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DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
FIRST SEMESTER APRIL 2002

1) CE 219 - Statics and Introduction to Strength of Materials
2) CE 365 - Soil Science, Roads and Hydraulics
3) CE 531 - Structural Concrete Design
4) CE 582 - Construction Techniques and Management
5) EA 311 - Farm Power and Machinery
6) EE 209 - principles of Electricity 1
7) EE 311 - Electric Circuits
8) EE 321 - Electromechanics & Electrical Machines
9) EE 431 - Electronics & Electronic Engineering 11
10) EG 212 - Workshop Technology
11) EG 365 - Fluid Mechanics & Thermodynamics
12) EM 211 - Engineering Mathematics 1
13) EM 311 - Engineering Mathematics III
14) EM 411 - Engineering Mathematics III V
15) SE 481 - Introduction to Surveying
16) SE 561 - Principles of Land/Geographic Information Systems

THE UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATION – APRIL

CE 219: STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS

CLOSED BOOK Examination
TIME: THREE HOURS

INSTRUCTION TO CANDIDATES

1. Candidates must ensure that their computer numbers are clearly written on each answer sheet used.
2. Answer any THREE (03) questions from Section A and any TWO from Section B.

Section A

Question 1

A force P=(**195I+325j+130k**)N is applied at point A and a force-couple is applied vertically at points E and F as shown in the figure. Determine

(a) The magnitude of the force acting at A.
(b) The total moment of the force and couple about line CD.

Question 2

The lever AB is pinned at C and attached to a control cable at A. If the lever is subjected to a 178 N horizontal force at B, determine the tension in the cable AD and the reaction at pin C acting on the lever. Report both the magnitude and direction of the pin reaction at C.

Be sure to illustrate the reference axis from which the angle is measured.

Question 3

The 100N weight disk is in equilibrium as shown, where it is loaded by the 20N force as well as a pure couple C. It is in contact with a rough surface in the form of a plane inclined at 60° to the horizontal. Show an accurate and complete free body diagram of the disk, and then determine the values of C as well as the reaction forces from the plane necessary for equilibrium.

Question 4

For the plane area shown in the figure, determine

(a) The first moments with respect to the X and Y axes.
(b) The location of the centroid.

Section B

Question 5

Using the Mohr Circle, transform the stresses shown in the figure into stresses acting on a plane at an angle of $22^1/_2{}^\circ$ with the vertical axis.

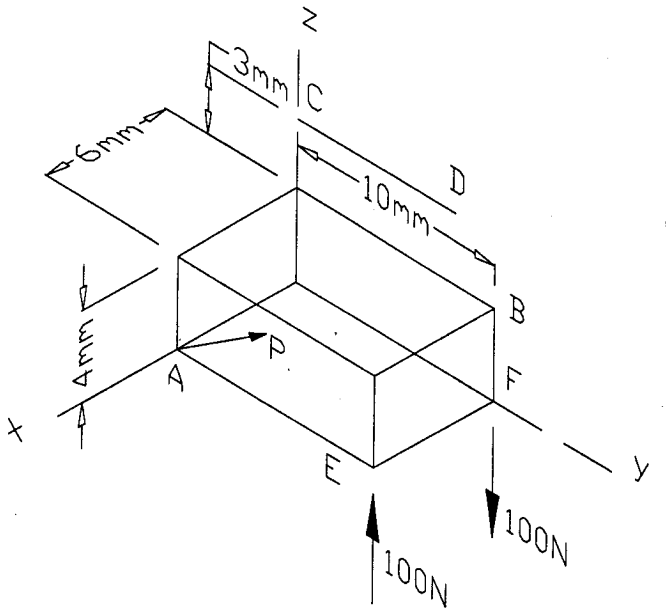
Question 6

A compound bar 90cm long is made of a rod of steel 30cm long 3cm diameter securely fastened to a rod of copper 60cm long. Under a pull of 50kN the extension in each portion are found to be equal. Answer the following questions:

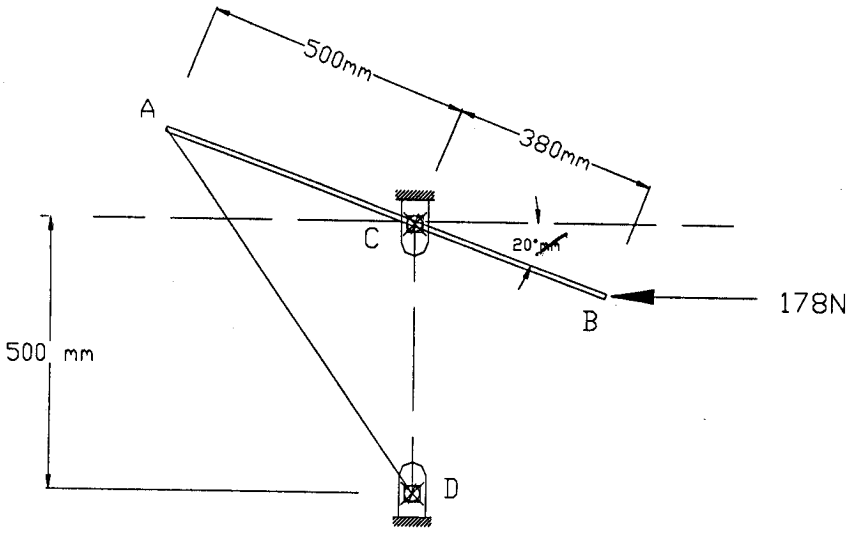
(a) What is the diameter of the copper rod?
(b) What are the stresses in steel and copper?
(c) What is the work done in extending the compound bar?
($E_s = 205{,}000\ N/mm^2$, $E_c = 110{,}000\ N/mm^2$)

Question 7

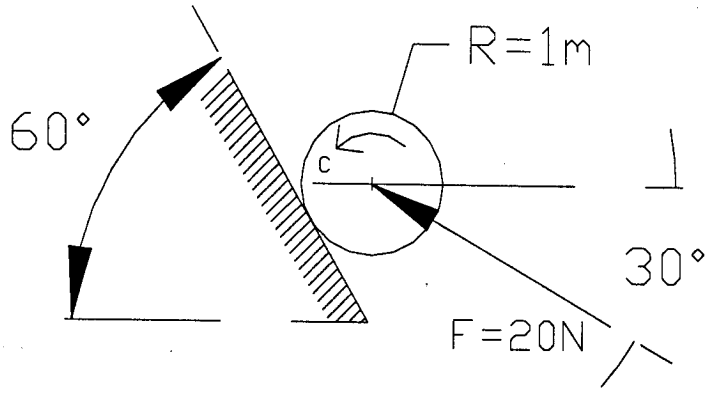
For the frame element shown, determine the internal reactions (Shear force V, Axial force P, and Bending moment M) at sections (1) and (2). Assume smooth support at B.



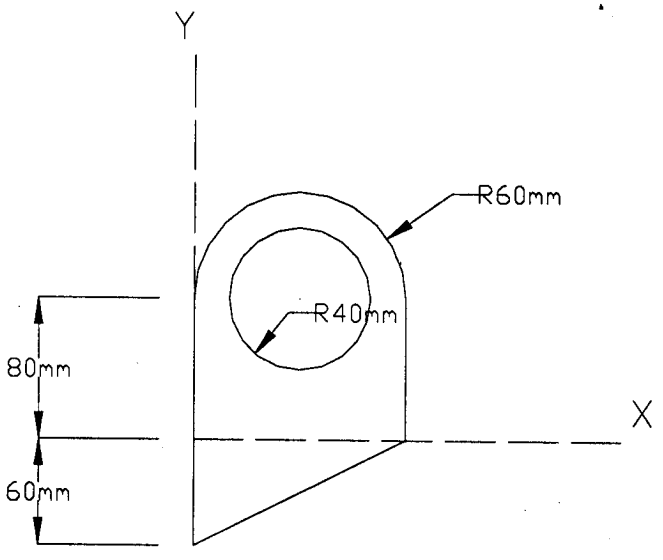
Question 1.



