THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS- 1st SEMESTER 1998/99

CE365

SOIL SCIENCE/ROADS/HYDROLOGY

TIME: THREE HOURS

INSTRUCTIONS TO CANDIDATE

(a) Candidates must ensure that their computer numbers are clearly written on each answer booklet used and that the number of questions answered are entered in the space provided on the front cover of the answer booklet.

(b) Answer **FIVE** questions, **MAXIMUM OF TWO QUESTIONS FROM ONE SECTION.**

(c) All questions carry equal marks (20). Marks of sub-questions are indicated at the end of each sub-question.

(d) Mathematical gadgets and drawing instruments are allowed.

MAXIMUM SUM OF MARKS: 100 **CLOSED BOOK**

SECTION 1
SOIL SCIENCE

Q1. a. Give an Engineer's definition of soil. (5)

b. Why do clay soils attract water? (5)

c. In terms of molecular structure how are sands different from clay? (5)

d. Contrast ***residual*** soils, ***colluvial*** soils and ***cumulose*** soils.(5)

Q2. a. Define the following terms as relates to soils; void ratio, porosity ratio, water content, degree of saturation and dry density. (5)

b. During a Proctor's compaction test weight of the soil sample was 0.019kN at moisture content of 17.54%. The Proctor's mould was measured to be 0.104 m in diameter and 0.112 m in height. Find out the void ratio, dry density and the degree of saturation if the specific gravity of the solids is 2.6. (10)

c. What do liquid limit, plastic limit and plastic index represent for a soil?(5)

Q3. a What is soil stabilisation?(5)

b. Give five reasons why Portland cement is the most common cement used in soil stabilisation.(5)

c. Discuss the following soil stabilisation methods, Soil Cement, Cement-modified soil and Plastic soil cement.(10)

SECTION 2
ROADS

Q4. a What are the criteria used for the design of vertical curves?

b. A horizontal curve has an e value (superelevation) = 6%. What is the recommended speed given the following:

μ_R(coefficient of radial friction) = 0.12

Curve radius, R = 1200 m

c. The deflection angle of a 2° curve is 6°. If the PC is located at station (171+023), determine the length of the curve and the stationing of the PT. Also determine the defelection angle for setting out purposes.

Q5. a What are the fuinctions of the following pavement layers:

-wearing course

-base

-subbase

b. Design a pavement using the SATCC design procedure. The road is to be constructed in an arid area. The average equivalence factors for commercial traffic are given in the following table:

Group	Description	Equivalence Factor
3	2 axle and tandem rigid trucks	2.0
4	Rigid truck + drawbar trailer	6.0
5	Articulated Unit with semi-trailer	6.0
6	Bus	1.0

The subgrade CBR = 8%. The traffic ADT is 1800 and the traffic distribution is as follows;

Group 3 - 50%

Group 4 - 21%

Group 5 - 22%

Group 6 - 7%

$$DT = T_d \times 365 \times \frac{\left[1 + \frac{r}{100}\right]^N - 1}{\frac{r}{100}}$$

The traffic growth rate is 2.5% and the design period = 15 years.

Q6. Give brief explanations of the following:

(i) Expansion and longitudinal joints in rigid pavements (use diagrams).

(ii) Widening of circular curves

(iii) Attainment of superelevation (use diagram)

(iv) Intersection sight distance.

SECTION 2 3
INTRODUCTION TO HYDROLOGY

Q7. (a) Give a definition of Hydrology and briefly outline the roles of a surveyor in Hydrogy. **(4)**

(b) Describe the three traditional methods of determining catctment rainfall figures (use neat sketches where necessary). In your descriptions, include the limitations of each method .**(12)**

(c) For the catchment shown in Figure Q1c, calculate the average precipitation using the arithmetic and Thiessen Methods and comment on the results. **(4)**

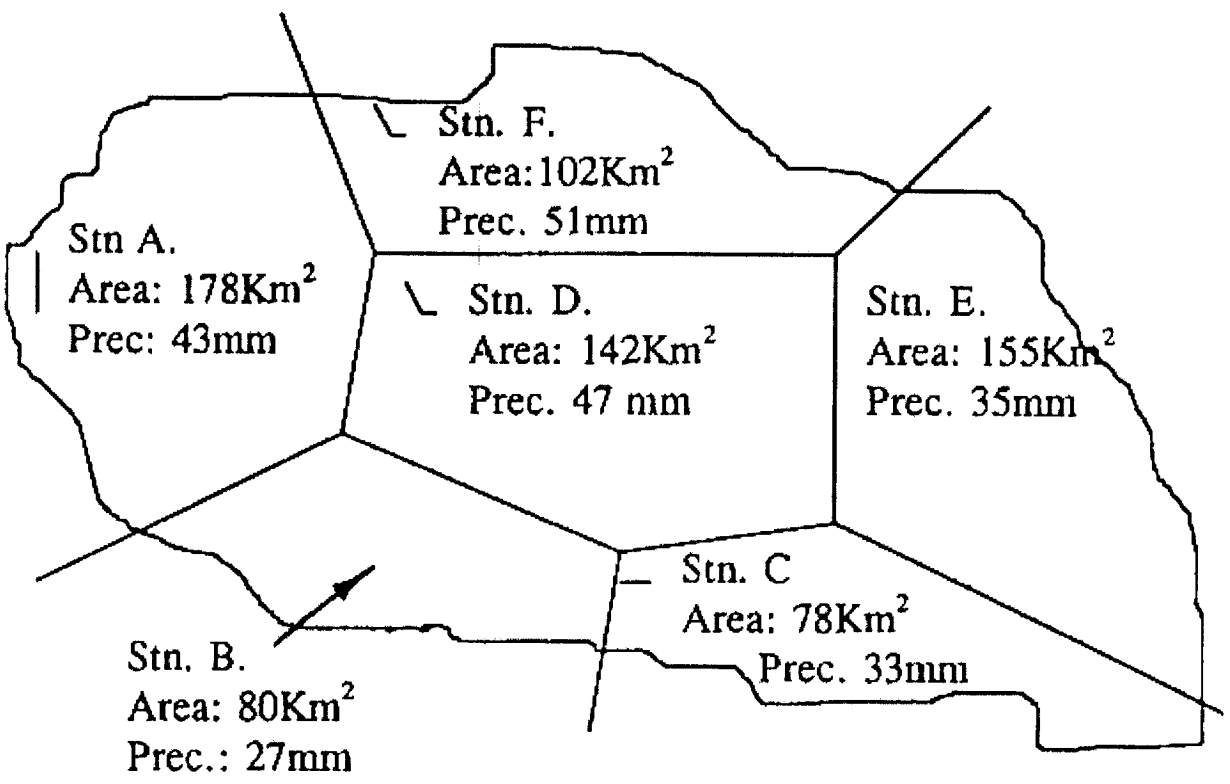


Figure Q1c

Q8. (a) With the aid of neat sketches and equations based on Darcy's law, illustrate the differences in the application of the two types of equipment used to estimate the coefficient of permeability (hydraulic conductivity) (K) of a sample of soil material from a given catchment. **(10)**

(b) Boreholes A and B are sited 100 m apart and are 80m below the ground level. They penetrate a confined aquifer of thickness 28 m. If the water is being pumped from each borehole at a rate of 20l/s, estimate:

(i)The drawdown at point C , is 20 m from borehole A and 80 m from borehole B. **(6)**

(ii) The drawdown in borehole A. **(2)**

(iii) The hydraulic gradient between borehole A and point C. **(2)**

Given data: *K = 0.0001 m/s; radius of borehole A = 0.3m; Radius of Borehole B = 0.2m; Orignal peizometric surface was 20m below the ground level.; The drawdown in Borehole A when only borehole A is being pumped is 14m; The drawdown in Borehole B when only borehole B is being pumped is 14m.*

Q9. (a) State, without describing, five (5) of the principle methods of streamflow measurements. **(5)**

(b) (i) What is a current meter in Hydrology? Briefly describe its principles of operation.**(4)**

(ii) State the two types of current meters used in Hydrology. **(2)**

(c) What are the principle guidelines in selecting a cross section accross a river if one wanted to determine discharges of the river using the current meter gauging method? **(3)**

(d) (i) State the two approaches that can be used to introduce a chemical when applying the

Dilution gauging method for the determination of stream discharges?**(2)**

(ii) A Salt solution of 10 gm/l concentration is injected into a stream at a rate of 0.05 l/s.

Downstream the concentration of salt in the water rises from 0.01 gm/l to a steady 0.5 gm/l. What is the discharge of the stream? **(4)**

Table 16.3 Materials applicable for subbase, base and wearing course (ref. 4).

Layer/material	*Layer coefficient*	*Thickness range (mm)*
Wearing course:		
Single surface dressing[1]	$a_1 = 0.20$	–
Double surface dressing[1]	$a_1 = 0.20$	–
Asphalt concrete[2]	$a_1 = 0.35$	30–90
Base:		
Asphalt macadam	$a_2 = 0.20$	70–150
Gravel (CBR > 80%):		
natural	$a_2 = 0.12$	125–200
crushed	$a_2 = 0.13$	125–200
Graded crushed stone (CBR > 100%)		
on natural gravel subbase	$a_2 = 0.14$	125–200
on stabilized subbase	$a_2 = 0.18$	125–200
Cement-stabilized gravel:		
with UCS = 2.0–3.5 MPa	$a_2 = 0.14$	125–200
with UCS = 3.5–5.0 MPa	$a_2 = 0.18$	125–175
Subbase:		
Natural gravel (CBR > 30%)	$a_3 = 0.11$	100–250
Cement or lime-stabilized materials:		
with UCS = 0.7–2.0 MPa	$a_3 = 0.12$	100–200
with UCS > 2.0 MPa	$a_3 = 0.16$	100–200

UCS = unconfined compressive strength after seven days.
[1] Surface dressing is assumed to contribute to the strength of the pavement only when applied on a bituminous layer to improve impermeability of the wearing course.
[2] Adjustment for extreme temperature conditions is described in the design guide.

$$\log CN_{esa} = 9.36 \log\left(\frac{SN}{25.4} + 1\right) - 0.83 + \log\frac{1}{R} + 1.395 \log CBR$$

where:

SN = structural number in mm;
CBR = Design CBR for the subgrade (minimum 8%);
R = regional adjustment factor.

Regional adjustment

The regional adjustment factor R makes the design equation applicable to design of pavements in areas with different climatic conditions. R is assumed to be 1.0 for areas with rainfall throughout most of the year, creating permanently saturated conditions of the subgrade and the unbound pavement layers (12 wet months). A factor of 0.1 is assumed for very arid climates (0 wet months) where the pavement structure and the subbase never reach a saturated condition.

For CN_{esa} less than 0.5×10^6 no equation is given for SN, but different values of SN are listed for different ranges of subgrade CBR (ref. 4).

Thickness design

After the materials for the different pavement layers have been selected the thicknesses are determined by trial and error so that the following equation is satisfied:

$$SN$$

THE UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER DEFERRED/SUPPLEMENTARY EXAMINATIONS

DECEMBER 1999

EA 311 (FARM POWER AND MACHINERY)

INSTRUCTIONS

Time Allowed: Three hours
There are **two** sections in this examination, **Section A** and **Section B**.
Attempt **five** questions only, **at least two** from each section.
Each question carries **20 marks**.
Answer **Section A** and **Section B** on separate answer sheets.

Section A

1. a) How are lubricating oils classified?

[4marks]

b) What are multi-grade and universal oils?

[4marks]

c) Distinguish between detergent and non-detergent oils? What precautions would you take in switching over to a detergent oil if you had been using a non-detergent type?

[4marks]

d) List and describe briefly the various types of lubrication system used on tractors and other farm implements

[8marks]

2. With reference to figure Q2;
   a) Can you name any **five** of the parts from 1 to 10

[10 marks]

b) What are the functions of parts 2,3, 8,and 10

[8marks]

c) What is the purpose of the relief valve in a pressure cap?

[2marks]

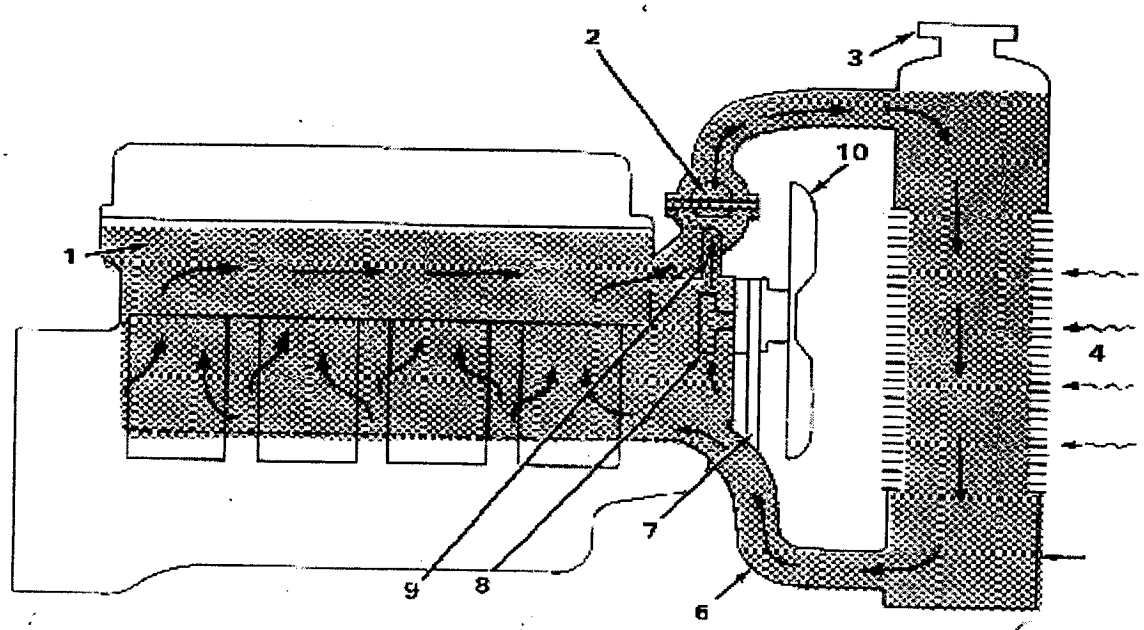


Fig Q2

3. What angle **has** the crankshaft got to **travel** between one power stroke and the next in a:

a) One cylinder four stroke engine **[1 mark]**

b) Four cylinder four stroke engine **[1 mark]**

c) Two cylinder two stroke engine **[1 mark]**

d) Six cylinder four stroke engine **[1 mark]**

e) Assuming a firing order of 1-5-3-6-2-4 for a six-cylinder engine, complete the **events** in the other cylinders if the **events** for cylinder 1 are as shown in table Q3 **on page 4. (Use this table and submit it with your answer sheet)** **[12 marks]**

f) Why does a camshaft run at half the speed of the crankshaft? Illustrate. **[4 marks]**

4. Engine maintenance

a) What could you do to improve the cranking speed of an engine? **[2 marks]**

b) Give 4 fuel or ignition problems that will prevent a gasoline engine from running properly, even though it will start. **[4 marks]**

c) A cracked distributor cap can be welded. True or False? **[1 mark]**

d) List two fuel-related reasons a spark-ignition engine may not run properly. **[2 marks]**

e) What may cause a gasoline engine to pre ignite? **[2 marks]**

f) What may cause a gasoline engine to knock? **[2marks]**

g) Give three reasons why a diesel engine may not start. **[3 marks]**

h) What may cause low battery output? (two reasons) **[2 marks]**

i) What would you do to correct a battery that continuously loses its charge? **[2 mark]**

SECTION B

5. a) Define the following terms in the context of agricultural mechanisation;
   i) Farm mechanisation
   ii) Appropriate technology
   iii) Agricultural implement
   iv) Agriculture machine **[8 marks]**

b) State any **three** advantages and **two** disadvantages of mechanising field operations to mechanical power technology level. **[10 marks]**

c) List **two** primary objectives of mechanisation of field operations **[2 marks]**

6. a) State **two** aspects of crop planting that are examined during calibration of a seed drill

[4 marks]

b) A farmer would like to plant 75 kg/ha of wheat seed using his 10 x 250 mm seed drill. The seed metering mechanism for the seed drill is driven by 1273 mm diameter seed drill wheels via a chain and sprocket linkage. Calculate:

i) the width of the seed drill.

[4 marks]

ii) the length of travel necessary for the seed drill to cover 0.25 ha

[4 marks]

iii) the number of wheel revolutions needed to cover an equivalent of 0.25 ha

[4 marks]

iv) the amount of seed expected from each seed delivery tube

[4 marks]

7. a) Define the term Integrated Pest Management

[2 marks]

b) Briefly describe **three** components of Integrated Pest Management and give **one** example of each component.

[6 marks]

c) State **two** advantages of applying dry chemicals as opposed to spraying.

[4 marks]

d) List any **four** major components of a sprayer and briefly explain the function of each component.

[8 marks]

Table Q3

Crank travel	Cylinder number					
	1	2	3	4	5	6
0						
30						
60						
90						
120						
150						
180						
210						
240						
270						
300						
330						
360						
390						
420						
450						
480						
510						
540						
570						
600						
630						
660						
690						

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

FINAL EXAMINATION-(*FIRST SEMERSTER*)

COURSE: **EA-421** (*FUNDAMENTALS OF FARM STRUCTURES*)

DATE: 25/05/99 TIME ALLOWED: 3 hours

INSTRUCTIONS:

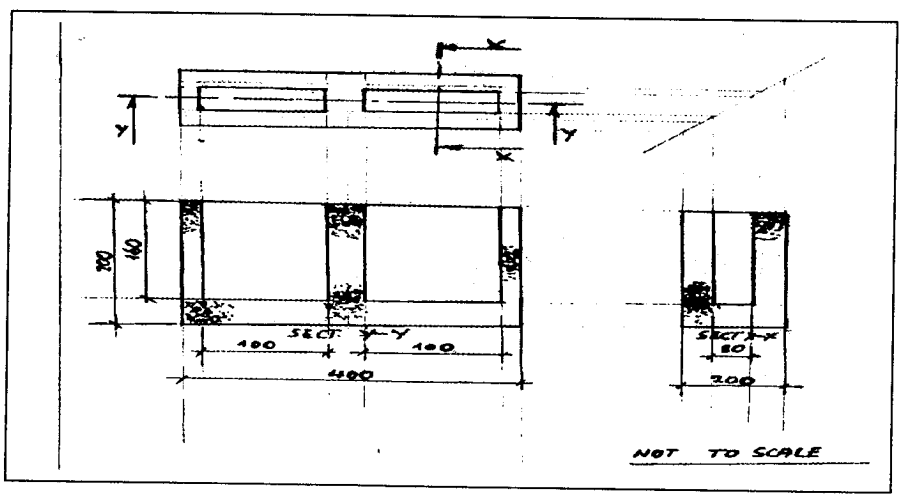
1. Attempt **all** Questions in **Part A** and any **two (2)** questions in **Part B**.
2. **A Psychrometric chart** will be provided for the **question 6.**

PART A

Q1. a) Discuss the rationale behind the need for proper selection of building materials.
(2 marks)

b) What factors influence the selection of building materials?
(4 marks)

c) A concrete foundation is to be constructed using " **8-inch** " (200 mm) **blocks.** The dimensions for this block is shown below:



i) how many of such blocks can you produce from a 1 m^3 of the concrete ingredients if a 1:3:5 nominal mix is to be used. (Shrinkage is 30% and allowable wastage is 5%)?

(8 marks)

ii) How many bags (50 kg) of cement are you going to use?

(2 marks)

iii) How much water would you recommend to be added to the mix , why?

(3 marks)

iv) Suppose the moisture content of sand is 8% and that of stones is 2%, how much water would you add to the mix in order to achieve concrete of maxim strength? (Assume the density of sand is 1400 kg/m^3 and that of stones is 1600 kg/m^3)

(5 marks)

v) Establish the aggregate cement ratio.

(2 marks)

vi) What other measures would you undertake to ensure that the concrete is of high strength and quality?

(4 marks)

Q2. a) Distinguish flat roofs to pitched roofs.

(4 marks)

b) With the aid of a clearly labelled sketch, explain the procedure of laying roofing sheets. (Assume you are facing the roof and the wind is blowing from your right to the left.)

(3 marks)

c) Discuss factors influencing the magnitude of the slope of the roofing material.

(3 marks)

d) Given roofing material with the following specification:

- **C.S. NOMINAL 10/100**
  - **Length = 3 m,**
  - **Width = 100 cm.**

This has to be laid on the structure whose walls measure as follows:

- **Length = 9 m,**
- **Width = 5 m.**

The recommended slope is to be - 1:3,

i) what kind of a roof would you recommend, why?

(2 marks)

ii) How many roofing sheets are you going to require if the following is the case:

- **Roof overhang = 80 cm,**
- **End lap = 100mm &**
- **Side lap = 2 corrugations.**

(5 marks)

iii) Discuss precaution to be observed in order to prevent leakages through nail holes.

(3 marks)

PART B

Q3. In the endeavour to up-lift the living standards, ventilated improved pit latrines (VIP) are to be introduced.

a) Discuss the operation, merits and de-merits of the VIPs with aid of a clearly labelled sketch.

(7 marks)

b) What precautions do you have to observe when siting pit latrines?

(5 marks)

c) The average household size is 8, with the sludge accumulation rate of 0.05 m^3/hd/year, calculate the volume of the pit and also establish the dimensions required for this pit.

(8 marks)

d) Distinguish a **pit latrine** to a **water-borne toilet** system.

(5 marks)

Q4. a) Discuss **walls.**

(10 marks)

b) Distinguish **blocks** to **bricks**

(4 marks)

c) What is the **significance of bonding** in wall construction, give some examples with aid of clear sketches?

(6 marks)

e) What criterion must a **mortar** fulfill to achieve its objectives in building?

(5 marks)

Q5. a) List factors influencing **Farmstead planning**

(7 marks)

b) Discuss **Zone planning**

(8 marks)

c) i. What are merits and de-merits of the **cage** or **battery** systems as against the **deep-litter floor** system **(in poultry production)**?

(8 marks)

ii. What measure would you undertake to overcome some of the major bottlenecks of the cage system?

(2 marks)

Q6. a) Grain having been harvested with a relatively high moisture content had to be dried using blower heaters. The initial air temperature was 17^0 C at the relative humidity of 60%,
and after the drying process the RH of the air rose to 90% at the same energy levels, Using the Psychrometric chart establish;

i) the temperature of air going out .

(5 marks)

ii) the amount of moisture removed in the drying process.

(6 marks)

b) With aid of a clearly drawn graph (not to scale), illustrate :

i) Sensible heating,

(3 marks)

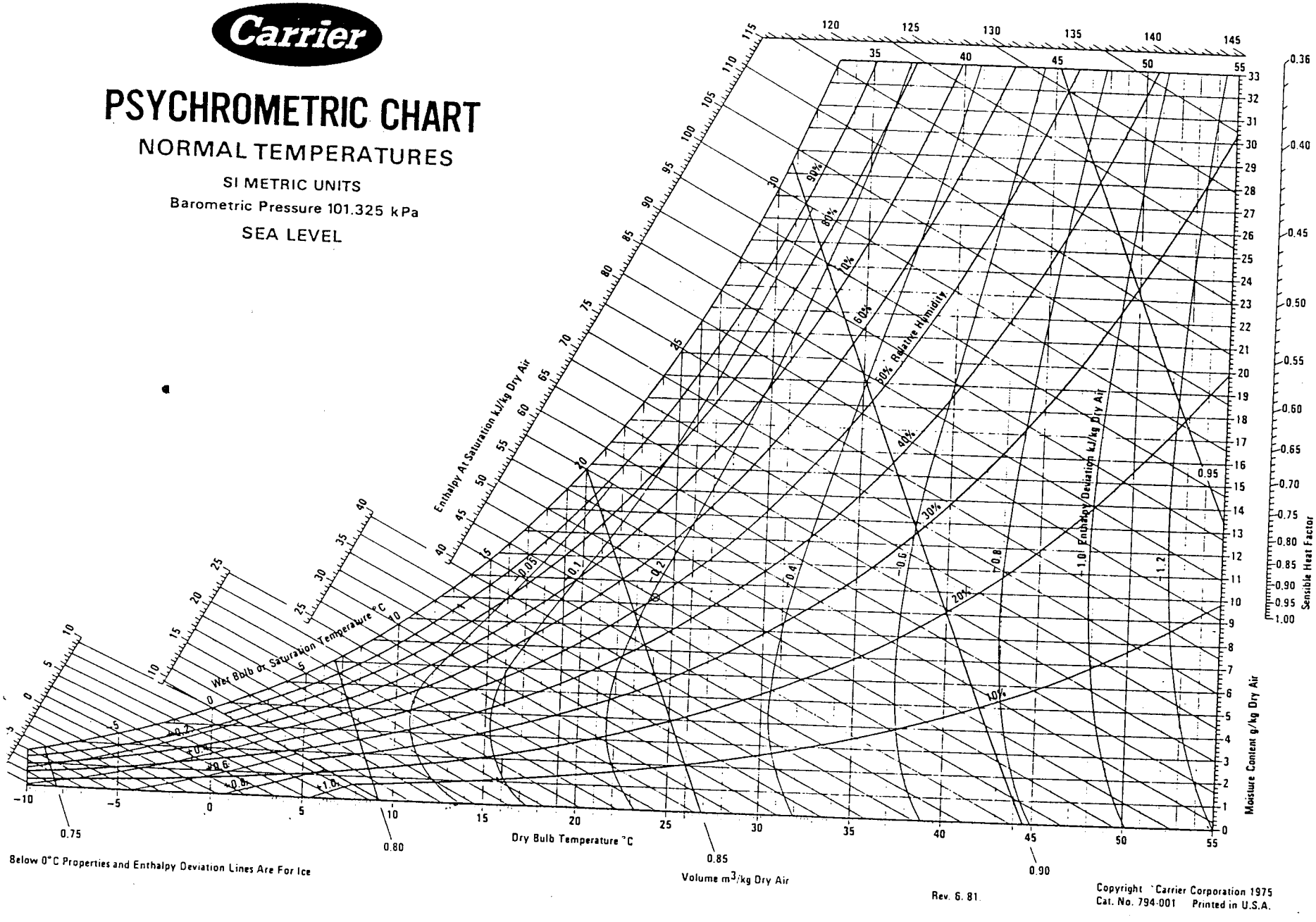
ii) **Sensible cooling,**

(3 marks)

Give some examples of this processes.

c) What purposes does **ventilation** serve in farm buildings?
Give two examples of the common ventilation systems.

