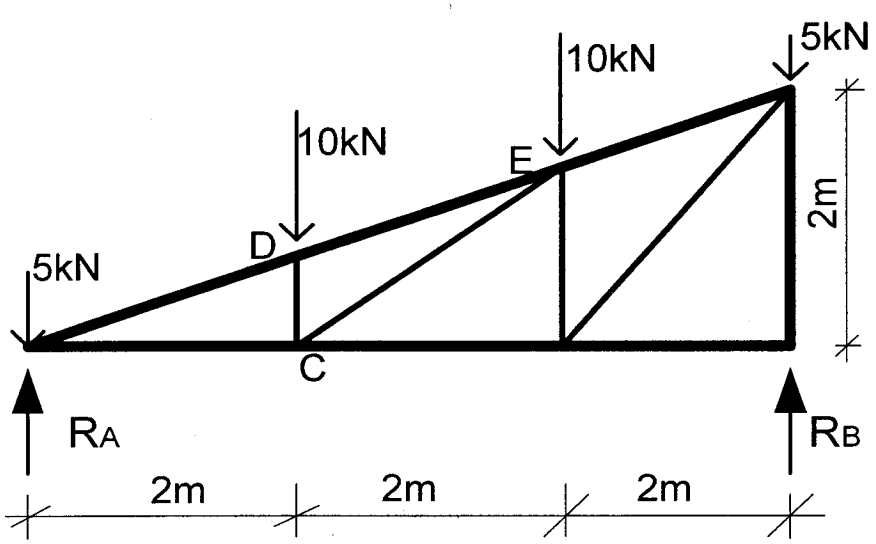
Fig. Q2

i) Replace the couple-force system and force by an equivalent, single force acting on the plate. [12 marks]

ii) Determine the distance from O to the point of application of this force. [4 marks]

Question 3

a) Fig. Q3 below shows a simply supported truss.



i) Determine the reaction forces R_A and R_B. [6 marks]

ii) Using the method of joints, find the internal force in member DC. [5 marks]

iii) Using the method of section, find the internal force in member CE. [5 marks]

b) Define the following terms as used in mechanics.

i) Truss [2 marks]

ii) Coplanar forces [2 mark]

Question 4

a) Name two types of friction [4 marks]

b) Fig. Q4 shows a hand driven wood drilling machine. The drilling screw has a double square thread of mean diameter 10mm and with a pitch of 2.5mm. The coefficient of friction between the threads is $\mu_s = 0.25$. If a maximum force of 150N is applied on the spindle at point A to drive the screw, determine:

i) The force exerted on the wood [8 marks]

ii) The torque required to loosen the drill. [8 marks]

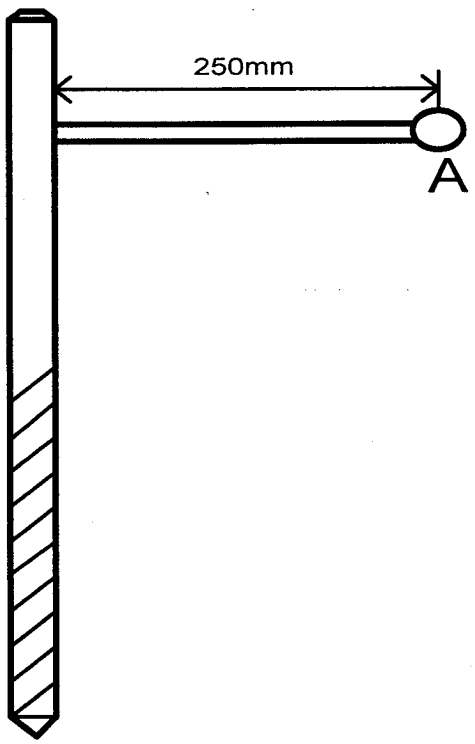


Fig. Q4

Question 5

a) Fig. Q5 below shows a mechanism used to lift a load A, using a flat belt ABC passing through a cylindrical drum at point B. By applying a pulling force of 80N at point C, a man can just keep the load A equalling 1500N, from slipping.

i) Determine the angle of contact between the belt and the cylindrical drum B, if the coefficient of friction between the two is $\mu_s = 0.30$. [6 marks]

ii) Determine the load that could be resisted by a 120N force if the belt were wrapped one-third (1/3) times it is in (i) above around the drum. [6 marks]

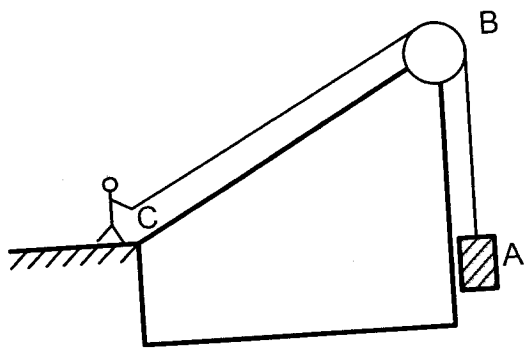


Fig. Q

b) What is kinetic friction? How does it compare coefficient of kinetic friction with coefficient of static friction? [4 marks]

c) If the coefficient of static friction between any two surfaces is μ_s, show that the angle of static friction ϕ_s, is given by $\phi_s = \tan^{-1} \mu_s$ [4 marks]

Question 6

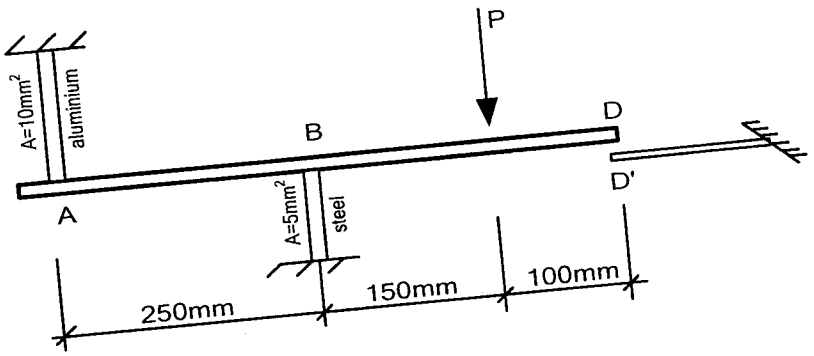


Fig. Q6

A load sensitive mechanism, shown on Fig. Q6 below, consists of a relatively rigid bar AD, supported by an aluminium and steel rods at A and B, respectively. Before any load is applied, the bar AD is horizontal. When point D closes the gap DD′ which is 2.5mm, an electrical circuit is completed and the alarm goes. Show that the load P required to trigger the alarm is $P \geq 9.8kN$. [20 marks]

(Aluminium bar - L_A =250mm, E_A = 66.7kN/mm^2 and steel bar - L_S =150mm, E_S = 200kN/mm^2)

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY FIRST SEMESTER EXAMINATION – OCTOBER/NOVEMBER 2010.

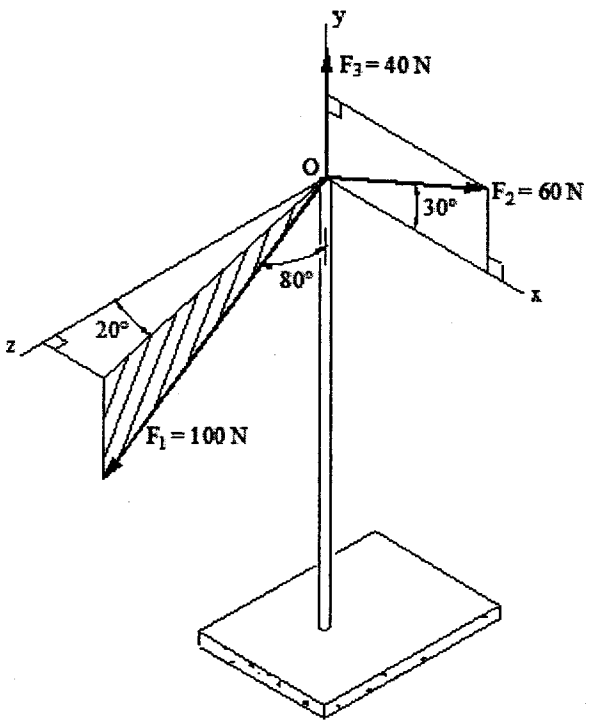
CE 219 : STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours. **ANSWER:** Any THREE from Section A, and Any TWO from Section B. All questions carry equal marks (20 marks)

Section – A.

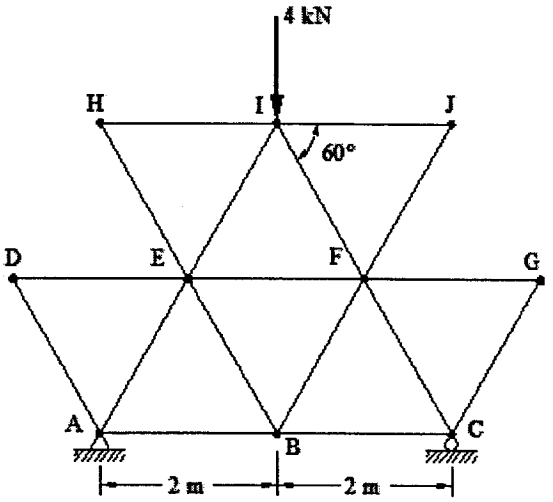
Question 1

Determine the magnitude and coordinate direction angles of the resultant of the three forces acting on the mast.



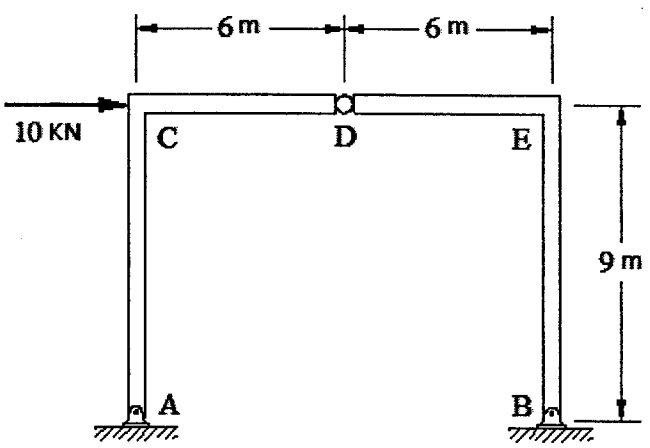
Question 2

Determine the force in each member of the truss and state whether the force is tension or compression.



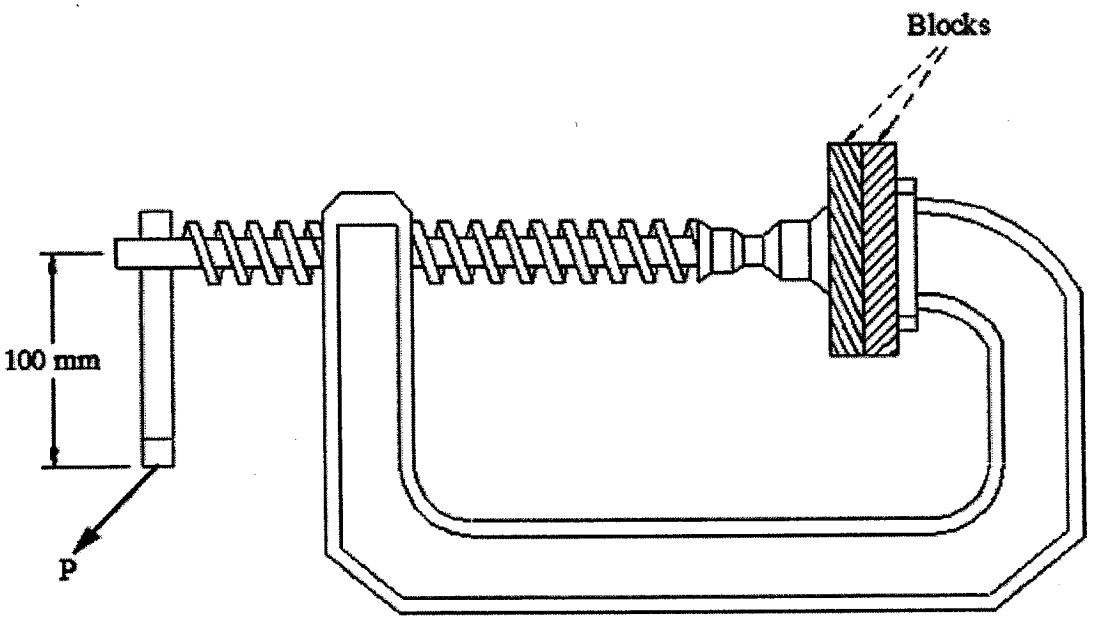
Question 3

The frame is pin-connected at D and at the supports A and B. Determine the reactions at A and B.



Question 4

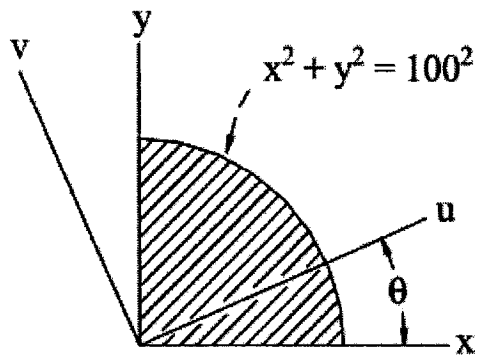
The C-clamp provides a compressive force of 900N to the two blocks that are being glued together. Determine the minimum force P necessary to loosen the clamp. The clamp has a square-threaded screw with lead L=7mm and mean radius r=8mm. The coefficient of static friction between the screw and the supporting threads in the frame is μ=0.25.



Section – B.

Question 5

Given that for the quarter circle shown below $I_x=I_y=\frac{1}{16}\pi r^4$, use the Mohr Circle to determine the value of θ for which the product of inertia of the crosshatched area with respect to the u and v axes is zero. Calculate I_u and I_v for this value of θ and compare I_u and I_v to I_{max} and I_{min}.

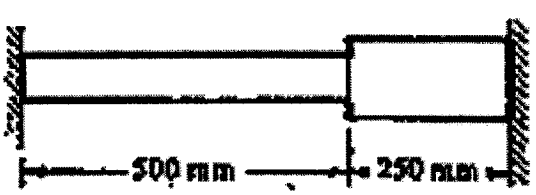


Question 6

Two bars are joined together and attached at supports as shown. The left bar (L=500mm) is brass for which E=90 GPa, $\alpha=20\times10^{-6}C^{-1}$ and the right bar (L=250mm) is aluminium for which E=70GPa, $\alpha=25\times10^{-6}$. The cross sectional area of the brass bar is 500 mm^2 and that of the aluminium bar is 750mm^2. The system is initially stress free and the temperature then drops by 20°C. The bars have negligible weight.