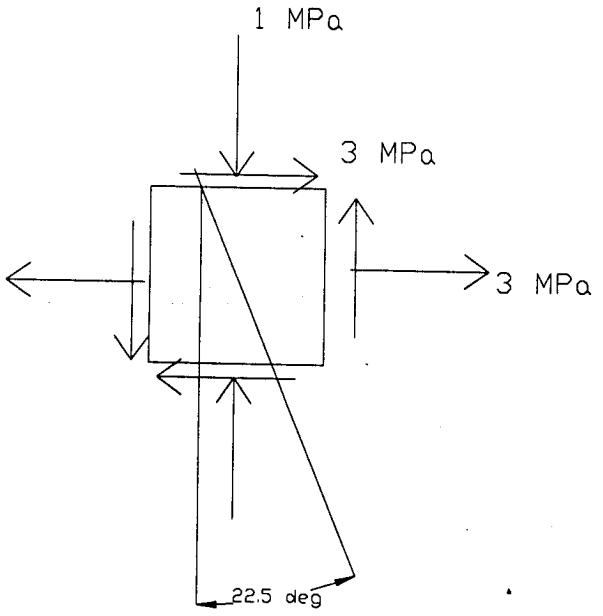
Question 2



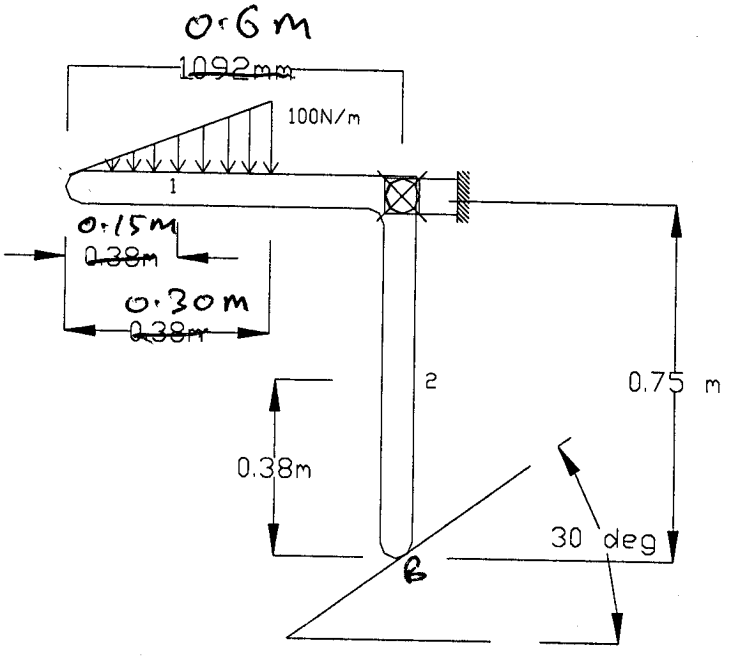
Question 3



Question 4



Question 5



Question 7

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENTOF CIVIL AND ENVIROMENTAL ENGINEERING

FINAL EXAM

E: CE 531 TIME 4HOURS

STRUCTURAL CONCRETE DESIGN

PART ONE
ANSWER ALL QUESTIONS

esign the longitudinal steel reinforcement for an interior simply supported beam,6 etres long and spaced at 2 metre centres. The width of the beam is 200mm and s depth is 300 mm. The depth of the slab is150mm as shown in figure 1.The oncrete cover to links is 25mm while the diameter of the links is10mm. Use the 8110 / I. Struct. E Manual design procedure. Take f c u =25N/ mm2, f y =460N / m2 and unit weight of Concrete =24KN /m3. Take the weight of finishes as 0.3 N /m2 and the live load as 2.5 KN / m2.

esign the longitituinal reinforcement for a braced column of clear height 5 metres ith the following fixity conditions, about the x – x-axis pinned at the top and ttom, about the Y – Y-axis pinned at the top and fixed at the bottom. The ading and moments are as follows, load N = 200KN,
1x = 150KN, M2X = 200KNM, M1Y= 75KNM and M2Y= 100KNM, b= 400mm d h = 500mm. Take h'= 0. 9h and b'= 0.875b and the optional reduction factor k unity. Use the design chart in figure 2. F c u= 30N /mm2 and Fy= 460N /mm2.

esign the reinforcement for a short braced axially loaded square column quired carry an ultimate axial load of 2000KN assuming a steel ration 2.06 % d assuming durability and architectural requirements are satisfied. Take Fc u = N/mm2 and Fy = 460N / mm2

e design ultimate moment M for a rectangular beam of width b =300mm and ective depth d = 750mm is 350 KNM.If fcu = 40N / mm2 and fy = 0N/mm2,design the longitudinal reinforcement from first principals.

PART B
ANSWER TWO QUESTIONS ONLY

Determine the ultimate moment of resistance M and x/d ratio of the beam section in figure 3 using

(a) The design chart in figure 4
(b) The BS 8110 simplified stress block

Given f c u = 40N/mm2 and f y = 460N /mm2

Design the longitudinal reinforcement for the 450 mm by 350mm short column section given the following:- axial load N= 2362.5 kN.

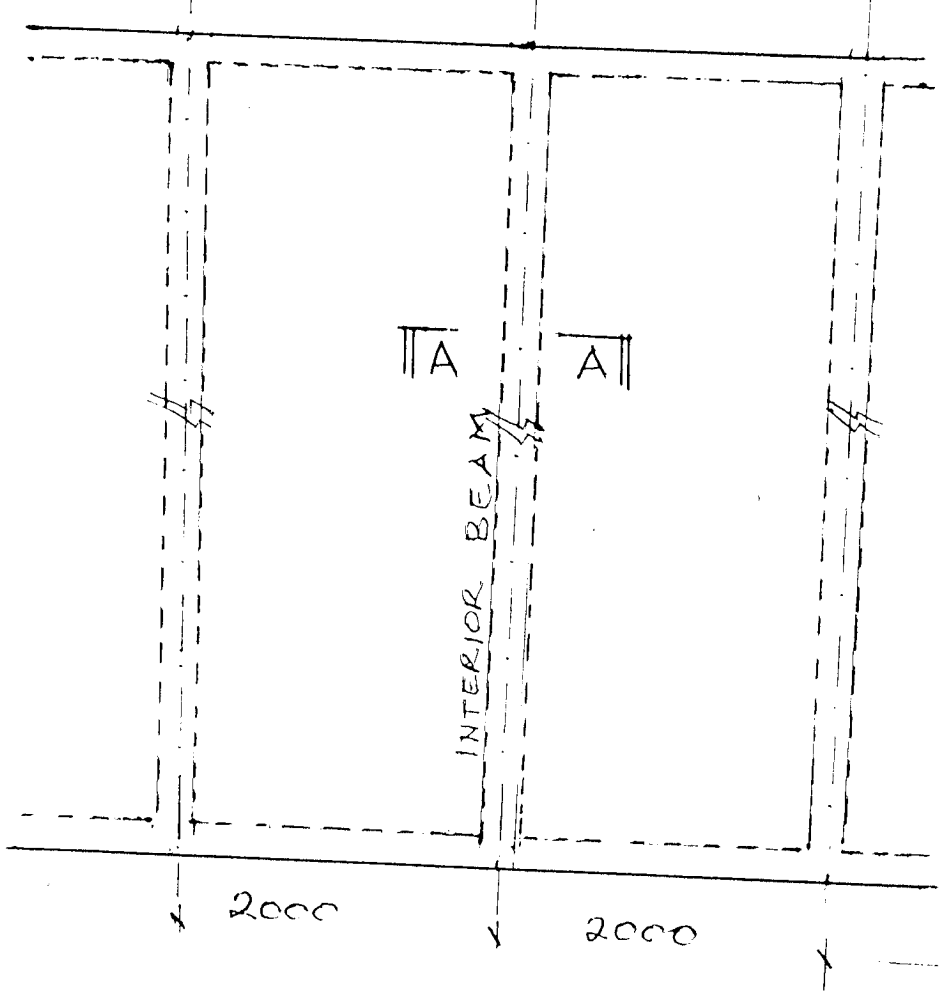
Mx =250 kNm and m y = 100 kNm. Assuming the distances from the top, bottom and sides to the centres of the bars is 50 mm. Take f y =460 N/mm 2 and f c u = 30N /mm 2 and assume d /h =0.9. Use the column interaction chart in figure 2.

(a) A two span continuous beam of spans 5 metres as shown in figure 5 has the following specifications ;- web width b = 300 mm and effective depth d = 400 mm. After calculation of moments, the moment at the support is redistributed by 15% to 237knm while the maximum mid – span moment is found to be 190knm. Design the reinforcement at the support and mid – span assuming fcu = 30n/mm2 and f y = 460n/mm2 and effective length = 0.7L

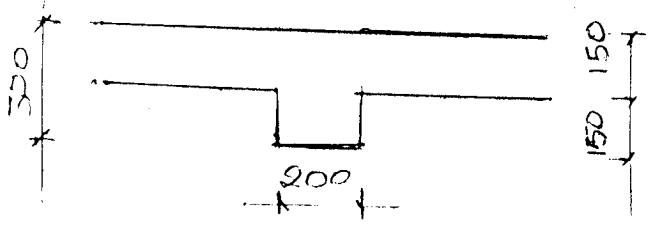
(b) Check the deflection of the beam designed in question 6 (a) above

(a) The reactions in a two span continuous beam of 5 metres each are as shown in figure 6 for the three load cases shown. Draw the shear force envelope.