(9 marks)


Carrier
PSYCHROMETRIC CHART
NORMAL TEMPERATURES
SI METRIC UNITS
Barometric Pressure 101.325 kPa
SEA LEVEL
Enthalpy At Saturation kJ/kg Dry Air
Wet Bblb or Saturation Temperature °C
Dry Bulb Temperature °C
Volume m³/kg Dry Air
Moisture Content g/kg Dry Air
Sensible Heat Factor
Relative Humidity
Enthalpy Deviation kJ/kg Dry Air
Below 0°C Properties and Enthalpy Deviation Lines Are For Ice
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THE UNIVERSITY OF ZAMBIA

FIRST SEMESTER UNIVERSITY SUPPLEMENTARY AND DEFERRED EXAMINATIONS DECEMBER 1999

EA521 FARM STRUCTURES I

INSTRUCTIONS:

ANSWER: ANY FIVE QUESTIONS
TIME: THREE (3) HOURS

THIS EXAMINATION PAPER CONTAINS SIX QUESTIONS
ALL QUESTIONS CARRY 20 MARKS
THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS

QUESTION 1

(a) What are the main factors that affect the selection of building materials? **(6)**
(b) Describe four (4) steps by which you would ensure that good quality concrete is produced. **(8)**
(c) Discuss three (3) properties of stones important in the building industry. **(6)**

QUESTION 2

Estimate using the slope-deflection method the reactions developed in the beam shown in Figure Q2 and draw the bending moment and shear force diagrams. **(20)**

All dimensions are in mm.

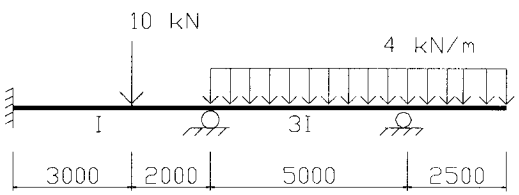


FIGURE Q2

QUESTION 3

(a) What are the functions of a foundation? **(4)**

(b) Describe three (3) types of foundations using sketches. **(6)**

(c) A 400 mm square column carries a dead load (G_k) of 900 kN and an imposed load (Q_k) of 300 kN as shown in the Figure Q3. The safe bearing capacity of the soil is 150 kN/m^2. Design a square pad footing to resist the loads assuming the following material properties:

f_{cu} = 35 N/mm^2
f_y = 460 N/mm^2
Unit weight of concrete = 24 kN/m^3.

In calculating the ultimate load to be used in reinforcement design only, increase the value of G_k by 40% and that of Q_k by 60%.

You must assume a certain initial footing weight and crosscheck it at the end of your design. You must also assume a certain depth h of the footing in order to obtain the effective depth.

Assume the cover to reinforcement c is 40 mm and use 20 mm diameter bars in both directions.

(10)

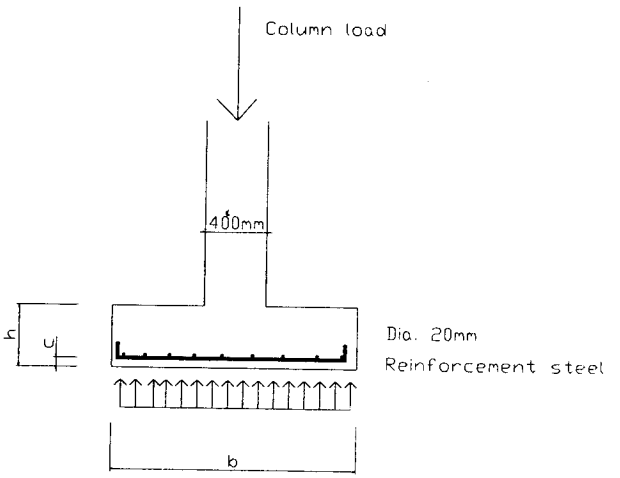


FIGURE Q3

QUESTION 4

A flat roof spanning 4.5 m is constructed using timber joists with the strength properties given below. The joists have a section of 47 x 225 mm and are spaced at 450 mm centres. The total dead load due to the roof covering and ceiling including the self-weight of the joists can be assumed to be equal to 1 kN/m^2. Calculate the maximum imposed load the roof can carry in the long term and medium term. **(20)**

Bending parallel to grain (N/mm^2) $\sigma_{m,g,\|}$	Compression perpendicular to grain (N/mm^2) $\sigma_{c,g,\perp}$	Shear parallel to grain (N/mm^2) τ_g	Modulus of elasticity (N/mm^2) E
5.3	1.7	0.67	8800

Modification factors
(to be multiplied with the permissible stresses to obtain allowable stresses):
Duration of loading factors:
Long term = 1.0
Medium term = 1.25
Depth factor = $(300/h)^{0.11}$ where h = 225 mm.
Load sharing factor = 1.1

Hint: Maximum deflection = 5/384 wl^4/EI + 12/5 wl^2/EA

QUESTION 6

(a) Describe three (3) methods of timber preservation giving their advantages and disadvantages if any. **(6)**

(b) Discuss three (3) methods of timber conversion giving their advantages and disadvantages if any. **(6)**

(c) Discuss the following properties of wood:
Strength
Hardness
Stiffness
Toughness
Workability **(5)**

(d) List three (3) important materials commonly used in construction that are derived from wood **(3)**

QUESTION 6

In Figure Q6 shown below, joints B, C and D each carry vertical loads of 120 kN. Use the method of virtual work to determine the vertical deflection of joint D if the modulus of elasticity of the material is 205 kN/mm^2. All members are circular hollow sections with a wall thickness of 4 mm. **(20)**

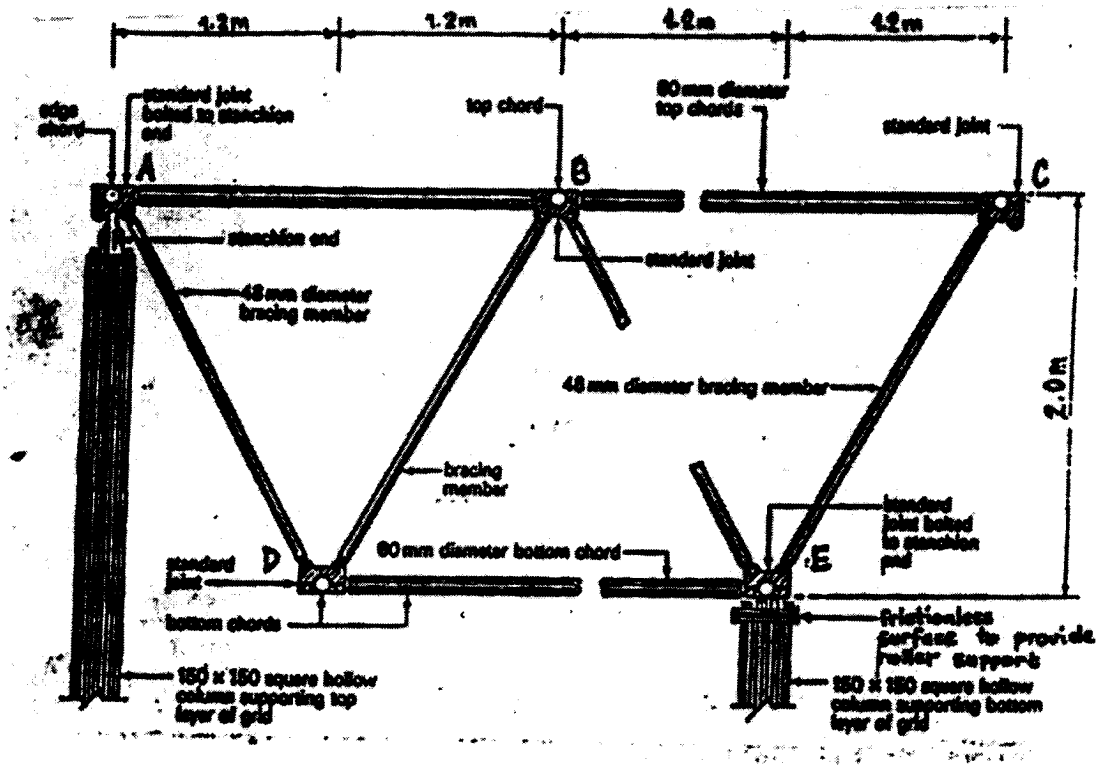


FIGURE Q6

END OF EXAMINATION

EXAMINER: **Dr. Edward Lusambo Department of Agricultural Engineering**

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
EE 209 PRINCIPLES OF ELECTRICITY
SEMESTER I FINAL EXAMINATIONS

TIME: 3HOURS **DATE: MAY 1999**

ANSWER QUESTION ONE AND FOUR OTHER QUESTIONS OUT OF EIGHT
ALL QUESTIONS HAVE 20 EACH

Q1. (a) Draw a schematic circuit diagram of a zener voltage regulator for a variable load resistance R_L. The variable rectified DC voltage source is connected to the regulator through the maximum allowable series –limiting resistance $R_S(max)$.

(b) What is the relationship between $R_S(max)$, V_{in} , V_{out} and I_L(the current through R_L).

(c) If the above regulator has an input voltage ranging from 15V to 20V, and the load current varying from 20 mA to 100 mA. In order to hold the load voltage constant under all conditions:what maximum value should R_S have if $V_Z = 10V$?

(d) State what happens if R_S is greater than the maximum value? Under these conditions what is the value of V_{IN} and I_L.

Q2. Draw circuit diagrams with the input and output waveforms for:

(a) Positive Clipper

(b) Negative Clamper.

(c) Three input Diode AND-GATE with its truth table.

(d) Voltage doubler: at the peak of the negative half cycle; at the peak of the positive half cycle; and after several cycles the output voltage across the output device.

Q3. Given a common-base npn (silicon) bipolar transistor.
The emitter resistance R_E =22 kΩ is connected to $-V_{EE}$ = -15V and a coupling capacitor C1. V_{in} = 2 m V rms is fed into the emitter through C1.
The collector resistance R_C = 10 kΩ is connected to $+V_{CC}$ = + 15V and a bypass capacitor C2. C2 is connected to the load resistance R_L = 30 kΩ.

(a) Draw the original circuit diagram.

(b) DC equivalent circuit.

(c) AC equivalent circuit.

(d) Calculate the AC emitter current and output voltage, and the voltage gain $A_V = V_{in}(ac)/ V_{out}(ac)$.

Q4. (a) A resistance ladder network has five connection points namely: A,B,C, D and E. E is the common point for: the negative terminal of the 1V DC voltage source V1; three 1Ω resistors R2,R4, and R6. A is connection point for the positive terminal of V1 and R1. B is the connection point of R1, R2, and R3. C is the connection point of R3, R4, and R5. D is the connection point of R5 and R6. All resistors have a value of 1Ω. Find the power dissipated in resistor R3.

(b) Given a current source feeding a parallel load consisting of : Y_R = 0. 3 S , Y_C = j 0. 6 S, and Y_L = -j 0. 2 S. Draw the circuit and phasor diagram of the currents in R, L, and C components. Use the phasor diagram to find the value of the source current required to establish a voltage of 10 $\angle 0^\circ$ across the three parallel components.

Q5. (a) Given a circuit consisting of: Current sources I1=1A (between nodes 3-4) and I2=2A (between nodes 3-2); Resistors R1=1Ω (between nodes 4-1),R2=2Ω (between nodes 1-3), R3=2Ω (between nodes 1-2), and R4=1Ω (between nodes 2-3). I1 and I2 flow into nodes 4 and 2 respectively. Solve for voltages at nodes 1 and 2.

(b) Given two Thevenin equivalent sources: [V1= $240\angle 0^{\circ}$, Z1= 0.6+j0.8 Ω] and [V2= $240\angle -3.43^{\circ}$, Z2= 0.5+j0.866 Ω]feeding a single load impedance Z_L = 16 + j12 Ω].Transform the voltage sources and impedances into current sources and admittances, and Z_l into Y_L. Draw the original circuit and the transformed circuit diagram.

Q6. (a)Determine the Thevenin source impedance and (b) the Thevenin source voltage with respect to terminals A and B. X_L= 100 Ω and R3=100 Ω are connected to terminal A. R1=100Ω , R2=100Ω and X_L are connected together. The positive terminal of V1= $200\angle 0^{\circ}$ V is connected to R1 and the negative terminal to B. R2 and R3 are also connected to B. Draw the original circuit diagram.

Q7. (a) Sketch the ideal and actual magnitude frequency response of: a low pass, high pass, bandpass, and band reject filters. Show the bandwidth of the passband by indicating the low (ω_L) and high (ω_H) half-power angular frequency (rad/s) points.

(b) Draw RC circuit realizations for a low pass and a high pass filter. What is the qualitative behaviour of the capacitive impedance under low and high frequencies in both circuits. Explain your answer using circuit diagrams for: f = 0 Hz and f = ∞ Hz.

(c) What inductance is required to resonate at 10MHz with a capacitance of 100 pF.

Q8. (a) Explain the term 'multiplexing' and give four types of multiplexing .
(b) Name the five elements common to all feedback control systems. Draw a diagram of a regulator-type feedback motor-speed control system and identify the five common elements.

END OF EE209 SEMI FINAL EXAMINATION

EE209 SEM I SUP. NOV. 1999

FIG. 1.

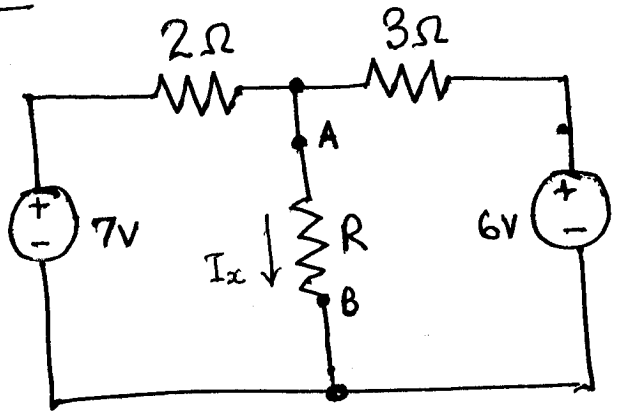


FIG. 5.

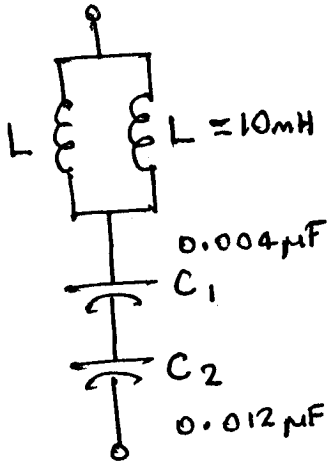


FIG. 2.

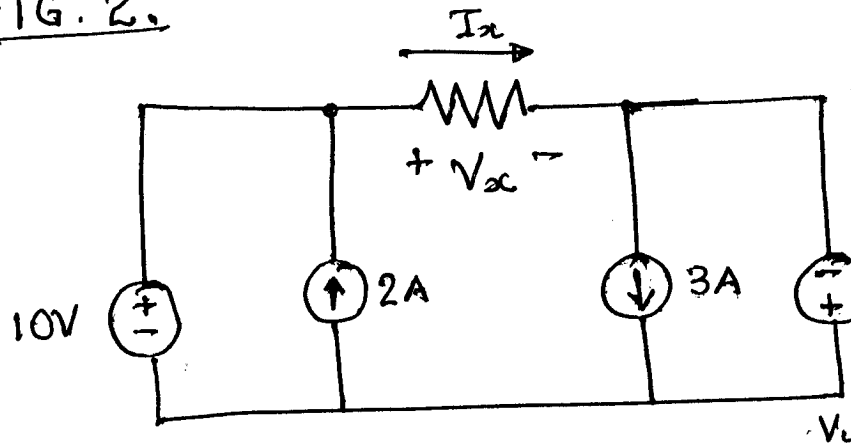


FIG 6a

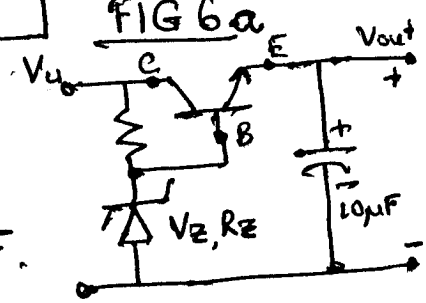


FIG. 3.

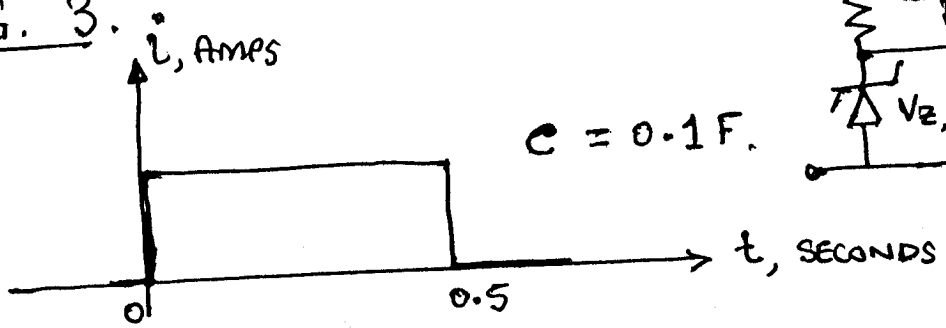
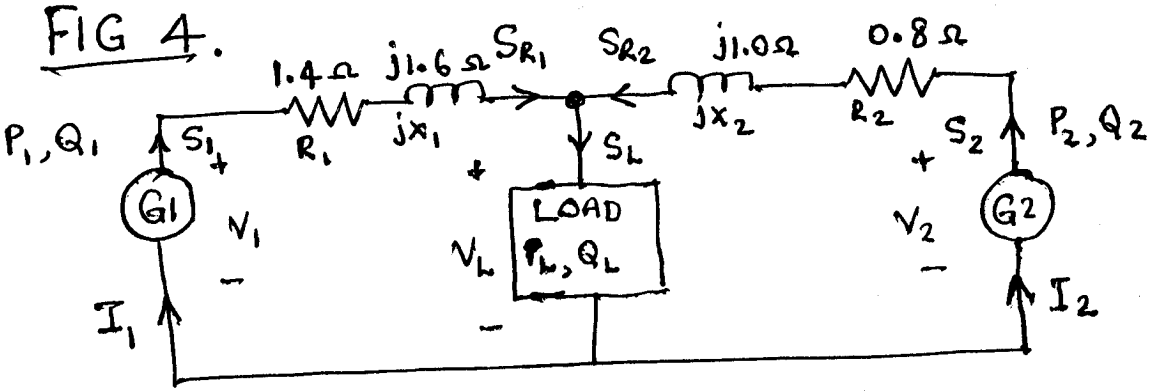


FIG 4.



THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
EE 209 PRINCIPLES OF ELECTRICITY
SEMESTER I DEFERRED FINAL EXAMINATIONS

TIME: 3HOURS **DATE: NOV 1999**

ANSWER FOUR QUESTIONS OUT OF SIX
ALL QUESTIONS HAVE 25 EACH

Q1. (a) Find the current I_x through R in Figure 1 by using Thevenin's Theorem. [15 Points]

(b) Plot I_x for different values of R . Assume first R = 1 Ω . [10 Points].

Q2. Consider the circuit of Figure 2 . Using implicit circuit analysis:

(a) Find powers involved in each of the five elements and indicate whether power is absorbed or generated in the element. Give your answer in table form showing all currents and voltages associated with each element. [15 Points].
(b) Redraw the circuit to demonstrate the application of KVL in order to find the voltage drop V_x across the 2 Ω resistor and I_x as shown. [10 Points].

Q3. The current in a 0.1 F capacitance in Figure 3 is that of a pulse having a value of 4A for times between 0.0 and 0.5 seconds , and zero magnitude thereafter. Sketch the waveforms of the capacitance : voltage v(t), charge q(t), power p(t), and stored energy w(t) as a function of time t. [25 Points]

Q4. Figure 4 is the equivalent circuit of a load supplied from two generators overlines with impedances shown. The load requires 10kW at 0.8 power factor lagging. Source G1 operates at a terminal voltage V1= 460 V and supplies 5kW at 0.8 power factor lagging. Using the Volt-Ampere Method: find values of V2 and V_L, and P2, Q2 for G2. [25 Points].

Q5. (a) Define the resonance condition for a series impedance circuit. [10 Points].

(b) Determine the resonance frequency of the circuit in Figure 5. [15 Points]

Q6. (a) In Figure 6a : Use KVL and the Transistor DC Equivalent Circuit of an Emitter Follower Zener Voltage Regulator to determine output DC voltage. State all assumptions used if any. [10 Points]

(b) Draw an unregulated AC /DC full wave bridge rectifier circuit. Show the input and output waveforms as a function of ωt from 0 to 360^0. Then show from first principles that the average DC output voltage of a full wave bridge rectifier is $V_{DC} = 2 V_m / \Pi$. Where V_m is the peak of the AC input voltage. [15 Points]

END OF EE209 SEM I DEFERRED FINAL EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

UNIVERSITY EXAMINATIONS MAY 1999

EE 311 ELECTRIC CIRCUITS

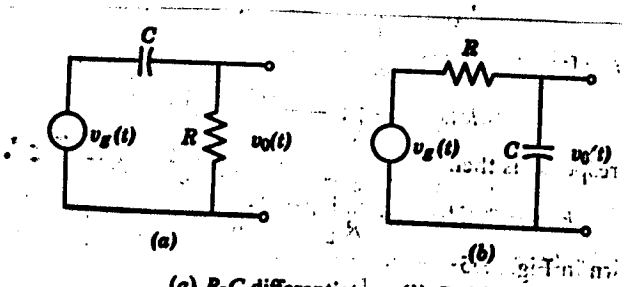
Time: Three hours

Answer: Five questions

Laplace transform table will be distributed

Q1.

(a)



(a) *R-C* differentiator. (b) *R-C* integrator.

(a) Analyse the above R-C differentiator and integrator circuits. In doing so make the necessary assumptions

(b) When the excitation is a voltage source and the response is also a voltage, then the system function H(s) is a voltage ratio transfer function. Draw this circuit and analyse it.

Q3. Solve the following equation

$x''(t) + 3x'(t) + 2x(t) = 4\delta'(t)$

using step and impulse response method

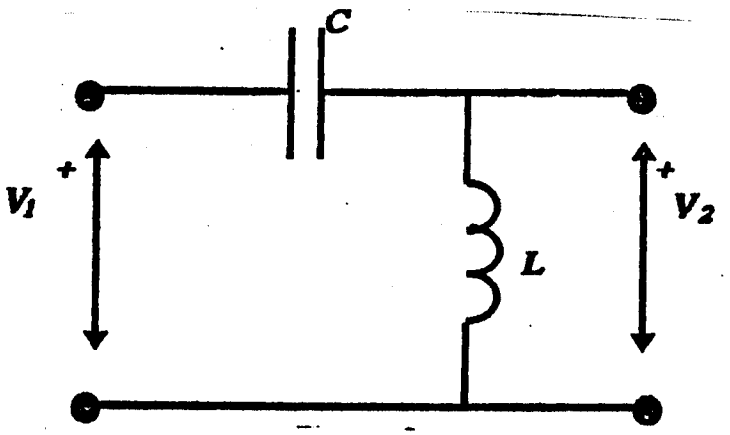
(c) find the impulse response for the equation

$2x''(t) + 4x'(t) + 10x(t) = \delta'(t)$

the initial conditions at t = 0- are

$x(0-) = x'(0-) = x''(0-) = 0$

Q4. Consider the network in figure

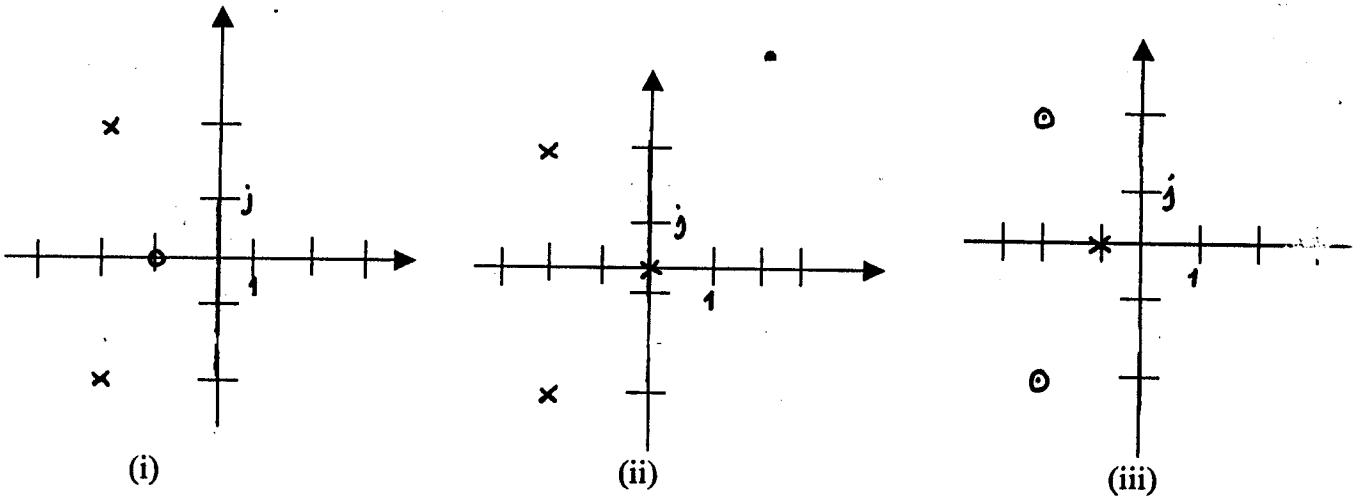


(*a*) Find the transfer function $H(s) = \frac{V_2(s)}{V_1(s)}$

(b) Find the step response from the network

(c) Find the impulse response of the network in the time domain.

Q5. Consider the three different pole zero plots in the s-planes in the figure



(i) (ii) (iii)

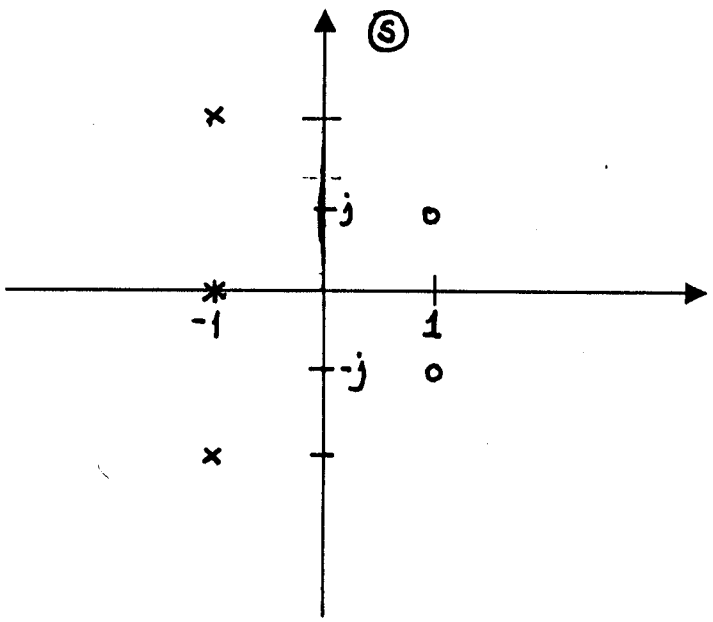
(a) Find the transfer function H(i), H(ii) and H(iii)

(b) If these systems are driven by steps, what responses will we get for (i), (ii) and (iii) respectively.