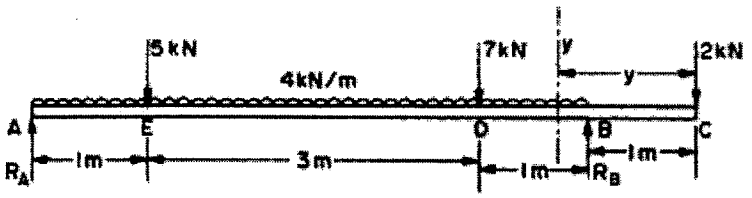
(a) If the supports are unyielding, find the normal stress in each bar.

(b) If the right support yields 0.1mm, find the normal stress in each bar.



Question 7

Draw the S.F. and B.M. diagrams for the beam loaded as shown in the figure below, and determine the position and magnitude of the maximum B.M.



END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

FIRST SEMESTER FINAL EXAMINATIONS

OCTOBER 2010

EA 3 11 (FARM POWER AND MACHINERY)

TIME ALLOWED: **THREE** HOURS.

INSTRUCTIONS: THIS EXAMINATION PAPER CONSISTS OF TWO SECTIONS, SECTION A AND SECTION B. ATTEMPT **ALL** QUESTIONS IN SECTION A AND ANY **FOUR** QUESTIONS FROM SECTION B.

SECTION A (20 MARKS): ATTEMPT **ALL** QUESTIONS IN THIS SECTION

For each of the following questions, choose the BEST answer and then in the answer sheet write the letter corresponding to your answer in capital letters.

1. The energy needed for muscle contraction so that the body can produce the motion necessary to carry out manual work is provided by:
   a) ATP
   b) creatine phosphate
   c) glycogen
   d) All of the above

2. When pyruvic acid is produced by anaerobic metabolism faster than it can be utilized, the surplus is converted to:
   a) carboxylic acid.
   b) lactic acid
   c) creatine phosphate
   d) adenosine triphosphate

3. The energy released from the breakdown of the high-energy phosphates, ATP and creatine phosphate combined, can sustain maximum manual power output for:
   a) 1-2 seconds
   b) 5-10 seconds
   c) 30-40 seconds
   d) 50-60 seconds

4. A spark ignition engine is running at 2000 rpm. If the petrol fuel takes 0.0025 seconds to completely burn in the combustion chamber. How much spark advance is needed if the fuel has to be completely consumed by the time the crankshaft reaches 10° after top dead centre (TDC).
   a) 15°
   b) 20°
   c) 25°
   d) 30°

5. Which one of the following is not a function of a piston in an engine?
   a) Draw in air / air fuel mixture into the cylinder during induction stroke
   b) Transmit power produced during power stroke to the crankshaft
   c) Keep the engine running during the idle strokes
   d) Push out exhaust gases during exhaust stroke

6. 240 hectares of row crop is to be planted in a period estimated to have 10 available workdays, each with 12 hours of possible field time. Planting speed is 5.4 km/h and the required row spacing is 90 cm. Assuming a field efficiency of 75%, what should be the minimum size of the planter (i.e. in terms of number of rows) to carry out the task on time?
   a) 4 Row Planter
   b) 5 Row Planter
   c) 6 Row Planter
   d) 7 Row Planter

7. Increasing the operating pressure of a tractor mounted boom sprayer four times combined with doubling the tractor forward speed during spraying operation will:
   a) have no effect on pesticide application rate
   b) reduce pesticide application rate by half
   c) double pesticide application rate
   d) increase pesticide application rate four times

8. Which one of the following measures is not a cultural pest control method?
   a) crop rotation
   b) flood irrigation
   c) phyto-sanitation
   d) planting pests resistant crop varieties.

9. During calibration of a fertilizer broadcaster, 1.25 g of fertilizer was collected on a square tray measuring 25cm x 25cm. The equivalent fertilizer application rate (in kg/ha) is
   a) 20 kg/ha
   b) 50 kg/ha
   c) 200 kg/ha
   d) 500 kg/ha

10. The presence of threshed grains in the straw ejected at the back of a combine harvester during harvesting of the grain is an example of:
   a) cutter bar loss
   b) threshing loss
   c) separation loss
   d) cleaning loss

SECTION B: ATTEMPT ANY **FOUR** QUESTIONS FROM THIS SECTION **(80 MARKS)**

QUESTION 11

A farmer has a pair of oxen, each weighing about 500 kg that he uses for ploughing his field. The soil is predominantly clay loam. The plough cuts a furrow slice 20 cm wide by 25cm deep. The specific soil resistance of clay loam soil is about 20 kN/m^2. The oxen work for 5 hours per day at an average speed of 3.6 km/h. The oxen are fed on guinea grass. Given the following additional information:

Guinea grass gross energy content: = 14.0 MJ/kg

Groundnut cake gross energy content = 20.7

Guinea grass DE : GE Ratio (DE/GE): = 0.5

Groundnut cake DE : GE Ratio (DE/GE): = 0.85

Maintenance Energy: = 8.3 + (0.091W) MJ/day

Appetite Limit: = 0.025W kg of dry matter where W is the weight of the draft animal

Metabolisable Energy (ME) = 0.8 of Digestible Energy (DE)

Oxen sustainable pull = 12.5% of the animal weight

Energy conversion efficiency of draft animals: = 20%

a) Determine whether the oxen can pull the plough?

[2 Marks]

b) Show that the oxen will need supplementary feed to meet their total daily energy requirement during the ploughing period.

[8 Marks]

c) Calculate the total amount of groundnut cake supplement required per ox per day if the oxen have to meet the total daily energy requirement under existing conditions.

[6 Marks]

d) Suggest two measures that the farmer can take to enable the oxen meet the total daily energy requirement **without** having to provide supplementary feed.

[4 Marks]

QUESTION 12

a) State the condition(s) under which human beings need rest when performing physical tasks? Briefly explain why the rest periods are necessary under the circumstances.

[4 Marks]

b) Ten farm workers were tasked to weed a soya beans field using hand hoes. On average each worker is able to sustain the task without rest for 7 minutes and 51 seconds only. During that time, each worker is able to weed 12.5 m^2 of the field. The workers are however expected to be in the field from 07:00 to 12:00 each day. Continuous physical power output of a normal healthy human being varies with time according to the following equation.

$$P = (68 + 932\,e^{-0.908\,t^{0.16}})$$

where: P = power output [W]
t = time [s]

Assume energy conversion efficiency of a normal healthy human being is 25%.

i) Calculate the power output that can be sustained in 7 minutes and 51 seconds.

[4 Marks]

ii) What's the ratio of work period to rest period?

[4 Marks]

iii) Determine the total time (in hours) that each worker spends resting during the 5 hour work session.

[4 Marks]

iv) Calculate the total area weeded per workday?

[4 Marks]

QUESTION 13

a) Figure Q 13 below shows the valve train for a four cylinder four stroke cycle petrol engine. Name the parts A - E

[5 Marks]

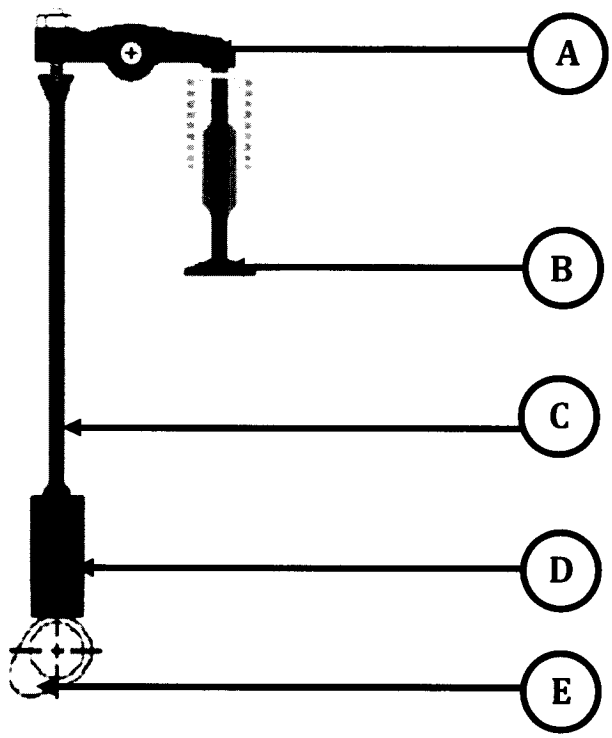


Figure Q13: Valve train

b) For the engine to run, the opening and closing of the valves have to be timed with the movement of the piston in the cylinder through the crankshaft. List three types of transmission mechanisms commonly used to synchronise the movements of the piston and the opening and closing of the valves.

[3 Marks]

c) What is the gear ratio of the crankshaft to the camshaft for the engine.

[2 Marks]

d) Given the following specifications for the valve events: IVO at 12° before TDC, IVC at 40° after BDC, EVO at 45° before BDC, EVC at 10° after TDC. Calculate:

i) valve overlap

[2 Marks]

ii) the number of crankshaft degrees during which each intake valve is open in a cycle

[2 Marks]

iii) the number of crankshaft degrees during which each exhaust valve is open in a cycle.

[2 Marks]

e) If the engine is running at 2000 rpm, calculate the total number of power strokes per minute.

[4 Marks]

QUESTION 14

a) A bag of agricultural lime has a label "Neutralising Value (NV) = 55". What does this mean?

[2 Marks]

b) Given two agricultural liming materials, Ndola Agro-lime with NV = 66% being sold for ZMK125,000 per tonne and Turtle Agro-lime with NV = 85% going for ZMK 150,000 per tonne. Which one of the two limes is more cost effective? Briefly explain your answer.

[5 Marks]

c) State **two** objectives for calibrating a full width agricultural lime spreader.

[5 Marks]

d) List **three** types of nozzle spray patterns.

[3 marks]

e) A farmer would like to apply 121 l/ha of a certain herbicide using a tractor mounted sprayer. Only one set of nozzles is available and each nozzle is rated at 2.27 litres/minute when operating at a pressure of 4 bars. If the sprayer has 40 nozzles spaced 75 cm apart, what tractor speed is required to apply the correct amount of the herbicide.

[5 marks]

Question 15

A farmer has 2,500 hectares of arable land. He grows 1,000 hectares of soya beans under rain fed condition and 2,000 hectares of irrigated winter wheat. The New Holland TC5050 combine harvester used to harvest both crops has a rated width of 3.75m, an average operating speed of 6.5 km/h and field efficiency of 65%. Given that the harvester is only used for the above mentioned tasks per year.

Calculate:

a) the combine harvester effective field capacity

[2 Marks]

b) the combine harvester total annual use (in hours)

[2 Marks]

c) Given the following additional information:

Combine Harvester Purchase price, P	K 850,000,000
Trade-in value, S	10% of Purchase Price
Shelter/Insurance/Tax	1% of Purchase Price
Economic life	8 years
Repair & Maintenance Cost (per hour)	0.0005% of Purchase Price
Fuel Consumption	15 l/hr
Pump Price of Diesel Fuel	K 7,000/l
Cost of lubricants	15% of Fuel Cost

Labour cost is K 15,000 per hour and the bank interest rate on the money borrowed for the purchase of the combine harvester is 20%.

i) Calculate the total cost for harvesting the crop per hour.

[6 Marks]

ii) Calculate the total cost for harvesting the crop per hectare.

[2 Marks]

iii) As an alternative to buying a combine harvester, the farmer has an option of hiring a contractor to harvest the crop. If the contractor's charge comprise a fixed cost of K250,000 (for machinery mobilisation) and K 160,000 per hectare, calculate the breakeven hectarage.

[4 Marks]

iv) Sketch the breakeven chart to show the behaviour of total cost of harvesting the crop using a contractor and own combine harvester over hectarage range 0 – 5000 hectares and advise the farmer the most cost effective option for his farm.

[4 Marks]

END OF EXAMINATION

By thought, the things you want are brought to you. By action, you receive them.

Unknown

"The highest reward for a person's toil is not what they get for it, but what they become by it."

John Ruskin

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

FIRST SEMESTER FINAL EXAMINATIONS

OCTOBER 2010

EA 401 (FARM POWER)

TIME ALLOWED: **THREE** HOURS.

INSTRUCTIONS: THIS QUESTION PAPER HAS **SEVEN** QUESTIONS. ATTEMPT ANY **FIVE** QUESTIONS. ALL QUESTIONS CARRY **EQUAL** MARKS (20 MARKS EACH).

QUESTION 1

A farmer has a pair of oxen, each weighing about 500 kg that he uses for ploughing his field. The soil is predominantly clay loam. The plough cuts a furrow slice 20 cm wide by 25cm deep. The specific soil resistance of clay loam soil is about 20 kN/m^2. The oxen work for 5 hours per day at an average speed of 3.6 km/h. The oxen are fed on guinea grass. Given the following additional information:

Guinea grass gross energy content: = 14.0 MJ/kg

Groundnut cake gross energy content = 20.7

Guinea grass DE : GE Ratio (DE/GE): = 0.5

Groundnut cake DE : GE Ratio (DE/GE): = 0.85

Maintenance Energy: = 8.3 + (0.091W) MJ/day

Appetite Limit: = 0.025W kg of dry matter where W is the weight of the draft animal

Oxen sustainable pull = 12.5% of the animal weight

Energy conversion efficiency of draft animals: = 20%

a) Determine whether the oxen can pull the plough?

[2 Marks]

b) Show that the oxen will need supplementary feed to meet their total daily energy requirement during the ploughing period.

[8 Marks]

c) Calculate the total amount of groundnut cake supplement required per ox per day if the oxen have to meet the total daily energy requirement under existing conditions.

[6 Marks]

d) Suggest two measures that the farmer can take to enable the oxen meet the total daily energy requirement **without** having to provide supplementary feed.

[4 Marks]

QUESTION 2

a) State the condition(s) under which human beings need rest when performing physical tasks? Briefly explain why the rest periods are necessary under the circumstances.