(b) Design the shear reinforcement for the beam in question 7a where reinforcement details are as in figure 7b.
Take fy = 460n/mm and fcu = 40N/mm,
b= 300mm and effective depth = 400mm2

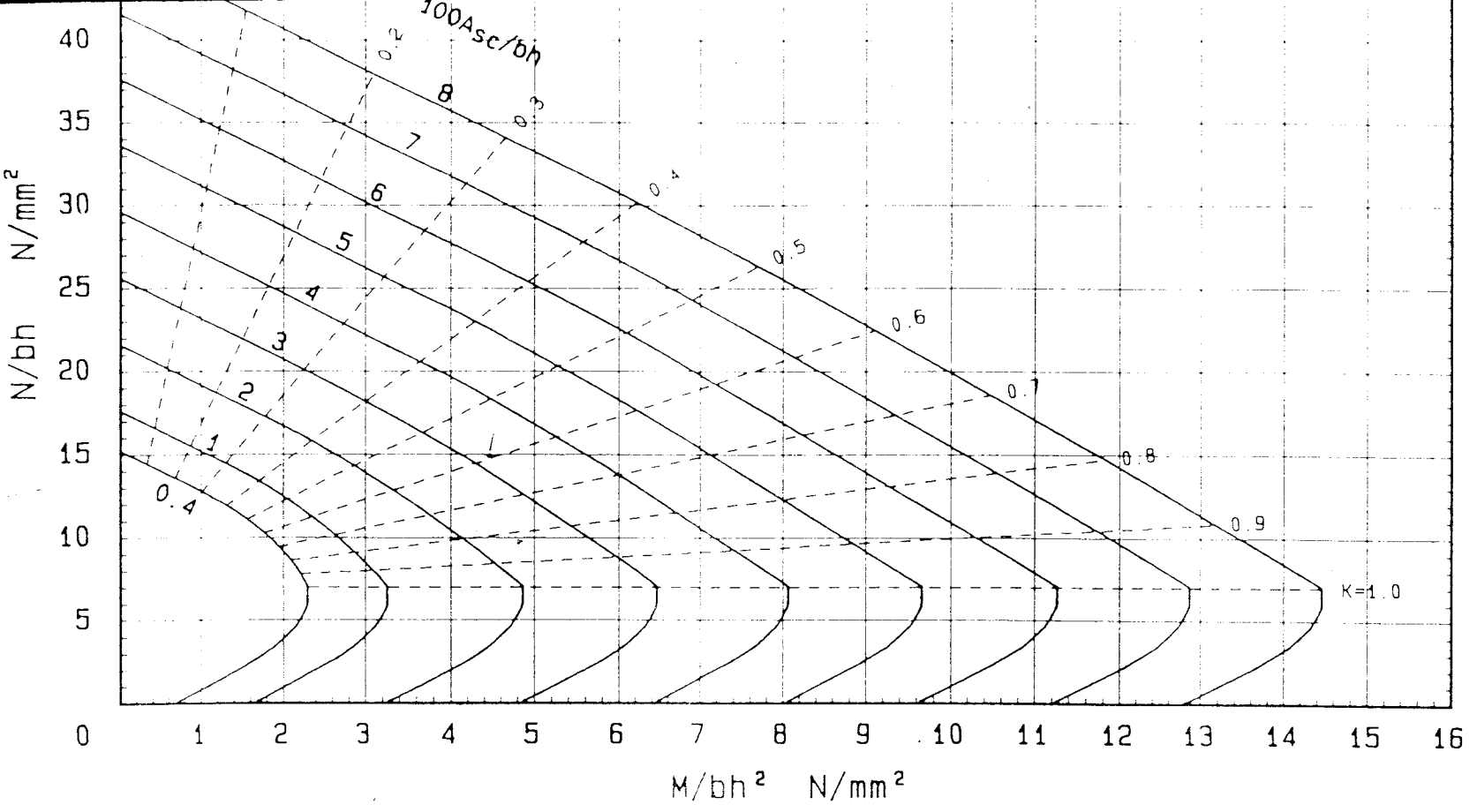


SLAB BEAM LAYOUT

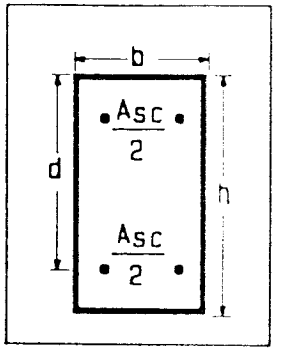


BEAM SECTION A-A

FIGURE 1



Rectangular columns



f_{cu}	30
f_y	460
d/h	0.90

Chart No. 29

FIG 3

Chart No. 2

4

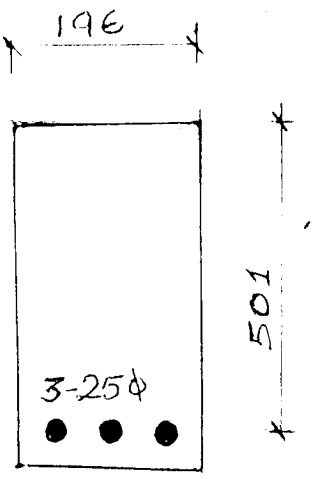


FIGURE 3

6

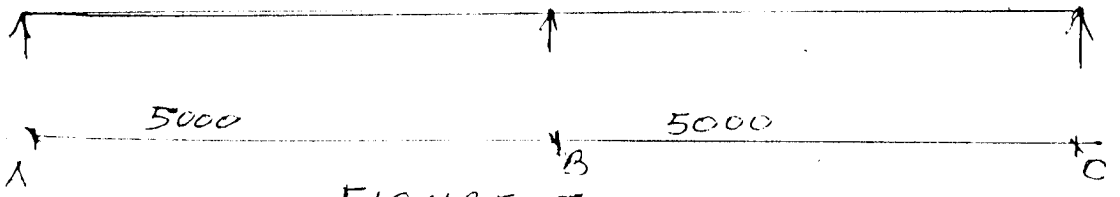
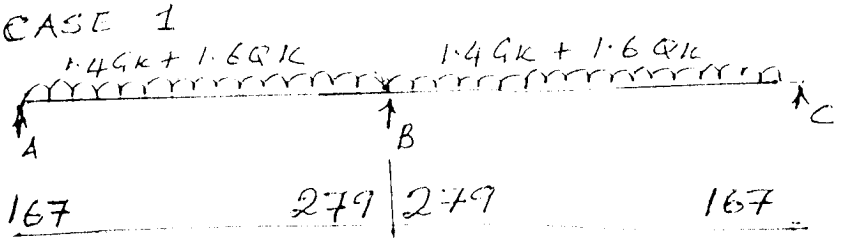
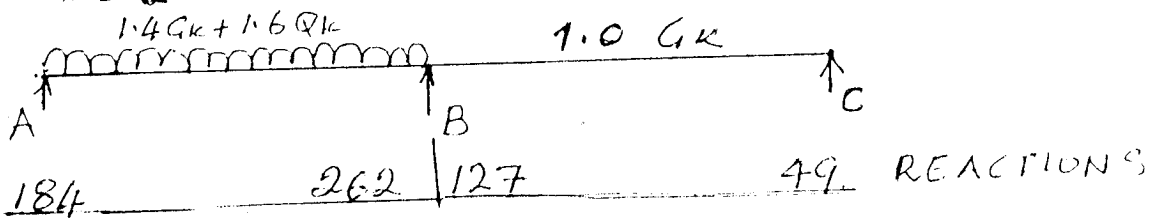


FIGURE 5

CASE 1



CASE 2



CASE 3

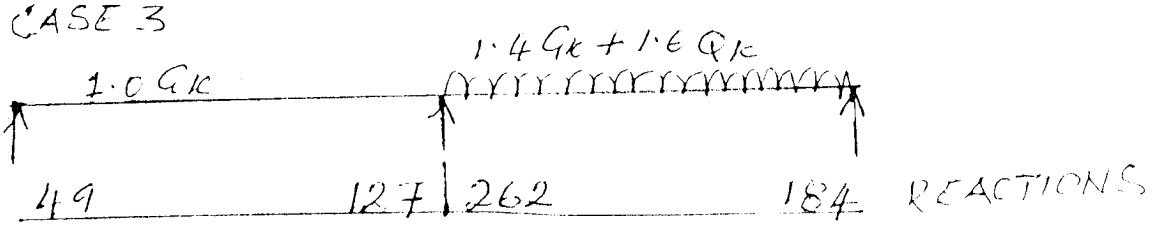


FIGURE 6

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS – APRIL 2002

CE 582 – CONSTRUCTION TECHNIQUES AND MANAGEMENT

INSTRUCTIONS

TIME: THREE (3) HOURS

ATTEMPT: **FIVE (5)** QUESTIONS FROM THE GIVEN SEVEN (7)

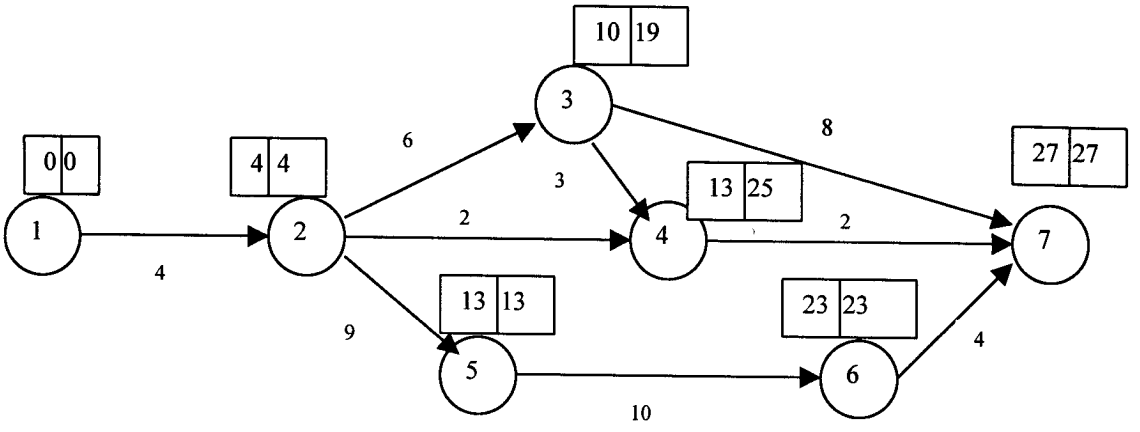
Q1 The network shown in Fig. Q1 represents a section of work being undertaken by a subcontractor. The subcontractor's labour requirements are shown in Table Q1. Because this work has to phase in with the work of the main contractor, this section must be completed within 27 weeks. Nevertheless, the subcontractor wishes to carry out some resource smoothing in order that there are no excessive 'peaks' or 'troughs' in his labour aggregation chart.