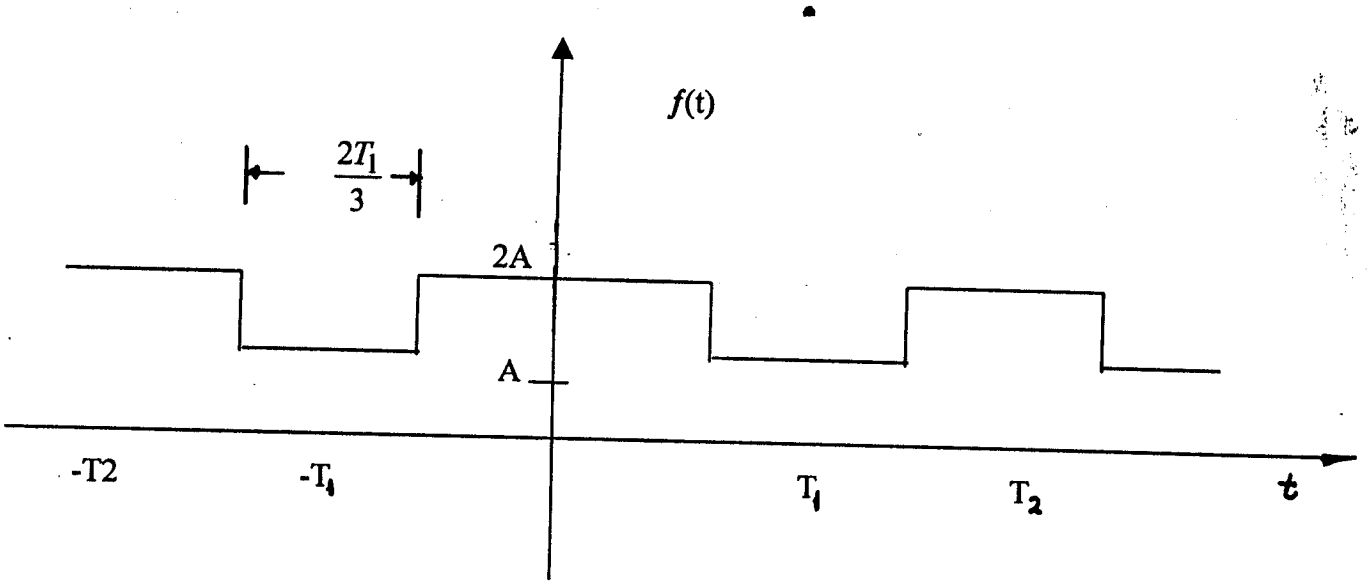
(c) Which transfer function (i) (ii) or (iii) perform integration.

(d) Consider the s-plane in the Figure,

Find the laplace equation F(s) of the pole zero plot



Q6. Consider the periodic time function $f(t)$ as shown



The function $f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty}(an \cos n\omega t + bn \sin n\omega t)$

(a) Find the constant a_o

(b) Find the constant a_n

(c) Find the constant b_n

Q7. In this problem you shall answer "true" or 'false." You should attach the reasoning behind your answers. Wrong answers will be penalised.

		True	False
(a)	For a system to be stable the Laplace equation has to have its zeros in the left part of the s-plane.		
(b)	The fourier transform of an odd time function is pure imaginary.		
(c)	The intergral of the δ function is the step function		
(d)	The voltage over an ideal inductor cannot change instantaneously unless the driving function is an impulse.		
(e)	The fourier transform of x(t) = cos t equals $X(f)=\delta\left(f+\frac{1}{2\pi}\right)-\delta\left(f+\frac{1}{2\pi}\right)$		

Q8. (a) Give the voltage – current relation for a resistor

(b) Give the equation that describes the current in an ideal capacitor, $i_c(t) = \ldots$

Give the equation that describes the voltage over an ideal capacitor, $U_c(t) = \ldots$

(c) Give the equation that describes the current in an ideal inductor, $i_L(t) = \ldots$

Give the equation that describes the voltage over an ideal induct $U_L(t)\ldots$

(d) Repeat the above (a) to (c) in complex frequency domain.

1.	$f(t)$	$F(s) = \int_{0-}^{\infty} f(t)e^{-st}dt$
2.	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(s) + a_2 F_2(s)$
3.	$\frac{d}{dt} f(t)$	$sF(s) - f(0-)$
4.	$\frac{d^n}{dt^n} f(t)$	$s^n F(s) - \sum_{j=1}^{n} s^{n-j} f^{(j-1)}(0-)$
5.	$\int_{0-}^{t} f(\tau)d\tau$	$\frac{1}{s}F(s)$
6.	$\int_{0-}^{t}\int_{0-}^{\sigma} f(\tau)d\tau d\sigma$	$\frac{1}{s^2}F(s)$
7.	$(-t)^n f(t)$	$\frac{d^n}{ds^n}F(s)$
8.	$f(t-a)u(t-a)$	$e^{-as}F(s)$
9.	$e^{at} f(t)$	$F(s-a)$
10.	$\delta(t)$	1
11.	$\frac{d^n}{dt^n}\delta(t)$	s^n
12.	$u(t)$	$\frac{1}{s}$
13.	t	$\frac{1}{s^2}$
14.	$\frac{t^n}{n!}$	$\frac{1}{s^{n+1}}$
15.	$e^{-\alpha t}$	$\frac{1}{s+\alpha}$
16.	$\frac{1}{\beta-\alpha}\left(e^{-\alpha t} - e^{-\beta t}\right)$	$\frac{1}{(s+\alpha)(s+\beta)}$
17.	$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
18.	$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
19.	$\sinh at$	$\frac{a}{s^2-a^2}$
20.	$\cosh at$	$\frac{s}{s^2-a^2}$
21.	$e^{-\alpha t}\sin \omega t$	$\frac{\omega}{(s+\alpha)^2+\omega^2}$
22.	$e^{-\alpha t}\cos \omega t$	$\frac{s+\alpha}{(s+\alpha)^2+\omega^2}$
23.	$\frac{e^{-\alpha t}t^n}{n!}$	$\frac{1}{(s+\alpha)^{n+1}}$
24.	$\frac{t}{2\omega}\sin \omega t$	$\frac{s}{\left(s^2+\omega^2\right)^2}$
25.	$\frac{1}{\alpha^n}J_n(\alpha t)$; $n = 0,1,2,...$ (Bessel function of first kind, n'th order.)	$\frac{\left[\sqrt{s^2+\alpha^2}-s\right]^n}{\sqrt{s^2+\alpha^2}}$
26.	$\frac{1}{\sqrt{\pi t}}$	$s^{-1/2}$
27.	t^k (k need not be an integer)	$\frac{\Gamma(k+1)}{s^{k+1}}$

Q3(a)
given initial
conditions
$x(0-) = -2$
$x'(0-) = -1$
$x''(0-) = 7$

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DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS MAY 1999

EE321

ELECTROMECHANICS & ELECTRICAL MACHINES

Time: **Three hours.**
Answer five questions.

Permeability of free space, $\mu_0 = 4\pi \times 10\text{-}7$ H/m
Permittivity of free space, $\varepsilon_0 = 8.85 \times 10\text{-}12$ F/m

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1.

What are the factors which determine the capacitance of a parallel plate capacitor? Mention how a variation in each of these factors will influence the value of the capacitance.

[10 marks]

A 5-μF capacitor having a paper dielectric has to operate on a peak voltage of 500 V. This capacitor is to be charged from a dc source. Determine the plate area and spacing if the maximum permissible stress in the paper is 250 kV/m and the relative permittivity is 6.

[10 marks]

2.

For a uniform magnetic circuit with constant cross-sectional area A, length l, and excited by a coil of N-turns, derive the expression of the reluctance S, of the magnetic circuit, and hence the inductance of the coil (a) from the circuit point of view, and (b) from the field point of view.

[12 marks]

The relay shown in Figure 1 has a linear magnetic circuit. When energised with a current of 4 A the flux is 0.5 mWb in the open position and 1.5 mWb in the closed position. Find the air-gap length in the open position and calculate the amount of work done when the relay is closed by energising the coil with a constant current of 4 A.

[8 marks]

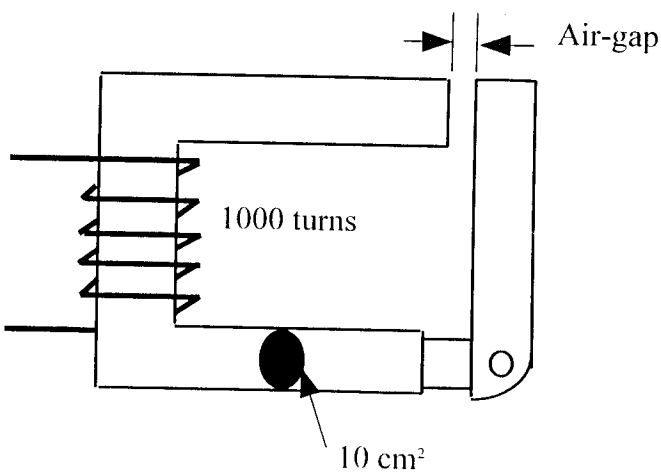


Figure 1.

3.

Derive, from basic principles, expressions for the mechanical forces exerted in (a) an electric field of strength E and relative permittivity ε_r, and (b) a magnetic field of density B and relative permeability μ_r.

[10 marks]

An electrode boiler is designed to absorb 10 kW when connected to a 240-V supply, the depth of the water being 50 cm in the axial direction. The boiler has an earthed metal cylinder of 1 m diameter with non-conducting ends and a co-axial central electrode of 10 cm diameter. What is the required specific conductivity of the water?

[10 marks]

4.

Using graphic illustrations, describe the effect of the non-linearity and saturation of the magnetic circuit on the waveform of the no-load current of a transformer. Referring to the equivalent circuit of a single phase transformer, how are the power losses in the transformer represented?

[8 marks]

The no-load input to a 5-kVA, 500/100-V, single phase transformer is 100 W at 0.15 lagging power factor at rated voltage. The voltage drops due to resistance and leakage reactance are 1% and 2% respectively, of the rated voltage, when the transformer operates at rated load. Find the input power and input power factor when the load is 3 kW at 0.8 power factor lagging at rated voltage.

[12 marks]

5.

Show the connections of the two-wattmeter method for measuring power in a three-phase system. Prove that this method gives total power in a general unbalanced situation.

[8 marks]

A 380-V line feeds two balanced three-phase loads. The first load is at 5 kVA at 0.8 lagging power factor while the second is a 10-kVA load at 0.9 lagging power factor. What is the line current measured at the line terminal? Determine the readings of two wattmeters connected at the terminals to measure the total power.

[12 marks]

6.

From "$v = Blu$", where l is the length of a conductor, cutting a magnetic field of density B at constant speed u, and experiences an induced voltage v, derive expressions for the brush terminal voltage for a commutator machine and for a slip-ring machine.

[8 marks]

A dc generator has an open circuit characteristic given by $V_{oc} = \frac{200\ I_f}{k + I_f}$ such that the open circuit voltage V_{OC} is 150 V when the field current is 1.5 A. Find the open circuit voltage when the field resistance is 200 Ω. If the armature resistance of the generator is 0.5 Ω, calculate the terminal voltage and the load current when the armature is connected to a load of resistance 10 Ω with the field resistance at 100 Ω.

[12 marks]

7.

Derive the torque-speed characteristic of a dc series motor, clearly stating any assumptions. Contrast this with the torque-speed characteristic of the dc shunt motor.

[10 marks]

A 220-V dc series motor takes 60 A when developing its rated output at 1000 rpm. The armature resistance is 0.12 Ω and the field resistance is 0.08 Ω.

(a) Calculate the torque developed at rated output.

[4 marks]

(b) If the maximum current on starting is not to exceed 100 A, find the resistance to be connected in series at starting and the starting torque.

[6 marks]

8.

Show how a constant speed "rotating" magnetic field of fixed magnitude is produced from a set of balanced three-phase sinusoidal currents. Hence develop a simplified equivalent circuit of the synchronous machine.

[14 marks]

With the use of phasor diagrams, distinguish between the modes of operation of the synchronous machine as a generator and as a motor, and between leading and lagging reactive power handling.

[6 marks]

END OF EE321 EXAMINATION

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF ELECTRICAL AND ELECTRONIC OF ENGINEERING
UNIVERSITY EXAMINATION - MAY 1999
EE 411 Electromagnetic Fields

Time : ***Three hours***
Answer: ***Four questions.*** **All questions carry equal marks**

Question 1 .

(i) Given a vector function $F=(x+c_1z)\,a_x+(c_2x-3z)a_y+(x+c_3y+c_4z)a_z$.
Determine : (a) the constant c_1,c_2, and c_3 if F is irrotational; (b) the constant c_4 if F is also solenoidal; and (c) the scalar potential function V whose negative gradient equals F.(6 *pts*)

(ii) Three units vectors are given in cylindrical coordinates as follows : A = a_{rc} at $\left(1,\pi/2,0\right)$, B = a_ϕ at $\left(2,\pi/3,1\right)$ and C = a_z at $\left(1,\pi/4,0\right)$. Find : (a) A . B ;(b) A x B; and (c) B . C *(7 pts)*

(iii) Convert the vector $a_x+a_y-\sqrt{2}\,a_z$ at the point $\left(1,1,\sqrt{2}\right)$ to one in spherical coordinates.*(6 pts)*

(iv) Obtain the equations for the flux lines for the following vector fields : (a) $2y\,a_x-x\,a_y$ and ; (b) $x\,a_x+y\,a_y+z\,a_z$ *(8 pts)*

Question 2

(i) A ssume that in the parallel -plate capacitor of Fig.2i,(a) , a source of mechanical force F_m is applied to the movable plate such that F_m is always maintained equal to electric force - F_e. By appropriately varying V and F_m , the system is made to traverse the closed cycle in Q-x plane , shown in Fig.2i,(b). Calculate the energy converted per cycle and determine whether the conversion is from electrical to mechanical or vice versa *(4 pts)*

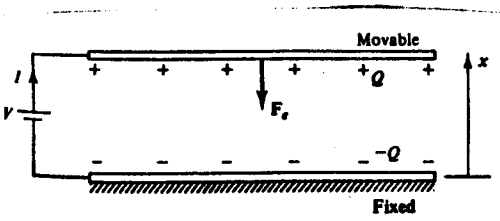


Fig.2.i,(a)

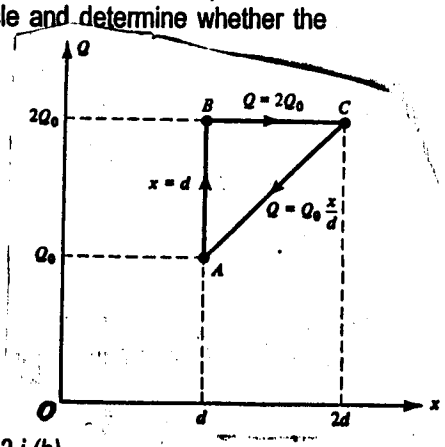


Fig.2.i,(b)

(ii) The end of a coaxial cable is closed by a dielectric piston of permittivity ε , as shown in Fig. 2ii (a partial cut view) . The radii of the cable conductors are *a* and *b* and the other part of the cable is air . What is the magnitude and the direction the axial force acting on the piston(explain why in that direction), if the potential between the conductors is V ? *(10 pts)*

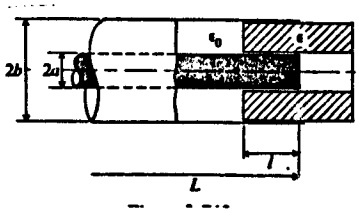


Fig.2.ii

Question 3.

(i) - Explain what is meant by the terms,electrotstic field , magnetostatic field , electroctromagnetic field and specify for each the different forms (i.e point and integral forms) of the governing equations *(6 pts)*

(ii) - A person does a work *W* pushing a carton of mosi beer up an inclined plane , through a distance l as illustrated in Fig. 3.i . What is the physical meaning of the gradient *dW / dl* ? *(3 pts)*

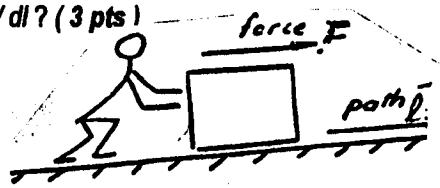


Fig. 3.i

(iii) - Make a two -dimension sketches of the electric field lines for an electric and magnetic dipoles (2 pts)

(iv) - Let us consider an electric machine with two different media 1 and 2 ; the first one is nomagnetic (like air) and the second is a ferromagnetic magnetic material (like iron) having permiability μ_1 and μ_2 respectively. Assume that μ_1 is negligible comparing to μ_2 and that the magnetic flux lines in the second media reach the interface at any arbitrary angle θ . How do the flux lines will emerge in the the first medium and explain .*(3 pts)*

(v) - Explain what is meant by the terms soft and hard ferromagnetic materials, and indicate some of them. And in which case of applications for each are desirable or indesirable (explain why using an appropriate graphs for illustration).*(3 pts)*

(vi) Prove the following statement : the charges introduced in the interior of a conductor will move to the conductor surface and redistribute themselves in such a way to make in time $\rho_v = 0$ and **E** inside under equilibrium conditions.*(4 pts)*. And how much time does the initial charge density ρ_{vo} (i.e., ρ_v at $t = 0$) will take to drop to 38.8 % of its value? *(2 pts)* . Discuss the difference of the relaxation time for a good conductor (like a copper) a and that of a good insulator (like a fused quartz). Explain why the difference. *(2 pts)*

Question 4.

(i) The electric field intensity in polystyrene ($\varepsilon_r = 2.5$) filling the space between the plate of a parallel - plate capacitor is 10 kV /m. The distance between the plates is 1.5 mm. Calculate : (a) the displacement vector; (b) the polarization vector; (c) the surface charge density of free charge on the plates; (d) the surface density of polarization charge; (d) the pressure on the surface of the plate due to electric field; (e) the p.d. between plates. *(10 pts)*

(ii) Given the magnetic vector potential $\mathbf{A} = -\frac{r_c^2}{4}\,\mathbf{a_z}$ Wb/m, calculate the total magnetic flux crossing the surface $\phi = \pi/2$, $1 \le r_c \le 2\,m, 0 \le z \le 5\,m$.*(8 pts)*

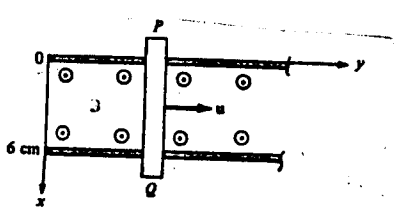
(iii) A small current loop L_1 with magnetic moment $5\,\mathbf{a_z}$ A.m^2 is located at the origin while another small loop of current L_2 with a magnetic moment $3\,\mathbf{a_y}$ A.m^2 is located at (4, -3, 10) . Determine the torque on L_2. *(7 pts)*

Question 5.

(i) Two long ,straight wires cross at right angles in a plane , such that one is along the X axis and the other is along the Y axis. If each wire carries a current I (the first I_1 in the X direction and the second I_2 in the Y direction) , where in the plane the total **B** field from the two wires equal to zero for I_1 equal I_2 and then for I_1 different to I_2. *(7 pts)*

(ii) The xy-plane serves as the interface between two different media. Medium 1 ($z < 0$) is filled with a material whose $\mu_r = 6$ while medium 2 ($z > 0$) is filled with a material whose $\mu_r = 4$. If the interface carries current $1/\mu_o\,\mathbf{a_y}$ mA/m, and $\mathbf{B_2} = 5\,\mathbf{a_x} + 8\,\mathbf{a_z}$ Wb/m^2. Find H_1 and B_1 . *(9 pts)*

(iii) A conducting bar can slide freely over two conducting rails as shown in Fig.5iv. Calculate the induced voltage in the bar : (a) if the bar is stationed at y = 8 cm and $\mathbf{B} = 4\cos 10^6 t\;\mathbf{a_z}\,mWb/m^2$; (b) if the bar slides at velocity $\mathbf{u} = 20\,\mathbf{a_y}\,m/s$ and $\mathbf{B} = 4\;\mathbf{a_z}\,mWb/m^2$ *(9 pts)*



End of EE411 Exam.

University of Zambia
Department of Electrical and Electronic Engineering
University Examination, June, 1999
EE471 Telecommunication I

Time: **Three** Hours
Answer: **Five** Questions

Permitted Materials
Calculator
Table of Bessel Function
Complimentary Error Function Table
Smith Chart

Question 1

(i) A receiver system consist of a waveguide with L_1 = 1.5dB, a preamplifier with G_2=20dB and the temperature T_2 = 50K, and a receiver with F_3 = 10dB. To what temperature must the waveguide be cooled so that the system has $T_e \leq 150K$? [4]

(ii) A receiver system consists of a preamplifier with F = 3dB and g = 20dB, a cable with L = 6dB at T_0, and a receiver with F = 13dB. (a) Calculate the system noise figure in dB. (b) Repeat part a with the preamplifier between the cable and the receiver. What significant difference did you notice between the two configuration? [4]

(iii) When the noise temperature at the input to a certain amplifier changes from T_0 to $2T_0$, the output noise power increases by one-third. Find T_e and F. [4]

(iv) Derive a formula for the overall noise figure for an analog cascade network, as shown in Fig. 1.1, by considering noise out from stage one is noise in for stage two and a similar scenario for stage three. State the important relationship between F_1 and G_1 for the network. [8]

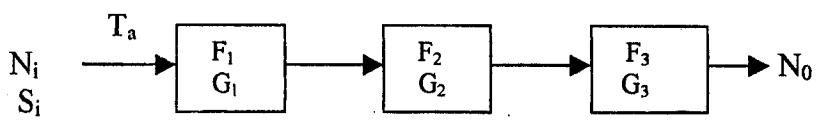


Figure 1.1 An analog cascade network block diagram

Question 2

(i)We are given a four point filter $x_0 = x_1 = 1$, and $x_2 = x_3 = -1$. The discrete frequency response $X\left(\frac{n2\pi}{N}\right) = \sum_{k=0}^{N-1} x_k e^{\frac{-j2\pi nk}{N}}$. Find the DFT for X(n)of the filter and plot its frequency response from π to $-\pi$. The filter frequency response is given by $x(\omega) = \sum_{k=0}^{3} x_k e^{-j\omega}$. [7]

(ii) Consider a purely real signal x_k, using the definition of the DFT, prove the following: $|X_1| = |X_{N-1}|$ and $\phi(X_1) = -\phi(X_{N-1})$. [5]

(iii) Let x(t) be an energy signal, bandlimited to BHz, and $x_s(t)$ be a sampled version of x(t) with sampling interval T_s. A periodic version of x(t) with period T can be expressed as a Fourier Series. We know that the Fourier Series coefficients, Cn, can be derived from X(f), taking on the form: $C_n = \frac{1}{T} X\left(\frac{n}{T}\right)$. From this information derive the DFT definition - $X_n = \sum_{k=0}^{N-1} x_k e^{-\frac{j2\pi nk}{N}} = \frac{1}{N} \sum_{n=0}^{N-1} X_n e^{-\frac{j2\pi nk}{N}}$ [4]

(iv) Find the DFT for the sampled ramp shown in Figure2.1. [4]

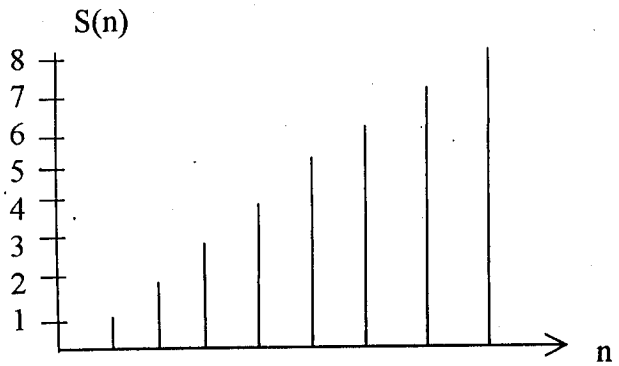


Figure 2.1 A sampled ramp function

Question 3

(i) The envelope of an AM wave has the same shape as the message, independent of carrier frequency and phase, demodulation can be accomplished by extracting the envelope. Sketch the schematic diagram of a simple diode AM detector, and state the importance of the following: [6]

(a) State the purpose of the resistor-capacitor (RC) network in terms of detection and the two different RC time constants

(b) The relationship between carrier frequency, f_c, and the signal bandwidth, B.

(ii) The multitone modulating signal $x(t) = 2K(Cos10\pi t + 4Cos30\pi t)$ is the input to an AM transmitter with modulation index m = 1 and f_c = 1000. Find K so that x(t) is properly normalized, draw the positive frequency line spectrum of the modulated wave. [10]

(iii) Calculate the peak envelope power of an AM wave with 100% tone modulation (modulation index is 1) and transmitted power, P_T = 6Kw. [4]

Question 4

(i) An FM modulator has input m(t) = 2cos 8πt. The peak frequency deviation of the modulator output is 32Hz. The modulator is followed by an ideal bandpass filter with a center frequency equal to the carrier frequency and a bandwidth of 20Hz. Determine the power at the filter output assuming that the power at the modulator output is 100W. [5]

(ii) An FM modulator has output - $x_c(t) = 40\cos\left[2\pi f_c t + 2\pi f_d \int m(t)dt\right]$, where f_d=10Hz/V. Assume that m(t) = 5 [rec (t – 1)]. [10]

(a)Sketch the phase deviation
(b)Sketch the frequency deviation
(c)Determine the peak frequency deviation in hertz
(d)Determine the peak phase deviation in radians, and
(e)Determine the power of the modulator output.

(iii) Design a FM detector Foster-Seeley frequency discriminator schematic circuit, and briefly describe the operation of the circuit with aid of diagram. What is the purpose of the RF choke in your design? [5]

Question 5

(i) Draw a block diagram for a PAM wave natural sampling, and briefly describe the mode of operation, with the aid of equation and diagram. [5]

(ii) Sketch a schematic diagram of a short section of a particular modulating wave, the sampling pulse train, and the corresponding PAM, PPM, and PDM [6]

(iii) A hardware design engineer is engaged as a consultant to design a PDM system, and was given the following specification: [4]

- Leading edge sawtooth wave sampler
- Message signal will be multi-tone sinusoid with centre frequencies, f_1=35KHz and f_2=63.5KHz respectively
- Should state the minimum sampling rate for the sawtooth wave and the minimum bandwidth required.