[4 Marks]

b) Five farm workers were tasked to weed a maize field using hand hoes. On average each worker is able to sustain the task without rest for 7 minutes and 51 seconds only. During that time, each worker is able to weed 12.5 m^2 of the field. The workers are however expected to be in the field from 07:00 to 12:00 each day. Continuous physical power output of a normal healthy human being varies with time according to the following equation.

$$P = (68 + 932\,e^{-0.908\,t^{0.16}})$$

where: P = power output [W]

t = time [s]

Assume energy conversion efficiency of a normal healthy human being is 25%.

i) Calculate the power output that can be sustained in 7 minutes and 51 seconds.

[4 Marks]

ii) What's the ratio of work period to rest period?

[4 Marks]

iii) Determine the total time (in hours) that each worker spends resting during the 5 hour work session.

[4 Marks]

iv) Calculate the total area weeded per workday?

[4 Marks]

QUESTION 3

a) List five major components of cam-in-block valve train.

[5 Marks]

b) A three-cylinder Perkins engine has a 127.0 mm stroke and a 107.9 mm bore. According to the engine specifications, the compression ratio for the engine is 15.5:1. While overhauling the engine, a mechanic unintentionally installed a cylinder head gasket that is 1.25 mm thicker than the recommended gasket.

i) What is the function of the cylinder head gasket on an engine?

[2 Marks]

ii) Calculate the cylinder displacement, V_d, the clearance volume, V_c, and the maximum volume, V_1 of each cylinder.

[6 Marks]

iii) Calculate the compression ratio of the engine with the thicker cylinder head gasket installed.

[4 Marks]

c) Would the mistake made by the mechanic likely to affect the operation of the engine? Briefly explain your answer.

[3 Marks]

QUESTION 4

A Two Wheel Drive Massey-Ferguson, M-F 390, tractor has the following engine and power train specifications:

Engine

Rated engine power: 64.1 kW at 2200 rpm

Maximum engine torque: 283 Nm at 1400 rpm

Power Train

Clutch Type: Dry disc clutch: outside diameter: d_o = 305 mm
inside diameter: d_i = 203 mm

Transmission: 8 speed sliding spur: 8 forward
2 reverse

Differential: Bevel pinion gear: 8 teeth
Ring gear: 39 teeth

Final Drive: Planetary gear set: Sun gear: 33 teeth
Ring gear: 70 teeth
Power comes **in** through the sun gear and **out** through the planet carrier.
The ring gear is held stationary.

Wheels: Front wheel rolling radius: 560 mm
Rear wheel rolling radius: 1100 mm
Efficiency of the transmission, η_T = 0.95
Efficiency of the differential, η_D = 0.96
Efficiency of final drive, η_{FD} = 0.98

Table Q4 Road Speeds at rated engine speed of 2200 rpm

Forward gear	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Road speed (km/h)	2.5	3.7	5.1	6.8	10.4	15.2	20.8	27.9

a) i) State **two** advantages of using a planetary gear set at the final drive.

[4 Marks]

ii) Show that the gear ratio for a planetary gear set when power comes **in** through the sun gear and **out** through the planet carrier while the ring gear is held stationary is given by. $i = 1 + \frac{Z_r}{Zs}$, where Z_r is number of gear teeth on the ring gear and Z_s is number of gear teeth on the sun gear.

[4 Marks]

b) Calculate the transmission (gearbox) gear ratios and torque at the drive wheel in the following gears: gear 1, gear 3 gear 5, and gear 8.

[8 Marks]

c) State **two** advantages of engaging a differential lock when carrying out some field operations with a tractor.

[4 Marks]

QUESTION 5

a) State **two** advantages and **two** disadvantages of using hydraulic systems for power transmission.

[4 Marks]

b) Figure Q5 below shows a hydraulic circuit diagram drawn using standard JIC hydraulic symbols. Identify hydraulic components 1 - 5 in the diagram and state their respective function(s).

[10 Marks]

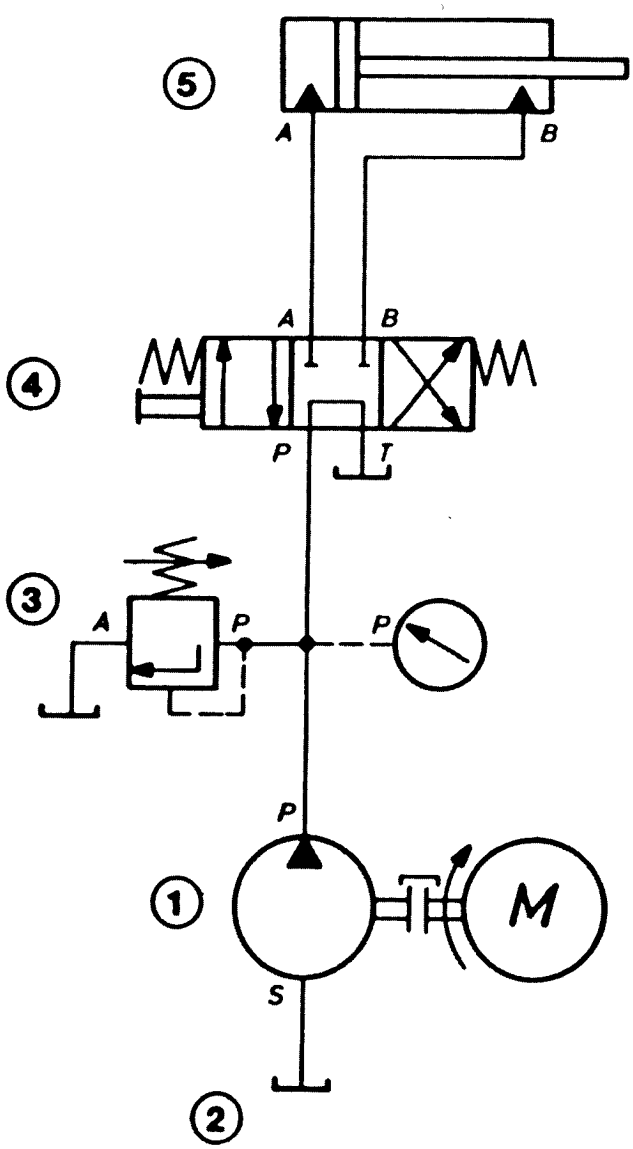


Figure Q5 Schematic diagram for a hydraulic system using JIC symbols

c) Explain why hydraulic systems generally use positive displacement pumps?

[2 Marks]

d) State **two** differences between by-pass filtration and full-flow filtration systems.

[4 Marks]

QUESTION 6

a) If air consists of 20.8% oxygen and 79.2% of nitrogen by volume, show that it contains 23.1% oxygen and 76.9% nitrogen by weight.

Element	Atomic Symbol	Atomic Weight	Molecular Formula	Weight
Carbon	C	12	C	12
Hydrogen	H	1	H_2	2
Oxygen	O	16	O_2	32
Nitrogen	N	14	N_2	28

[3 Marks]

b) Calculate stoichiometric air to fuel ratio of the following fuels:

i) Petrol (C_8H_{18})

ii) Ethanol (C_2H_5OH)

[8 Marks]

c) Briefly explain in general terms the adjustment needed for an engine that currently uses petrol fuel, if it has to switch to ethanol for fuel.

[3 Marks]

d) Name the reference fuels used in determining the Octane Number and Cetane Number of petrol and diesel fuels respectively and state the associated Octane and Cetane Numbers for each reference fuel.

[6 Marks]

QUESTION 7

a) How is a generator different from an alternator as a means for electric power generation?

[2 Marks]

b) Give three reasons for the popularity of an alternator for commercial power generation.

[6 Marks]

c) Why is the voltage for power generated at a power station stepped up before being transmitted over a long distance?

[4 Marks]

d) A 230 volts, single phase, 50 Hz induction motor draws a current of 10.6 Amperes with a power factor of 0.60. What size of parallel connected capacitor bank would be required to improve the power factor to 0.97

[8 Marks]

END OF EXAMINATION

By thought, the things you want are brought to you. By action, you receive them.

Unknown

"The highest reward for a person's toil is not what they get for it, but what they become by it."

John Ruskin

UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

UNIVERSITY SEMESTER I EXAMINATIONS – OCTOBER/NOVEMBER 2010

EE209
Principles of Electricity I

Time: Three Hours
All Questions carry equal marks
INSTRUCTIONS:

1. This paper is divided into Section A and Section B.
2. Attempt Five QUESTIONS. Answer at least ONE Question from Section B.
3. Questions from the two Sections should be answered using different answer booklets and submitted separately.

SECTION A

Q1.

a) Find the resistance R_{AB} of the network shown in Fig Q1a. **(4 Marks)**

b) Find the currents in the 30 Ω and 40 Ω Resistors of the circuit shown in Fig Q1b. **(16 Marks)**

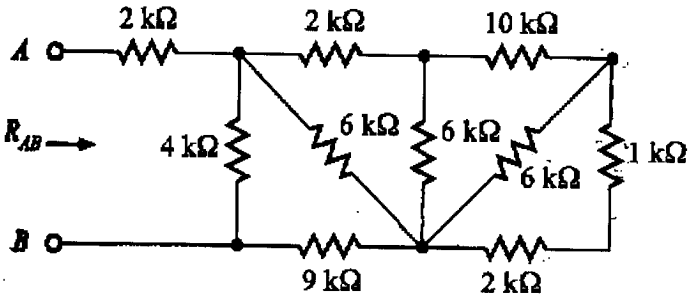


Fig Q1a

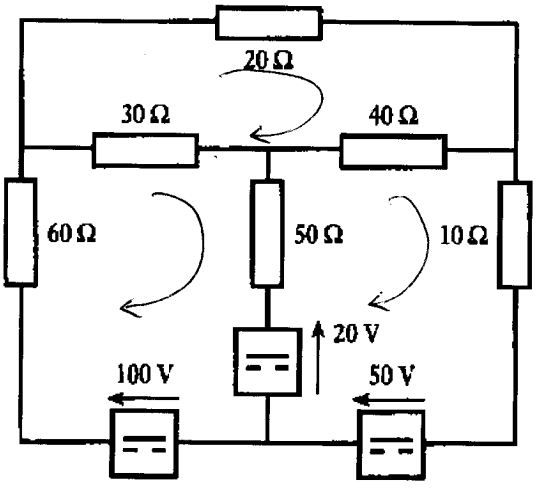


Fig Q1b

Q2.

A Battery Box contains four car batteries with their positive terminals connected together and their negative terminals connected together .Their open circuit voltages and internal resistances are: 12.2 V & 0.5 Ω; 12.2 V & 0.5 Ω; 12.4 V & 0.2 Ω, and 12.4 V & 0.2 Ω.

a) Draw the equivalent circuit of the four batteries connected in parallel. **(2 Marks)**

b) Find V_{Th} and R_{Th} of this Battery Box and draw the corresponding equivalent circuit **(12 Marks)**

c) What would be the load current if 3 x 60 W, 12 V halogen lamps are connected across the output terminals of the Battery Box. Determine the corresponding output power. **(4 Marks)**

Q3.

a) Use the Y-Δ or Δ-Y transformation to find R_T of the network shown in Fig Q3a. **(10 Marks)**

b) Find output voltage V_o of the circuit shown in Fig Q3b **(4 Marks)**

c) Briefly state any three of the following:-

i) The maximum power transfer theorem,

ii) Millman's theorem,

iii) The superposition theorem

iv) Norton's theorem

(6 Marks)

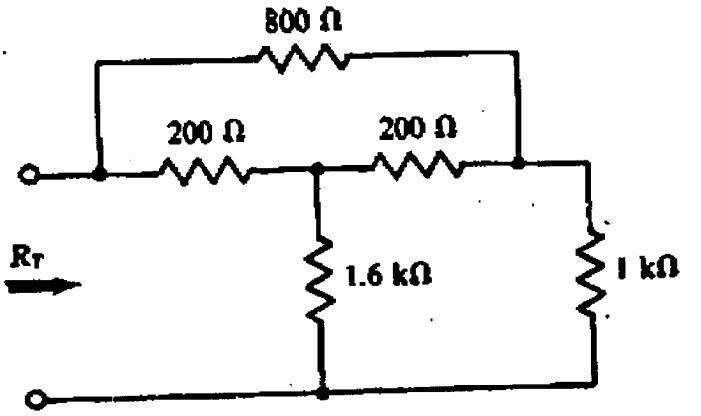


Fig Q3a

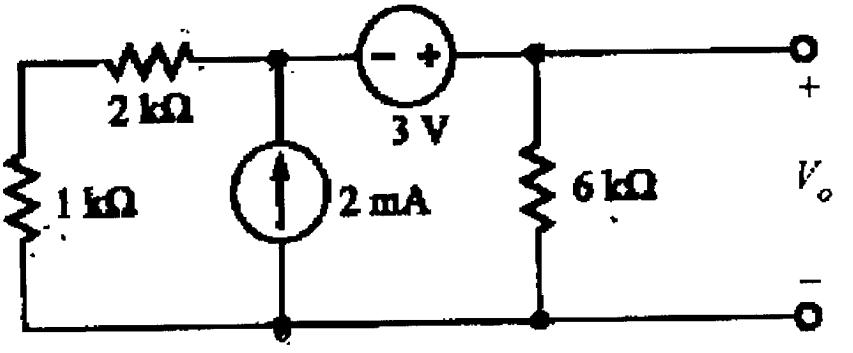


Fig Q3b

Q4.

a) An inductor coil is connected in series with a pure resistor of 10 Ω across a 230 V, 50 Hz supply. The voltage measured across the coil is 180 V, and that across the resistor is 130 V.

i) Draw the circuit diagram showing the various components. **(2 Marks)**

ii) Draw a phasor diagram of the voltages across the resistor and the inductor coil. **(3 Marks)**

iii) Calculate the current drawn from the power supply, the total active power dissipated in the resistive components, and hence or otherwise, the overall power factor. **(1+6+1 Marks)**

b) A 60 kW load operates from an 11 kV, 50 Hz, single phase supply, with 0.6 power factor lagging. Draw the power triangle showing the magnitudes of the various components. Hence or other wise, calculate the capacitor which must be connected in parallel with the load to achieve 0.9 power factor lagging. **(2+5 Marks)**

Q5.