Prepare two labour charts, one based on all activities starting as early as possible and the other based on all activities starting as late as possible.

(10 + 10 Marks)

Table Q1: Subcontractor's labour requirements

Activity	Labour required in numbers of men
1-2	2
2-3	3
2-5	4
2-4	4
3-4	3
3-7	4
5-6	2
6-7	2
2-7	1



Durations alongside each arrow are in weeks

Fig.Q1: Network for subcontractor's operations

Q2 Identify the various tasks which can be performed by the following pieces of equipment and their limitations, if any:

(a) the bulldozer; **(5 marks)**

(b) the tower crane; **(5 marks)**

(c) the grader; and **(5 marks)**

(d) the smooth wheel roller. **(5 marks)**

Q3

(a) Identify the documents that constitute bidding requirements and briefly explain the purposes each serve **(15 marks)**

(b) Explain the difference between contract documents and those documents that constitute bidding requirements **(5 marks)**

Q4 Table Q4.1 shows the contract budget for a small factory building. All items of work are being carried out by the main contractor except items H and I, which have been placed as fixed price contracts with subcontractors.

At the end of month 3, the progress report showed the following percentage completions: A, 80%; B, 40%; C, 15%; and items D to I not yet started. The analysis of the recorded site costs at this time revealed the variances shown in Table Q4.2

Table Q4.2

Labour categiries					Plant	Materials	Subcontractors	Site O/H	Total
1	2	3	4	5					
-K140,000	-K220,000	-	-	-	-K100,000	-K20,000	-	+K40,000	-K440,000

Total variance = 3.9% of contract value to date (negative sign indicates an adverse variance).

The decision of site management at this time was to increase the amount of supervision on site by employing another engineer with the specific tasks of looking after progress and materials reconciliation.

At the end of month 6, the progress report showed the following percentage completions: A, 100%; B, 100%; C, 90%; D, 75%; E, 20%; F, 10%; and G, H and I not yet started.

The recorded costs at the end of month 6 are shown in Table Q4.3.

Table Q4.3

Labour Categories (K'000)					Plant (K'm)	Materials (K'm)	Subcontractors (K'm)	Site O/H (K'm)	Total (K'm)
1	2	3	4	5					
K3 600	K4 700	K250	K200	-	K11 200	K3 680	-	K3 105	K26 795

(a) Draw up a table of variances for the site costs at month 6 and calculate the total variance as percentage of the value completed.

(b) Comment on the effect of the management's decision at month 3 and suggest what future policy should now be adopted.

(c) Comment on the distribution of profit throughout the items indicating why the contractor may have may have distributed his profit in this manner, and suggest why no profit is allocated to items H and I.

(10 + 5 + 5 marks)

Table Q4.1

	Cost Headings								
Item	Labour Category	Labour (K'000)	Plant (K'000)	Materials (K'000)	Subcontractors (K'000)	Site O/H (K'000)	Head Office O/H (K'000)	Profit (K'000)	Total (K'000)
A Excav.	1	3 500	5 000	-	-	400	300	1 800	11 000
B Conc. Founds.	2	2 300	3 000	1 500	-	800	400	1 400	9 400
C Ground Slab	2	1 800	2 500	1 200	-	800	400	1 200	7 900
D Columns	2	800	1 000	800	-	700	300	900	4 500
C Roof Structures	3	1 200	1 000	2 600	-	600	300	500	6 200
F Brick infill Panels	4	1 800	600	1 500	-	300	200	400	4 800
G Roof Cladding	5	900	600	1 800	-	300	200	100	3 900
H Glazing	-	-	-	-	2 500	300	200	-	3 000
I H & V & Electrical Services	-	-	-	-	11 000	800	500	-	12 300
Totals		12 300	13 700	9 400	13 500	5 000	2 800	6 300	63 300

Q5 Identify the various groups of people who use construction specifications and for what purpose. **(20 marks)**

Q6 Table Q6.1 shows the activities for the construction of a garage building. Draw an activity-on-arrow network diagram for the project. Calculate the critical path of the network, clearly showing the i-j values, durations, early start, late start, early finish and late dates.

Table Q6.1

Activities	Activity Numbers		Duration
	Tail	Head	(days)
A Set out site & excavate	1	2	2
B Place shuttering	2	5	1
C Hardcore	5	6	2
D Dig cable trench	2	3	1
E Lay conduit in trench	3	4	1
F Order & deliver ready-mixed concrete	1	6	7
G Pour base &harden	6	7	1
H Order & deliver bricks & mortar	1	8	7
I Lay bricks to window	8	9	8
J Order & deliver windows	1	9	3
K Fit windows	9	11	1
L Order & deliver roofing & doorposts	1	12	12
M Finish bricklaying	11	12	12
N Glaze & paint windows	11	15	2
O Fit roof beams	12	13	2
P Secure roof	13	15	4
Q order & deliver doors	1	14	10
R Fit doors	14	15	2
S Strip shuttering	7	15	1
T pull cable & connect mains	4	10	1
U Backfill trench clear of base	10	15	1
V Clean up	15	16	1

(10 + 2+ 2 + 2 +2 +2 marks)

Q7 (a) With respect to construction equipment, differentiate between ownership and operating costs. ~~**(5 marks)**~~ (10 MARKS

(b) State and explain the different costs into which ownership and operating costs can be classified. **(10 marks)**

ENDS

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
AGRICULTURAL ENGINEERING
FIRST SEMESTER EXAMINATIONS APRIL 2002
EA 311 (FARM POWER AND MACHINERY)

INSTRUCTIONS

TIME ALLOWED: **THREE HOURS**

ATTEMPT: **FIVE** QUESTIONS ONLY; **TWO FROM SECTION A, ONE FROM SECTION B** AND THE **LAST TWO FROM SECTION C**.

ANSWER **SECTION A, SECTION B** AND **SECTION C** IN **SEPARATE ANSWER BOOKLETS.**

ALL QUESTIONS CARRY **EQUAL MARKS**, (20 MARKS EACH).

THIS QUESTION PAPER COMPRISES **EIGHT** QUESTIONS.

SECTION A: ANSWER TWO (2) QUESTION FROM THIS SECTION.

Question 1

d) With reference to **Figure Q1** list the parts **A** to **G**. **[7 marks]**

e) What type of engine is this? Give reasons for your answer **[3 marks]**

f) Describe how ignition is achieved in this engine. **[5 marks]**

g) Make a sketch of the gasoline fuel system and label the 3 basic component of this system and describe the primary function of these parts. **[5 marks]**

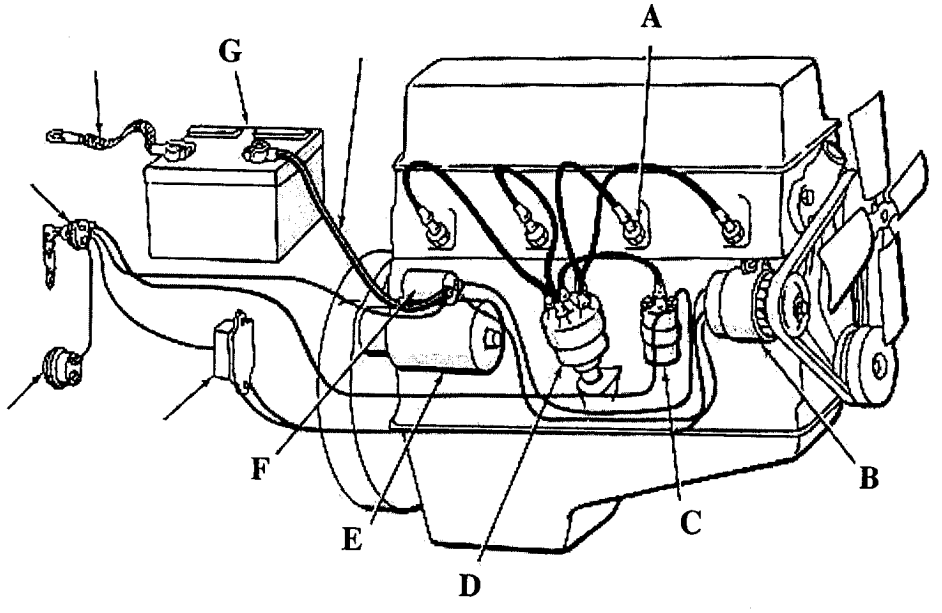


Figure Q1

Question 2

a) List the functions of a governor.

[2 marks]

b) What does a mechanical governor control in:

i) a petrol engine?

[1 mark]

ii) a diesel engine?

[2 marks]

c) Describe the operations of the mechanism in injector pumps used to meter the amount of fuel delivered to injectors on a diesel engine

[8 marks]

d) Describe the oil mist lubrication system.

[4 marks]

e) Briefly explain why an electric powered tractor would be preferred to a diesel-powered tractor for use in a green house.

[3 marks]

Question 3

a) A four cylinder four stroke cycle engine with a firing order 1-3-4-2 is given in **Table Q3a.** Make a similar table for a six cylinder two stroke cycle engine with a firing order 1-4-2-6-3-5 by first determining the angle between any two power strokes that immediately follow each other. **Use Table Q3b on the last page of this examination paper to answer this question.**

[10 marks]

b) For this engine what is the ratio of the crankshaft gear to the camshaft gear.