(iv) We want to transmit 899 characters/s, where each character is represented by its 7-bit ASCII codeword, followed by an eighth bit for error detection, per character,. A multilevel PCM format with M = 16 levels is used. [5]

(a)What is the effective transmitted bit rate?
(b)What is the PCM symbol rate?

Question 6

(i) A linear combination of orthogonal signals can be used to construct arbitrary wave Demonstrate the following concept: [8]

(a) Show that the three functions illustrated in Fig. 6.1 are pairwise orthogonal over the interval (-2, 2).
(b) Determine the value of the constant, A, that makes the set of functions in part (a) an orthonormal set.
(c) Express the following waveform, x(t), in terms of the orthonormal set of part (b) above.

Where, $x(t) = \begin{cases} 1 & for 0 \le t \le 2 \\ 0 & otherwise \end{cases}$

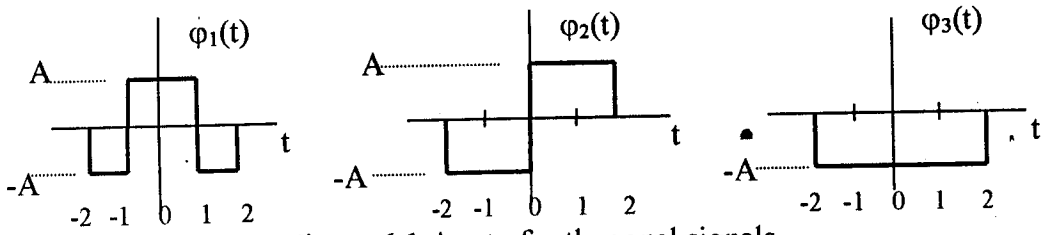


Figure 6.1 A set of orthogonal signals.

(ii) Design a coherent detector for a binary transmission system which transmits the following two signals:

$$S_1(t) = A\text{Cos}(2\pi f_c t)$$
$$S_2(t) = A\text{Cos}(2\pi f_c t + 180^0)$$

Use only one local oscillator and correlator. Assume that the signals are equally likely. [4]

(iii) An ASK system is to be designed where the peak amplitude of the sinusoidal bursts is 0.5Volts. The Additive White Gaussian Noise has a power spectral density of 10^{-5}Watts/Hz. A control loop is used to recover the carrier, so a coherent detector can be used. What is the maximum bit transmission rate if the specifications call for a maximum bit error rate of 10^{-4}? [4]

(iv) Find the probability of bit error, Pb, for the coherent matched filter detection of the equally likely binary FSK signals

$$S1(t) = 0.5 \cos 2000\pi t$$
$$S2(t) = 0.5 \cos 2020\pi t$$

Where the two-sided AWGN power spectral density is $N_o/2 = 0.0001$. Assume the symbol duration is T = 0.01s. [4]

Question 7

Note! Submit your labelled Smith Chart with your solution.

(i) A 50Ω line has a VSWR of two (2) when an unknown load impedance is connected to its output terminals. Adjacent voltage minima are found to be 30cm apart. When the unknown load is removed from the line and replaced by a short circuit the voltage minima moves by 7.5cm towards the source. Calculate the value of the unknown load impedance. [6]

(ii) A lossless transmission line of length 0.434λ and characteristic impedance 100Ω is terminated in an impedance (20 + j180) Ω. Find: [4]

(a) The voltage reflection coefficient, Γ
(b) The standing wave ratio, S
(c) The input impedance Z_i, and
(d) The location of a voltage maximum on the line.

(iii) The single-stub method is used to match a load impedance (25 + j25) Ω, to a 50Ω transmission line. Find the required length and position of a short-circuited stub made of a section of the same 50Ω line. [6]

(iv) Calculate the position and length of a short-circuited stub designed to match a 200Ω load to a transmission line whose characteristic impedance is 300Ω. There was disturbance on the line, calculate the SWR on the main line when the frequency is increased by 10 percent, assuming that the load and line impedances remain constant. [4]

Question 8

(i) The vertical height of a layer is 110Km and its critical frequency is 4MHz. Calculate the MUF (minimum usable frequency) for two points on the surface of the earth that are 600Km apart. Assume the earth surface to be flat. [4]

(ii) From the illustration of direct and reflected rays in Fig. 8.1, on the assumption of a flat earth prove that the difference in path lengths is $R_2 - R_1 = \frac{2h_t h_r}{d}$. When h_1 and h_2 are very small compared with d, and use of the binomial expansion can be exploited. Briefly explain the effects of interference on field strength relative to its value under free-space conditions. [6]

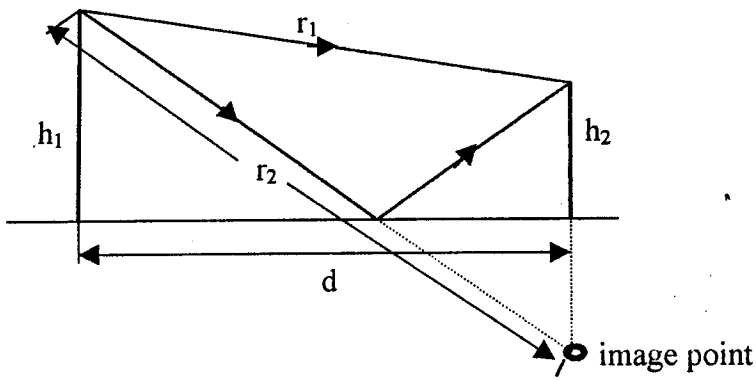


Figure 8.1 Illustration of direct and reflected rays.

(iii) With the aid of diagram or equation, define the following terms: [8]

(a)noise floor

(b)Total Harmonic Distortion

(c)Minimum Detectable Signal

(d)Third Order Intermodulation Product

Fundamental Constants:

Boltzmann's Constant	$K = 1.38 \times 10^{-23}$
Velocity of light in free space	$c = 2.997 \times 10^{8}$ m/s
Charge on the electron	$q = 1.6 \times 10^{-19}$C

Noise Figure = $\dfrac{input(S/N)ratio}{output(S/N)ratio}$

Noise Figure of cascade amplifiers (Friis formula):

$$F_{total} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$

Noise:

Thermal $\overline{V_n}^2 = 4KTRB$ $\overline{i_n}^2 = 4KTB/R$

Shot $\overline{i_n}^2 = 2qIB$

Flicker $\overline{i_n}^2 = \dfrac{K(I_{DC})^a B}{f_b}$

Power Transfer:
Maximum power delivered to matched load $V^2/4R$

Linear Modulation:

modulation index $q = \dfrac{V_{max} - V_{min}}{V_{max} + V_{min}}$

power efficiency η = (power in side tone)/(power in total)

Angular Modulation:
instantaneous phase $\phi(t)$
PM $k_p m(t)$, FM $2\pi k_f \int m(\lambda)d\lambda$

Digital Modulation

Coherent Detection: PSK $Q\left(\sqrt{\frac{2E_b}{N_0}}\right)$, ASK, FSK $Q\left(\sqrt{\frac{E_b}{N_0}}\right)$

Noncoherent Detection: FSK $\frac{1}{2}\exp^{\left(-\frac{E_b}{2N_0}\right)}$, MPSK (M-1) $Q\left(\sqrt{\frac{E_s}{N_0}}\right)$

Transmission lines:

$$Z_i = Z_0\left[\frac{Z_l \cos\beta\ell + jZ_0 \sin\beta\ell}{Z_0 \cos\beta\ell + jZ_L \sin\beta\ell}\right]$$

SWR = $\dfrac{1+|\Gamma|}{1-|\Gamma|}$, For loss-less line $Z_0 = \sqrt{\dfrac{l}{c}}$

Trigonometric Identity:
$\sin(a) + \sin(b) = 2\sin[(a+b)/2]\cos[(a+b)/2]$
$\cos^2(a) = [1 + \cos(2a)]/2$
$\cos(\theta) = (e^{j\theta} + e^{-j\theta})/2$

Binomial Theorem

$$(a+b)^n = a^n + \frac{na^{n-1}b}{1!} + \frac{n(n-1)a^{n-2}b^2}{2!} + \ldots + nab^{n-1} + b^n$$

TABLE 2.

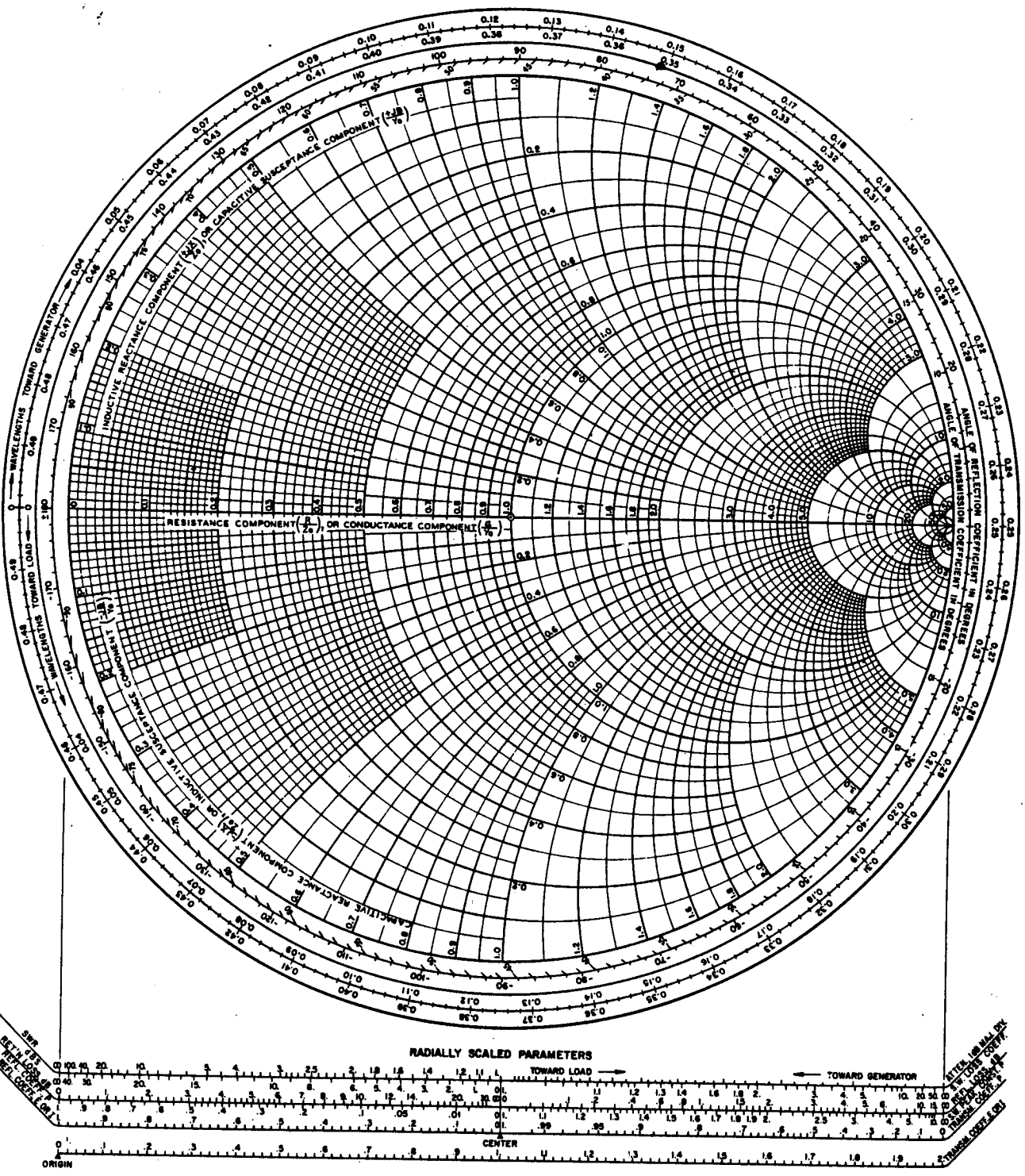
FM Side Frequencies from Bessel Functions

x (β)	n Order															
	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	-
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	-
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	-
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	-
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	-
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	-
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	-
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	-
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	-
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	-
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	-
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	-
8.0	0.17	0.23	−0.11	−0.29	−0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	-
9.0	−0.09	0.24	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.30	0.21	0.12	0.06	0.03	0.01	—	-
10.0	−0.25	0.04	0.25	0.06	−0.22	−0.23	−0.01	0.22	0.31	0.29	0.20	0.12	0.06	0.03	0.01	-
12.0	0.05	−0.22	−0.08	0.20	0.18	−0.07	−0.24	−0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.
15.0	−0.01	0.21	0.04	−0.19	−0.12	0.13	0.21	0.03	−0.17	−0.22	−0.09	0.10	0.24	0.28	0.25	0.

The probability of an error, P_B, is equal to the probability that an incorrect hypothesis, H_1, will be decided when $s_2(t)$ is sent, or that H_2 will be decided when $s_1(t)$ is sent. Thus P_B is numerically equal to the area under the "tail" of either

TABLE 1 Complementary Error Function $Q(x) = \int_x^\infty (1/\sqrt{2\pi}) \exp(-u^2/2)\, du$

	$Q(x)$									
x	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2168	0.2148
0.8	0.2169	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002



SMITH CHART (1966) with transmission coefficient scales (see Chart A in cover envelope).

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Department of Electrical and Electronic Engineering
UNIVERSITY EXAMINATIONS - MAY 1999
EE481: COMPUTER ENGINEERING

TIME: THREE HOURS
ANSWER: ANY FIVE QUESTIONS
TOTAL MARKS: 100

Q1. (a) Draw a flowchart for a computer program for sorting 100 different positive integers in the ascending order of magnitude. Use the interchange sort algorithm.
(b) Write a PL/I program for sorting 200 different positive integers in the ascending order of of magnitude by using the interchange sort.

[10+10]

Q2. (a) Write a C program to count lines, words, and characters in input.
(b) Write a binary search function in C language that finds if a particular value x occurs in the sorted array v. The elements of v must be in increasing order. The function returns the position if x occurs in v, and -1 if not.

[10+10]

Q3. (a) Write the C function "atoi ", which converts a string of digits into its numeric equivalent. Explain the working of the function by means of an example.
(b) Write a C program that reads a set of text lines and prints the longest. Use character arrays and functions to manipulate them in this program. Make any necessary assumptions.

[8+12]

Q4. (a) Explain "call by value" and "call by reference" that are found in computer languages.
(b) Explain recursion.
(c) What is a pointer in C ? Explain with an example. Can a pointer be considered as a variable ?
(d) Write a function escape (s,t) that converts characters like newline and tab into visible escape sequences like \n and \t as it copies the string t to s.

[6+3+4+7]

Q5. (a) Explain various inter -register transfer micro-operations giving the statements in symbolic notation using the register transfer language. Explain at least seven such micro-operations.
(b) Explain the following arithmetic micro-operation:

$$P: EA \leftarrow A+B$$

Draw the block diagram for its hardware implementation.
(c) An 8-bit register A has one binary input x. The register operation can be described symbolically as follows:

$$P: A_8 \leftarrow x,\ A_i \leftarrow A_{i+1},\ i = 1,2,\ldots,7$$

What is the function of the register ? The cells are numbered from left to right.
(d) Show the block diagram that executes the statement

$$T: A \leftarrow B,\ B \leftarrow A$$

(e) A serial computer employs 32-bit registers and clock pulses at a rate of one million per second.What is the bit time and the word time of the computer ?

[7+6+2+3+2]

Q6. (a) Show the hardware in the form of a block diagram for the symbolic statement

$$FT_1 + R'T_3 : A \leftarrow B$$

Where A and B are registers. The control function is $FT_1 + R'T_3$

(b) Discuss briefly the internal architecture of the Intel 8085A microprocessor.
(c) What is the function of a control unit in a microprocessor. Show the control unit with the instruction register and the instruction decoder in one diagram. Comment on the actions implemented by the control unit for the instruction execution. Draw a state diagram to show the instruction execution cycles in a microprocessor. There should be a provision for the halt instruction.

[4+9+7]

(CONTINUED IN PAGE 2)

Q7. (a) Explain the following program written in 8085A assembly language :

```
IN 40H
OUT 20H
HLT
```

(b) Explain the following statements written in 8085A assembly language :

(i) MOV A,H
(ii) LDA 2050H
(iii) MOV E,M
(iv) SUI 7

(c) Write a single byte instruction that transfers a byte of data from register B to a memory location. Use 8085A assembly language.

(d) What is a two-pass assembler ? Draw the simplified flowchart of the first pass of a two-pass assembler and explain the flowchart.

[4+6+2+8]

Q8. Write short notes on any four :

(a) External variables and scope (b) Phases of a compiler (c) Levels of abstraction in a database management system (d) DMA in a microprocessor (e) The "switch" statement in C (f) Procedure and begin blocks in PL/I (g) Input/output statements in PL/I (h) DO statements in PL/I (i) Arithmetic,relational,and logical operators in C.

[20]

END OF QUESTION PAPER.

The University of Zambia
Dept of Electrical & Electronic Engineering

EE561 (SYSTEMS & CONTROL ENGINEERING I)

FIRST SEMESTER EXAMINATIONS

OCTOBER, 1999

ANSWER ANY **FIVE** QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

A STANDARD TABLE OF LAPLACE TRANSFORMS IS SUPPLIED

Q1. (a) Define stability and with the help of examples show the stability possibilities of a system. Why do we consider system stability to be very important during the design of a control system?

(b) A six legged micro robot system using highly flexible legs with high gain controllers may be represented as the block diagram in Fig. 1. Determine the stability of the system

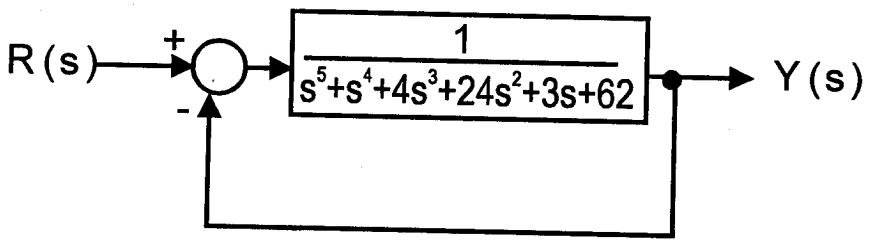


Fig. 1.

Q2. (a) With the help of simple illustrations, discuss the advantages and disadvantages of feedback.

(b) A process whose transfer function is given as $\frac{s+1}{s(s-1)(s+6)}$ is to be controlled directly by an amplifier of gain K (proportional control). If there is negative unity feedback in the control system, determine

(i) the block diagram of the control system

(ii) the range of values of the amplifier gain K for which the system is stable.

Q3. (a) Part of a system in a plant comprises two masses m_1 and m_2 interconnected by a spring with a spring constant K_2 and a dumper whose constant is b. The mass m_2 hangs at the end of another spring with a spring constant K_1 which is fixed on the other end to the ceiling. A downward force F, is exerted on to mass m_1. If the state vector includes the positions and velocities of the two masses, derive the state-space model of the system.

(b) A control system is shown in Fig. 2. What should be the transfer function of $G_1(s)$ such that the output C(s) becomes a replica of the input R(s) in appearance? $G_2(s)=\frac{1}{s}$ and $H_1 = H_2 = 1$.

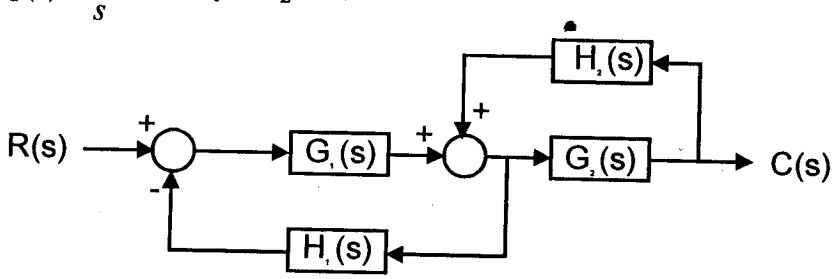


Fig. 2

Q4. (a) A magnetic disk drive requires a motor to position a read/write head over tracks of data on a spinning disk as shown in Fig. 3. The motor and head may be represented by

$$G(s)=\frac{10}{s(\tau s+1)}$$

where $\tau = 0.001$ seconds. The controller takes the difference of the actual and desired positions and generates an error. This error is multiplied by an amplifier K.

(i) What is the steady-state position error for a step change in the desired input?

(ii) Calculate the required K in order to yield a steady-state error of $0.1mm$ for a ramp input of $10cm/s$

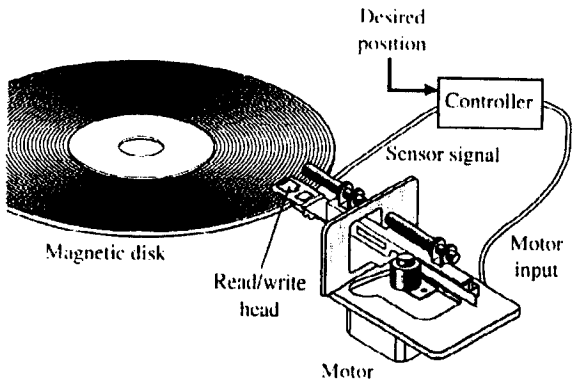


Fig. 3

(b) Find the transfer function of the system represented in Fig. 4.

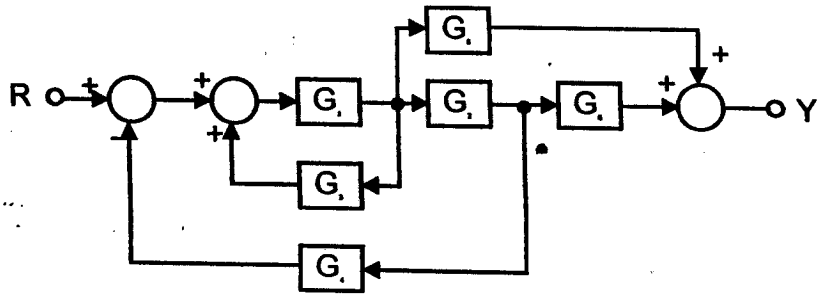


Fig. 4

Q5. (a) What is a control system and name the present challenges to control engineers.

(b) Why has the importance of control engineering been growing in the recent past and state the need for control engineering in industry.

(c) Name and explain the steps required in the design process of a control system.

(d) An industrial plant requires a turntable rotating at a selected constant speed. The plant is required to run for many days without being shut off. You have been asked to design a control system to maintain a constant speed of rotation for the turntable. By using well labelled diagrams, show two control techniques which may be used. Discuss the merits and demerits of each method and state which design you would go for, giving specific reasons for your answer.

Q6. (a) What is model linearization? Name and briefly explain two linearization techniques.

(b) Find the differential equation describing the height of the water in the tank in Fig 5. Assume there is a relatively short restriction at the outlet and that $\alpha = 2$. Linearize the developed model about the operating point h_0.

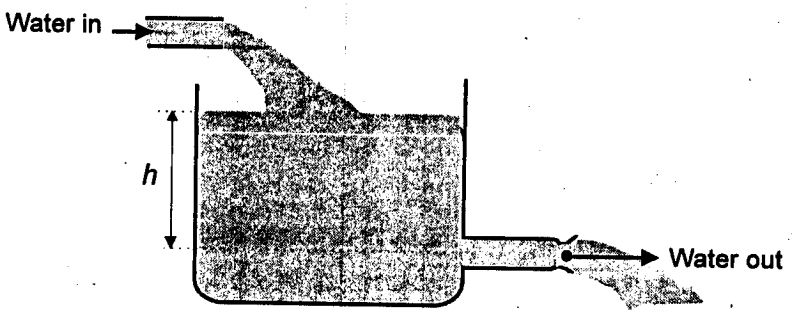


Fig. 5.

Q7. (a) What is the difference between the step and impulse responses of a system?

(b) It is desired to design a system that settles in less than 3s, has a rise time of less than 60 ms and an overshoot of less than or equal to 10%. What are the allowable regions in the s-plane for the poles of the system such that it satisfies the above specifications? Show these specifications on a time response plot.

(c) Does a system with the transfer function $\frac{2s+1}{s^2+2s+5}$ satisfy the specifications in (b)? If not, what could be done to make the system response conform to the desired specifications in (b).

(d) What are nonminimum-phase zero systems?

Q8. (a) A block diagram model of a boring machine control system is given in Fig. 6.

The transfer function of the boring machine is $G(s)=\frac{1}{s(s+12)}$.

(i) What values of K would reduce the effect of distrurbance on the control system?

(ii) What is the steady-state value of the output C(s), when the disturbance signal is a unit step and the desired angle is r(t) = 0?

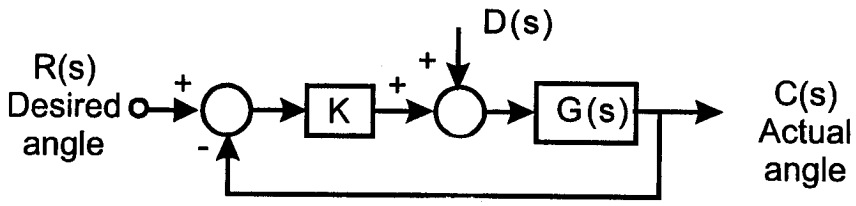


Fig. 6.

******END OF EE561 FINAL EXAMINATION******

TABLE A.2 Table of Laplace Transforms

Number	$F(s)$	$f(t), \quad t \geqslant 0$
1	1	$\delta(t)$
2	$1/s$	$1(t)$
3	$1/s^2$	t
4	$2!/s^3$	t^2
5	$3!/s^4$	t^3
6	$m!/s^{m+1}$	t^m
7	$\dfrac{1}{s+a}$	e^{-at}
8	$\dfrac{1}{(s+a)^2}$	te^{-at}
9	$\dfrac{1}{(s+a)^3}$	$\dfrac{1}{2!}t^2e^{-at}$
10	$\dfrac{1}{(s+a)^m}$	$\dfrac{1}{(m-1)!}t^{m-1}e^{-at}$
11	$\dfrac{a}{s(s+a)}$	$1-e^{-at}$
12	$\dfrac{a}{s^2(s+a)}$	$\dfrac{1}{a}(at-1+e^{-at})$
13	$\dfrac{b-a}{(s+a)(s+b)}$	$e^{-at}-e^{-bt}$
14	$\dfrac{s}{(s+a)^2}$	$(1-at)e^{-at}$
15	$\dfrac{a^2}{s(s+a)^2}$	$1-e^{-at}(1+at)$
16	$\dfrac{(b-a)s}{(s+a)(s+b)}$	$be^{-bt}-ae^{-at}$
17	$\dfrac{a}{s^2+a^2}$	$\sin at$
18	$\dfrac{s}{s^2+a^2}$	$\cos at$
19	$\dfrac{s+a}{(s+a)^2+b^2}$	$e^{-at}\cos bt$
20	$\dfrac{b}{(s+a)^2+b^2}$	$e^{-at}\sin bt$
21	$\dfrac{a^2+b^2}{s[(s+a)^2+b^2]}$	$1-e^{-at}\left(\cos bt+\dfrac{a}{b}\sin bt\right)$

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
EG-279 INFORMATION TECHNOLOGY – EXAMINATION

October 1999

INSTRUCTIONS

TIME: **Three Hours**

ATTEMPT: Question 1 and any other two questions from SECTION A and question 5 and another question from SECTION B. (Total number of questions attempted =5).