a) Explain why it is possible to have a much higher voltage across a capacitor than the supply voltage in a series R, L and C circuit. What is this condition called? **(9 Marks)**

b) A coil, of resistance R and inductance L, is connected in series with a capacitor C across a variable-frequency source. The voltage is maintained constant at 300 mV and the frequency is varied until a maximum current of 5 mA flows through the circuit at 6 kHz. If, under these conditions, the Q factor of the circuit is 105, calculate:

i) the voltage across the capacitor; **(6 Marks)**

ii) the values of R, L and C. **(5 Marks)**

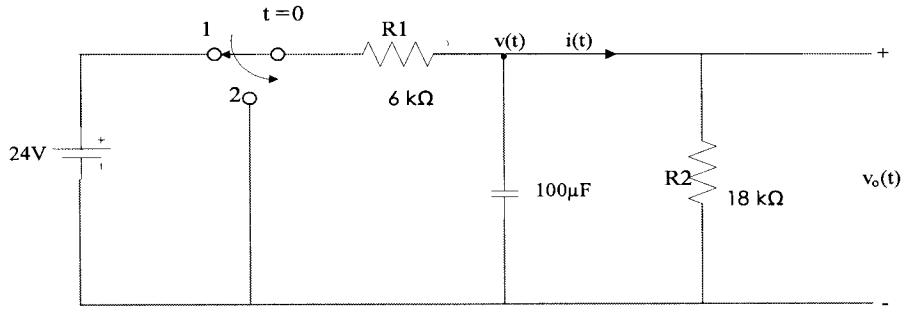
$Q = R\sqrt{\frac{L}{C}}$

SECTION B

Q6.

a) With the aid of a diagram, explain full wave rectification. **(6 Marks)**

b) Consider the circuit shown below;



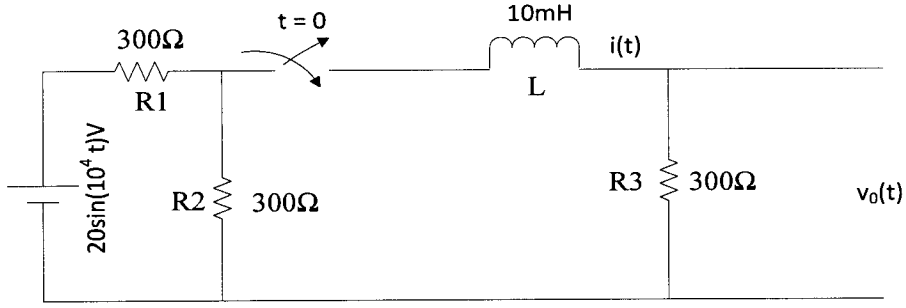
Assuming that the switch has been in position 1 for a long time, calculate the following; given that at time t = 0, the switch is moved to position 2.

i) The voltage $v_o(t)$ for t > 0; **(8 Marks)]**

ii) The current i(t) for t > 0; **(6 Marks)**

Q7.

Consider the circuit shown below; the switch has been in the off position for a long time. At time t = 0, an exponentially decaying source is applied.



Determine;

i) i(t) for t > 0 **(15 Marks)**

ii) $v_0(t)$ for t > 0 **(5 Marks)**

END OF EE209 EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY SEMESTER I EXAMINATIONS NOVEMBER, 2010

EE309

Principles of Electricity II

Time: Three Hours

All Questions carry equal marks

INSTRUCTIONS:

1. This paper is divided into Section A and Section B.
2. Attempt Five QUESTIONS. Answer at least TWO Questions from each Section.
3. Questions from the two Sections should be answered using different answer booklets and submitted separately.

SECTION A: Answer at least two questions

1.

a) Question

i) State ampere's current law; [4]

ii) Calculate the magnetizing force and flux density at a distance of 6cm from a long straight circular conductor carrying a current of 110A and placed in air. [9]

b) Explain in detail the formation of a PN Junction. [7]

2.

a) List the steps necessary for small signal transistor models analysis. [5]

b) Explain the reasons as to why the AND gate is sometimes called a coincidence gate. Give an explanation of the meaning of simultaneity in relation to the AND gate. [7]

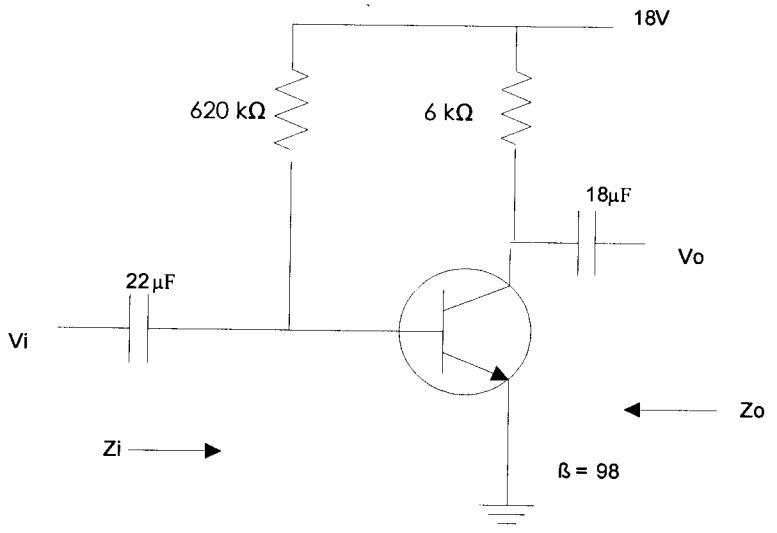
c) Given that $I_E = 3.5mA$, $h_{fe}=140$, $h_{oe}=80\mu S$, $h_{ob}=0.6\mu S$. Determine;

i) The common-emitter hybrid circuit [4]

ii) The common-base r_e model [4]

3.

Given the circuit shown below;



i) Determine the short circuit input impedance h_{ie}; [4]

ii) Find input impedance Z_i, given that $r_o = 600k\Omega$ [3]

iii) Calculate output impedance Z_o given that $r_o = 580k\Omega$; [3]

iv) Determine the voltage gain A_V given that $r_o = 880k\Omega$; [5]

v) Find the current gain A_i given that $r_o = 150k\Omega$ [5]

4.

a) Explain the differences between a donor atom and an acceptor atom. [5]
b) Explain what is meant by the AND gate being associative and commutative. [6]
c) Derive and explain the hybrid parameters for a bipolar transistor in detail. [9]

SECTION B: Answer at least two questions

5.

a) What is the basic application of the d'Arsonal moving coil mechanism or meter movement. [2]
b) The d'Arsonal moving coil mechanism may be represented by an internal resistance in series with a deflecting meter as shown in Fig Q5.
   i) Draw two schematic diagrams to show how this can be connected for an Ammeter and a Voltmeter. [2]
   ii) Draw a schematic diagram to show how current greater than the full scale deflection may be measured. Briefly explain how this is possible. [3]
   iii) Draw a circuit for a four-range Voltmeter including the range corresponding to full scale deflection of the meter movement [4]
c) Sketch a circuit diagram to show how the D'Arsonal meter movement could be used to measure sinusoidal alternating currents. What other modifications would you make to the scale. [4]
d) Explain how the moving iron meter movement responds to the root mean square (rms) value. [5]

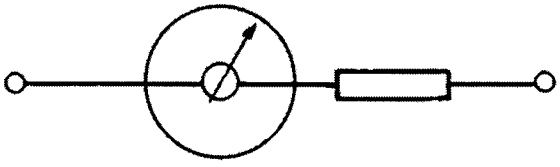


Fig Q5

6.

a) A generator rated at 480V, 60 Hz is connected to a transmission line with an impedance of 0.18+j0.24 Ω. At the end of the transmission line there is a load of 4+j3 Ω. [redacted]

i) Draw the power system equivalent circuit. [2]

ii) Use the generated voltage as reference; calculate the load current, the load voltage and the output power. [7]

iii) Calculate the transmission losses [2]

b) Suppose a 1:10 step-up transformer is placed at the generator end of the transmission line and a 10:1 step-down transformer is placed at the load end of the line. Assume ideal transformers i.e no voltage drops in the windings.

i) Draw the new power system equivalent circuit. [3]

ii) What will the load voltage be? [4]

iii) What will the transmission line losses be? [2]

7.

a) A 100-kVA 400/2000 V single-phase transformer has the following parameters:

$R_1 = 0.01\ \Omega$ $R_2 = 0.25\ \Omega$

$X_1 = 0.03\ \Omega$ $X_2 = 0.75\ \Omega$

$G_c = 2.2\ mS$ $B_m = 6.7\ mS$

Note that G_c and B_m are given in terms of primary reference. The transformer supplies a load of 90 kVA at 2000 V and 0.8 PF leading.

i) Draw the approximate equivalent circuit. [2]

ii) Calculate the primary voltage and current using the approximate equivalent circuit. Use the secondary voltage as reference. [8]

b) What type of motor which is widely used in industry where there is three-phase power supply is available? What is the special feature of this motor? [2]

c) Explain, by one statement, the necessity for using a starter with a d.c. motor. [2]

A 240 V shunt d.c. motor has an armature resistance of 0.2 Ω. Calculate:

i) the resistance which must be introduced into the armature circuit to limit the starting current to 40 A; [3]

ii) the e.m.f. generated when the motor is running at a constant speed with the additional resistance in circuit and with an armature current of 30 A. [3]

END OF EE309 EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY SEMESTER I EXAMINATIONS 10TH NOVEMBER 2010

EE 321
ELECTROMECHANICS AND MACHINES

TIME : *Three (3) hours*

ANSWER : *Any FIVE (5) Questions*

QUESTION 1

(a) Point charges in air are located as follows; +5x 10^{-8} C at (0, 0) metres, +4x10^{-8} C at (3, 0) metres and -6x10^{-8} C at (0, 4) metres. Given that $\varepsilon_0 = 8.854x10^{-12} F/m$;

(i) Find the electric field intensity at (3, 4) metres **[12 Marks]**

(ii) The resultant electric field intensity direction **[2 Marks]**

(b) A current of 15A is passing along a straight wire. Calculate the magnetizing force on a unit magnetic pole placed 0.15 meters from a wire. **[6 Marks]**

QUESTION 2

(a) The pipe shaft at Konkola mine winding room is powered by a 20-hp (14.92kW) 230V, 1150 r.p.m , 4 pole d.c shunt motor which has a total of 620 conductors arranged in two parallel paths and yielding an armature circuit resistance of 0.2Ω. When it delivers rated power at rated speed, it draws a line current of 74.8A and a field current of 3A. Calculate:

(i) The flux per pole, **[2 Marks]**

(ii) The torque developed, **[2 Marks]**

(iii) The rotational(friction) losses, **[3 Marks]**

(iv) Calculate the motor efficiency. **[3 Marks]**

(b) (i) Briefly describe the principle of operation of an induction machine **[5 Marks]**

(iii) Sketch the equivalent circuit of an induction machine **[5 Marks]**

QUESTION 3

A 50 Hz, 3 phase 100km long line delivers a load of 20MVA at 220kV and 0.7 power factor lag. The line constants (line to neutral) are: resistance of 0.09Ω/km, inductive reactance of 0.39Ω/km and capacitive susceptance of 3×10^{-4} Siemens. Find:

(i) Sending-end voltage, **[5 Marks]**

(ii) Sending current, **[5 Marks]**

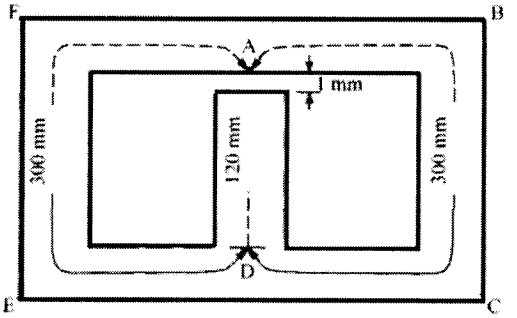
(iii) Sending power factor, **[5 Marks]**

(iv) Efficiency of power transmission. **[5 Marks]**

Use nominal π method.

QUESTION 4

A magnetic circuit made of mild steel is arranged as shown in the figure below. The central limb is wound with 500 turns and has a cross-sectional area of 800mm^2. Each of the outer limbs has a cross-sectional area 500mm^2. The air-gap has a length of 1mm. Assuming no magnetic leakage and fringing. Mild steel required 3800AT/m to produce flux density of 1.625T and 850 AT/m to produce flux density of 1.3T.given that $\mu_0 = 4\pi x10^{-7} H/m$



(i) Calculate the mmf required to set up a flux of 1.3mWb in the central limb. **[5 Marks]**
(ii) Calculate the mmf in the air-gap **[5 Marks]**
(iii) Calculate the total required mmf for the given magnetic circuit **[5 Marks]**
(iv) Calculate the current required to setup a flux of 1.3mWb in the central limb. **[5 Marks]**

QUESTION 5

There has been a complaint on the aluminous level in the Sports Hall tennis court. The standard required luminance level for indoor tennis is 130lx. The tennis hall is 27m × 17m.Assuming that the maintenance factor in each case is 0.8 and that the coefficient of utilization is 0.6. Only two types of lightings are available as indicated below. Calculate the total number of lamps required for each case below:

(i) 150W tungsten-filament lamps at 13 lm/W. **[10 marks]**
(ii) 80W fluorescent lamps at 35 lm/W. **[10 marks]**

QUESTION 6

(a) The School of Engineering Substation supplied by a three phase transformer 11000/550V delta/star, 300kVA core type transformer operates with a flux of 0.05Wb. Determine:
(i) number of H.V and L.V turns per phase, **[6marks]**
(ii) e.m.f per turn, **[2marks]**
(iii) full load H.V and L.V phase-currents. **[6marks]**

(b) Derive and show graphically the maximum flux and e.m.f equation of the transformer **[6 Marks]**

END

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY SEMESTER I EXAMINATIONS NOVEMBER 2010

EE 581
TELECOMMUNICATIONS THEORY

TIME: Three hours.
ANSWER: Five questions – All carry equal marks

Question One

a) Suppose that nonlinear devices are available for which the output current i_c and input voltage v_i are related by

$$i_o = a_1 v_i + a_3 v_i^3$$

Where a1 and a3 are constants. Explain how these devices may be used to provide:

i. A product modulator
ii. An amplitude modulator

[4 marks]

b) Given that $x(t)$ and $A_c \cos \omega_m t$ are inputs to the product modulator that yields an output of $x_c(t) = A_c \cos \omega_m t + x(t) A_c \cos \omega_m t$. Draw the corresponding block diagram of the product modulator, and a schematic diagram that implements this modulator using an analog multiplier and an op-amp summer.

[4 marks]

c) A DSB-SC signal can be obtained by using a Balanced modulator. Using the theory in (a); draw a block diagram of how this is implemented.

[4 marks]

d) A DSB-SC modulated signal is modulated by applying it to a coherent detector.

i. Evaluate the effect of frequency error Δf in the local carrier frequency of the detector, measured with respect to the carrier frequency of the incoming DSB-SC signal.