[2 marks]

c) **True** or **False**? "For an engine operated at variable speeds a lighter flywheel is needed."

[2 marks]

d) Name **three** functions of a lubrication system.

[6 marks]

Table Q3a

Crank travel	Cylinder number			
	1	2	3	4
180°	Power			
360°			Power	
540°				Power
720°		Power		

SECTION B: ANSWER ONE (1) QUESTION FROM THIS SECTION.

Question 4

a) What is the purpose of a harness and what factors influence its choice?

[5 marks]

b) List three species of animals most widely used for animal draught power and state at least three advantages and three disadvantages of each specie.

[10 marks]

c) State five characteristics of good animal housing?

[5 marks]

Question 5

a) Define both dynamic and static work and give an example of each.

[4 marks]

b) Why should lactic acid not be allowed to accumulate in the body and how is it removed

[3 marks]

c) What three functions does the food a human being eat used for?

[3 marks]

d) Explain the concept and the necessity for a human being to rest when carrying out certain jobs

[10 marks]

SECTION C: ANSWER TWO (2) QUESTIONS FROM THIS SECTION.

Question 6

a) State two differences between a disc plough and a disc harrow?

[5 marks]

b) With the help of a sketch of a tandem disc harrow, briefly explain its action and effects on the soil.

[5 marks]

c) For each of the following tillage objectives on fields located within Lusaka Province, state one implement that would best accomplish each task:

i) Clean tillage around mid January in a field that has a lot of crop residue and weeds.

ii) Conservation tillage in the month of May of a field that is prone to wind erosion and has developed a medium strength hard pan due to repeated use of a disk plough.

iii) Seedbed preparation of a field in one pass following harvesting of the previous crop.

iv) Covering barley seeds after broadcasting operation in early December.

v) Primary tillage of a field with extremely dry soils and outcrops of stones and roots just before the on-set of rains in October.

[5 marks]

d) State two adjustments that have to be carried out on almost all soil engaging implements to ensure that the implement works the soil to a uniform depth.

[5 marks]

Question 7

a) State the key difference between the procedure of workshop calibration and that of field calibration of a seed drill.

[4 marks]

b) Outline two sources of discrepancy in the results of workshop calibration and those of field calibration of a seed drill.

[4 marks]

c) State the functions performed by the following components of a tractor mounted sprayer

i) Nozzle

ii) Pump

iii) Pressure relief valve

iv) Filter

[4 marks]

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

[4 marks

e) If the operating speed of the tractor had to be limited to 10 km/hr due to poor field conditions, calculate the pressure at which the sprayer should be operated in order to maintain the pesticide application rate of 121 l/ha.

[4 marks]

Question 8

a) Briefly discuss crop rotation as a mechanism for weed control.

[5 marks]

b) Describe the harvesting process of a crop of wheat using a combine harvester, clearly outlining the tasks involved in their correct order of execution and state the components that perform each task indicated.

[10 marks]

c) List the possible causes of the following situations during combine harvesting of a crop:

i) excessive shatter of a crop

ii) excessive amount of unthreshed heads

iii) broken kernels of grain

iv) excessive amount of chaff in the grain tank.

v) excessive clean seed loss.

[5 marks]

COMPUTER No.:

Table Q 3b

Crank angle	Cylinder Number							

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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
APRIL 2002 SEMESTER I FINAL EXAMINATION
EE 209 PRINCIPLES OF ELECTRICITY I

TIME: 3 Hours Total Marks : 100

PART I : ANSWER ALL QUESTIONS TOTAL : (50 marks)

1. The output of a certain independent current source is a function of temperature. T(°K), $i_s = 1x10^{-6}\ T^2 - 6x10^{-4}T + 0.1$ [A]

   (a) At what temperature in the range $250 \leq T \leq 320$°K is i_s a minimum? (2 marks)

   (b) At the minimum temperature, how much charge can the source deliver in 10 minutes? (2 marks)

2. The switch has been in position 1 for a long time. At $t = 0^+$ the switch is moved to position 2 in Fig.Q2. $V_s = 12v$, $R_1 = 200\Omega$, $R_2 = 1000\Omega$, $C = 2\ \mu F$, $R_3 = 500\Omega$

   (a) Determine the transient voltage v(t) for $t > 0$ (5 marks)
   (b) Determine the transient current i(t) for $t > 0$. (5 marks)

3. Each part has 3 marks. Total (36 marks)

   (a) The alloy transistor is sliced into wafers while the mesa transistor is diced into thin squares. [True or False]
   (b) The transistor saturated mode operation most nearly duplicates the functions of a mechanical switch. [True or False]
   (c) α is greater than 1.0 for a transistor. [True or False]
   (d) An optical Isolator combines an LED and a Photodiode. [True or False]
   (e) In a Zener diode regulator: $R_S(max) = (V_Z - V_{IN}(min))/ I_L(max)$. [True or False]
   (f) The positive clipper is a circuit that removes negative parts of an input signal. [True or False]
   (g) For proper transistor operation the B-E and C-B are reverse biased. [True or False]
   (h) An AND-Gate is a logic circuit. [True or False]
   (i) Diodes become resistors in small signal ac equivalent circuits. [True or False]
   (j) In transistor the collector current is a base current controlled source. [True or False]
   (k) Transducers provide the link between the physical world and electronics. [True or False]
   (l) In digital and analogue telecommunications MODEMS allow multi-way communications. [True or False]

PART II : ANSWER ANY TWO **TOTAL** **(20 marks)**

4. In the circuit shown in Fig. Q4 find:

   (a) V_1, (b) voltage V across both sources if I_s is given as 12A. (10 marks)

5. Find G_{ad} for the network of Fig. Q5 (7 marks)
   (a) As it is shown.
   (b) If every component is disconnected and the six elements reconnected in parallel. (1mark)
   (c) If every component is disconnected and the six elements reconnected in series. (2marks)

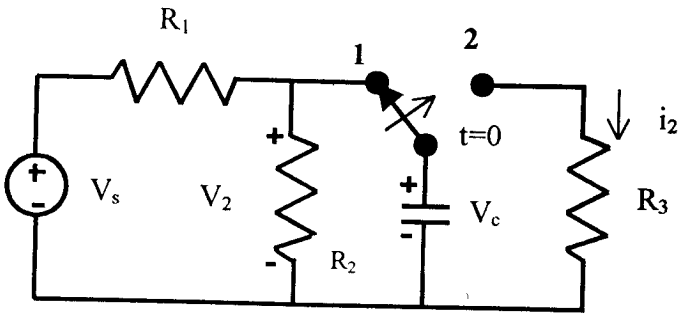
6. A linear time-invariant resistor of 4Ω has a current through it given by $i(t)= 1\text{Sin}(\pi t)$. If $E(0) = 0$ (energy at t =o), find the energy dissipated in the resistor at t = 1s, (b) t=2s , (c) t =6s. (10 marks)

PART III : ANSWER ALL QUESTIONS **TOTAL** **(30 marks)**

7. A series loop contains the following circuit elements in order: a 6V source, a 2kΩ resistor, a 3 kΩ resistor, a 18 V source, a 7kΩ resistor. The voltage sources add.
   (a) Draw the circuit diagram. (5 marks)
   (b) Find the magnitude of the voltage across each resistor. (5 marks)
   (c) Determine the power absorbed by each element. (5 marks)

8. Find the current that will flow in a series circuit containing a 5kΩ resistors, a 470pF capacitor, a 150mH inductor, and a 0.001μF capacitor if the exciting voltage is 65v at 25kHz. Assume: $Vs = 65 \angle 0°[V]$. (15 marks)

END EE 209 EXAMINATION



$V_s = 12$ V, $R_1 = 200\ \Omega$, $R_s = 1000\ \Omega$,
$C = 2\mu F$, $R_3 = 500\ \Omega$

FIG. Q2

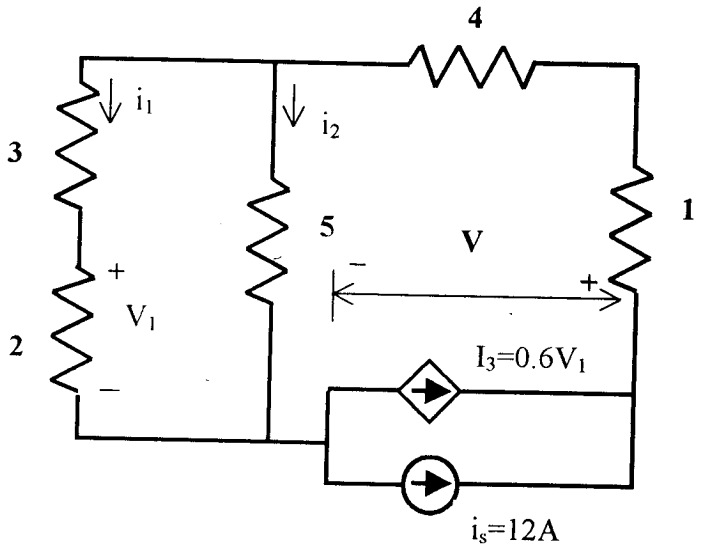


FIG. Q4

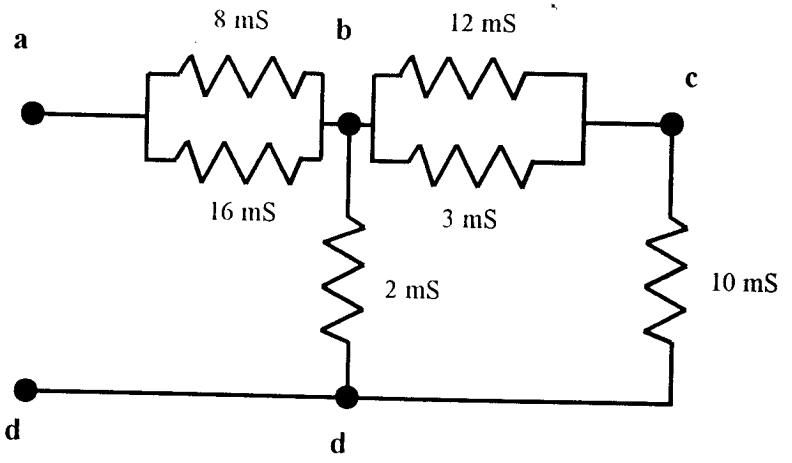


FIG. Q5

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRIC & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION – APRIL 2002

EE 311 ELECTRIC CIRCUITS

TIME : **THREE (3)** HOURS

ANSWER : **FIVE (5)** QUESTIONS

Laplace transform table will be distributed by the Lecturer

QUESTION 1.