Questions from SECTION A carry 20 marks each while questions from SECTION B carry 15 marks except for the compulsory question (question 5) which carries 25 marks.

Answer SECTION A and SECTION B on separate answer sheets.

Number of pages for question paper **3**

Total marks 100

SECTION A

1) a) Determine which of the following are valid identifiers. If not explain why?
i) first-name ii)3numbers iii) page number iv)SetdaTa (4 Marks)

b) A C++ program contains the following expressions. Use the values initially assigned

int i=8, j=5, k=-6

Determine the value of each of the following expressions. Use the values initially assigned to the variables for each expression

i)i/j
ii)(3*j-2*k)%3
iii)(i>0) || (j<0) && (k>j)
iv)(k>0) ? i:j

(4 Marks)

c) Create a class **book** that stores the title (a string), price(type **float**) and page count (type **int**)
The class book should have a **getdata()** function to get its data from the user at the keyboard and a **putdata()** function to display its data.
Write a main() program to test the book by creating an object of it, asking the user to fill in their data with getdata(), and then displaying the data with putdata()

(12 Marks)

(Total 20 Marks)

2) The specification of a typical business microcomputer is
intel 586 32 bit processor
256 Kb RAM
2 Gb disc storage
1.44 Mb floppy disk

800 * 400 SVGA
Explain the meaning and purpose of each of these items and comment on the specification given

(Total 20 Marks)

3) .a) Distinguish between a Local Area Network (LAN) and a Wide Area Network (WAN) (7 Marks)

b)Many organisations and individuals are now connected to internet

i)What is internet ? (2 Marks)

iii)What hardware and software is needed to link to internet ? (6 Marks)

ii)What benefits do individuals and organisations have in being linked to internet? (5 Marks)

(Total 20 Marks)

4) .a)Write brief notes on each of the following programming languages

i)dBASE iv

ii)Small talk

iii)Visual basic

(6 Marks)

b)Discuss the steps involved in program development (6 Marks)

c)What are the advantages and disadvantages of using off the shelf application packages (8 Marks)

(Total 20 Marks)

SECTION B. (Databases and GIS)

5) An estate agent wants to implement a database application for storing information about buildings. The type of information that is to be stored include date of construction, use (namely hotel/house/factory/farm), type of construction (namely wood/brick/other); and information about the owner such as Name, Date of birth, home address. To be stored also is parcel (i.e. plot) information such as owner, area, address, and number of buildings on the plot.

(a). Identify the entity types and the various attributes for each entity type.

(b). Identify the relationship types.

(c). Identify attributes that can be used as key attributes.

(d). Identify which attributes are atomic and composite.

(e). Draw a complete entity relationship (E-R) diagram and design the database schema.

(Total 25 marks)

6) a) What are the main components of an automated GIS? Explain briefly the functions of each of these components.

b) ~~What processes are involved in using a GIS~~? Explain briefly ~~with the help of diagrams~~, the different ways to input data in a GIS.

(Total 15 marks)

7) a) Mention the two types of data models used in GIS. What are the differences between them?

b) You are in charge of a GIS project for a certain application. You decide to choose a system that is raster or vector based. Discuss the reasons why you decide to use one instead of the other.

(Total 15 marks)

END OF EXAMINATION!

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
EG-279 : INFORMATION TECHNOLOGY
1ST SEMESTER SUPPLEMENTARY/DEFERRED EXAMINATION

Instructions

ATTEMPT: Question 4 and any other two questions from SECTION A and question 5 and another question from SECTION B. (Total number of questions attempted =5).

Questions from SECTION A carry 20 marks each while questions from SECTION B carry 15 marks except for the compulsory question (question 5) which carries 25 marks.

Answer SECTION A and SECTION B on separate answer booklets.

Number of pages for question paper 3

Total marks 100

SECTION A

Answer question **Four** and **any two** other questions from this section.

1) Distinguish between

   a) ROM and CD-ROM
   b) Modem and Multiplexor
   c) E-Mail and Fax
   d) Magnetic tape and magnetic disk

(Total 20 Marks)

2) a) Latest versions of operating systems use new techniques to make them user friendly.
   i) Briefly explain five tasks performed by an operating system. **(10 Marks)**
   ii) Define the term user friendly. **(2 Marks)**

   b) The mnemonic WIMP is used to describe a type of strategy employed in the design of user friendly software on many microcomputer systems with the initials representing Windows, Icon, Mouse and Pull down menu .
   Give a definition for each of the words from which the mnemonic WIMP is derived.
   (8 Marks)
   (Total 20 Marks)

3) a) Computer systems need to be protected from viruses

   i) What is a computer virus? **(2 Marks)**
   ii) How are computer viruses spread from one computer system to another? **(3 Marks)**
   iii) What measures can a user take to safeguard computer systems from attack

by viruses. **(6 Marks)**

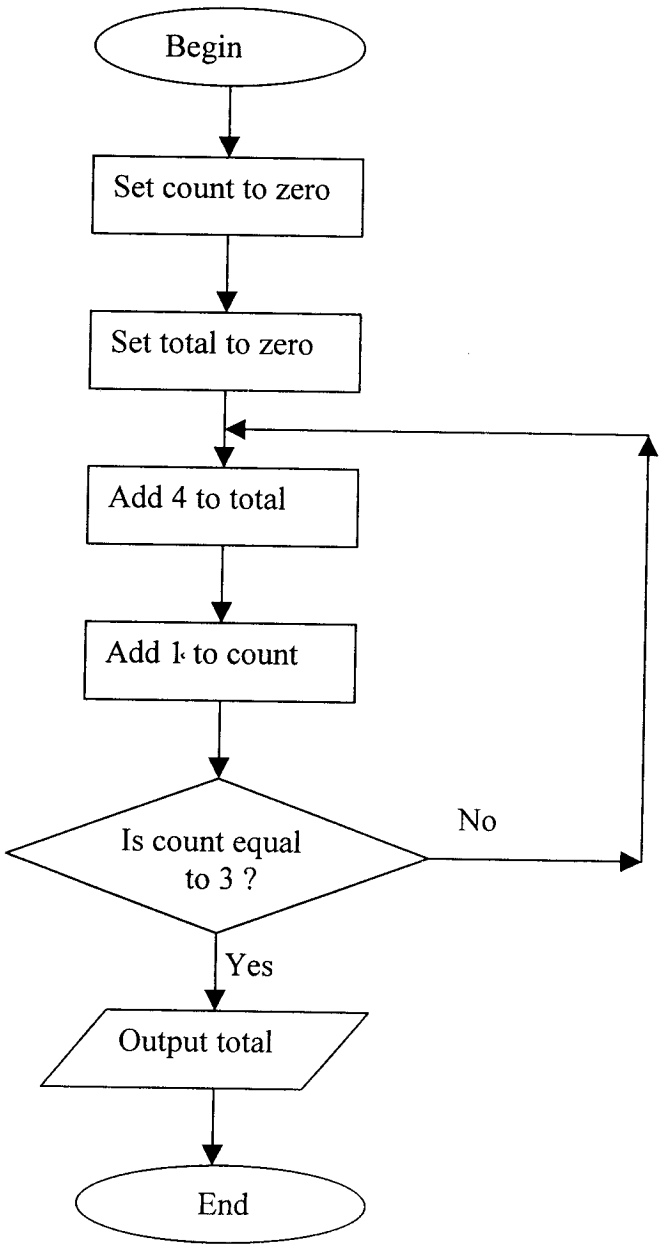
iv) What is a 'write protected floppy disk' ? **(3 Marks)**

b) . Explain the following techniques employed to provide for continuity in the event of a disaster.

i) backups
ii) standby facilities.

(8 Marks)
(Total 20 Marks)

4) The flowchart for a particular process is shown below.



a) How many loops are there in this flowchart? **(1 Mark)**
b) How many times is the loop in this process executed **(3 Marks)**
c) State the value of total that is output. **(4 Marks)**
d) Give one advantage of flowcharts over other methods of describing an algorithm **(2 Marks)**
e) Write a C++ program to carry out the process shown in the flowchart above. **(10 Marks)**

(Total 20 Marks)

Section B

Instructions: Answer question 5 and one other question from this section.

5.

A manufacturing company wants to create a database for its every day activities. They want to document information about their customers i.e. Customer_ID, company name of each customer, contact name, contact title (e.g. sales representative, marketing manager). They also want to keep information about their product names, product types, quantities, unity price for each product and the units in stock for each product. Other information to be documented include order numbers (or order Ids), which customer makes which order, the name of the employee through whom the order is made, the order date, date when the order is required, transporting agent, the product ordered and quantities ordered. The names of employees for the company, title, date of birth, addresses and their immediate supervisors are to be included in the database.

a) Identify the entities and their various attributes.
b) Identify the relations between the entities.
c) For each entity type, identify the attribute(s) that can be used as key attributes.

(Total 25 marks)

6.

a) Clearly define a Geographic Information System (GIS)
b) Describe briefly the different ways you can input data into GIS
c) Differentiate the main data types used in GIS

(Total 15 marks)

7.

a) What distinguishes a GIS from other database systems is its ability to perform a variety of spatial operations on the data. Briefly describe three (3) of the operations involved in GIS.
b) Give three (3) examples or areas of practical applications of GIS.

(Total 15marks)

End of Examination
Good luck.

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
SEMESTER I DEFERRED/SUPPLEMENTARY EXAMINATIONS 1998/99
(DECEMBER, 1999)

EG 365 - FLUID MECHANICS AND THERMODYNAMICS

INSTRUCTIONS

1. USE DIFFERENT SETS OF ANSWER BOOKLETS FOR EACH SECTION
2. MAKE SURE THE COMPUTER NUMBER IS CLEARLY INDICATED ON ALL THE BOOKLETS TOGETHER WITH THE QUESTIONS ATTEMPTED.
3. ATTEMPT **AT LEAST TWO** QUESTION FROM EACH SECTION

TIME: THREE (3) HOURS CLOSED BOOK EXAM

SECTION A - FLUID MECHANICS

1(a) Define a fluid.

(b) Distinguish between fluid mechanics and solid body mechanics?

(c) What brings about viscosity in gases? How does this differ from causes of viscosity in liquids?

(d) Two horizontal plates are placed 1.25cm apart. The space between them is filled with a fluid which has a kinematic viscosity of $1.14*10^{-6}$ m^2/s. Calculate the shear stress if the upper plate moves with a relative velocity of 2.5m/s. Take the density of the fluid to be $1000kg/m^3$.

[2+4+4+10]

2(a) The general momentum equation when applied to deflectors is given by $F= \Psi(V_2-V_1)$ where Ψ is the mass flux, V_1 is the velocity with which the jet strikes the deflector and V_2 is the velocity with which it leaves. State clearly all the underlying assumptions in the derivation of this expression.

(b) State Bernoulli's theorem. What are its underlying assumptions?

(c) Figure 2 shows a horizontal pipe bend through which water is flowing. The flow rate is 1.0m^3/s. Because of the flexible section, the bend is free to move horizontally. If the bend changes the flow direction by 90°, calculate the magnitude of the supporting forces Fx and Fy required at the sections shown to just prevent the movement.

[4+6+10]

3(a) Distinguish between laminar and turbulent flow.

(b) In the system presented in figure 3.1, the water level in the piezometer is 8m. When the tap at point B is opened, the level immediately falls to 7.5m but rises to 8m immediately the tap is closed.

(i) Discuss this change in water levels in the piezometer.

(ii) What is the level of the free surface in the reservoir.

(c) A pumping system presented in figure 3.2 abstracts water from a river at a rate of 200m^3/hour. The water is conveyed to an elevated storage reservoir through a 250mm diameter rising main of length 100m. Given that the relative roughness of the pipe is 2.50mm (ie k=2.50mm) and the dynamic viscosity of the water in the system is $1.005*10^{-3}$ Ns/m^2 (i.e. $\mu=1.005*10^{-3}$), what will the level of water in the reservoir (i.e value of x) be if the pump is supplying a head of 10m of water column per unit weight. Neglect all minor losses in the system.

[4+6+10]

SECTION B - THERMODYNAMICS

ANSWER QUESTION 4 AND AT LEAST ONE OTHER FROM THIS SECTION

Steam Tables, Mollier charts, Freon Tables and Charts may be used.

Q4. The following statements are either true or false. Indicate which by writing down the appropriate letter in your answer book.

Marking:

$$\left[Number\ Correct - \frac{Number\ Incorrect}{2}\right] \times 1.25$$

(i) The Coefficient of Performance of a Carnot Refrigerator working between temperature limits T_1 and T_2 ($T_1 > T_2$) is $T_1/(T_1-T_2)$. T F

(ii) In an isobaric process, the work done is proportional to the head added. T F

(iii) A wet vapour is an ideal gas. T F

(iv) If two reversible heat engines work between the same source and sink, one engine using an ideal gas, the other steam, the engine using an ideal gas will have the higher efficiency. T F

(v) From a 1st law analysis for an isobaric process, as in a heat exchanger, the thermal efficiency of any heat exchanger will always equal unit. T F

(vi) For water, a rise in pressure raises the melting point but drops the boiling point. T F

(vii) In an isobaric process, the work done is proportional to the head added. T F

(viii) Changes in parameters such as pressure, volume, temperature, entropy and work and heat transfers are common to both non-flow and steady-flow processes. T F

(ix) For a perfect gas in an adiabatic process which is reversible steady flow, work transfer is given as: $({}_1w_2)_s = c_v (T_1-T_2)$. T F

(x) Entropy is neither created nor destroyed in a reversible cyclic process. T F

(xi) In the saturation envelope, temperature and pressure are independent of each other. T F

(xii) High-speed diesel engines are less efficient than Otto engines. T F

(xiii) A device converting heat transfer into work transfer is a heat pump. T F

(xiv) All vapour power cycles are open systems. T F

(xv) In a no-work process for a closed system, the heat transfer is equal to the change of enthalpy. T F

(xvi) At the same compression ratio, the efficiency of the Diesel Cycle is lower than that of the Otto Cycle.

T F

[20 marks]

Q5. (a) Show that no heat engine receiving heat from a heat source at a temperature T_1 and rejecting heat to a heat sink at a temperature T_2 can be more efficient than a Carnot engine operating between the same temperature ($T_1 > T_2$).

Sketch the Carnot cycle for a gas on P - v and T - s diagrams.

(b) What is enthalpy and what does its change represent in an isobaric process?

(c) One kg of air is taken through a Carnot cycle. The initial pressure and temperature of the air are 1.73 MN/m² and 300°C, respectively. From the initial conditions, the air is expanded isothermally to three times its initial volume and then further expanded adiabatically to six times its initial volume. Isothermal compression completes the cycle. Determine:

(i) the pressure, volume and temperature at each corner of the cycle;
(ii) the thermal efficiency of the cycle; and
(iii) the work done during the cycle.

Take R=0.29 kJ/kg.K, γ=1.4.

[20 marks]

Q6. (a) What is the difference between an ideal gas and a perfect gas?

(b) During operation of a spark ignition engine, air is initially compressed from 0.104 kN/m² to 1.85 kN/m². Determine

(i) the overall volume ratio
(ii) the thermal efficiency

Take the adiabatic compression index to be 1.4.

(c) A sample of wet steam at a pressure of 6 bars is throttled to atmospheric pressure and a resultant temperature of 110°C. Determine the temperature drop due to throttling and the quality of the initial sample.

[20 marks]

Q7. (a) Explain the difference between thermal efficiency and isentropic efficiency.

(b) In a gas turbine system at steady state, gases enter and leave at the rate of 15kg/s. At the inlet section, the mean gas velocity is 100 m/s and the specific enthalpy is 2000 kJ/kg; while at the exit section, the mean gas velocity is 50 m/s and the specific enthalpy is 1000 kJ/kg.

Neglecting heat losses to the surroundings and changes due to gravitational potential energy, estimate the work transfer rate.

(c) A closed-circuit gas-turbine plant operates on the Joule cycle between temperatures 1000K and 300K with a pressure ratio of 5. Taking the adiabatic index as 1.4 and c_p to be 1.005 kJ/kg.K, determine:

(i) the cycle efficiency;
(ii) the work ratio; and.
(iii) the specific work output.

[20 marks]

END OF EG 365 EXAMINATION

Mr J M Tembo and Dr A N Ng'andu

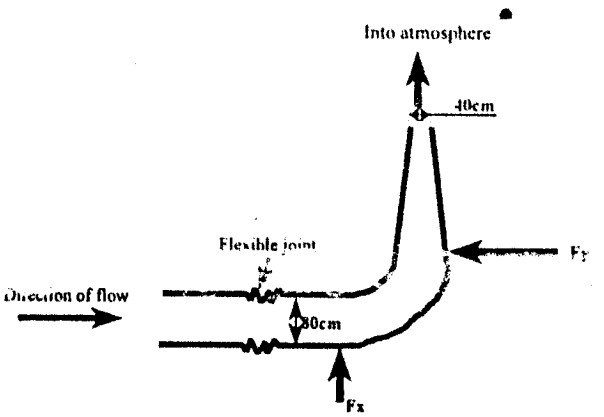


Figure 2

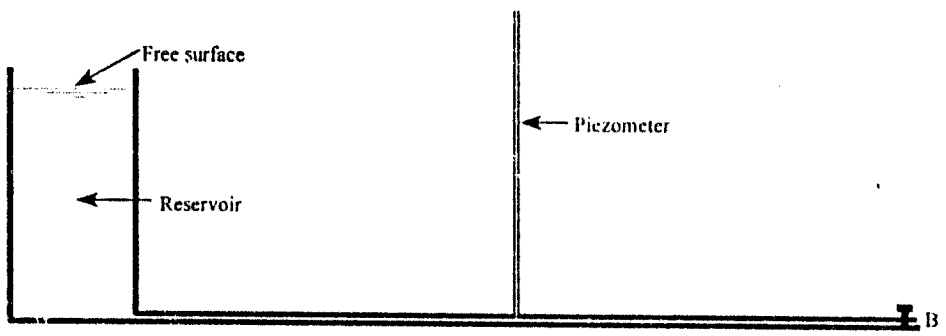


Figure 3.1

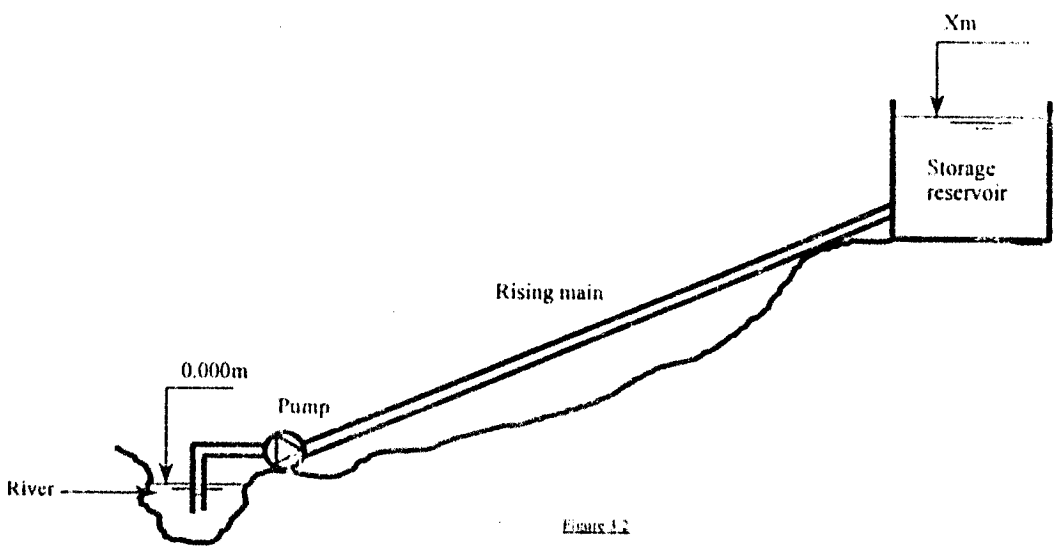


Figure 3.2

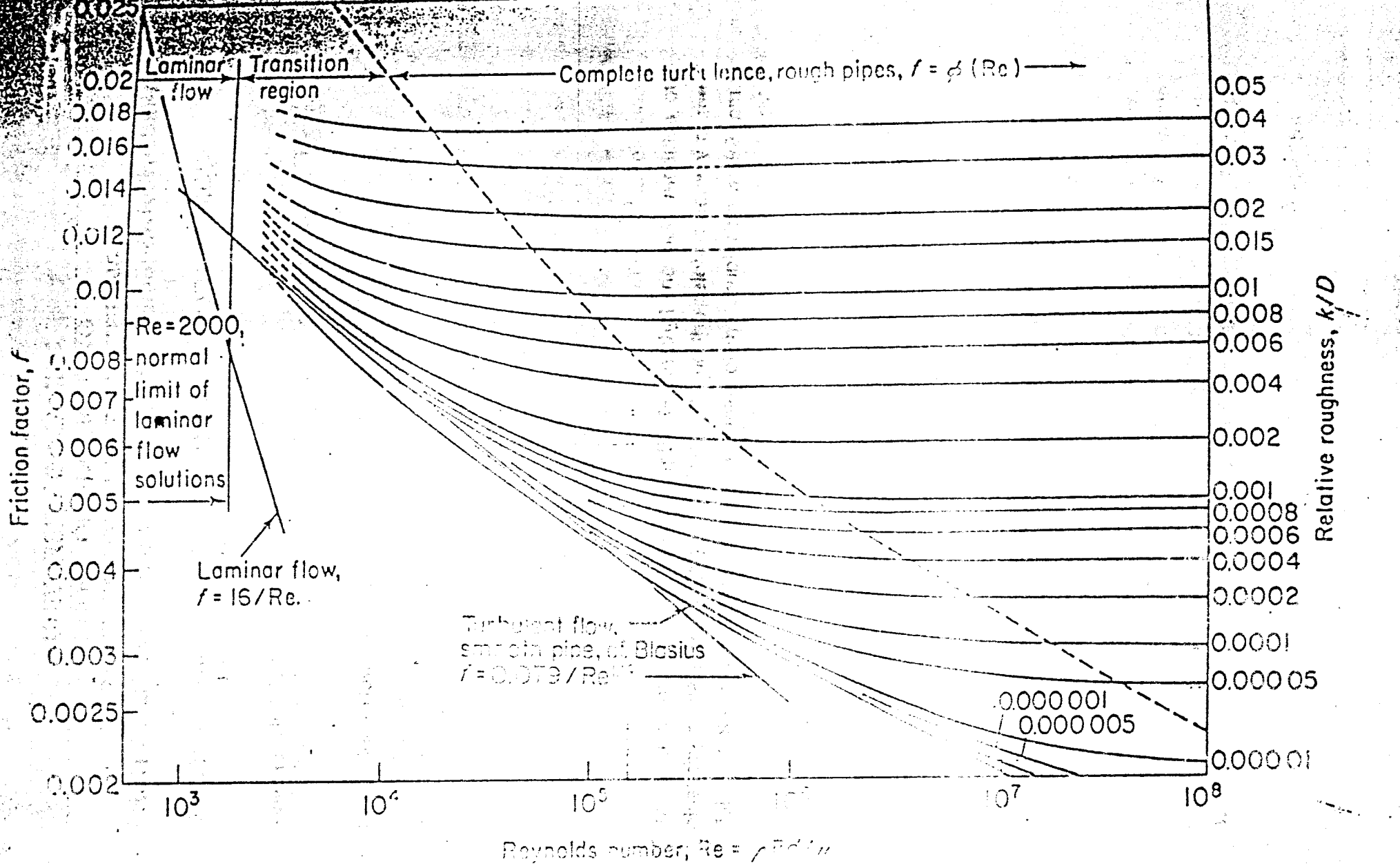


Figure 8.7 Variation of friction factor f with Reynolds number and pipe wall roughness for ducts of circular cross-section

UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS - SEMESTER ONE 1998/99

EM211 - ENGINEERING MATHEMATICS I

INSTRUCTIONS: Answer ANY Five(5) Questions.

TIME ALLOWED: Three (3) hours.

---

1. (a) An ellipse has centre C at $\left(-3, \frac{3\pi}{2}\right)$, a focus F at the origin and corresponding vertex V at $\left(1, -\frac{\pi}{2}\right)$. Find the polar equation for the ellipse.

   (b) Given the equation of a conic

   $$4x^2 - y^2 + 12y + 16x - 16 = 0,$$

   find the eccentricity, foci, vertices, and (if conic is a hyperbola) equations for the asymptotes. (Do not sketch the graph.)

   (c) Find the area enclosed between the curves

   $$x = 1 + 4y - y^2 \text{ and } x = 1 + y^2.$$

2. (a) Evaluate the indefinite integral

   $$\int \frac{dx}{x^2\sqrt{x^2 - 2}}$$

   (b) Use Leibinitz's theorem to find

   $$\frac{d^4y}{dx^4} \text{ if } e^{2x}y = x^2.$$

2. (c) Given that $I_n = \int_o^{\pi} \sin^{2n} x dx$, where $n \geq 0$,

i) obtain a reduction formula expressing I_n in terms of I_{n-1}.

ii) Hence, or otherwise, evaluate

$$\int_o^{\pi} \sin^6 x dx.$$

3. (a) Show that if $|r| < 1$,

$$a + ar + ar^2 + ... = \frac{a}{1-r}.$$

(b) A ball is dropped from *a* metres above a surface. Each time the ball hits the surface after falling through h, it rebounds a distance *rh*, where *r* is a positive number less than 1. Find the total distance, in terms of *a* and *r*, the ball travells up and down.

(c) Find the Maclaurin polynomial $P_4(x)$ of $f(x) = x\cos 2x$.

4. (a) Find the coordinates of the centroid of the region bounded by the curves $y^2 - x = 0$ and $2x - y - 1 = 0$.

(b) Find the volume generated when the region bounded by the curves

$y = x$, $y = \sin x$, and $x = \pi$ is revolved about the y-axis.

(c) Find the length of the arc of the curve $6xy - x^4 - 3 = 0$ between the points $\left(1, \frac{2}{3}\right)$ and $\left(2, \frac{19}{12}\right)$.