[3 marks]

ii. For the case of a sinusoidal modulating wave, show that because of this frequency error, the demodulated signal exhibits beats of the error frequency. Illustrate your answer with a sketch of the demodulated signal.

[5 marks]

Question Two

a) Verify the relationship of C_n and ϕ_n to A_n and B_n as given by the equations below:

$C_0 = A_0$, $C_n = \sqrt{A_n^2 + B_n^2}$, and $\phi_n = \tan^{-1}\frac{B_n}{A_n}$.

[2 marks]

b) Calculate C_n, ϕ_n, A_n and B_n for the waveform $v(t)$ which is symmetrical square wave and which makes peak excursions to $+\frac{3}{4}$ volt and $-\frac{1}{4}$ volt, and has a period of T=1sec. A positive going transition occurs at $t = 0$.

[4 marks]

c) A certain computer becomes inoperable if two components C_A and C_B both fail. The probability that C_A fails is 0.01 and the probability that C_B fails is 0.005. However, the probability that C_B fails is increased by a factor of 4 if C_A has failed. Calculate the probability that the computer becomes inoperable. Also find the probability that C_A fails if C_B has failed.

[4 marks]

d) Twenty-four voice signals are sampled uniformly and then time-division multiplexed. The sampling operation uses-flat top samples with 1μs duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of sufficient amplitude and also 1μs duration. The highest frequency component of each voice signal is 3.4kHz.

i. Assuming a sampling rate of 8kHz, calculate the spacing between successive pulses of the multiplexed signal.

ii. Repeat your calculation assuming the use of Nyquist rate sampling.

[6 marks]

e) Two dice are tossed.

i. Find the probability of 3 and 4 appearing.

ii. Find the probability of a 7 being rolled.

[4 marks]

Question Three

a) Describe, by aid of diagrams, the process of Amplitude modulation for the following cases;

i. Percentage modulation less than 100

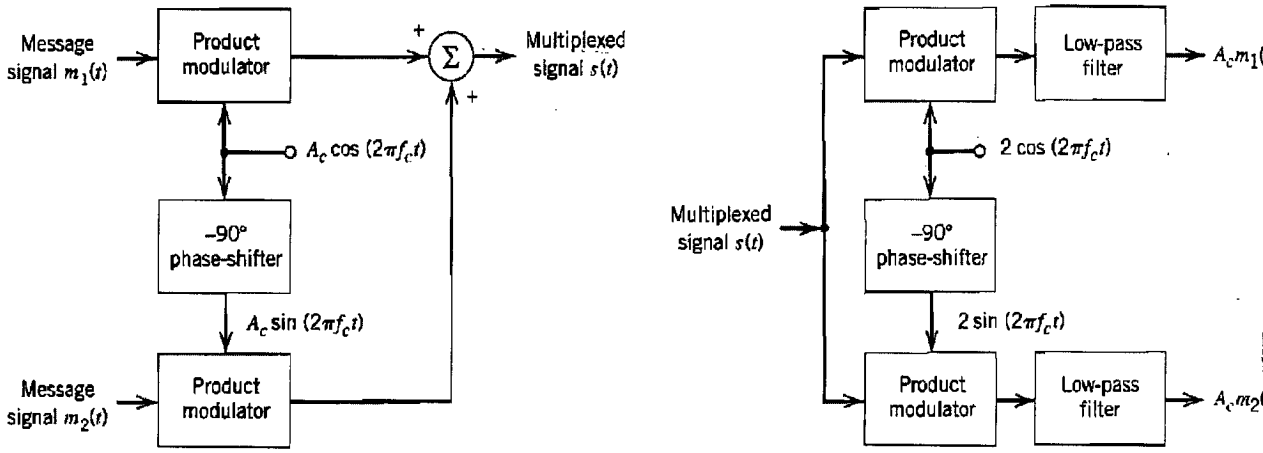
ii. Percentage modulation greater than 100.

[4 marks]

b) Consider the quadrature-carrier multiplex system below. The multiplexed signal s(t) produced at the transmitter output is applied to a communication channel of frequency response H(f). The output of this channel is, in turn, applied to the receiver input. Prove that the condition

$H(f_c - f) = H^*(f_c - f), \quad 0 \le f \le W$

...is necessary for recovery of the message signals $m_1(t)$ and $m_2(t)$ at the receiver outputs; f_c is the carrier frequency, and W is the message bandwidth. Hint: Evaluate the spectra of the two receiver outputs.



[6 marks]

c) Suppose that in the receiver of the quadrature-carrier multiplex system above (in a.) the local carrier available for demodulation has a phase error ϕ with respect to the carrier source used in the transmitter. Assuming a distortion-less communication channel between transmitter and receiver, show that this phase error will cause cross-talk to arise between the two demodulated signals at the receiver outputs. By cross-talk we mean that a portion of one message signal appears at the receiver output belonging to the other message signal, and vice versa.

[4 marks]

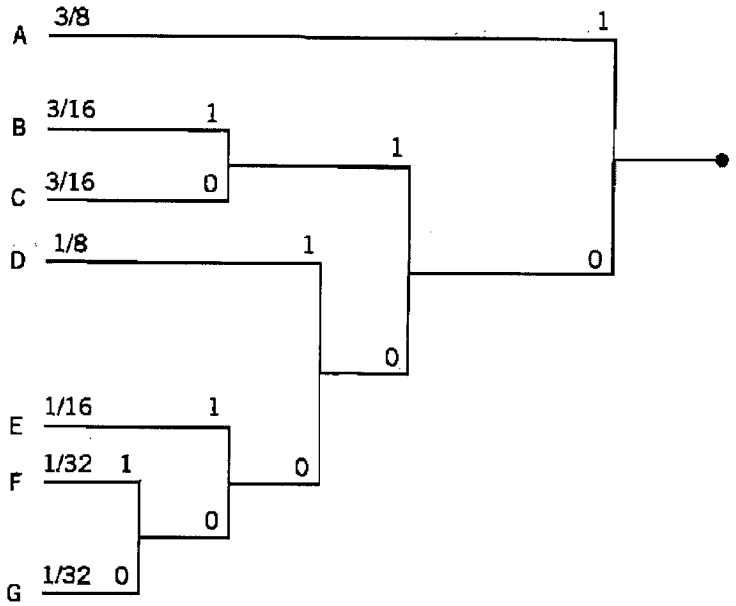
d) One method of obtaining a practical synchronous receiver_system, suitable for demodulating DSB-SC waves, is to use the costas receiver. Draw a block diagram of a costas receiver and briefly explain it's operation. **[6 marks]**

Question Four

a) What is data compaction?

[2 marks]

b) The figure below shows a Huffman tree. What is the code word for each of the symbols A, B, C, D, E, F, and G represented in this Huffman tree? What are their individual code word lengths?



[7 marks]

c) A discrete memoryless source has an alphabet of seven symbols whose probabilities of occurrence are as given below:

Symbol	s_0	s_1	s_2	s_3	s_4	s_5	s_6
Probability	0.25	0.25	0.125	0.125	0.125	0.0625	0.0625

Compute the Huffman code for this source, moving a "combined" symbol as high as possible. Explain why the computed source code has an efficiency of 100 percent.

[6 marks]

d) Consider the following binary sequence

1110100110001011010 0...

Use the Lempel-Ziv algorithm to encode this sequence. Assume that the binary 0 and 1 are already in the codebook.

[5 marks]

Question Five

a) What is the purpose of a communication system? **[2 marks]**

b) A PAM telemetry system involves the multiplexing of four input signals $s_i(t), i = 1,2,3,4$. Two of the signals $s_1(t)$ and $s_2(t)$ have bandwidths of 80Hz each, whereas the remaining two signals $s_3(t)$ and $s_4(t)$ have bandwidths of 1kHz each. The signals $s_3(t)$ and $s_4(t)$ are each sampled at 2400 samples per second. The sampling rate is divided by 2^R (i.e., an integer power of 2) to derive the sampling rate for $s_1(t)$ and $s_2(t)$.

i. Find the maximum value of R.

ii. Using the value of R found in part (i), design a multiplexing system that first multiplexes $s_1(t)$ and $s_2(t)$ into a new sequence, $s_5(t)$, and then multiplexes $s_3(t)$ and $s_4(t)$, ad $s_5(t)$.

[6 marks]

c) A voice-grade channel of the telephone network has a bandwidth of 3.4kHz.

i. Calculate the information capacity of the telephone channel for a signal-to-noise ratio of 30dB. **[2 marks]**

ii. Calculate the minimum signal-to-noise required to support information transmission through the telephone channel at the rate of 9600b/s.

[2 marks]

d) A source emits one of four possible symbols during each signalling interval. The symbols occur with the probabilities:

$$p_0 = 0.1$$
$$p_1 = 0.2$$
$$p_2 = 0.3$$
$$p_3 = 0.4$$

Find the amount of information gained by observing the source emitting each of these symbols.

[4 marks]

e) A source emits one of four symbols s_0, s_1, s_2, and s_3 with probabilities 1/3, 1/6, ¼, and ¼, respectively. The successive symbols emitted by the source are statistically independent. Calculate the entropy of the source.

[4 marks]

Question Six

a) Let p denote the probability of some event. Plot the amount of information by the occurrence of this event for $0 \leq p \leq 1$. **[3 marks]**

b) Given the data stream 1110010100, sketch the transmitted sequence of pulses for each of the following line codes:

i. Unipolar non return-to-zero

ii. Polar nonreturn-to-zero

iii. Unipolar return-to-zero

iv. Bipolar return-to-zero

v. Manchester code

[5 marks]

c) Suppose the binary stream considered in (b) is differentially encoded and then transmitted using one of the five line codes considered therein. Sketch each of the transmitted data streams, assuming the use of symbol 1 for the reference bit. How is the result affected if symbol 0 is used for the reference it?

[6 marks]

d) Consider a discrete memoryless source whose alphabet consists of K equiprobable symbols.

i. Explain why the use of a fixed-length code for the representation of such a source is about as efficient as any code can be.

ii. What conditions have to be satisfied by K and the code-word length for the coding efficiency to be 100 percent?

[6 marks]

Question Seven

a) Consider the (31, 15) Reed-Solomon code.

i. How many bits are there in a symbol of the code?

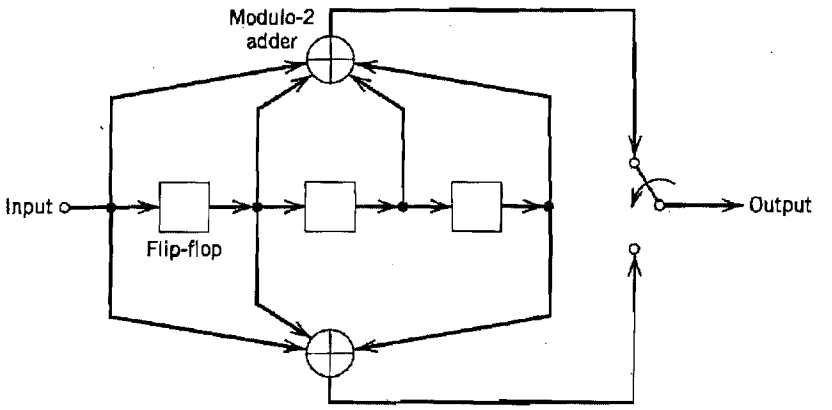
ii. What is the block length in bits?

iii. What is the minimum distance of the code?

iv. How many symbols in error can the code correct?

[8 marks]

b) The figure below shows the encoder for a rate r=1/2, constraint length K=4 convolutional code. Determine the encoder output produced by the message sequence 10111.



[4 marks]

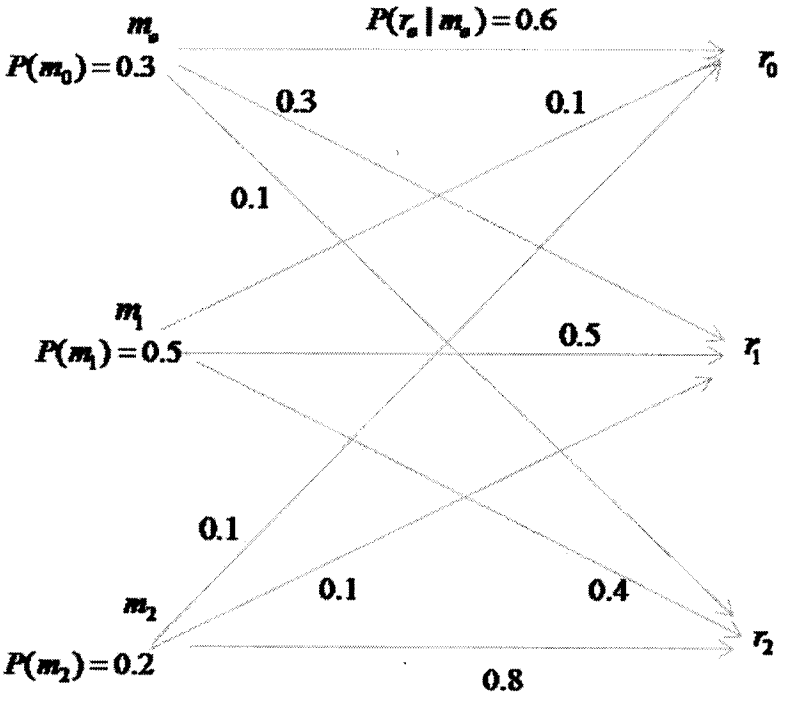
c) Construct the code tree for the encoder above (in b). Trace the path through the tree that corresponds to the message sequence 10111. Compare the resulting encoder output with that found in (b) above. **[4 marks]**

d) Construct the trellis diagram for the encoder in (b), assuming a message sequence of length 5. Trace the path through the trellis corresponding to the message 10111. Compare the resulting encoder output with that found in (b).

[4 marks]

Question Eight

a) For the channel of message probabilities given in the figure below, determine the best decision about the transmitted message for each possible received response. **[6 marks]**



b) With decisions made in (a), Calculate the probability of error. **[6 marks]**

c) Suppose the decision-making apparatus at the receiver were inoperative so that at the receiver nothing could be determined except that a message had been received. What would be the best strategy for determining what message had been transmitted and what would be the corresponding probability? **[6 marks]**

d) What are the virtues, and limitations, of Amplitude modulation? **[2 marks]**

End of Exam. All the best!!!