Consider the s-plane in figure 1.

a) Find the laplace equation, F(s) of the pole-zero plot.

b) Find the inverse laplace transform of F(s) i.e find f(t).

c) Use the initial and/or final value theorem to verify that your answer in (b) is correct.

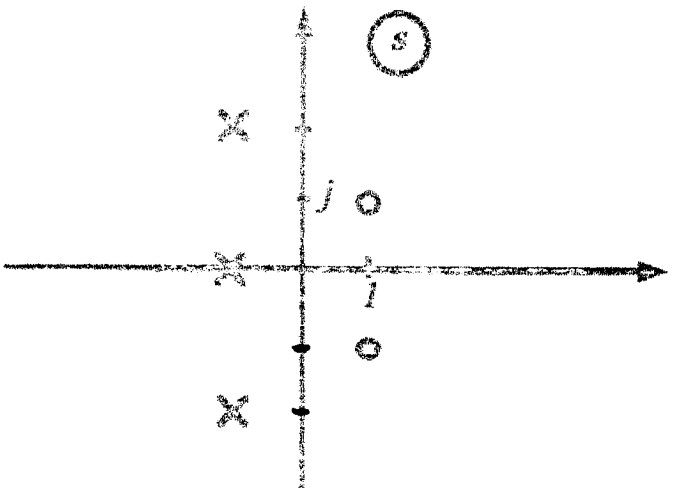


Figure 1

QUESTION 2.

Consider the network in figure 2.

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

b) Find the step response from the network in the time domain

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

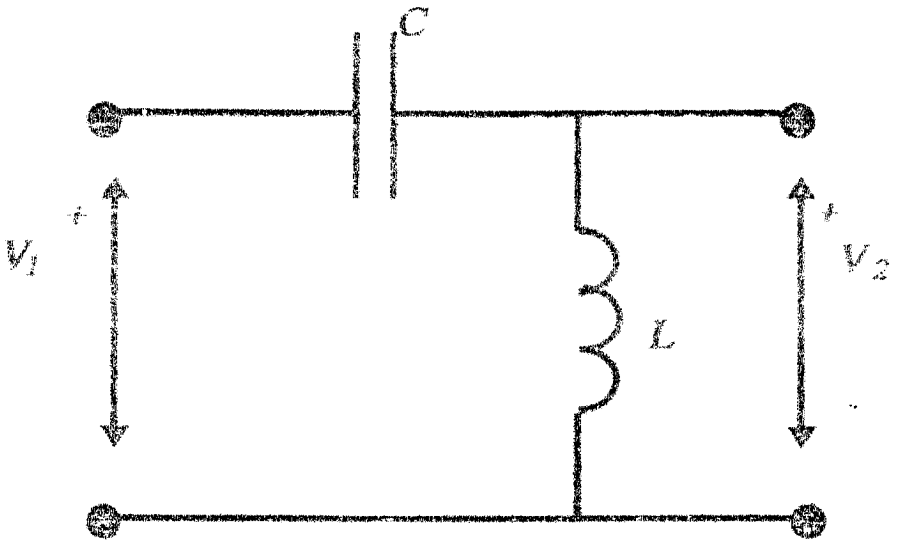


Figure 2

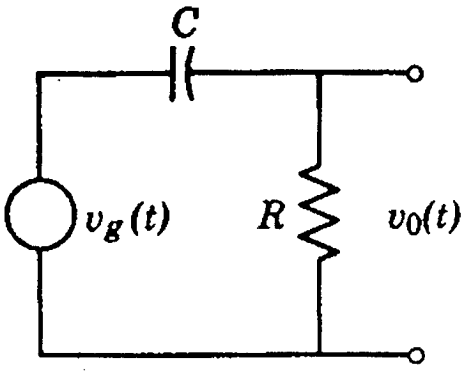
QUESTION 3.

For the RC networks given below. Figure 3.

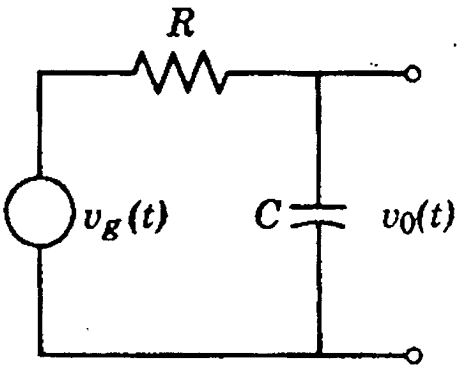
a) Obtain the transfer function of the systems

b) Make assumption to prove and identify integrator and differentiar circuits.

c) Draw bode plots.



(a)



(b)

Figure 3

QUESTION 4.

The fourier transform is defined as $S(f) = \int_{-\infty}^{\infty} s(t)e^{-j\pi ft}dt$

Find the Fourier transform for:

a) The function

$$s(t) = \frac{1}{2}[\delta(t-5) + \delta(t+5)].$$

b) The function

$$s(t) = u(t+\frac{\tau}{2}) - u(t-\frac{\tau}{2})$$

c) The function

$$S(t) = Ae^{-\beta|t|} \text{ where } \beta > 0.$$

QUESTION 5.

a) Sketch the function defined by
$s(t) = u(t) - u(t-1) + t.(u(t-1) - u(t-2)) + 3u(t-2)$

b) Sketch neatly s'(t) i.e. sketch $\frac{d}{dt}s(t)$.

c) Find and sketch the integral of the function s(t), i.e find $\int_0^t s(\tau)d\tau$.

QUESTION 6.

Consider the differential equation

$$x''(t) - 6x'(t) + 9x(t) = 3e^{-2t}\cos 2t$$

Which is defined only for t > 0.

a) Find the complementary solution, $x_c(t)$ to the equation.

b) Find the particular integral, x_p (t) to the equation.

c) Assume that the initial conditions are $\begin{cases} x(0+) = 1 \\ x'(0+) = 0 \end{cases}$

Find all constants and give the complete solution.

Hint: guess $x_p(t) = e^{-2t}$ (A cos 2t + B sin 2t)

QUESTION 7.

a) Given $s(t) = A\delta(t-t_o)$
Find S(f) and plot the amplitude and phase frequency responses.

b) For a given system function $H(s) = \frac{\alpha^2 + \beta^2}{(s + \alpha^+ j\beta)(s + \alpha - j\beta)}$
express the system in vector form and draw the diagram, also using graphical methods draw the geometrical diagram to determine the cutoff frequency ω_c, the half power frequency ω_{max} and natural frequency ω_o.

c) For a system with one singularity
$p_o = -\sigma_o + j\omega_o$, determine the delay due to the pole, the maximum delay and the frequency at which the delay is half the maximum

QUESTION 8.

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	The voltage over an ideal inductor cannot change instantaneously unless the driving function is an impulse		
b	For a system to be stable the laplace equation has to have its zeros in the left part of the s-plane		
c	The simplest form to express $\frac{d}{dt}[u(t).\sin t]$ is $\delta(t)+u(t)\cos t$		
d	The integral of the δ-function is the step function		
e	At a pole on the jω axis the phase response is discontinuous by -180^{o}		

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS APRIL 2002

EE321

ELECTROMECHANICS & ELECTRICAL MACHINES

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

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

1.

(i) Describe the construction and principle of operation of a gas-filled incandescent filament lamp.

[6 marks]

(ii) Deduce the relation to find the illumination at any point on a plane surface due to a light source of luminous intensity I, suspended at a height h from the plane surface.

[6 marks]

(iii) Two street lamps of 1000 cd and 800 cd are mounted 12.5 m above road level and are spaced 25 m apart. Find the illumination at a point on the ground midway between the lamp posts and just below the lamp post, assuming the lamps emit light uniformly in all directions.

[8 marks]

2.

Show that, for a given voltage V and maximum electric field E_{max} in the dielectric of a single-core cable, the sheath radius R_2 is minimum when $\frac{R_2}{R_1} = e$, where R_1 is the conductor radius.

[10 marks]

A 10-kV a.c. voltage is applied between the conductor and sheath of a single-core cable. The insulation can withstand an electric stress of 23 kV/cm. Find the most economical dimensions of the cable.