5. (a) Find the radius of convergence R and the convergence set for the series

$$\sum_{k=1}^{\infty} \frac{(3x-4)^k}{3^k}.$$

(b) Find the Taylor polynomial of

$$f(x) = 4x^3 - 3x^2 + 5x - 1$$

expanded about the point $x = 2$.

(c) Use the Mean Value theorem to show that if $x > 15$

$$\sqrt{1+x} < 4 + \frac{x-15}{8}.$$

6. (a) Distinguish between absolute convergence and conditional convergence of an infinite series $\sum a_k$.

(b) If $\lim_{k\to\infty} \frac{3k+8}{k+3} = 3$, find an integer N such that for all $k > N$

$$\left| \frac{3k+8}{k+3} - 3 \right| < 0.003.$$

(c) Determine convergence or divergence of the following infinite series. If the series converges find its sum.

(i) $\sum_{k=1}^{\infty} \frac{1}{k(k+1)}$ (ii) $\frac{1}{2} + \frac{3}{4} + \frac{7}{8} + \frac{15}{16} + \ldots$

7. (a) Find the equation of the plane containing the points A(1,1,0), B(3, -2,1) and C(2,0,1), in the form $ax + by + cz + d = 0$.

(b) Let $\bar{u} = 2i + j$, $\bar{v} = 2i - j + 3k$. Find the direction cosines of

$\bar{u} \times \bar{v}$.

(c) Find the value of λ such that $\bar{u} = \lambda i + 2j - k$ and $\bar{v} = i + j - 3\lambda k$ are mutually perpendicular.

END OF EXAMINATION.

UNIVERSITY OF ZAMBIA
UNIVERSITY SUPPLEMENTARY/DEFERRED EXAMINATIONS
SEMESTER - ONE 1998/99

EM211 - ENGINEERING MATHEMATICS I

INSTRUCTIONS : **Attempt Any Five(5) Questions.**
TIME ALLOWED: **Three(3) Hours**

1. (a) Find the n^{th} derivative of

$$y = \frac{4x}{(x+2)(x-1)^2}.$$

(b) Disouss the function $f(x) = \frac{x^2}{x^2-1}$ for relative maxima, minima, concavity, points of inflection, vertical and horizontal asymptotes.
Hence, sketch the graph of f(x).

2. (a) Evaluate any three of the following integrals:

(i) $\int \frac{e^{2x}}{e^x - 1}\, dx$

(ii) $\int_0^1 x\sqrt{x+1}\, dx$

(iii) $\int_0^{\pi} \frac{x \sin x}{1+\cos^2 x} dx$

(iv) $\int_0^{\infty} \frac{dx}{(x^2+1)^2}$

(b) Obtain a reduction formula expressing $\int \left(x^2 + a^2\right)^{n/2} dx$ in terms of $\int \left(x^2 + a^2\right)^{\frac{n}{2}-1} dx$.

3. (a) Find the center of mass of a thin triangular plate with vertices at (0,0), (3,4) and (0,8) if the mass density of the plate at (x,y) is $x + 1$.

(b) Find the volume of the torus generated by revolving the disk $x^2 + y^2 \leq a^2$ about the line $x = b$ for $b > a$.

4. (a) Find the equation of the parabola with focus at F(-1,-2) and directrix the line $x - 2y + 3 = 0$.

(b) Given the equation $8x^2 - 4xy + 5y^2 - 36 = 0$, change from the xy system to an $x'y'$ system such that the $x'y'$ term is missing in the equivalent form of the above equation.

Sketch the graph and identify the foci, directrices, eccentricity and vertices of the conic represented by the equation.

5. (a) A ball is dropped from a height of 8 meters. Each time it hits the ground, it rebounds to a height of two-thirds the height from which it fell.

Find the total vertical distance travelled by the ball until it comes to rest.

(b) For what values of x does the series

$$\sum_{k=0}^{\infty} \frac{x^k}{k+1}$$ converge?

(c) Assuming that the function $f(x) = \cos x$ can be written as a Maclaurin series, find that series

6. (a) Find the equation of the plane containing the points A(1,1,0), B(3,-2,1) and C(2,0,1), in the form $ax + by + cz + d = 0$.

(b) Given that $\vec{OA} = 2\hat{i} - 3\hat{j} + k$, $\vec{OB} = \hat{i} + \hat{j} + k$, $\vec{OC} = 4\hat{i} + 2\hat{j} - 2k$, where i, j, k are mutually perpendicular unit vectors, show that OA is perpendicular to OB and also to OC.

Find the volume of the tetrahedron OABC.

END OF EXAMINATION.

UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS - SEMESTER ONE 1998/99

EM311 - ENGINEERING MATHEMATICS III

INSTRUCTIONS: Attempt ANY Five(5) Questions, showing all necessary working. All questions carry equal marks.

TIME ALLOWED: Three (3) hours.

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1. (a) Give sufficient conditions for a function f(t) to be of exponential order.
Given that f(t) is of exponetial order, show also that $\int_o^t f(s)ds$ is of exponential order.

(b) Given the fourier transform

$\hat{f}$ (w) = H(w + a) - H(w - a), a > 0, where H is the unit step function, find its inverse fourier transform.

(c) Determine if the PDE $xu_{xx} - u_{xy} + yu_{yy} + 3u_y = 1$
defined over $-\infty < x,y < \infty$, is elliptic, parabolic hyperbolic, or of mixed type.

2. (a) Explain whether or not the function $f(x) = e^{-x}$ is piecewise continuous over $[0,\pi]$.

(b) Evaluate $L\left\{\int_o^t \frac{e^{-3t}\sin 2t}{t}\,dt\right\}$

(c) Evaluate $\int_o^\infty \frac{x^c}{c^x}\,dx$ where c > 0.

3. (a) Given that $J_\nu(x) = \sum_{m=0}^{\infty} \frac{(-1)^m x^{\nu+2m}}{2^{\nu+2m}.m!\Gamma(\nu+m+1)}$

show that $\frac{d}{dx}\left(x^\nu J_\nu(x)\right) = x^\nu J_{\nu-1}(x)$.

(b) Solve the homogeneous differential equation

$$\frac{d^2y}{dx^2} + \frac{3}{x}\frac{dy}{dx} + \frac{3y}{x^2} = 0$$

(c) Given that $L\{f(t)\} = \frac{s+2}{s^2-4}$ find f(t).

4. (a) Find the right and left-hand derivatives of

$$f(x) = \begin{cases} 100, & x = 0 \\ 0, & \textit{elsewhere.} \end{cases}$$

(b) Given the differential equation

$x^2(x + 1)^2y'' + (x - 1)y' + 2y = 0$, determine if the points $x = 0$ and $x = 1$ are ordinary, regular singular or irregular singular points.

(c) Find one linearly independent solution corresponding to the bigger indicial root of $3xy'' + y' - y = 0$ expanded about $x = 0$ and express it in its closed form.

5. (a) Evaluate $L\{(f(t).\delta(t - a)\}$ where δ is the Dirac delta function.

(b) Find the Fourier series expansion of $f(x) = x^2$, $0 < x < 2\pi$ with period 2π.

(c) Hence, or otherwise, prove that

$$\sum_{m=1}^{\infty} \frac{6}{m^2} = \pi^2.$$

6. (a) Determine if the function

$f(x) = x(10 - x)$ over $0 < x < 10$ with period 10 is even, odd or neither.

(b) Derive the Fourier integral representation of

$$f(x) = \begin{cases} x, & |x| \le L \\ 0, & |x| > L. \end{cases}$$

At which points, if any, does the fourier integral fail to converge to f(x)? To what value does the integral converge at those points?

(c) Express x^3 in terms of Legendre polynomials $p_n(x)$, where

$$p_n(x) = \frac{1}{2^n n!} \frac{d^n}{dx^n} \left[\left(x^2 - 1 \right)^n \right].$$

7. (a) Find the Laplace transform of

$(t^2 - 1)H(t - 1)$, where H is the unit step function.

(b) Show whether the PDE $U_{xx} + U_{yy} - e^u = 0$
is Linear or nonlinear.

(c) Find the solution of the ODE

$y'' + y = F(t)$ where $F(t) = n + 1$ for

$n\pi < t < (n + 1)\pi$, for $n = 0,1,2,...$, and given that $y = y' = 0$ at $t = 0$.

END OF EXAMINATION.

UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS - SEMESTER ONE 1998/99

EM411 - ENGINEERING MATHEMATICS V

INSTRUCTIONS: Answer ANY Five(5) Questions.

TIME ALLOWED: Three (3) hours.

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1. (a) (i) Suppose the Bisection method is applied to find an approximate value of the root of the equation $f(x) = 0$ in the interval $[a_o,b_o]$. Let the successive intervals that arise in the process of Bisection method be $[a_o,b_o]$, $[a_1,b_1]$,... and so on.

Show that $b_n - a_n = 2^{-n}(b_o - a_o)$

(ii) Let c_n be the approximate value of the root, based on the interval $[a_n, b_n]$ of the Bisection method and r be the true value of the root of the equation $f(x) = 0$. Find a bound on the error $|c_n - r|$.

(b) Find a bound on the number of iterations needed to achieve an approximation lying in the interval $[1,2]$, with accuracy 10^{-4} to the solution of $f(x) = 0$ by the Bisection method.

2. (a) (i) Sketch the graphs of $y = e^{-x}$ and $y = \sin x$ in the same cartesian plane and show that the smallest root of the equation $e^{-x} - \sin x = 0$ lies in the interval $\left(0, \frac{\pi}{2}\right)$.

(ii) Use the Newton Raphson method and the initial estimate $x_0 = 0.6$ to approximate the smallest root of the equation $e^{-x} - \sin x = 0$ to four places of decimals.

(b) Use the Gauss elimination method to find a solution to the system of equations

$$\begin{aligned} 10x_1 - x_2 + 2x_3 &= 4 \\ x_1 + 10x_2 - x_3 &= 3 \\ 2x_1 + 3x_2 + 20x_3 &= 7 \end{aligned}$$

3. (a) Using sin (0.1) = 0.09983 and sin(0.2) = 0.19867, find an approximate value of sin (0.15) by lagrange interpolation. Obtain a bound on the truncation error.

(b) The data in the following table are the short-wave radiation flux(R) at the outer limit of the atmosphere in gram-calories per square centimeter per day for the month of September:

R	891	856	719	494	219
Latitude(°N)	0°	20°	40°	60°	80°

(i) Compute the finite - difference table and derive an interpolating polynomial using Newton's forward difference method.

(ii) Estimate R at a latitude of 35°.

4. (a) In a circuit with impressed voltage V(t) and inductance L, Kirchhoff's first law gives the relationship

$$V(t) = L\frac{di}{dt} + Ri$$

where R is the resistance in the circuit and i the current. Suppose we measure the current for several values of t and obtain:

t	1.00	1.01	1.02	1.03	1.04
i	3.10	3.12	3.14	3.18	3.24

where t is measured in seconds, i in amperes, the inductance L is a constant 0.98 henries and the resistance is 0.142 Ohms. Approximate the voltage V at time t = 1.02 using 2 step differentiation.

(b) (i) Show that h, the width of a subinterval to approximate the integral $\int_1^2 \ln x dx$ by the composite simpson's rule satisfies $h \leq 0.23$ if the approximation is to be within 10^{-4}.
[The truncation error of the composite simpson's rule is $-\frac{(b-a)^4}{180}h^4 f^{(4)}(c), a < c < b.$]

(ii) Approximate $\int_1^2 \ln x dx$ to five places of decimal by the composite simpsons rule given h = 0.25. Find the true error of approximation.

5. (a) Derive the difference equations associated with the modified Euler's method to solve the initial value problem

$$\frac{dy}{dt} = t + y, \quad 0 \le t \le 1, \; y(0) = -1, \text{ with } h = 0.1$$

(b) Using the difference equations derived in part(a), approximate the solution of the initial value problem at $t = 0.5$

6. (a) Find the values of z for which the function $f(z) = z + \frac{1}{z}$ is analytic.

(b) Show that $\cos z = \cos x \cosh y - i \sin x \sinh y$ and $|\cos z|^2 = \cos^2 x + \sinh^2 y$
Hence find the zeros of $\cos z$.

7. (a) Find the principal value of $(i)^{-3i}$

(b) In the following problems, evaluate the integral

$$\int_c f(z)dz, \text{ given}$$

(i) $f(z) = z$, c is the parabola $y = x^2$ from 0 to $1 + i$

(ii) $f(z) = \frac{1}{(z - z_o)^{n+1}}$, c is the circle of radius r and centre z_o.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY DEFERRED/SUPPLEMENTARY EXAMINATIONS
SEMESTER ONE -1998/99
EM 411-ENGINEERING MATHEMATICS V

Time allowed: Three (3) hours.
Answer any five questions.

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1. a. Sketch the graphs of the functions y = cosx and $y = xe^x$ for x>0, in the same Cartesian plane. Hence determine an interval which encloses the true solution to the equation $\cos x - xe^x = 0$

   b. Estimate, to a precision of 0.05, the root of the equation given in part (a) that lies in the interval (0,1) using the bisection method.

2. a. Show that the initial estimates of the roots of the equation $x^2 - 5x + 2 = 0$ are 0.5 and 4.5 . Hence find the roots of the given equation correct to five decimal places by the Newton-Raphson method.

   b. Find the solution to the following system of equations using Gaussian Elimination method

$$2x_1 + 3x_2 - 2x_3 - x_4 = -2$$
$$2x_1 + 5x_2 - 3x_3 + x_4 = 7$$
$$-2x_1 + x_2 + 3x_3 - 2x_4 = 1$$
$$5x_1 + 2x_2 - x_3 + 3x_4 = 8$$

3. a. The population of African continent is given in the following table:

Year	1930	1940	1950	1960	1970	1980
Population (in thousands)	123203	131669	150697	179323	203212	226505

   Find the Lagrange polynomial of degree five that fits into the given data and use it to estimate the population in the year 1965.

   b. The dissolved oxygen concentration is an important element in some water quality analyses. The saturation values of the oxygen concentration are a function of temperature. The following table gives the saturation values (D) for temperatures (T) from 0^0 to 25^0 in increments of 5^0 .

T^0(c)	0	5	10	15	20	25
D(mg/L)	14.62	12.8	11.33	10.15	9.17	8.38

Estimate the saturation concentration of oxygen at 13^0c using Newton's finite difference interpolation polynomial.

4. a. The following table gives the water vapor capacity of air (v_c) in grains per cubic foot for selected temperatures (T) in degrees Fahrenheit. Determine the slope of the water vapor capacity curve at a temperature of 54^0 F using the two step finite difference approximation.

T	50	54	58	62	66
V	4.108	4.725	5.420	6.203	7.082

b. Evaluate the integral $I = \int_0^1 \frac{dx}{1+x}$ using the composite Simpson's rule with 8 equal subintervals. Find the true value of I and the true relative error.

5. a. Derive the difference equations associated with the modified Euler's method and step size 0.1 to solve the initial value problem
$y' = -y + t^2 + 1, 0 \le t \le 1, y(0) = 1$
Hence approximate the solution of the given initial value problem at t= 0.5

b. Find the exact solution of the initial value problem of part (a). Hence find the percent relative error of approximation in part (a).

6. a. Find the values of z for which the function $f(z) = z\bar{z}$ is analytic.

b. Find all roots of the equation $e^z = -i$

7. a. Find the principal value of $(1+i)^i$

b. Evaluate the following integrals

(i) $\int_{c_1} z^2 dz$, where c_1 is the part of the unit circle from z = 1 to z = i

(ii) $\oint_{c_2} z^2 dz$, where c_2 is the circumference of the unit circle travelled in an anti-clockwise sense.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY SEMESTER I EXAMINATIONS - MAY, 1999

ME 341 - THERMODYNAMICS I

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

INSTRUCTIONS: **ANSWER FIVE (5) Questions only.**
ANSWER At least two (2) Questions from each section.
All Questions Carry Equal Marks .
Use separate answer books for each section.
Steam Tables, Mollier Charts, Freon Tables and Charts may be used.

SECTION A

Answer Question ONE (1) and At least One other Question from this Section

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Q1. The following statements are either true or false. Indicate which by writing down the appropriate letter in your answer book.

$$\textit{Marking: } [\textit{Number correct} - \frac{\textit{Number Incorrect}}{2}] \times 1.25$$

(i) In an isochoric non-flow process, work is done at the expense of internal energy. T F

(ii) If water is at a pressure lower than the critical pressure, it is always in a liquid phase. T F

(iii) A 10 m^3 volume would be described as an extensive property. T F

(iv) The First Law of Thermodynamics can be stated as: "The net heat transfer is equal to the net work done for any system". T F

(v) For a perfect gas in an isentropic non-flow process, work transfer is given as $({}_1W_2)_s = c_v (T_1 - T_2)$ T F

(vi) A process that involves no interactions other than work is called an adiabatic process. T F

(vii) A device converting heat transfer into work transfer is a heat pump. T F

(viii) A wet vapour is a perfect gas. T F

(ix) For water, a rise in pressure drops the melting point but raises the boiling point. T F

(x) A system of a pure substance cannot consist of several co-existing phases, say gas and liquid. T F

(xi) In an isobaric flow process, the work done is proportional to the heat added. T F

(xii) An isentropic process with a wet vapour can not be expressed in terms of $PV^{\gamma} = \text{Const.}$ T F

(xiii) It is impossible to devise a machine to deliver a limited quantity of work without requiring a source of energy in the surroundings. T F

(xiv) A free expansion is an irreversible isothermal process in which no work is done. T F

(xv) If a system is taken through a cycle while exchanging heat with only one reservoir, the work done must either be zero or negative. T F

(xvi) In the saturation envelope, temperature and pressure are not independent of each other. T F

[20 marks]

Q2. (a) A gas in a cubical volume with sides at different temperatures is suddenly isolated with reference to transfer of mass and energy. Is this system in thermodynamic equilibrium? Why or why not?

[4 marks]

(b) Show from first principles that, for a perfect gas with constant specific heat capacities expanding polytropically (i.e. according to the law $pv^n = constant$) in a non-flow process, the change of entropy can be expressed by

$$s_2 - s_1 = \frac{n-\gamma}{\gamma-1}\,\frac{R}{n}\,ln\frac{p_2}{p_1}$$

[6 marks]

(c) Gaseous Methane is compressed polytropically by a piston from 25°C and 0.8 bar to a pressure of 5 bar. Assuming an index of 1.2, calculate the change in entropy and work done, per unit mass of gas. The gas constant of Methane is 0.5197 kJ/kg.K and $\gamma = 1.30$. Explain which of the answers depends upon an assumption that the process is (i) reversible and (ii) non-flow.

[10 marks]

Q3. (a) Show that the efficiency of a Carnot engine operating between two reservoirs is independent of the working substance used by the engine.

[6 marks]

(b) An inventor proposes an engine that operates between the 27°C warm surface layer of the ocean and a 10°C layer a few meters down. The inventor claims that the engine produces 100 kW by pumping 20 kg/s of seawater. Given that the specific heat capacity of water, $c_p = 4.18$ kJ/kg.K, evaluate this claim.

[6 marks]

(c) Steam at 16 bar, dryness fraction 0.95, expands reversibly in a cylinder until the pressure is 3 bar. Calculate the final specific volume and the final temperature of the steam, given that the expansion follows the law $pv = constant$.

Using the same initial data as before for the steam, calculate the heat that would have been supplied per unit mass had the expansion been isothermal.

[8 marks]

Q4. (a) Briefly state why 'enthalpy ' is a useful concept when dealing with open systems.

[3 marks]

(b) Air enters a centrifugal compressor at 1.05 bar and 15°C, and leaves at 2 bar and 97°C. The mass flow is 50 kg/min. Assuming that kinetic and potential energies are negligible and that the process is adiabatic, what power is actually required to drive the compressor? What would be the power required for the same pressure ratio if the compression had been frictionless? What is the rate of increase of enthalpy due to friction? For air, take $c_p = 1.005$ kJ/kg.K and the adiabatic index as 1.4.

[7 marks]

(c) A quantity of air occupying a volume of 1 m³ at 4 bar and 150°C is allowed to expand isentropically to 1 bar. Its enthalpy is then raised by 70 kJ by heating at constant pressure. What is the total work done during this process? For air, take $R = 0.287$ kJ/kg.K, $c_p = 1.005$ kJ/kg.K and the adiabatic index as 1.4.

If the process is to be replaced by a reversible polytropic expansion which will result in the same final state being reached, what index of expansion is required? In which process is the work done greater in magnitude?

[10 marks]

END OF SECTION A

SECTION B

Answer AT LEAST TWO (2) Questions from this Section

Q5. (a) Discuss the various processes occurring in a dual combustion cycle with the help of P-V and T-S diagrams.

(b) (i) Derive the equation for the thermal efficiency of a dual combustion cycle.

(ii) Based on the equation obtained in (i), determine the equation for the efficiency of spark ignition and diesel engines.

Q6. The compression ratio in an air standard Otto cycle is pre-determined as 8. At the beginning of the compression stroke, the pressure is 1.03 bar and the temperature is 25°C. The heat transfer to air is 1870 kJ/kg.

(a) Draw the cycle involved in the operation on the P - V and T - S diagrams.

(b) Determine

(i) The pressure and temperature at the end of each process of the cycle if the compression index and specific heat capacity of air are given as 1.4 and 1.003 kJ/kg °C respectively.

(ii) Determine the thermal efficiency of the cycle.

Q7. (a) With the help of diagrams, discuss the cycle, processes and operations involved in a compressor type refrigeration system.

(b) A vapour compression refrigerator circulates 0.075 kg of ammonia per second. Condensation takes place at 30°C and evaporation at -15°C. There is no under cooling after condensation. The temperature after isentropic compression is 75°C while the specific heat of super heated vapour is 2.82 kJ/kg K. Determine the refrigeration performance.

END OF ME 341 EXAMINATION
Dr A N Ng'andu and Prof F D Yamba

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY SEMESTER I EXAMINATIONS 1998/99
(OCTOBER 1999)

ME365 - FLUID MECHANICS AND THERMODYNAMICS

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

SECTION A - FLUID MECHANICS

ANSWER AT LEAST TWO QUESTIONS FROM THIS SECTION

Q1(a) State Pascal's law of pressure at a point.

(b) Given that x, y and z are the Cartesian cordinates of a static water body where x and y are in the horizontal plane and z is the vertical axis increasing with the water depth (i.e the value of z is increasing as the water depth increases):

(i) Give the equation(s) for the pressure variation in the horizontal plane.

(ii) Give the equation(s) for the pressure variation in the vertical plane.

(c) What do you understand by the term piezometric head? Show that the piezometric head is constant throughout a static body of a fluid.

(d) What instrument would you employ to measure the difference in pressure in two different pipes?

(e) Calculate the pressure difference between pipe A and B for the system shown in figure 1.

[2+4+4+2+8]

Q2(a) The general momentum equation when applied to deflectors is given by $\Sigma F=\omega(V_2-V_1)$ where ω is the mass flux, V_1 is the velocity with which the jet strikes the deflector and V_2 is the velocity with which it leaves. State clearly all the underlying assumptions in deriving this expression.

(b) Distinguish between Energy grade line and Hydraulic grade line.

(c) What do you understand by the term ideal fluid. How does the flow of an ideal fluid differ from that of a real one?

(d) Water is pumped at a rate of 0.15 m^3/s from a reservoir as shown in figure 2. Point A is 2 m below the water surface while point B is 3.9 m above point A. Point B^1 is 0.2 m above the nozzle of the pipe. The pump imparts a head of 7.0 m of water column per unit weight of the fluid in the system. Assuming ideal flow conditions, determine

(i) the pressure intensities at points A and B.

(ii) the pressure intensity and the velocity at point B^1

[4+2+4+10]

Q3(a) Distinguish between open channel flow and pressurised flow?

(b) Define the following terms as applied to open channel flow

(i) specific energy

(ii) critical flow

(iii) alternate depths

(iv) the Froude number

(v) specific discharge

(c) Figure 3 shows a 200mm diameter wash pipe connected to a reservoir. This pipe is used to drain off the reservoir in case maintenance works are to be carried out. It is 300m long after which it terminates into an open rectangular channel with a width of 0.75m. Taking the hydraulic radius as 0.25m, calculate:

(i) the depth of flow in the rectangular channel

(ii) the froude number

(iii) the critical depth for the flow

(iv) the specific energy

Assume ideal flow conditions in the pipe and a constant head in the reservoir.

[2+8+10]

SECTION B - THERMODYNAMICS

ANSWER <u>QUESTION 1</u> AND <u>AT LEAST ONE OTHER</u> FROM THIS SECTION

Steam Tables, Mollier charts, Freon Tables and Charts may be used.

Q4. The following statements are either true or false. Indicate which by **<u>writing down</u>** the appropriate letter in your answer book.

Marking:

$$[Number\ Correct - \frac{Number\ Incorrect}{2}] \times 1.25$$

(i) If two reversible heat engines work between the same source and sink, one engine using an ideal gas, the other steam, the engine using an ideal gas will have the higher efficiency.

T F

(ii) A Perpetual Motion Machine of the 2nd Kind obeys the 1st Law of Thermodynamics.

T F

(iii) Potential energy is an intensive property. T F

(iv) A heat engine with an efficiency of 100% disobeys the 1st Law of Thermodynamics

T F

(v) From a 1st law analysis for an isobaric process, as in a heat exchanger, the thermal efficiency of any heat exchanger will always equal unit. T F

(vi) In an Isobaric flow process, the work done is proportional to the heat added. T F

(vii) A free expansion is an irreversible isothermal process in which now work is done. T F

(viii) In a cycle where the work is positive, the energy of the system decreases. T F

(ix) In an adiabatic expansion process for a closed system, the temperature of the working fluid rises. T F

(x) In a throttling process, the change of enthalpy is proportional to the change in pressure. T F

(xi) If a process is drawn on T-s coordinates, the area under the curve gives the work done during the process. T F

(xii) A wet vapour is an ideal gas. T F

(xiii) High-speed diesel engines are less efficient than Otto engines. T F

(xiv) The Joule cycle efficiency is lower than the Carnot efficiency but higher than the Rankine efficiency. T F

(xv) The Rankine cycle comprises irreversible processes at constant pressure for heat supply and rejection, with isentropic expansion and compression. T F

(xvi) A device converting heat transfer into work transfer is a heat pump. T F

[20 marks]

Q5. (a) (i) What are the three main characteristics of a free expansion?

(ii) What are the main characteristics of a property in relation to a cyclic process?

(iii) What is enthalpy and what does its change represent in an isobaric process?

(b) A heat source at constant temperature 1000K transfers heat uniformly at 100W to a system operating in a Carnot engine located in an environment at 300K. If the source transfers to the system

(i) Reversibly

(ii) Irreversibly at 800K

find the system efficiency, the work output per second, and the net change in entropy per second associated with the source heat transfer.