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

2010-2011 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

EG 211: ENGINEERING WORKSHOP TECHNOLOGY

TIME: THREE (3) HOURS

INSTRUCTIONS:

1. This examination is Closed Book
2. Calculators are permitted
3. Time allowed is Three (3) Hours
4. ANSWER: ALL Five (5) questions
5. Show all the work leading to the solution
6. The Sections should be answered in separate booklets

SECTION A

QUESTION 1

(a) (i) State one of the goals of engineering in agriculture.

(ii) Use a diagram to show the three classes of soil water in reference to its availability to plants.

(iii) Why is hygroscopic water not available for plant growth?

[4 Marks]

(b) A soil sample from the irrigated zone of UNZA farm was collected with a cylindrical core-ring having the following dimensions:

- Diameter = 50 mm
- Height = 100 mm
- Mass of wet soil sample = 331.8 g
- Mass of an oven dried sample at 105 ^{0}C = 302.4 g

Use the above soil parameters to calculate:

(i) the bulk density of the soil

(ii) the volumetric moisture content of the soil.

[6 Marks]

(c) Given the following data for the soil profile of an irrigated farm which consists of two horizons:

Horizon	A	B
Thickness of horizon, cm	30	90
Bulk density, g/cm^3	1.15	1.35
Mass basis moisture content (%)		
Wilting point	10	25
Field capacity	28	38
Saturation	40	47
Initial volumetric moisture content, (%)	15	35

(i) Calculate the amounts of hygroscopic water, plant available water and gravitational water for each horizon.

[3 Marks]

(ii) Plot the resultant moisture content of the soil profile after 16.57 cm of water is added by irrigation. Assume that the A-B horizon interface does not impede the flow of water from the A horizon to B horizon.

[7 Marks]

SECTION B

QUESTION 2

1. Briefly define the following terms:

(a) (i) Beam

(ii) Column

(iii) Slab

[3 Marks]

(b) Name and briefly explain three (3) good practice standards that need to be followed when selecting aggregates for good concrete.

[6 Marks]

(c). State and briefly explain three types of roof based on span sizes.

[3 Marks]

(d). State in correct order, the stages followed to produce a house from architectural stage to the end product. Explain briefly the responsibilities of every stage.

[8 Marks]

SECTION C

QUESTION 3

(i) State the factor affecting resistance of the material. **[1 Marks]**

(ii) An 8 mm^2 house wiring conductor of length 10 metres was found to be 16 Ohms, what would be the resistance of the same conductor if the cross section area was reduced to 3mm^2? **[3 Marks]**

(iii) State three recommendations in selecting of switches and outlets in residential wiring. **[3 Mark]**

(iv) State the principle of operation of a miniature circuit breaker. **[2 Marks]**

(v) Briefly state the types of classification of cables and name the cable structure. **[3 Marks]**

(vi) Describe what is meant by electrical shock and its treatment **[3 Marks]**

(vii) State any three general rules of electrical safety **[3 Marks]**

(viii) State the sources of electrical hazards **[2 Marks]**

SECTION D

QUESTION 4

(i) List any four Disciplines of Geomatic Engineering

[4 Marks]

(ii) Define any two other disciplines of Geomatics other than the ones listed in (i) above

[4 Marks]

(iii) Enumerate (spell out) the overlaps that exist between Engineering and Hydrographic classifications of surveys

[6 Marks]

(iv) Two corners ***A*** and ***B*** of a proposed building ***ABCD*** are to be set out from two control points ***P*** and ***Q***.

[6 Marks]

Table 1.

	Coordinates	
Point	*m E*	*m N*
A	591.370	606.220
B	621.370	606.220
P	637.830	621.180
Q	583.150	619.230

Compute the bearing *PA* and distance *QG*

SECTION E

QUESTION 5.

(i) List three situations in which the casting operation is the preferred fabrication technique from other manufacturing processes. **[3 Marks]**

(ii) Fig. S1 shows a schematic illustration of a sand mold showing various features. Fill in the parts. What are the functions of parts (C) and (L). **[9 Marks]**

(iii) Define milling and with the aid of a well labelled diagram, describe two basic types of milling. **[4 Marks]**

(iv) What is turning? With the aid of a well labelled diagram describe the primary and secondary motions in the turning operation. **[4 Marks]**

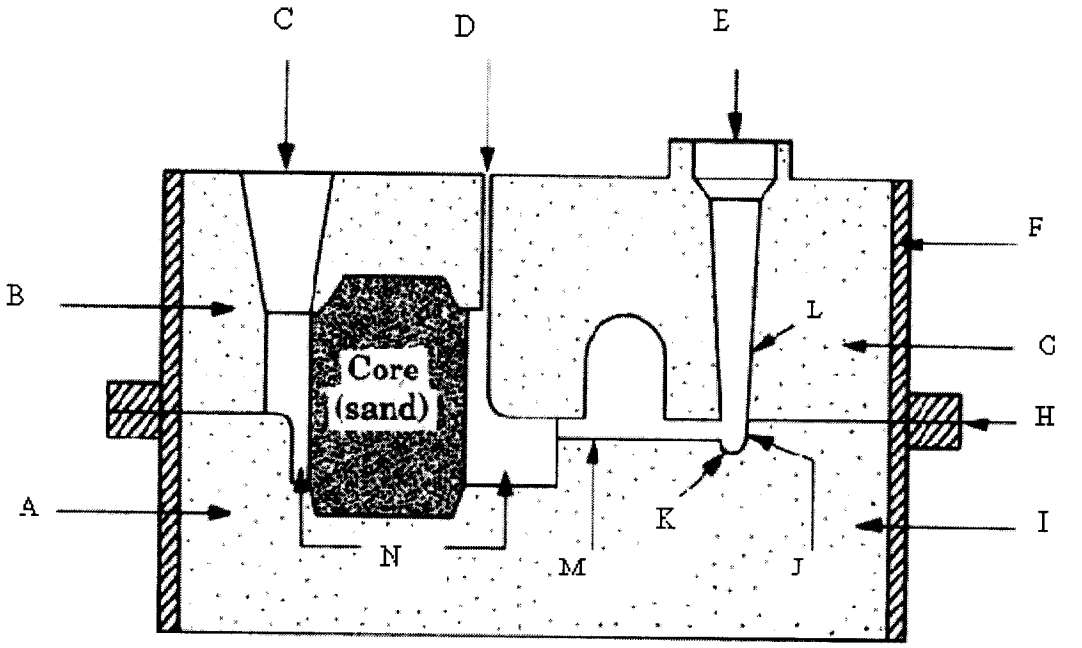


Fig. S1

END OF EG 211 FINAL EXAMINATION

UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATIONS
OCTOBER 2010

EM211 - ENGINEERING MATHEMATICS I

INSTRUCTIONS:

1. Answer any FIVE (5) questions
2. **Show all your work to earn full credit**
3. Use of calculators **NOT PERMITTED**

TIME ALLOWED: **Three (3) hours**

---

[1] (a) Given $4X^2 + 2Y^2 + 8X + 8Y - 8 = 0$

(i) Reduce the conic into canonical form

(ii) Find the vertices

(iii) Find the eccentricity

(iv) Find the foci

(v) Find the directrices

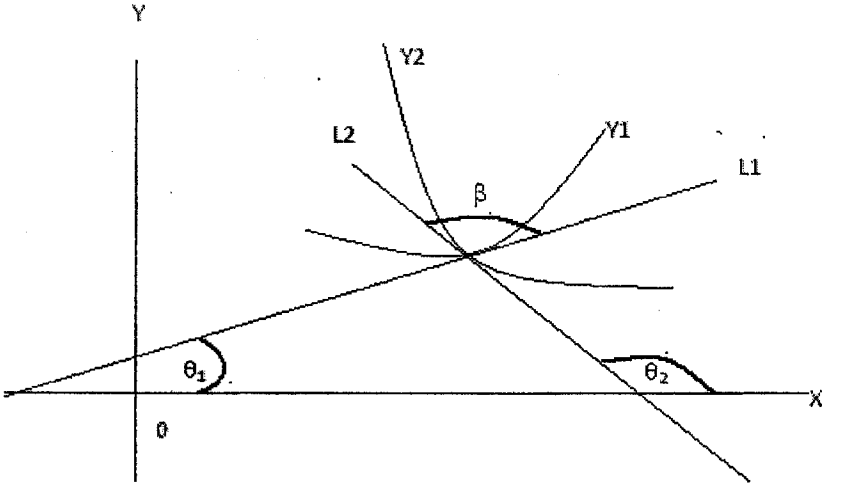
(b) Given $Y = X^2 + AX + B$ and $Y = CX - X^2$

(i) Determine the constants A, B and C so that the two curves will have a common tangent at (1, 3)

(ii) Find the equation of the tangent at (1, 3)

(iii) Find the equation of the normal at (1, 3)

[2] (a) If β is the angle between the two curves Y1 and Y2 as shown below.



(i) Show that $\text{Tan}\beta = \dfrac{\frac{dY2}{dx} - \frac{dY1}{dx}}{1+\frac{dY1}{dx}\times\frac{dY1}{dx}}$

(ii) Hence, find the angle between the curves represented by $X^2 + XY + Y^2 = a$ and $Y = 2X$.

(b) Given $r = \dfrac{12}{2+\text{Sin}\theta}$

(i) Describe the conic.

(ii) if $X = r\text{Cos}\theta$ and $Y = r\text{Sin}\theta$ express the conic in standard form in terms of X and Y

(iii) Find the center.

(iv) Find the foci.

[3] (a) (i) Find the partial sum of $\sum_{n=1}^{\infty} \frac{1}{n(n+1)}$

(ii) Find the sum of the series $\sum_{n=1}^{\infty} \frac{1}{n(n+1)}$

(iii) State the comparison test.

(iv) Show that $\sum_{n=0}^{\infty} \frac{1}{2^n+1}$ converges.

(b) (i) State Leibnitz's theorem.

(ii) Use Leibnitz's theorem to determine the general expression of D^nY in terms of X, where $Y = 2^X$ and D^n is the nth derivative.

(iii) Hence, or otherwise write down the Taylor series for $Y = 2^X$ about $X = 0$.

[4] (a) Given the two intersecting lines $\frac{x}{2} = \frac{y-2}{3} = \frac{z-1}{1}$ and $\frac{x}{1} = \frac{y-2}{-1} = \frac{z-1}{1}$

(i) Find the point of intersection

(ii) Find the equation of the plane containing the two lines.

(iii) Find the equation of a line perpendicular to the plane passing through the point of intersection.

(b) (i) If $aX + bY + cZ + d = 0$ is an equation of a plane and (x_0, y_0, z_0) is a point, prove that the distance of this point to the plane is given by.

$$\frac{|ax_0 + by_0 + cz_0 + d|}{\sqrt{a^2 + b^2 + c^2}}$$

(ii) Find the distance of the point (1, 1, 1) to the plane $2X - Y + Z - 8 = 0$

(iii) Find the distance of the point (1, 1, 1) to the line through (-1, 1, 0) and (1, 2, -1).

[5] (a) A curve is given by the parametric equations; $X = \frac{1}{2}t^2 + t$ and $Y = \frac{1}{2}t^2 - t$

(i) Express t in terms of X and Y

(ii) Express t^2 in terms of X and Y

(iii) Using (i) and (ii) show that the curve is $X^2 - 2XY + Y^2 - 4X - 4Y = 0$.

(b) (i) By a rotational of axes express the second degree equation in (a)(iii) in standard form

(ii) Identify the conic in b(i).

(iii) Sketch the conic in b(i) showing the new and old axes.

[6] (a) Given $\mathbf{R}(t) = a(\cos t + t \sin t)\mathbf{i} + a(\sin t - t \cos t)\mathbf{j}$

(i) Find a normal vector in the direction of $\mathbf{R}(t)$

(ii) Find $\frac{d\mathbf{R}(t)}{dt}$

(iii) Find the length of the arc from t = 0 to $t = \frac{\pi}{3}$

(b) Given $r = 2(1 + \cos\theta)$

(i) Mention one line of symmetry and verify

(ii) Sketch the graph of $r(\theta)$, i.e., the curve r.

(iii) Given that the length of an arc for $r(\theta)$ is given by $\int \sqrt{\left(\frac{dr}{d\theta}\right)^2 + r^2}\, d\theta$, determine the length of r.

END OF EXAMINATION

The University of Zambia

Department of Mathematics & Statistics

First Semester Examinations - 5th November 2010

EM311 - Engineering Mathematics III

Time allowed : Three (3) hrs Full marks : 100

Instructions:
- There are **six (6)** questions in this paper. Attempt **any five (5)** questions. All questions carry **equal** marks.
- **Full credit** will only be given when **detailed** is shown.
- Indicate your **computer number** on all answer booklets.
- **Calculators** are **not** allowed.

---

1. a) Find

   i) $\mathcal{L}\{e^{2t}\cosh 9t\}$;

   ii) $\mathcal{L}^{-1}\{\frac{4}{s^2}+\frac{3s+2}{s^2+9}\}$.

   b) i) Rewrite the following function in terms of the Heaviside step function

$$f(t)=\begin{cases}3t-t^2, & \text{if } 0<t<3\\ 0, & \text{elsewhere}\end{cases};$$

   ii) Find its Laplace transform.

   c) Solve the initial value problem using Laplace transforms

$$y''+4y=-2\delta(t-\frac{\pi}{4});\ y(0)=2, y'(0)=0.$$

2. a) i) Find $\mathcal{L}^{-1}\{\frac{s+4}{s^2-4s+13}\}$.

   ii) Solve the Euler equation

$$t^4x^{(4)}+4t^3x^{(3)}+t^2x''+tx'-x=0\ [\text{for } t>0].$$

b) Express

$$f(t) = \begin{cases} 3t^2, & \text{if } 0 \leq t < 2\pi \\ 3t^2 + \sin t, & \text{if } t \geq 2\pi \end{cases}$$

in terms of the Heaviside step function.

c) i) Solve the following system by Laplace Transform method

$$\begin{aligned} x' + 2x + y &= e^t \\ y' - x &= 0; \end{aligned}$$

with initial conditions $x(0) = y(0) = 0$.

ii) Solve the convolution equation $\int_0^t \cos(t-\tau)x(\tau)d\tau = t - t^2$.