[10 marks]

3.

Derive the expression of the reluctance S of a uniform magnetic circuit of constant cross-sectional area A, relative permeability μ_r, length l and excited by a coil of N turns.

[6 marks]

A ring of cast steel of relative permeability 1000 has an external diameter of 24 cm and a square cross-section of side 3 cm. Inside and across the ring an ordinary steel bar measuring 18 cm by 3 cm by 0.4 cm and of relative permeability of 2000 is fitted. Neglecting complications at joints and corners, calculate the current required in a 2000-turn coil wound on one half of the ring to produce a flux density of 1 T in the other half.

[14 marks]

4.

Derive an expression for the maximum efficiency of a transformer, indicating the conditions under which it is reached.

[10 marks]

An 11000/415-V, 50-kVA, single-phase transformer, works at 0.8 lagging power factor. At full-load, the iron loss is 400 W and copper loss is 500 W. Calculate the efficiency at half load and the total losses at maximum efficiency.

[10 marks]

5.

Show, by suitable derivations, how the power factor of a 3-phase load can be determined from the readings of two wattmeters.

[8 marks]

A star-connected balanced load is supplied from a 3-phase source with a line voltage of 416 V at 50 Hz. Each phase of the load consists of a resistance and a capacitance connected in series. The readings of the two wattmeters connected to measure the load power are 782 W and 1980 W, both positive, respectively. Calculate

(a) the power factor of the circuit

[4 marks]

(b) the line current

[4 marks]

(c) the capacitance.

[4 marks]

6.

With the help of equivalent circuits, predict the torque-speed characteristics of the DC Shunt motor and the DC series motor.

[10 marks]

The no-load armature current of a 230-V d.c. shunt motor is 2 A at a speed of 1200 rpm. If the full-load armature current is is 40 A, find the full-load speed and the torque developed. Assume that the armature resistance is 0.25 Ω and the field flux remains unchanged.

[10 marks]

7.

(a) Use phasor diagrams of magnetomotive forces, voltages and currents to describe the modes of operation of the synchronous machine as a generator, motor and compensator. In all cases, distinguish between leading and lagging reactive power handling.

[10 marks]

(b) Three phase ac machines operate on the principle of a "rotating" magnetic flux. Describe the principal features which establish the ac machine as a induction machine and as a synchronous machine.

[4 marks]

(c) A 3-phase, 4-pole induction motor operates on a 50-Hz supply. The frequency of the rotor induced current is 2 Hz.

(i) What is the slip?

[2 marks]

(ii) What is the speed of the rotor?

[2 marks]

(iii) What is the speed of the rotor mmf with respect to the rotor and with respect to the stator?

[2 marks]

8. Answer any three.

(a) Knowing the expression for the stored energy in electromagnetic fields, derive from basic principles, the expressions for the mechanical forces exerted in an electric field of strength E and relative permittivity ε_r.

[$6\frac{2}{3}$ marks]

(b) Describe the experimental methods used to determine the parameters of the equivalent circuit of a transformer.

[$6\frac{2}{3}$ marks]

(c) Explain how the a.c. voltage generated is converted to d.c. voltage in a generator.

[$6\frac{2}{3}$ marks]

(d) Describe the problem of starting d.c. machines and explain, with a suitable sketch, how it is overcome in practice.

[$6\frac{2}{3}$ marks]

END OF EE321 EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

UNIVERSITY EXAMINATIONS (FIRST SEMESTER)

FRIDAY (PM) - 19TH APRIL 2002

ELECTRONICS (EE 431) & ELECTRONIC ENGINEERING II (EE441) PAPER

TIME ALLOWED: THREE (03) HOURS TOTAL MARKS: 100

ANSWER: THIS PAPER HAS EIGHT QUESTIONS. YOU MUST ANSWER ANY FIVE (05) QUESTIONS. EACH QUESTION CARRIES 20 MARKS AND MARKS BREAKDOWN ARE INDICTED IN ITALICS. USEFUL CONSTANTS & VARIABLES ARE GIVEN AT THE END THE QUESTION PAPER.

Q1.

A. Silicon is the most widely used raw material for manufacture of present day electronic devices and this eptomised by so many 'Silicon Valleys and Parks' worldwide.

(i) Briefly discuss quantum numbers that completely describe the electronic structure of a silicon atom and state the limiting principle. *(2½ marks)*

(ii) Determine the electronic configuration of a silicon atom. *(1½ marks)*

(iii) Using the electronic configuration obtained in (ii) above, explain the formation of energy bands in a silicon crystal composed of N number of atoms where N is a very large number. *(4½ marks)*

(iv) Using the concept developed in (iii), describe a metallic conductor, semiconductor and insulator. *(1½ marks)*

B. For a pure silicon crystal specimen:

(i) Distinguish between electrons obeying Fermi-Dirac and Maxwell-Boltzmann statistics. *(5 marks)*

(ii) Which electrons take part in the conduction process? *(1 mark)*

(iii) Determine chances of a Fermi-Dirac electron and Maxwell-Boltzmann electron appearing in the conduction band at room temperature. *(4 marks)*

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

UNIVERSITY EXAMINATIONS (FIRST SEMESTER)

FRIDAY (PM) - 19TH APRIL 2002

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(iii) Determine chances of a Fermi-Dirac electron and Maxwell-Boltzmann electron appearing in the conduction band at room temperature. *(4 marks)*

Q2.

A. The Ebers-Moll model is an aid for describing modes of operation of transistor.

(i) Design an appropriate Ebers-Moll model circuit. *(4 marks)*

(ii) Using the model obtained in (i), derive the following Ebers-Mo general equations for emitter (I_E) and collector (I_C) currents:

$$I_E = I_{FO}\left[\exp\left(\frac{qV_{EB}}{kT}\right) - 1\right] - \alpha_R I_{RO}\left[\exp\left(\frac{qV_{CB}}{kT}\right) - 1\right]$$

and

$$I_C = \alpha_F I_{FO}\left[\exp\left(\frac{qV_{EB}}{kT}\right) - 1\right] - I_{RO}\left[\exp\left(\frac{qV_{CB}}{kT}\right) - 1\right]$$

where I_E is emitter terminal current, I_C is collector terminal current I_{FO} is saturation current of a normally forward biased diode, I_{RO} is saturation current of a normally reverse biased diode, α_F is forward common-base gain, α_R is reverse common-base gain, V_{EB} is emitter-base voltage and V_{CB} is collector-base voltage. *(6 marks)*

B. Figure 02. Below shows the basic arrangement of a bipolar junction transistor (BJT) in a functional circuit. In the diagram, V_{CC} is a fixed direct voltage, R_B and R_L are resistors, I_B and I_C are conventional currents and V_B is an applied direct voltage that controls I_B. By use of appropriate device output characteristics explain how the circuit can be:

(i) Used as an amplifier (hint: show how you obtain your operating point). *(5½ mark)*

(ii) Used as a switch when a signal is superimposed on V_B. *(4½ mark)*

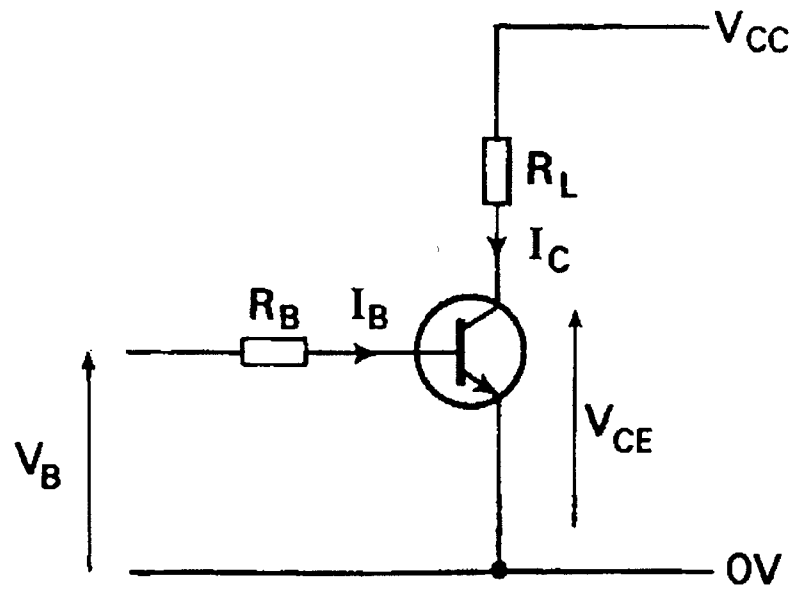


Figure 02. Basic arrangement of a BJT in a functional circuit

Q3.

A.

(i) Identify two main sources of noise in electronic devices and discuss their origins. *(4 marks)*

(ii) Write brief notes on Recombination, Partition, Intermodulation and Flicker noise in electronic devices. *(4 marks)*

(iii) Define noise factor? Sketch a general graph showing variation of noise factor with frequency in an electronic amplifier (clearly explain how noise factor varies with amplifier operating frequency). In which region must an amplifier be operated and why? *(4 marks)*

B. An amplifier of effective resistance 4kΩ operates at a current of 2mA over a bandwidth of 10 MHz. If the amplifier is operating at room temperature, determine the square mean:

(i) Shot noise current. *(4 marks)*

(ii) Thermal noise current. *(4 marks)*

Q4.