(c) A heat engine operates on a cycle made up of four processes. These four processes and the known values for the heat, work, and energy changes are given in the table below. Determine the values for the unknown quantities in the table.

Process	**q (kJ/kg)**	**w (kJ/kg)**	**Δe (kJ/kg)**
1-2	-5	-106	
2-3		0	485
3-4	0	276	
4-1	-302		

[20 marks]

Q6. (a) Explain the difference between thermal efficiency and isentropic efficiency.

(b) Briefly explain why "not all heat passing into (or from) a system is available for conversion into work on a cyclic basis" stating any thermodynamic laws which support this observation.

(c) An oil engine operates on the ideal Otto cycle. The operating conditions are:

intake pressure = $100kN/m^2$

Intake temperature =50°C

Volume compression ratio = 6:1

Heat supplied during the cycle = 950kJ/kg of working fluid

Determine:

(i) the maximum temperature attained during the cycle.

(ii) the thermal efficiency of the cycle.

(iii) the work done during the cycle per kg of working fluid.

Take $\gamma = 1.4$ and $c_v = 0.717kJ/kg.K$

[20 marks]

Q7. (a) Express the Zeroth Law of Thermodynamics.

(b) What is the significance of the term $\int pdv$ in a non-flow system?

(c) A system of 0.2kg of steam, at 200kPa and 200°C, is compressed isothermally and reversibly in a piston-cylinder assembly to one-tenth of its original volume.

(i) Show the process on a p-v diagram and a T-s diagram.

(ii) Find the volumes at the beginning and the end of the process.

(iii) Find the heat and work interactions.

Other relevant properties for the two states are summarised in the table below:

State	P (Mpa)	T (°C)	x	v (m^3/kg)	u (kJ/kg)	h (kJ/kg)	s (kJ/kg.K)
1	0.200	200	-	1.0803	2654.4	2370.5	7.5066
2	1.554	200	0.8	0.10803	2328.1	2495.9	5.8041

[20 marks]

END OF EG 365 EXAMINATION

Mr J M Tembo and Dr A N Ng'andu

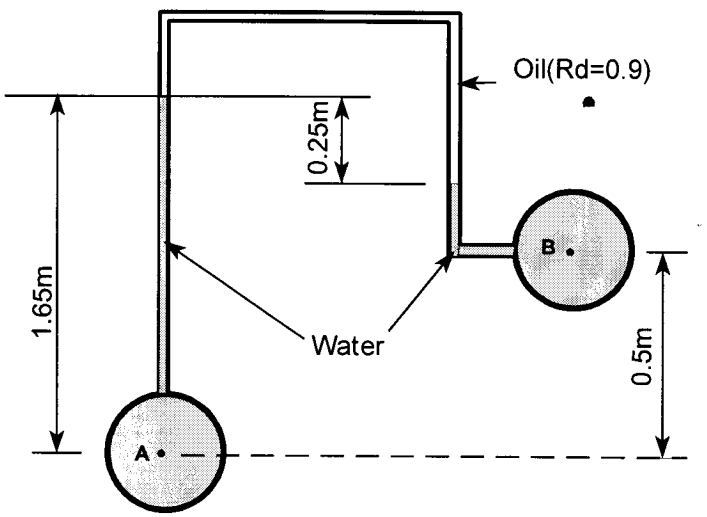

FIGURE1

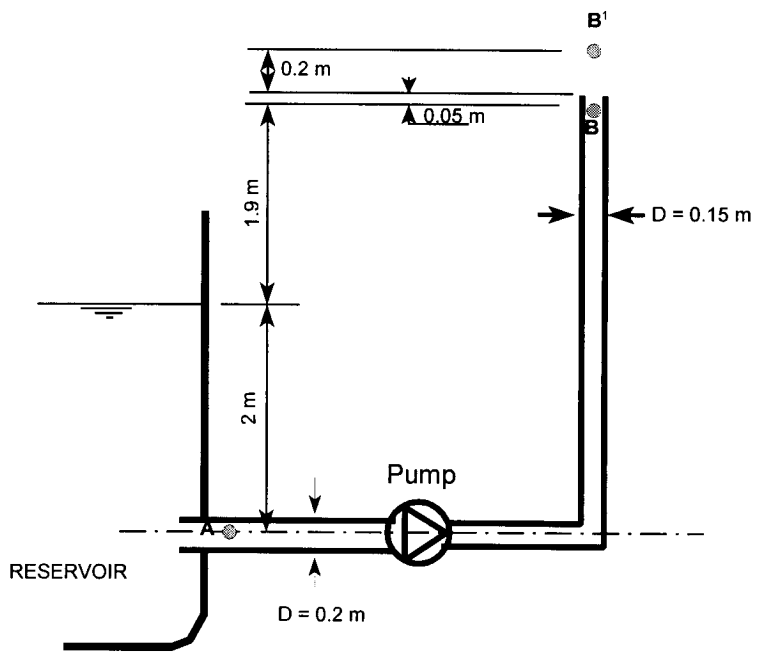

FIGURE 2

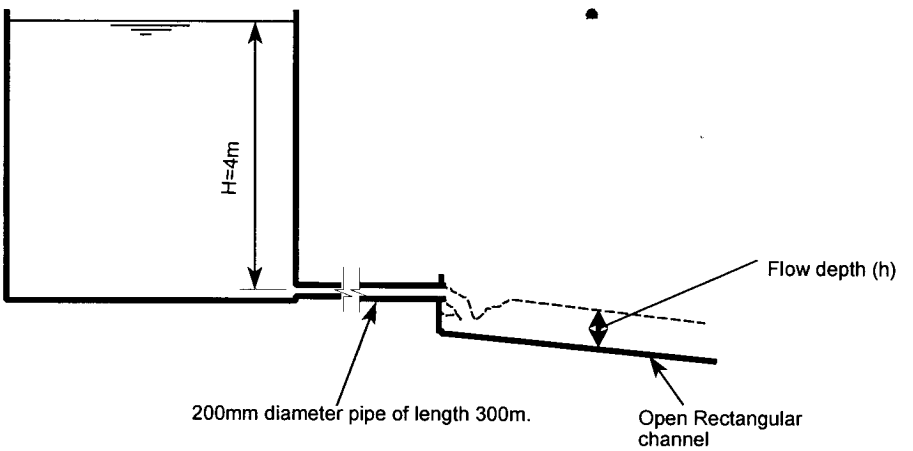
H=4m
Flow depth (h)
200mm diameter pipe of length 300m.
Open Rectangular channel

FIGURE 3

Q3. (a) Discuss general causes of errors in mechanical measurements. Give sketches to illustrate your discussion where possible.

(10 marks)

(b) Determine the instrument error when a low precision vernier calliper with a beam curve of 0.15 mm is set to measure 350 mm. The calliper jaw length is 80 mm. Derive any expressions used.

(10 Marks)

Q4. With help of clearly labelled sketches, describe how you would manufacture a cylindrical aluminum cup using the green sand and CO_2 process casting technologies. The cup has an internal diameter of 75 mm, a depth of 85 mm and a wall thickness of 5 mm. The cup has a normal cup handle.

(16 Marks)

What casting defects are likely to be experienced in this method of manufacturing an aluminium cup?

(4 Marks)

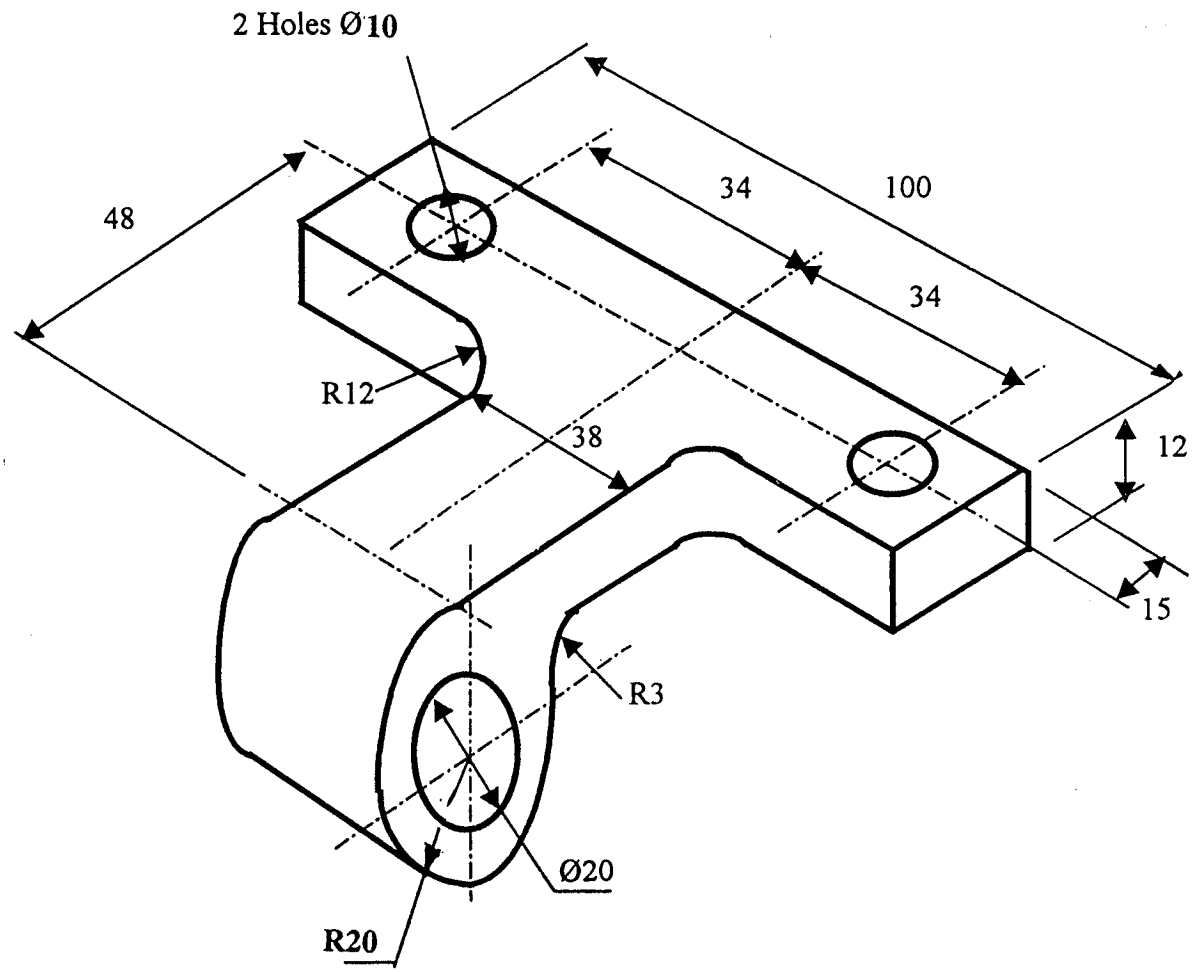

Fig. Q1 Hinge

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
UNIVERSITY EXAMINATIONS - SEMESTER I, JULY 1999

ME 415 PRODUCTION TECHNOLOGY I

CLOSED BOOK

TIME: THREE HOURS.
ANSWER: FIVE QUESTIONS, AT LEAST TWO FROM EACH SECTION;

SECTIONS A AND B TO BE ANSWERED IN SEPARATE BOOKS.

SECTION A.

Q1. Fig. Q1 shows a cast iron hinge whose Dia. 20 mm hole is to be drilled using a jig. The production rate is 100 hinges per day. Fig. Q1 dimensions are in mm.

With respect to the Dia. 20 mm hole on the hinge, suggest a casting design improvement to facilitate drilling of the hole.

(2 Marks)

Using graphic symbols, suggest suitable locator, holding force and support positions on the casting to be used for designing the Dia. 20 hole drilling jig. Indicate tool axial and rotational feed directions with respect to the Dia. 20 mm hole to be drilled.

(4 Marks)

Using the identified locator, holding force and support positions, design the drilling jig to be used for drilling the Dia. 20 mm hole. Give a good clearly labelled sketch of the jig (at least two views) and means for fastening the jig to a machine table. You should specify the type of bushing used, locating and clamping devices and the materials used to make the key components of the jig.

(14 Marks)

Q2. (a) Give reasons why gear production by form milling is considered to be a low cost gear production method. Give advantages and disadvantages of the process.

(5 Marks)

(b) Derive the expression

$$T_e = T_h \sec^3 a$$

where a is the helical angle, in relation to form milling of helical gears.

Give an outline of the significance of the expression.

(15 Marks)

SECTION B.

Q5. (a) State the 4 main assumptions of Merchant's theory of cutting. (2 marks)

(b) From Merchant's circle, Derive expressions in terms F_ϕ and $F_{\phi n}$, for:
(i) Force along the rake face. (4 marks)
(ii) Force normal to the rake face. (4 marks)

(c) Using the shear angle predicted by Merchant, calculate for the following conditions:

Cutting velocity	V	= 205 m/min
Tool rake angle	γ	= +7.5°
Cut thickness	h	= 0.35mm
Width of cut	b	= 5.15mm
Shear stress on shear plane	τ_ϕ	= 700N/mm^2
Apparent coefficient of friction	μ	= 0.67

(i) Cutting force (2.5 marks)
(ii) feed force (2.5 marks)
(iii) Force along the rake face (2.5 marks)
(iv) Force normal to the rake face (2.5 marks)

Q6. (a) State 4 main physical requirements for the selection of a suitable cutting tool material. (4 marks)

(b) Describe the 4 main types of carbide tool material. (16 marks)

Q7. (a) Derive the following expressions, based on Merchants minimum work principle:
(i) Merchants theoretic value for ϕ (3 marks)
(ii) $F_v = 2hbT_\phi COT\phi$ (7 marks)

(iii) $F_f = hbT_\phi(COT^2\phi - 1)$ (7 marks)

(b) Draw a comparison table between parameters in orthogonal cutting and practical turning operations. (3 marks)

Q8. (a) Define the phenomenon built up edge. (1 marks)

(b) State the 3 main problems caused by built up edge. (3 marks)

(c) Briefly describe with diagrams, the 4 forms of built up edge. (16 marks)

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Mechanical Engineering Department

ME 461 – Fluid Mechanics II
Semester I – Supplementary Examination - November 1999

Instructions:

i) *Give all relevant assumptions*
ii) *For all questions comment as much as possible to ensure clarity*
iii) *Give sketches where you think it is necessary*
iv) ***Answer ANY 5 QUESTIONS (CLOSED BOOK)***

Time: ***3:00 hrs***

****

Q1) A rocker plate constitutes a part of a tilting pad bearing in an installation designed to generate electric power. The plate has a width of 30-cm and slides with a linear velocity of 1.2 m/s. The wedge created in the bearing is such that the bigger end clearance is 75-μm and the smaller end one is 25-μm. From "first principles", showing all the details, find the volumetric discharge through the wedge neglecting any end flow. *(20 marks)*

Q2) a) The head-discharge characteristic of two identical pumps, which are connected to a pipe system to pump water into a high level reservoir (at point C), is given by the equation $\mathbf{H = 40 + 0.14Q - 0.0012Q^2}$, where Q is the discharge in "l/s" and H is the head developed by the pump in "m".

The pipe AB, between Pump1(at point A) and the junction (B), is 30-cm in diameter and 100-m long. The pipe BC, between the junction and the high-level reservoir (C), is 45-cm in diameter and 200-m long. For both the pipes the friction factor can be taken as 0.03. "V" is a regulating valve on the pipeline BC. The static lifts against which the pumps are working are 20-m, for Pump2 (between junction B and reservoir D) and 30-m, for Pump1 (between junction B and reservoir E).

For a given position of the valve "V", the pump operating against a static lift of 30-m develops a discharge of 140 l/s. Determine the discharge of the second pump and the loss coefficient of the valve. Neglect all other losses. *(14 marks)*

b) Give the "similarity laws" as applied to centrifugal pumps. Explain the use of similarity laws in engineering applications. *(6 marks)*

Q3) a) Briefly explain the principle of dimensional homogeneity with relevant examples. *(5 marks)*

b) (i) Define the specific speed for pumps and turbines, show how their Non-Dimensional expressions are obtained. Explain the significance of specific speed in pump applications. *(10 marks)*

(ii) A multi-stage centrifugal pump is required to lift 9000 litres of water per minute from a mine, the total head including friction being 75 metres. If the speed of the pump is 1200 rpm, find the least number of stages, if the specific speed per stage is not to be less than 60 rpm. *(5 marks)*

Q4) a) Drag tests were carried out in a towing tank on a 1/25-scale model of a ship which is expected to attain a peak speed of 8.25m/s. The model was towed at a speed given by Froude's law and the measured drag was found to be 15.6 N. The ship has a length of 90 m at the water line and a wetted area of 1670 m^2. Find the peak speed drag of the ship. For turbulent boundary layer the mean drag coefficient is given by:

$$C_f = (0.0735)*(Re)^{-0.2}$$

For sea water the density is 1025 kg/m^3 and the kinematic viscosity is $1.06*10^{-6}$ m^2/s, while the kinematic viscosity of tank water is $1*10^{-6}$ m^2/s. *(12 marks)*

b) Wind tunnel experiments were conducted with a speed of 50 km/h, on a flat plate 2 m long and 1 m wide. The specific weight of air is 1.15 kg/m^3. The plate is kept at such an angle that the coefficients of lift and drag are 0.75 and 0.15 respectively. Determine: (i) the Lift force, (ii) the Drag force, (iii) the resultant force and (iv) the power exerted by the air stream on the plate. *(8 marks)*

Q5) a) Find the force exerted by the nozzle on the fireman for the configuration and data in Fig. Q5 a. *10 marks)*

b) A viscometer consisting of a long vertical tank containing a fluid at the desired ambient conditions and a small sphere is employed for determining the viscosity of oil. If a copper ball (specific gravity 8.93) of 0.012 m diameter travels through a lubricant oil (specific gravity 0.8) a distance 0.5 m in 7.7 seconds, determine from "FIRST PRINCIPLES" the viscosity of the oil. Assume Stokes flow, hence $C_D=24Re^{-1}$ *(10 marks)*

Q6) a) If the velocity profile in a laminar boundary layer is approximated by a parabolic profile as:

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

Where:

"U" and "δ" are the free stream velocity and the thickness of the boundary layer at a given X-section respectively. "y" is the normal distance measured from the solid surface up to the point where the boundary layer velocity is "u".

Calculate:

(i) The displacement thickness and the momentum thickness (in terms of the distance "x" and the Reynolds Number)

(ii) The mean Drag Coefficient *(15 marks)*

b) For practical purpose, there are four alternative ways used to define the boundary layer region. Apart from the "displacement thickness" and the "momentum thickness" describe the other two ways. *(5 marks)*

Q7) a) For compressible isentropic flow, using the following expression:
$[dA/A] = \{[M^2-1]dU/U\}$, where A is cross section area, U is local velocity and M is the local Mach Number, explain the effect of the cross section area variation on the flow and also relate it to the "subsonic to supersonic" nozzle. *(6 marks)*

b) In a wind tunnel test on a model, the pitot tube gave readings for the static and stagnation pressures as 28-mm and 134-mm of water, respectively. Find the velocity of air in the test section, 1.2-m by 0.8-m cross section, and also the flow rate. The barometer read 760-mm Hg and temperature 28°C. Find the local Mach Number. *(7 marks)*

c) A jet airplane is propelled at a velocity of 1000 km/hr through air in which the atmospheric pressure is 0.9 kgf/cm^2. The temperature is –5°C and the wind velocity is negligible. Calculate the pressure intensity, the temperature, the density of air at the stagnation point on the nose of the jet, and determine its Mach number. *(7 marks)*

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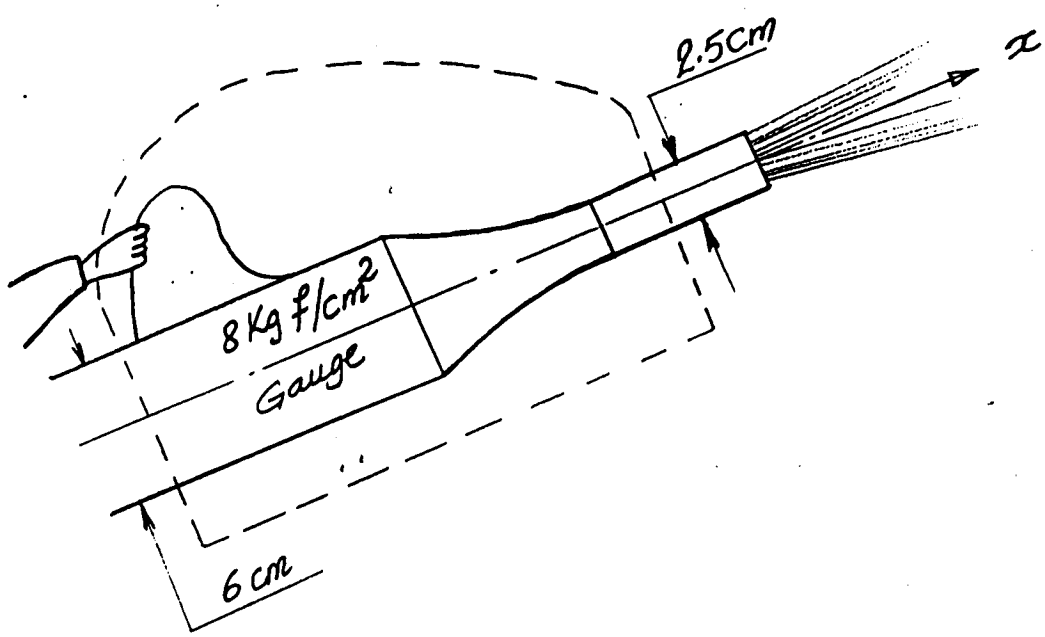


Fig. Q5 a

==========END OF EXAMINATION=&=GOOD LUCK!==========

Prepared by: Lewis MUNUNGA

University of Zambia
School of Engineering
Department of Surveying

25th October 1999

SE 321 - Cartography I **University Examinations**

Answer: All questions **Time Allowed:** Three hours

Question One

Write briefly about the following as regards cartography.

(a) The difference between a map and aerial photography.

(b) Graphic or scale bar.

(c) Coordinate systems.

(d) Lines and points of zero distortion.

(e) Letter forms.

[5 + 5 + 5 + 5 + 5]

Question Two

(a) When considering drawing a map or plan the appropriate drawing material has to be chosen. List and explain any five of the qualities the drawing material must have.

(b) When placing names of area features on a map the general 'rule' for name placement should apply. But there are certain instances when this is not possible.

(i) State one such instance.

(ii) What special 'rules' should apply in such a case?

[20 + 5]

Good Luck!!

Question Three

(a) By which four methods can a map be enlarged or reduced? Which of these is the most common way of changing the scale in cartographic processes?

(b) List and briefly discuss the cadastral plans that constitute the cadastral survey records.

(c) Map production at any scale should be based on confirmed technical specifications. For which maps are specifications available in Zambia?

(d) Using the rectangular coordinate systems conveniently plots coordinated points. Which two rectangular coordinate systems are in common use in Zambia?

[5 + 15 + 3 + 2]

Question Four

(a) The complex geometric figure that is assumed by our elastic planet is a result of the interaction of several forces. What are these forces?

(b) Give any three requirements, which will ensure sufficient precision when using a Master Grid as a substitute for an ordinary metal grid template.

(c) What is orthomorphism?

(d) In Zambia some Cadastral Surveys employ the LO (Longitude Zero) projections. What are its four properties? Why can't a zone larger than 2 degrees be used in large scale cadastral surveys?

[6+6+3+10]

Good Luck!!

The University of Zambia
School of Engineering
Department of Surveying
SE 371 - Principles and Methods of Surveying I
End of Semester Examination - Oct 1999.

Time : **3 Hours**
Total Marks : **100** **Answer Any Four Questions**

Question 1 **[3 + 4 + 3 +15] marks**

a. Name any three types of levels.

b. Define

i) level line,

ii) horizontal line,

iii) datum,

iv) misclosure in levelling.

c. Determine the approximate distance at which the combined effect of curvature and refraction in levelling amounts to 4 mm. [R= 6400Km]

d. A level line whose observations are shown below was run in order to establish reduced levels of points A, B, C, D and E.

1.716 **BM 1227.810**, [1.582 and 1.662] CP, -2.171, 1.566, -2.177, [1462 and 1.543] CP, 1.460 **TBM 1227.890.**

Fill in the booking form the above and carry out necessary computations, checks and adjustments, and determine the actual height difference between points A and E.

NB. Use one of the booking forms provided on page 6.

Question 2 **[5 + 10 + 10] marks**

a. Mention any five (5) methods of determining area of any type of figure.

b. **Figure 1** below shows a field with two straight boundaries AB and BC and an irregular third boundary AC. The irregular area is divided into eight offsets at regular intervals. The distances for the straight lines and the chainage of the offsets are given below:

Line	Distance (m)
AB	475
BC	555
CA	770

Offset No.	1	2	3	4	5	6	7	8
Offset length (m)	0	12.55	15.52	10.71	19.60	8.70	5.24	0

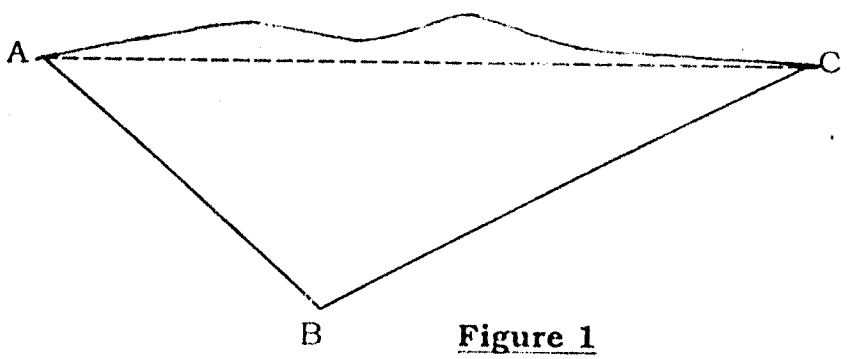


Figure 1

Determine the enclosed area by

i) Simpson's rule,

ii) Trapezoidal rule.

c. A land parcel is bonded by coordinated points A, B, C and D whose coordinates are listed below in the format Point(Y, X):
A (276.22, 405.35), B (487.17, 341.63), C (321.67, 100.81) and D (107.14, 211.33).

Calculate the area to the nearest square metre of the land of parcel by the coordinate method.

Question 3 **[8 +17] marks**

A link traverse survey is run near a construction site (**Fig. 2**) to determine the coordinates of points 1 and 2 for the purpose of carrying setting out surveys. The control points **A, B** and **C** used in this traverse have the following coordinates:

Point	Y(m)	X(m)
A	3248.36	2855.90
B	3724.09	3035.39
C	3706.47	6917.86

The data collected is shown below:

Adjusted Horizontal angle	Horizontal distance
∠CA1= 97° 31' 11"	a-1 = 186.11m
∠A12 =145° 31' 18"	1-2 = 168.45m
∠12B =150° 14' 00"	2-b = 214.90m
∠2BC=140° 01' 50"	

i. Find the linear misclosure.
ii. Adjust the traverse according to Bowditch method.