3. a) Find

i) $\mathcal{L}\{\frac{1-e^t}{t}\}$;

ii) $\mathcal{L}^{-1}\{\frac{(\sqrt{s}-1)^2}{s^2}\}$.

b) Show that

$$\int_0^\infty \frac{e^{-3t} - e^{-6t}}{t} dt = \ln(\frac{s+3}{s}).$$

c) Given that $y_1 = ct^3$ is a solution to the equation $ty'' - (t+2)y' + 3y = 0$; $t > 0$. Show, by reduction of order, that the general solution to this equation is $y = ct^3 + bt^3 \int \frac{e^t}{t^4} dt$.

4. (a)(i) If $g(x)$ is any function, defined for all x, prove that the function

$$p(x) = \frac{1}{2}[g(x) + g(-x)]$$

is even.

(ii) Sketch the graph of $f(x) = 1 + e^{-|x|}$ for $x \in (-\pi, \pi)$ and determine whether the function is even, odd, or neither even nor odd.

(b)(i) Sketch the graph of

$$f(x) = \begin{cases} \sin x, & 0 \leq x \leq \pi \\ 0, & \pi \leq x \leq 2\pi. \end{cases}$$

(ii) Given that $a_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\cos nx dx$, $b_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\sin nx dx$ for $n \geq 1$, first find a_1 and b_1, and consequently find the Fourier series expansion of the function $f(x)$ defined in part (i).

(iii) Using the Fourier series expansion in part (ii), deduce that

$$\frac{\pi}{2} - 1 = 2(\frac{1}{1(3)} - \frac{1}{3(5)} + \frac{1}{5(7)} - \frac{1}{7(9)} + \ldots\ldots).$$

(c) Find the Fourier integral representation of

$$f(x) = \begin{cases} 0, & -\infty < x < 0 \\ 1, & 0 < x < 1 \\ 0, & 1 < x < \infty. \end{cases}$$

5. (a) Show that the Fourier transform of

$$f(x) = \begin{cases} e^{2ix}, & -1 < x < 1 \\ 0, & \text{otherwise.} \end{cases}$$

is given by

$$\hat{f}(w) = \frac{2\sin(2-w)}{2-w}.$$

(b) Let $\hat{f}(w) = [H(w+\pi) - H(w-\pi)]e^w$.

(i) Sketch the graph of $\hat{f}(w)$.

(ii) Find $\mathcal{F}^{-1}\{\hat{f}(w)\}$.

(c) Verify that

$$u(x,y) = \tan^{-1}(\frac{y}{x})$$

is a solution of Laplace's equation $u_{xx} + u_{yy} = 0$.

6. (a)(i) Verify that $u(x,t) = e^{-w^2c^2t}\sin wx$ is a solution of the heat equation $u_t = c^2u_{xx}$.

(ii) Verify that the partial differential equation

$$u_x + u_y = 2(x+y)u$$

is variable separable.

(b) Use the Laplace transform method to solve the partial differential equation

$$u_x + 2xu_t = 2x$$

given that $u(x,0) = 1$ and $u(0,t) = 1$.

(c) Given that

$$\hat{g}(w) = \mathcal{F}\{e^{-4x^2}\} = \frac{\sqrt{\pi}}{2}e^{\frac{-w^2}{16}},$$

find $\hat{f}(w) = \mathcal{F}\{xe^{-4x^2}\}$.

END OF EXAMINATION!

The University of Zambia

Department of Mathematics & Statistics

First Semester Examinations - November 2009

EM411 - Engineering Mathematics V

Time allowed : Three (3) hrs Full marks : 100

Instructions:
- Attempt **any five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.
- Indicate your **computer number** on all answer booklets.

This paper consists of 3 pages of questions.

---

1. a) Write an algorithm to find a solution to $f(x) = 0$ by the Bisection Method, where the function f is continuous on the interval $[a, b]$ and f cuts the x-axis.

   b) Use the algorithm in part (a) to find an approximation to $x - \sin x - 1 = 0$, to within 10^{-3}. Show graphically that a solution exists in the interval $[\frac{\pi}{2}, \pi]$. Find a bound for the number of iterations needed to achieve the required accuracy for this interval.

2. The following data has been experimentally collected:-

x	0.2	0.4	0.6	0.8	1.0
$f(x)$	0.9798652	0.9177710	0.8080348	0.6386093	0.3843735

   a) Approximate $f(0.25)$ using the Newton Forward Divided-Difference formula.

   b) Use the 3-point formulae to approximate $f'(0.2)$, $f'(0.4)$ and $f'(0.6)$.

3. a) Derive the Newton-Raphson formula for finding a root of the equation $f(x) = 0$.

   b) Use the Newton-Raphson method to approximate, to within 10^{-4}, the value of x that produces the point on the graph of $y = x^2$ that is closest to $(1, 0)$.

4. a) Determine the values of n and h required to approximate $\int_0^{\pi} \sin x \, dx$ with an absolute error less than 2×10^{-5} using the Composite Simpson rule. Error is given by

$$\frac{b-a}{180} h^4 f^{(4)}(\mu) \ .$$

b) (i) Given the function f at the following values

x	1.8	2.0	2.2	2.4	2.6
$f(x)$	3.12014	4.42569	6.04241	8.03014	10.46675 ,

use the Composite Simpson rule to approximate the area bounded by the curve, the x-axis and the end points.

(ii) The arc length of the graph of a function g on $[a, b]$ is given by the integral

$$L = \int_a^b \left(1 + (g'(x))^2\right)^{\frac{1}{2}} dx \ .$$

Compute the arc length of the graph $g(x) = \tan x$ on $[0, \frac{\pi}{4}]$ using the Trapezoidal rule over 5 intervals.

5. Consider the following Runge-Kutta method for the differential equation $y = f(x, y)$:-

$$\begin{aligned} y_{n+1} &= y_n + \frac{1}{6}(k_1 + 4k_2 + k_3) \\ k_1 &= hf(x_n, y_n) \\ k_2 &= hf\left(x_n + \frac{h}{2}, y_n + \frac{k_1}{2}\right) \\ k_3 &= hf(x_n + h, y_n - k_1 + 2k_2) \end{aligned}$$

a) Compute $y(0.4)$ when

$$y' = \frac{y+x}{y-x} \ , \qquad y(0) = 1 \ ,$$

and $h = 0.2$. Round to five decimal places.

b) Using the given RK formula, what is the result after one step of length h when $y' = -y$, $y(0) = 1$.

6. a) Let

$$A = \begin{pmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 2 \end{pmatrix}$$

(i) Determine the region containing the eigenvalues of A.

(ii) Find the spectral radius of A.

b) Use the Jacobi Method to solve the linear system

$$\begin{aligned} 10x_1 - x_2 &= 9 \\ -x_1 + 10x_2 - 2x_3 &= 7 \\ -2x_2 + 10x_3 &= 6 \end{aligned}$$

with $tol = 10^{-3}$ in the l_∞ norm. The initial approximation is $\mathbf{x}^{(0)} = \mathbf{0}$.

7. a) The table below gives the temperatures (°C) and resistance R (ohms) obtained from an experiment to determine the effects of temperature on resistance. If $R = aT + b$, find the values of a and b that best fit the data.

T,° C	R, ohms
20.5	765
32.7	826
51.0	873
73.2	942
95.7	1032

b) Apply Taylor's method of order four (4) to approximate the value of y at $t = 0.6$, where y is the solution of the initial value problem

$$y' = y - t^2 + 1\,, \qquad 0 \le t \le 1\,, \qquad y(0) = 0.5\,,$$

using stepsize $h = 0.2$.

END!

The University of Zambia
Department of Mathematics & Statistics
First Semester Examinations - November 2009
EM411 - Engineering Mathematics V

Time allowed : Three (3) hrs Full marks : 100

Instructions:
- Attempt **any five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.
- Indicate your **computer number** on all answer booklets.

This paper consists of 3 pages of questions.

---

1. a) Write an algorithm to find a solution to $f(x) = 0$ by the Bisection Method, where the function f is continuous on the interval $[a, b]$ and f cuts the x-axis.

   b) Use the algorithm in part (a) to find an approximation to $x - \sin x - 1 = 0$, to within 10^{-3}. Show graphically that a solution exists in the interval $[\frac{\pi}{2}, \pi]$. Find a bound for the number of iterations needed to achieve the required accuracy for this interval.

2. The following data has been experimentally collected:-

x	0.2	0.4	0.6	0.8	1.0
$f(x)$	0.9798652	0.9177710	0.8080348	0.6386093	0.3843735

   a) Approximate $f(0.25)$ using the Newton Forward Divided-Difference formula.

   b) Use the 3-point formulae to approximate $f'(0.2)$, $f'(0.4)$ and $f'(0.6)$.

3. a) Derive the Newton-Raphson formula for finding a root of the equation $f(x) = 0$.

   b) Use the Newton-Raphson method to approximate, to within 10^{-4}, the value of x that produces the point on the graph of $y = x^2$ that is closest to $(1, 0)$.

4. a) Determine the values of n and h required to approximate $\int_0^{\pi} \sin x \, dx$ with an absolute error less than 2×10^{-5} using the Composite Simpson rule. Error is given by

$$\frac{b-a}{180} h^4 f^{(4)}(\mu) \, .$$

b) (i) Given the function f at the following values

x	1.8	2.0	2.2	2.4	2.6
$f(x)$	3.12014	4.42569	6.04241	8.03014	10.46675 ,

use the Composite Simpson rule to approximate the area bounded by the curve, the x-axis and the end points.

(ii) The arc length of the graph of a function g on $[a, b]$ is given by the integral

$$L = \int_a^b \left(1 + (g'(x))^2\right)^{\frac{1}{2}} dx \, .$$

Compute the arc length of the graph $g(x) = \tan x$ on $[0, \frac{\pi}{4}]$ using the Trapezoidal rule over 5 intervals.

5. Consider the following Runge-Kutta method for the differential equation $y' = f(x, y)$:-

$$\begin{aligned} y_{n+1} &= y_n + \frac{1}{6}(k_1 + 4k_2 + k_3) \\ k_1 &= hf(x_n, y_n) \\ k_2 &= hf\left(x_n + \frac{h}{2}, y_n + \frac{k_1}{2}\right) \\ k_3 &= hf(x_n + h, y_n - k_1 + 2k_2) \end{aligned}$$

a) Compute $y(0.4)$ when

$$y' = \frac{y+x}{y-x} \, , \qquad y(0) = 1 \, ,$$

and $h = 0.2$. Round to five decimal places.

b) Using the given RK formula, what is the result after one step of length h when $y' = -y$, $y(0) = 1$.

6. a) Let

$$A = \begin{pmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 2 \end{pmatrix}$$

(i) Determine the region containing the eigenvalues of A.

(ii) Find the spectral radius of A.

b) Use the Jacobi Method to solve the linear system

$$\begin{aligned} 10x_1 - x_2 &= 9 \\ -x_1 + 10x_2 - 2x_3 &= 7 \\ -2x_2 + 10x_3 &= 6 \end{aligned}$$

with $tol = 10^{-3}$ in the l_∞ norm. The initial approximation is $\mathbf{x}^{(0)} = \mathbf{0}$.

7. a) The table below gives the temperatures (°C) and resistance R (ohms) obtained from an experiment to determine the effects of temperature on resistance. If $R = aT + b$, find the values of a and b that best fit the data.

T,° C	R, ohms
20.5	765
32.7	826
51.0	873
73.2	942
95.7	1032

b) Apply Taylor's method of order four (4) to approximate the value of y at $t = 0.6$, where y is the solution of the initial value problem

$$y' = y - t^2 + 1\,, \qquad 0 \le t \le 1\,, \qquad y(0) = 0.5\,,$$

using stepsize $h = 0.2$.

END!

The University of Zambia
School of engineering
Department of Geomatic Engineering

University Examinations – Semester I

GE 481: Introduction to Surveying **5th November 2010**

Instructions

Time: Three (3) hours.
Answer four (4) questions in total

Three (3) from section A for all students. Use tables provided at the back

One (1) question from section B for Engineering and Agricultural Science Students only

PLEASE! Answer different sections on separate answer Booklet(s). DO NOT tie them together.

Section A: Answer any three (3) questions from this section

Question 1 (5 + 4 +5 + 8 + 3)

Driving pegs at 30 m intervals with the tops of the pegs on the required gradient, a gradient of 1 in 120 was set out falling from elevation 1195.700 m. After a period of time it was suspected that some of the pegs had been disturbed and the following observations were taken in checking their levels.

LEVELLING

PNT	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
	BS	IS	FS			
	1.760					BM1
	2.645		0.725			
	1.965		1.420			
		0.935				Peg 1
		1.180				Peg 2
		1.455				Peg 3
		1.685				Peg 4
		1.930				Peg 5
		2.175				Peg 6
	0.690		2.440			Peg 7
		0.925				Peg 8
		1.175				Peg 9
		1.435				Peg 10
	0.615		1.215			
			1.875			BM1

a) Calculate the amount of error at each peg

b) With the aid of clearly labelled diagrams describe any two of the three main types of levelling instruments

c) List any three other methods of levelling

Question 2 (3 + 16 + 6)

A steel tape of nominal length 50m was used to transfer a level from a reference line near the base of a vertical reinforced concrete column to a reference line near its top.

A 50N weight was attached to its free end and the tape was hung freely down the side of the column such that its 1.000m mark was against the bottom reference line. A reading of 28.439m was obtained at the top reference line.

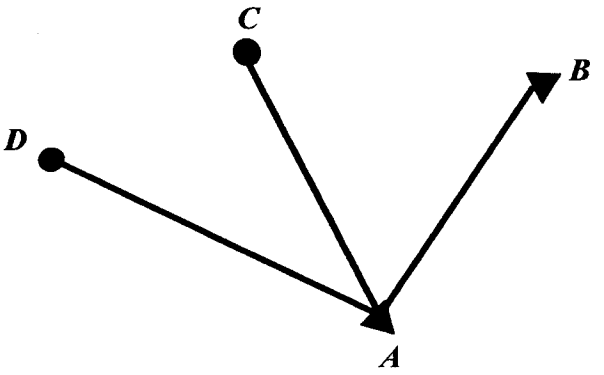
The tape used was standardised on the flat as 50.037m at a tension of 70N and a temperature of 20°C. It had a cross sectional area of 1.9 mm^2, the coefficient of thermal expansion of the tape material was 0.0000112 per °C and Young's modulus was 200 kN/mm^2mm. During the measurement the mean temperature of the tape was 12°C.

Calculate the **vertical distance** between the two reference lines.