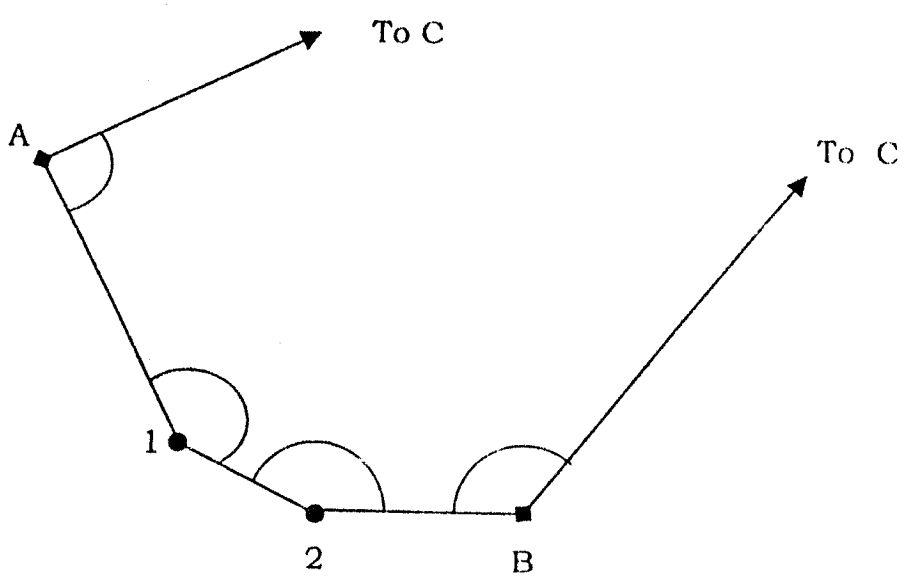


Figure 2

NB. Show necessary calculations on the separate answer sheet and the entries computation for provided on page 7.

Question 4 **[4+3+18] marks**

a. Mention any four conditions (defects) considered for permanent adjustment of a theodolite.

b. Why is it important to take the mean of face left (FL) and face right (FR) readings when measuring horizontal and vertical angles?

c. It is proposed to extend a straight road AB in the direction of AB produced. The centre line of the extension passes through a farm and

in order to obtain the centre line of the road beyond the farm a traverse is run from B to a point C, where A, B and C lie in the same straight line. The following angles and distances were measured:

ABD = 87° 42' 30"	BD = 29.02 m
BDE = 282° 36' 20"	DE = 77.15 m
DEC = 291° 06' 10"	

Calculate

i. the length of the line EC,

ii. the angle to be measured at C so that the centre line of the road can be extended beyond C.

iii. the chainage of C if the chainage of A is Zero and AB is 110.22 m

NB. Angles were measured clockwise from the back to the forward station.

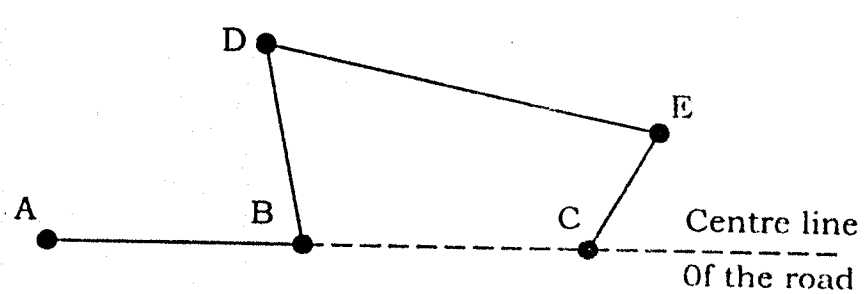


Figure 3

Question 5 **[12+6+7] marks**

Two points A and B were heighted using trigonometric heighting from a point X with known reduced level. The slope distances to the points A and B, and the target height are indicated below:

X to A = 290.88 m
Target height at A = 1.10 m
Instrument height at X = 1.40 m
Vertical angle to A = 6°13' 46"

X to B = 250.78 m
Target height at B = 2.86 m

Reduced level of X = 1200.00 m above mean sea level.
Height difference between A and B = 42.09 m (B below A).
Horizontal angle AXB = 46°25' 03"

Compute

a. the vertical angle to B from X, taking into consideration the effects of curvature and refraction,
b. the horizontal distance between A and B.
c. the coordinates of point B if the line XA lies along the positive Y – axis with point X at the origin.

END OF EXAM!!

WISHING YOU ALL THE BEST!

Computer No:.....

Date:.....Venue:.....

Height of Instrument Method

Pt	Readings			Height Instr.	Reduced Level	Adjusted RLs	Remarks
	BS	IS	FS				

Rise and Fall Method

Pt	Readings			Ht. Differ.		Reduced Level	Adjusted RLs	Remarks
	BS	IS	FS	Rise	Fall			

Computer No:.....

Date:.....Venue:.....

TRAVERSE COMPUTATION FORM (For QN 3)

Stn Pnt	Adjusted Hor. Angle			Bearing			Hor. Dist.	COORDINATE DIFFERENCES						CORDINATES		Stn Pnt
								Computed		Corr.		Adjusted				
	°	'	"	°	'	"		ΔY	ΔX	δY	δX	ΔY	ΔX	Y	X	

The University of Zambia
School of Engineering
Department of Surveying

University Examinations May 1999
SE411 Surveying Mathematics

Duration : *Three hours*
Answer : *Part A (Questions 1-3) - all questions*
Part B (Questions 4-5) - one of the questions
Total : *100 points*

Part A

Question 1 ~~(2+2+16)~~ (5+5+15)

a) What do the following terms mean in spherical trigonometry:
i) Great circle? ii) Spherical triangle?

b) In a spherical triangle two angles are known, A=45° and B=45°. The area of the triangle is given in area units and the radius of the sphere is unity. Calculate the remaining angle and the sides of the spherical triangle.

Question 2 ~~(3+2+2+3+5+5)~~ (3+2+2+5+5+8)

a) Define the following terms
i) precision, accuracy and uncertainty
ii) normal distribution
iii) systematic error

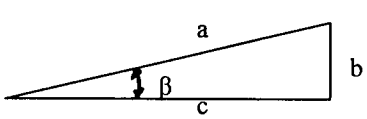
b) Suppose that the following values were obtained in 15 independent measurements of a distance: 212.22, 212.25, 212.23, 212.15, 212.23, 212.11, 212.29, 212.34, 212.22, 212.24, 212.19, 212.25, 212.27, 212.20 and 212.25 m.

Calculate
i) The most probable value
ii) The standard deviation
iii) The 50% and 90% uncertainties

Question 3 ~~(3+3+14)~~ (5+5+15)

a) Define the following terms
i) error propagation
ii) variance-covariance matrix

b) The angles and sides of a right-angled plane triangle are shown in the figure below. Sides **a** and **b** are measured and the measurement are 416.050m and 202.118m, respectively. The measurements are independent, the standard deviation of **a** is 0.020m, and the standard deviation of **b** is 0.012m. Evaluate the elements **c** and β of the triangle and their standard deviations. Also determine the correlation, if any between **c** and β.



Part B

(12+8+5)

Question 4 ~~(8+8+4)~~

A cadastral Survey is conducted in a local system. We want the co-ordinates transformed to the Lo system. The reference points are known in both systems.

a) Determine the transformation parameters between the local system and Lo.

b) Calculate the co-ordinates of point 1 in the Lo system.

	Local system		Lo system	
Point	x (m)	y (m)	Y (m)	X (m)
281	1203.14	2687.12	9487.138	6312.164
282	1166.43	2492.64	9469.588	6115.854
1	1204.68	2637.64		
2	1255.28	2635.03		
3	1212.71	2695.16		

c) Why is it better to have more than two common points when determining the transformation parameters between two different co-ordinate systems?

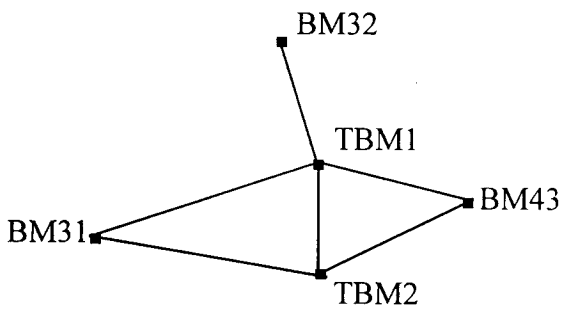
(6+4+15)

Question 5 ~~(4+2+14)~~

a) Define the terms "Least squares adjustment" and "residual".

b) Determine the redundancy in the level net below

c) Find the most probable heights of the points *TBM1* and *TBM2* and their standard errors for the levelling net given below.



Known heights (m)		Observations		
BM31	1186.043	From point to point	Δh(m)	dist (km)
BM32	1192.751	*BM31-TBM1*	1.361	3.1
BM43	1189.286	*BM31-TBM2*	-2.016	3.3
		BM43-TBM2	-5.254	2.6
		TBM1-BM31	-1.358	3.6
		TBM1-BM43	1.890	1.9
		TBM1-BM32	5.352	0.8
		TBM2-TBM1	3.380	1.3

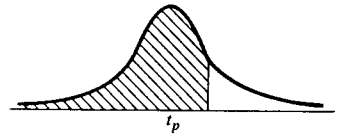
END OF EXAMINATION QUESTIONS

GOOD LUCK!

M. PHIRI
DEPT. OF SURVEYING
OFFICE F07

Table I. Values of the Standard Normal Distribution Function

$$\Phi(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} e^{-u^2/2}\, du = P[Z \leq z]$$



z	0	1	2	3	4	5	6	7	8	9
−3.	.0013	.0010	.0007	.0005	.0003	.0002	.0002	.0001	.0001	.0000
−2.9	.0019	.0018	.0017	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0126	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0238	.0233
−1.8	.0359	.0352	.0344	.0336	.0329	.0322	.0314	.0307	.0300	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0570	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0722	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
− .9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
− .8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
− .7	.2420	.2389	.2358	.2327	.2297	.2266	.2236	.2206	.2177	.2148
− .6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
− .5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
− .4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
− .3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
− .2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
− .1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
− .0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

z	0	1	2	3	4	5	6	7	8	9
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7703	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9278	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9430	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9648	.9656	.9664	.9671	.9678	.9686	.9693	.9700	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9762	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9874	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.	.9987	.9990	.9993	.9995	.9997	.9998	.9998	.9999	.9999	1.0000

The University of Zambia
School of Engineering
Department of Surveying

1st Semester Examinations, May 1999
SE 462 : Remote Sensing

Instructions:

1. **Time : Three (3) hours**
2. **Answer all questions in section A and only two (2) from section B.**

Section A: *Answer all questions*

Q1. Compare and contrast the following terms: [4+4+6]

a) Linear stretch and histogram equalisation
b) Geostationary and sun-synchronous orbits
c) Geometric correction, Image registration and Georeferencing.

Q2. [8+6]

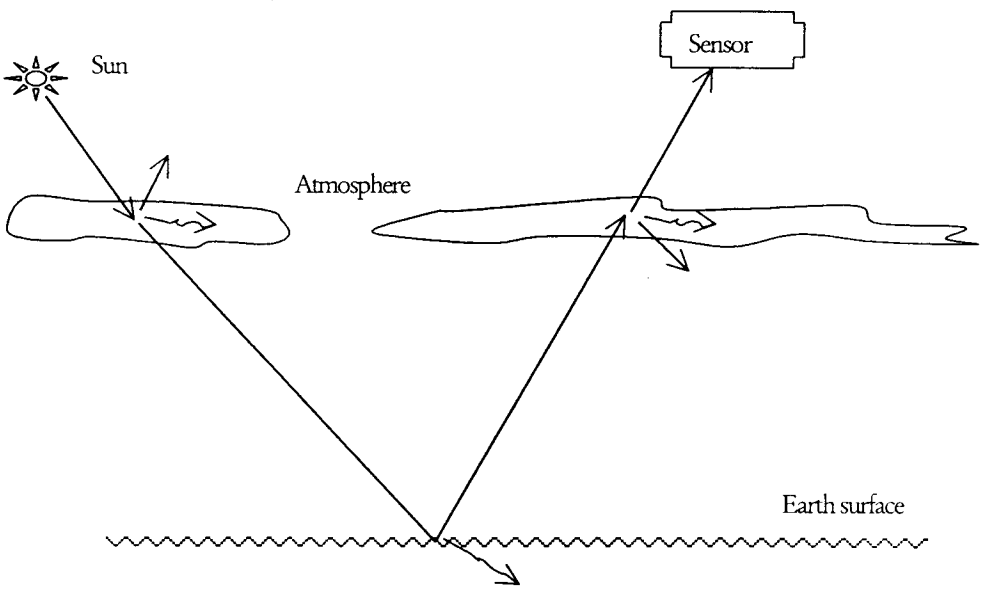
a) Define the following terms:
   i) Atmospheric windows
   ii) Azimuth resolution
   iii) Swath width
   iv) Spectral signature

b) Compare the following Remote Sensing platforms in terms of spatial, spectral and radiometric resolutions.
   i) Landsat MSS
   ii) SPOT pan
   iii) SPOT XS
   iv) NOAA

Q3. [9+5]

a) Briefly describe Wien's displacement law. Calculate the radiant temperature given that the radiant peak wavelength of an object is 0.55μm. Calculate also the amount of total radiant exitance from the same object. You may use constants given below.

b) The figure below gives a scenario of energy propagation from the sun through the atmosphere to the sensor. Assuming that the atmosphere absorbs 10%, reflects (or scatters) 10%, and transmits 80%; the earth surface absorbs 40 % and reflects (scatters) 60% of the energy incident upon it. Given that the sun radiates its energy at the same wavelength as the object in a), calculate an estimation of the amount of radiation transmitted through the atmosphere(from sun to earth), reflected at point X and received by the sensor from an instantaneous field of view at point X. What percentage is received by sensor?



Constants:

C_3=2898μm, σ = 5.6697 x 10^{-8} $Wm^{-2}K^{-4}$

Q4. [3+12+3]

a) List three (3) of the organisations/companies in Zambia which you feel would do well to establish a GIS. Only one example from each application area.

b) For each organisation mentioned in part a) above, list the data sources (or input) and the GIS processes (or analysis) that would be involved.

c) What would be the anticipated problems in establishing GIS with the suggested organisations.

Section B: *Answer only two (2) questions*

Q5. [9+3+3+5]

a) What factors influence the reflectance from the following earth surface features.
   i) Water
   ii) Vegetation
   iii) Soil

b) The spectral reflectance characteristics of a moist sandy soil are shown in the attached figure 5.1 on page 5. Sketch a curve on the graph that would be representative of the reflectance characteristics of the same soil after it had been air dried. Explain the shape of the curve.

c) Repeat part b) on figure 5.2 assuming the soil type was clay. Explain the shape of the curve.

d) Airborne radar RS is done with systems that use an antenna fixed below the aircraft and pointed to the side. Such systems are called Side-Looking Airborne Radar(SLAR). What are the major effects of topography on SLAR images? Explain with illustrations.

Q6. [5+15]

a) Make a description of the processes you would follow in order to have a satellite image overlaid with another existing map layer in local co-ordinate system, in digital form.

b) What is the purpose of image classification? The success of image classification is usually assessed by the accuracy level attained. This is done by a confusion or error matrix. Interpret (explaining the diagonal values and off diagonal values) the table below and give the overall accuracy of the data shown. Point out the classes with high misclassifications and give the possible causes.

Classification data	Reference data						
		Water	Sand	Forest	Urban	Corn	Hay
	Water	226	0	0	12	0	1
	Sand	0	216	0	92	1	0
	Forest	3	0	360	228	3	5
	Urban	2	108	2	397	8	4
	Corn	1	4	48	132	190	78
	Hay	1	0	19	84	36	219

Q7. [10+10]

a) Give an example of each of the following types of filters:

i) Low pass filter

ii) High pass filter

Explain how a digital image is affected by each of the above types of filters and give some applications of each.

b) What is the main purpose, with regard to image processing, of laplace filters? Apply a 5x5 median filter on the image below and show the image values of the filtered image. Use zeros (0s) in the areas not covered by the central pixel of the filter matrix.

54	40	31	27	27	28	39	51	52
55	37	37	35	31	27	26	35	58
56	40	39	45	39	42	27	26	36
52	39	33	42	49	48	36	31	26
42	34	24	30	60	67	49	33	27
26	29	26	44	76	76	49	37	33
14	31	36	50	85	70	36	37	38
20	31	39	51	72	56	35	35	37
21	26	36	46	58	49	37	35	36

End of Exam
Good luck.

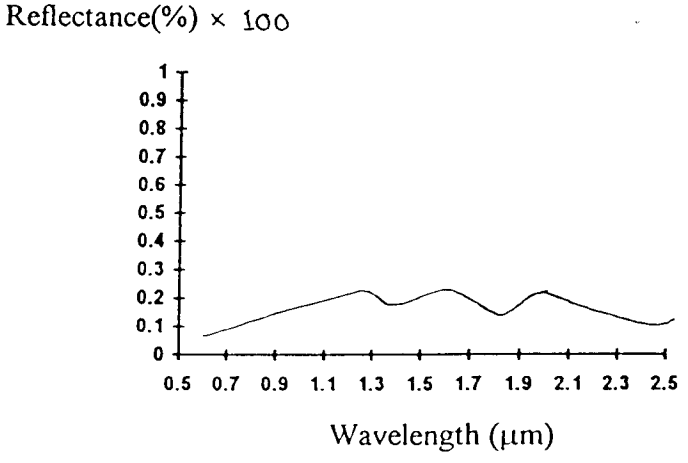


Figure 5.1:

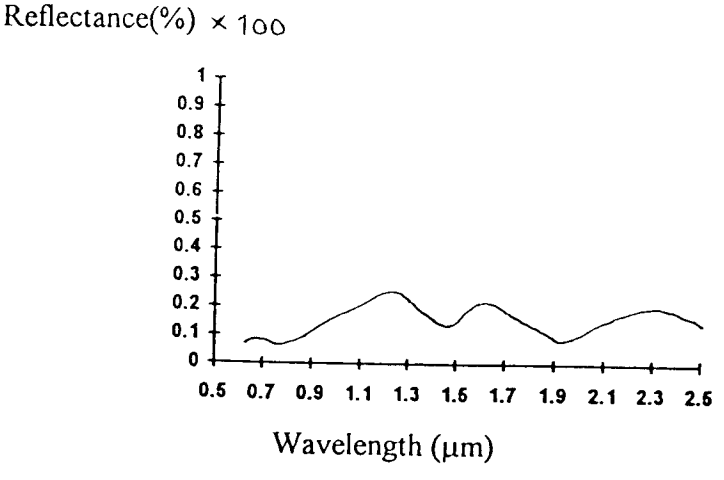


Figure 5.2:

THE UNIVERSITY OF ZAMBIA
School Of Engineering
Department Of Surveying

SEMESTER I FINAL EXAMINATION
1998/99 ACADEMIC YEAR

SE531 – PHOTOGRAMMETRY III

Read the following instructions carefully.

1. This paper is divided into two sections, A and B.
2. Answer all questions in SECTION A and any two in SECTION B.
3. All questions carry equal marks (i.e. total of 20 marks per question).
4. Maximum time allowed is **3 hours.**
5. Please read each question carefully before attempting it.

GOOD LUCK!!!

SECTION A (ANSWER ALL)

Question 1. (10 + 10)

1(a).
Explain the differences between mechanical stereoplotters and analytical plotters with respect to their design and execution of basic photogrammetric operations.

1(b).
Explain the principles of automatic image correlation. What are the advantages and disadvantages of using photogrammetric instruments with automatic image correlators?

Question 2. (12 + 8)

2(a).
Explain with help of diagrams, in general terms the concepts of Digital Photogrammetry (DP), Digital Photogrammetric Systems (DPS) and Digital Photogrammetric Workstation (DPW). Discuss the differences between DPS and DPW.

2(b).
At the heart of every DPS is the software. Explain the different software components or modules, with which various tasks are achieved in a DPS.

Question 3. (12 + 8)

3(a).
You are in charge of a mapping project and you have adopted photogrammetric techniques in combination with some field surveys for controls and missing data. What special requirements and precautions would you consider in the use of photogrammetric procedures?

3(b).
Explain the fundamental differences between CRP (i.e. Close Range Photogrammetry) and Aerial photogrammetry. What factors influence the potential of CRP in an application?

SECTION B (ANSWER TWO ONLY)

Question 4. (8 +12)

4(a).
What are the striking advantages of Digital Photogrammetric techniques over the analogue and/or analytical approach? Discuss any disadvantages if any also.

4(b).
Stereoscopic viewing in Digital Photogrammetric Workstation (DPW) is implemented in different ways by different system vendors. Describe any two stereoscopic viewing systems implemented in some DPW.

Question 5. (10+ 10)

Describe how Close range photogrammetry can be applied in the following:

a. Architectural applications
b. Industrial applications

In your description, mention the type of data acquisition systems that can be used.

Question 6. (12 +8)

6(a).
List and explain the various information types that may change in the terrain, which in turn would require update on an existing map.

6(b).
In revision of large-scale maps, stereo photogrammetric compilation is one of the most common methods used. Outline and briefly explain the steps involved.

SCHOOL OF ENGINEERING
DEPARTMENT OF SURVEYING

University Examinations - 1998/99

Principles of Land/Geographic Information Systems
(SE 561)

Instructions

Time: Three (3) hours
Questions 1 – 4 carry equal marks
Answer question five (5) and any other three (3) from the remaining four (4) questions

---

Question 1 (4+4+4+4+4)

Briefly define or explain each of the following terms:

a) Geographic Information System
b) Accuracy
c) Entity
d) Cardinality
e) Edge matching

Question 2 (4+6+10)

a) Name two main components of the data acquisition process
b) What problems associated with digitizing of data from paper maps affect the quality of the data obtained?
c) Given below are two raster images (A) and (B) of two separate areas

A C C B	A A A C
A A C B	A A C C
A A A B	A C C C
B A A A	A A A A
Image (A)	Image (B)

(i) Give the run length encoding and value point encoding for images (A) and (B)
(ii) What is the percentage of storage saving in the number of cells for each image when encoded with run length and value point?
(iii) Which one of the two images would be suitable for storage using run length encoding or value point encoding?

Question 3 (2+4+8+6)

a) What is a database?
b) Name and state the functions of two languages of a Database Management System (DBMS)
c) State the characteristics of a Database Management System
d) Name and briefly explain the various levels of database designing

Question 4 (2+5+5+8)

a) What is precision?
b) Distinguish the locational precision of coordinates for raster data against those of vector data
c) What are cartograms? Give four examples of cartograms.
d) Name and explain briefly the various ways of presenting spatial analysis results

Question 5 (40)

Chilubi Island is a beautiful island in the Lakes of Bangweulu with a mixed but happy population originating from the Eastern, Southern, Western and Northern Provinces of Zambia. The Island has only one City named Chilubi which is divided into several townships. Each township is divided into parcels.

All parcels have an area smaller than 100 m^2 and may have one house only. Due to a shortage of land, every parcel is leased by somebody, but a person may own leaseholds to more than one parcel. Subleases are not allowed while houses may be occupied by owners or tenants.

In this happy society of Chilubi Island a person may be married to one other person only.

Based upon the foregoing information, design a database to support a Parcel Based Information System for Chilubi Island by:

a) Identifying the entities and subsequently formulating the relevant enterprise rules
b) Formulating Entity-Relation (E-R) diagrams for the '*conceptual and logical data models*' for this database (do not forget to indicate the degree and membership class)
c) Formulating corresponding well normalised skeleton tables, not forgetting to underline the identifiers (key attributes) with a solid line and posted identifiers with a dotted line (Never bother to include the fully normalised tables)

Question 3 (10+15)

(a) Briefly discuss the use of simultaneous reciprocal trigonometric levelling. Stating why this operation may be necessary.

(b) Two points A and B are 8km apart and at levels of 102.50 and 286.50 AD respectively. The height of the target at A is 1.50m and at B 3.00m while the height of instrument in both cases is 1.50m. If 31m on the earth subtends 1 " of arc at the center of the earth and the effect of refraction is one seventh of that of curvature, what are the observed angles from A to B and from B to A?

Question 4(6+19)

a. Give reasons why the estimation of areas and volumes may be important in engineering projects.

b. A tank whose horizontal base ABCD is 40m long by 20m wide, is to be constructed in ground having a slope of 1 in 10 in the direction of larger dimensions BA and CD. The depths of excavation at A and D are to be 10 m, the side slope being 1 vertical to 1 horizontal. Calculate the volume of excavation required.

Question 5 (25)

The data on the next page was collected along the centre line of the proposed road. The reduced level of formation at regular intervals are given. Construct the mass haul diagram for this section of the road.. Comment on the results.

Additional information:
The existing ground has no cross fall
Side slopes are 1 in 2
The proposed road will be 10m wide

You may use the table provided

University of Zambia
School of Engineering
Dept of Surveying
SE571-Engineering Surveying
University Examinations October 1999

Duration 3hours: Answer Question **1** and any other **3** questions

Section A (Compulsory Question)

Question 1 (10 +15)

(a) Explain the term ***convergence of meridians.*** Show how this factor has to be taken into account when running long survey lines by gyrotheodolite.

(b) It was required to determine a grid bearing of XY using a gyrotheodolite. The gyro azimuth of a line was found to be 84°59′. In an earlier experiment the same gyro was set up at point A on the surface and it gave the circle reading of the true north as 56°17′ and that of AB as 92°00′. The line AB has always been known to have the grid bearing of 37°15′.
Compute the grid bearing XY.

Given that:
Diameter of earth = 12720km,
Easting of A = 470 km,
Easting of X = 300km,
Easting of central meridian = 500km
Mean latitudes of line AB 38°00′00″ south
And XY 18° 50′00″ North
Ignore (t-T) correction.
Assume gyro-constant (E) is same all over the earth

Section B Answer any 3 Questions

Question 2 (12+13)

a. What is Engineering surveying and what issues does a surveying engineer attend to at each of the following stages:

i Design
ii. Construction
iii. After construction

of a structure such as a dam and why?

b. Outline major steps in the process of triangulation stating necessary consideration for each step

Chainage	RL	Formation Level							
0	100	100							
50	101	100							
100	102	100							
150	100	100							
200	100	100							
250	99	99							
300	99	99							
350	98	99							
400	98	99							
450	97	99							
500	97	99							
550	97	99							
600	98	99							
650	99	99							
700	99	98							
750	100	98							
800	100	98							