Question 3 (7 + 12 + 6)

In order to determine the plane coordinates of points ***C*** and ***D***, a minute Theodolite was correctly mounted above point A. The distances ***AC*** and ***AD*** were measured twice along the slope with a tape as 160.936m and 272.155m. The known coordinates of ***A*** and ***B*** are:

A	64853.708mE	83276.404mN
B	64941.538mE	83280.606mN



The horizontal angles from point ***A*** are observed in two rounds and for the vertical angle only one FL and FR reading are taken.

Horizontal angles (Gon)

Pnt	Readings		Simple Mean	Reduced Mean	Remarks
	FL	FR			
B	283.2012	83.2000			
C	234.9540	34.9528			
D	200.1870	00.1864			
B	383.1497	183.1485			
C	334.9012	134.9009			
D	300.1361	100.1349			

Vertical angles (Gon)

Pnt	Readings		Reduced FL	Reduced FR	Mean
	FL	FR			
C	98.5151	301.4864			
D	94.1719	305.8293			

a) Complete the booking forms.
b) Calculate the co-ordinates of points ***C*** and ***D***.
c) Describe the rules that must be followed in the so-called Bessel –rounds.

Question 4 (5+ 5 + 6 + 3 + 6)

Explain the following terms and where applicable make a sketch in aid of your explanation.

i) Tilting Level
ii) Transiting of the Theodolite
iii) Engineering Surveys
iv) Photogrammetry
v) The **UTM** coordinate system (Zambia)

End of Section A

Exam No: **Exam Centre:**
Date:

Table for question 1:
Remember to attach the completed table to your answer booklet for Section A

LEVELLING

PNT	READINGS			HEIGHT OF INSTRUMENT	REDUCED LEVEL	REMARKS
	BS	IS	FS			
	1.760					BM1
	2.645		0.725			
	1.965		1.420			
		0.935				Peg 1
		1.180				Peg 2
		1.455				Peg 3
		1.685				Peg 4
		1.930				Peg 5
		2.175				Peg 6
	0.690		2.440			Peg 7
		0.925				Peg 8
		1.175				Peg 9
		1.435				Peg 10
	0.615		1.215			
			1.875			BM1

Exam No: **Exam Centre:**
Date:

Table for question 3:
Remember to attach the completed table to your answer booklet for Section A

Horizontal angles (Gon)

Pnt	Readings		Simple Mean	Reduced Mean	Remarks
	FL	FR			
B	283.2012	83.2000			
C	234.9540	34.9528			
D	200.1870	00.1864			
B	383.1497	183.1485			
C	334.9012	134.9009			
D	300.1361	100.1349			

Vertical angles (Gon)

Pnt	Readings		Reduced FL	Reduced FR	Mean
	FL	FR			
C	98.5151	301.4864			
D	94.1719	305.8293			

THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY EXAMINATIONS – NOVEMBER 2009

GG311 CRYSTALLOGRAPHY AND OPTICAL MINERALOGY

PAPER II – PRACTICAL

INSTRUCTIONS: ANSWER ALL QUESTIONS.
TIME: ONE AND HALF HOURS

Q.1 You are given Model 8. Do the following (20 marks):

(i) Determine the elements of symmetry (i.e. diads, triads, tetrads, hexads, planes of symmetry and centre).

(ii) Using the characteristic elements of symmetry classify the crystal into a given crystal system and state why.

(iii) Sketch the crystal and indicate on it the characteristic elements of symmetry.

Q.2 Plot a stereogram of Model 8 indicating on it the elements of symmetry and crystallographic axes. (15 marks)

Q.1 Using the optical properties identify the mineral in the given thin section A. (15 marks)

----------END OF EXAMINATION----------

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

2010 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

ME 341: THERMODYNAMICS

TIME ALLOWED: THREE (3) HOURS **CLOSED BOOK**

INSTRUCTIONS

1. Answer a **TOTAL OF FIVE (5)** questions.
2. Answer:

   TWO (2) Questions from Section A.

   THREE (3) Questions from Section B.
3. If any of **Questions 3, 5 and 7** is / are attempted, it / they should be tied together and submitted as a **separate booklet.**
4. If any of **Questions 1, 2, 4 and 6,** is / are attempted, it / they should be tied together and submitted as a **separate booklet.**
5. ALL Questions carry 20 Marks
6. **THERMODYNAMIC STEAM TABLES ARE ALLOWED.**
7. Draw neat sketches and graphs where necessary and clearly state any assumptions made.

SECTION A: Answer Any Two Questions from this Section

Question One

(a) Briefly explain the following:

(i) Saturation Temperature.
(ii) Saturation Pressure.
(iii) Relationship between the saturation temperature and pressure using a sketch graph.

(b) Derive the expression for determining the dryness fraction for the *Combined Separating and Throttling Calorimeter.*

(c) The dryness fraction of steam flowing through a steam main at a pressure of 800kN/m^2 is to be determined using a combined separating and throttling calorimeter. If the pressure, temperature and enthalpy of the steam *after* throttling are found to be 1.013MN/m^2, 116°C, and 2709kJ/kg respectively, and the volume of the steam condensed *after* throttling is found to be 2litres, while the water collected in the separator is 180ml, estimate the dryness fraction of the steam in the main.

[5+7+8 =20 Marks]

Question Two

(a) Explain with relevant sketches, the working principle of the following:

(i) Reheating Steam Plant.
(ii) Regenerative Steam Plant.
(iii) Closed Feed Water Pre-heater.
(iv) Open Feed Water Pre-heater.

(b) The University of Zambia Student Centre wishes to expand its facility to operate a small restaurant to provide lunch on week days in order to increase its revenue. The two options that are readily available for cooking are natural gas burners and electric stoves. The data sheet from the suppliers indicates that the efficiencies for the gas burners and electric stoves are 38% and 73% respectively and the rating of an electric stove is 2kW. The unit cost of electricity and natural gas are found to be K396/kWh and K 2,640/therm respectively *(1 therm = 105,000kJ)*. You have been approached for advice on choosing a cost effective option by providing the following information:

(i) Energy consumption in kW and unit cost of energy per kWh for the electric stove.
(ii) Energy consumption in kW and unit cost of energy per kWh for the gas unit.
(iii) Your final comment.

[12+8 = 20 Marks]

Question Three

What are the pre-requisites required to transform non-reacting systems of an ideal cycle to actual combustion systems?

[20 Marks]

SECTION A: Answer Any Two Questions from this Section

Question One

(a) Briefly explain the following:

(i) Saturation Temperature.
(ii) Saturation Pressure.
(iii) Relationship between the saturation temperature and pressure using a sketch graph.

(b) Derive the expression for determining the dryness fraction for the *Combined Separating and Throttling Calorimeter.*

(c) The dryness fraction of steam flowing through a steam main at a pressure of 800kN/m^2 is to be determined using a combined separating and throttling calorimeter. If the pressure, temperature and enthalpy of the steam *after* throttling are found to be 1.013MN/m^2, 116°C, and 2709kJ/kg respectively, and the volume of the steam condensed *after* throttling is found to be 2litres, while the water collected in the separator is 180ml, estimate the dryness fraction of the steam in the main.

[5+7+8 =20 Marks]

Question Two

(a) Explain with relevant sketches, the working principle of the following:

(i) Reheating Steam Plant.
(ii) Regenerative Steam Plant.
(iii) Closed Feed Water Pre-heater.
(iv) Open Feed Water Pre-heater.

(b) The University of Zambia Student Centre wishes to expand its facility to operate a small restaurant to provide lunch on week days in order to increase its revenue. The two options that are readily available for cooking are natural gas burners and electric stoves. The data sheet from the suppliers indicates that the efficiencies for the gas burners and electric stoves are 38% and 73% respectively and the rating of an electric stove is 2kW. The unit cost of electricity and natural gas are found to be K396/kWh and K 2,640/therm respectively *(1 therm = 105,000kJ)*. You have been approached for advice on choosing a cost effective option by providing the following information:

(i) Energy consumption in kW and unit cost of energy per kWh for the electric stove.
(ii) Energy consumption in kW and unit cost of energy per kWh for the gas unit.
(iii) Your final comment.

[12+8 = 20 Marks]

Question Three

What are the pre-requisites required to transform non-reacting systems of an ideal cycle to actual combustion systems?

[20 Marks]

SECTION B: Answer Any Three Questions from this Section

Question Four

(a) Define the following:

(i) Charles Law
(ii) Joule's Law

(b) Air is contained in a long vertical cylinder of internal diameter 600mm, under a piston of mass 66kg at a pressure and volume of 1.45MN/m^2 and 0.13m^3 respectively. The top of the cylinder is open to the atmosphere which has a pressure of 0.101MN/m^2. The piston is suddenly released to move upwards and the air expands to a pressure of 0.4MN/m^2 in the process. If the expansion is assumed to be frictionless and follows the law $PV^{1.36} = C$, determine:

(i) The distance in meters through which the piston is lifted.
(ii) The piston velocity at your calculated distance of lift.

[4+16 = 20 Marks]

Question Five

The pressure, volume and temperature at the beginning of compression of a constant volume cycle are 105kN/m^2, 0.005m^3 and 20°C respectively. The maximum pressure of the cycle is 5MN/m^2, while the volume ratio of the cycle is 10:1. *Make a sketch* of the cycle and determine:

(a) The pressure, volume and temperature at each of the cycle process state points. *Tabulate your results.*
(b) The thermal efficiency.
(c) The theoretical output in kW if the cycle repeats 3000 times per minute
(d) The mean effective pressure.
(e) The Carnot efficiency within the cycle temperature limits.

(Take C_p = 1.006kJ/kgK; C_v = 0.716kJ/kgK; R = 0.287kJ/kgK)

[20 Marks]

Question Six

(a) Distinguish between a *"Refrigerator"* and a *"Heat Pump"*. Give appropriate diagrams to illustrate your answer.

(b) A Freon – 12 compression refrigeration system of refrigeration capacity 7 Tons, has a condensing temperature of 50°C and an evaporating temperature of 0°C. The liquid leaving the condenser is saturated liquid and the compression is isentropic. The mass flow rate is 3.5 times the refrigeration capacity in tonnes, divided by the heat absorbed in the evaporator. Given that the enthalpy at the end of isentropic compression is 210kJ/kg, determine:

(i) The mass flow rate of the refrigerant.
(ii) Power required for running the compressor.
(iii) The heat rejected in the plant.
(iv) The COP of the system.

(c) Comment on the *properties* of a good refrigerant and state the *types* that you would consider for large and small applications.

Question Seven

Propane enters the combustion chamber of a boiler and reacts with air. The heat released from the combustion produces steam in a jacket and the steam is led to expand on a turbine to produce electricity. After performing useful work, the steam is condensed and the water formed is led back to the boiler.

(a) Name and draw the PV diagram of the ideal cycle involved in this operation.

(b) Determine the percentage theoretical air used in the operation of this boiler if gas analysis reveals that the products of combustion include:

CO_2	11.5%
O_2	2.7%
CO	0.7%
N_2	85.1%

[20 Marks]

End of ME 341 – Thermodynamics Semester I Final Examination
November, 2010.

Prepared By:
Prof. F.D. Yamba and Mr. S.S. Virdy

UNIVERSITY EXAMINATIONS

2010 SEMESTER 1 FINAL EXAMINATIONS

MI 469 INVESTMENT ANALYSIS

TIME: 3 HOURS **FULL MARKS: 100**

INSTRUCTIONS: ANSWER ONLY FIVE QUESTIONS

1. Diatech limited has identified three key parameters as sales quantity, selling price and total operating costs whose probability distributions were established as follows:

Sales Quantity (Q)	Probability p(Q)	Sales price per unit (P)	Probability p(P)	Total operating costs (OC)	Probability p(OC)
5,000	0.1	$20	0.1	$100,000	0.2
7,500	0.3	22	0.2	125,000	0.5
10.000	0.4	24	0.4	150,000	0.3
12,000	0.2	26	0.2		
		28	0.1		

i) Determine the expected value of each of the above three parameters **[3 marks]**

ii) Determine the expected value of the net profit. **[3 marks]**

iii) Using Monte Carlo simulation technique with the following table of random numbers below, determine the expected profit and its associated variance from 10 simulations. Why does this figure from 10 simulations differ from the one obtained in (ii) above? **[10 marks]**

Table of Random Numbers

Sales Quantity Random numbers	Sales price Random numbers	Total cost Random numbers
0.798	0.690	0.504
0.496	0.053	0.211
0.176	0.569	0.304
0.383	0.067	0.601
0.591	0.942	0.118
0.776	0.583	0.013
0.529	0.597	0.223
0.477	0.545	0.334
0.180	0.009	0.743
0.910	0.132	0.261

iv) From the simulation (assuming each of the ten outcomes has an equal probability of occurrence), determine the probability of obtaining a greater than $90,000 profit. **[4 marks]**

2. Discuss briefly factors that may affect mineral investment decisions in a country. **[20 marks]**

3. Discuss reasons why feasibility studies are undertaken before an investment is made. Give the various stages involved in a mine feasibility study. **[20 marks]**

4. Consider the following three mining project proposals:

End of Year	Cash Flows		
	Proposal A	Proposal B	Proposal C
0	-$75,000	-$75,000	-$75,000
1	25,000	20,000	0
2	25,000	25,000	0
3	25,000	30,000	0
4	25,000	35,000	130,000
Salvage value at end of year 4	5,000	2,000	3,000

The minimum acceptable rate of return is 10%

Determine the most attractive alternative based on:

i) The Payback period **[10 marks]**
ii) Net present value **[10 marks]**

5. Some equipment costs $840,000 and has a six-year depreciable life and an estimated salvage value of $120,000 at the end of six years.

Taking into account the salvage value, find the depreciation rate for:

i) Straight-line method **[4 marks]**
ii) Declining balance method **[4 marks]**
iii) Sum-of-digits method **[4 marks]**

What is the book value of the equipment after 3 years using the straight-line method? **[4 marks]**

What is the book value of the equipment after 5 years using the sum-of-digits method? **[4 marks]**

6. (i) What is optimum economic life of equipment? **[5 marks]**
(ii) The initial cost of a truck is $30,000. Operating costs and salvage values for the following 10 years are:

Year	Operating costs	Salvage values
1	10,000	21,000
2	11,000	14,500
3	12,000	10,200
4	13,200	7,000
5	15,000	5,000
6	17,500	3,000
7	21,000	2,500
8	25,000	2,000
9	30,000	1,500
10	35,000	1,000

Assume a Declining balance scheme of 30% and tax rate of 50%

Determine the optimum economic life of this equipment. **[15 marks]**

End of Examination