A. Derive an expression for total hole current in a semiconductor. *(10 marks)*

B. Electrons are injected into one end of a bar of p-type silicon. The initial concentration of excess electrons is $10^{24}\,m^{-3}$. The minority carrier mobility in silicon is 1450 $cm^2V^{-1}s^{-1}$ and the lifetime is $10\,\mu s$. Assuming room temperature, determine the distance along the bar at which minority carrier concentration drops to half its equilibrium value. *(10 marks)*

Q5.

A. A bipolar junction transistor (BJT) has several modes of operation subject to certain conditions. For a p^+-n-p transistor:

(i) Identify all the modes of operation and state junction(s) biasing polarities. *(4 marks)*

(ii) It is given that P_{no} is the equilibrium minority carrier concentration in the neutral (or field free) base region whose width W is defined by $0 \le x \le W$. Determine minority carrier concentration $P_n(x)$ at base boundary x = 0 and x = W for each mode. (Illustrate the distribution profile $P_n(x)$ by a clearly labeled sketch of the base region). *(8 marks)*

B. A silicon a p^+-n-p transistor has impurity concentrations of $5\times10^{18}\,cm^{-3}$, $10^{16}\,cm^{-3}$ and $10^{15}\,cm^{-3}$ in the emitter, base and collector regions respectively. The transistor is operated at room temperature with the emitter-base junction forward biased to 0.5V and base-collector junction reverse biased to 5V. Calculate:

(i) The equilibrium minority carrier concentrations in the emitter, base and collector. *(3 marks)*

(ii) The minority carrier concentration at the edge of emitter-base junction. *(2½ marks)*

(iii) The minority carrier concentration at the edge of the collector-base junction. *(2½ marks)*

Q6.

A. Fabrication of modern bipolar junction transistors (BJT's) employs the planar process in which the device is formed only on one side of the silicon wafer as shown in figure 03 below.

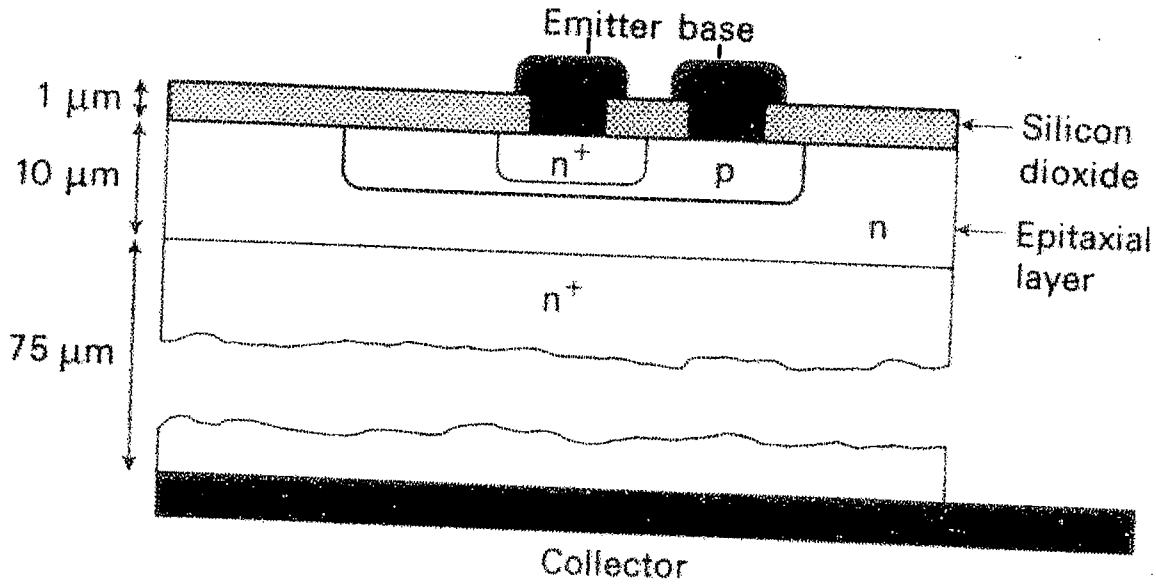


Figure 03. Sectional view of a planar process n^+-p-n bipolar junction transistor

(i) Describe any two processes used to selectively dope various regions of the BJT during manufacture. *(5 marks)*

(ii) Detail the role of the n^+ region on the emitter contact-side and that of the n^+ region on the collector contact-side. *(3 marks)*

(iii) Why is an aluminium sheet used as the collector? *(1 ½ marks)*

(iv) What is the role of the silicon dioxide layer covering the top of the device and why is it preferably used in silicon based devices? *(2 marks)*

B. An ideal n^+-p-n transistor has a current gain of 80 and is operated on a base current of 25 μA. The recombination time of charge carriers in the base is 0.2μs.

(i) Establish a fundamental relationship of the emitter, collector and base terminal currents for this transistor. *(2½ marks)*

(ii) Find the emitter current. *(2 marks)*

(iii) Determine the time taken by minority carriers to cross the base region. *(2 marks)*

(iv) Excess minority charge in the base. *(2 marks)*

Q7.

A. The concept of crystal formation is central in the development semiconductor electronics.

(i) Describe the structure of a crystal in terms of arrangement of atoms and competing inter-atomic forces. *(2 marks)*

(ii) Discuss any two important bonds in electronic engineering materials naming an example for each case. *(3 marks)*

(ii) Briefly discuss the origins of lattice and impurity scattering of charge carriers moving in a semiconductor crystal. *(5 marks)*

B. When doping silicon, both acceptor and donor impurities may be added until the desired semiconductor composition is obtained. Calculate the majority and minority carrier concentrations at room temperature in silicon doped with the following impurities: (Assume all impurities are ionised and clearly state the type of semiconductor obtained. N_d and N_a are donor and acceptor impurity atom concentrations respectively).

(i) $N_d = 10^{18}\,cm^{-3}$, $N_a = 10\,cm^{-3}$ *(2½ marks)*

(ii) $N_d = 10^{20}\,cm^{-3}$, $N_a = 10^{20}\,cm^{-3}$ *(2½ marks)*

(iii) $N_d = 10\,cm^{-3}$, $N_a = 10^{14}\,cm^{-3}$ *(2½ marks)*

(iv) $N_d = 0$, $N_a = 0$ *(2½ marks)*

Q8.

A. Operation of optoelectronic devices is based on interaction of light energy with electrons.

(i) Name three devices in which light is absorbed to produce an electrical output and three devices in which light is generated due to an electrical input. *(2 marks)*

(ii) A photodiode is a p-n junction diode cased in a transparent cover. Detail the construction of a basic p-n junction photodiode and describe its operation. *(5 marks)*

(iii) How can a photodiode be operated as a solar cell? *(2 marks)*

(iv) Differentiate between a p-n and a p-i-n photodiode. *(2½ marks)*

(v) Describe the construction and operation of a basic direct-coupled optoisolator. *(2 marks)*

B. When a semiconductor is illuminated with light, there exists a minimum frequency of the incident radiation at which electron-hole pairs are generated. This minimum frequency at which charge carrier are produced can be related to a maximum limiting wavelength known as threshold.

(i) Define the term luminous flux. *(1 mark)*

(ii) Derive an expression for threshold wavelength. *(2½ marks)*

(iii) Determine threshold wavelength for the compound semiconductor gallium phosphide at room temperature. *(3 marks)*

END OF EXAMINATION

LIST OF USEFUL CONSTANTS AND VARIABLES

1. Boltzmann constant $= 1.38\times10^{-23}\,\mathrm{JK}^{-1}$
2. Electronic charge $= 1.602\times10^{-19}\,\mathrm{C}$
3. 1 electron volt $= 1.602\times10^{-19}\,\mathrm{J}$
4. Room temperature $= 27^{\circ}\mathrm{C}$
5. Silicon intrinsic carrier concentration $= 1.5\times10^{16}\,\mathrm{m}^{-3}$ at room temperature

6. Gallium phosphide energy gap = 2.24 eV at room temperature
7. Silicon energy gap = 1.12eV at room temperature & 1.16eV at 0K
8. Absolute Temperature $= -273^{o}C$
9. Planck constant $= 6.63x10^{-34}Js$
10. Speed of light $= 3.0 \times 10^{8} m/s$
11. Silicon atom atomic number =14
12. Assume room temperature if not specified.

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

SEMESTER I FINAL EXAMINATIONS - APRIL 2002

EG 212 WORKSHOP TECHNOLOGY

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

ANSWER: SECTIONS **A, B, C, D** AND **E** QUESTIONS AS STATED

NOTE: **EACH SECTION** SHOULD **BE ANSWERED IN A SEPARATE ANSWER BOOKLET** CLEARLY MARKED AS **SECTION A, B, C, D or E.**

SECTION A: AGRICULTURAL ENGINEERING

ANSWER QUESTION 1 OR QUESTION 2

Question 1

Given a John Deere 4 cylinder tractor with the following specification

Engine

Make/type	John Deere
Number of cylinders	4
Bore	106.5mm (4.19 in)
Stroke	110.0mm (4.33 in)
Compression ratio	15.0:1:
Power	DIN-kW 46

Determine:

(a) The crank radius **[2 Marks]**
(b) The piston displacement **[2 Marks]**
(c) The combustion volume CV **[3 Marks]**
(d) The total cylinder volume **[3 Marks]**
(e) The engine displacement **[3 Marks]**
(f) From the compression ratio, deduce the type of fuel used in the engine **[2 Marks]**
(g) Hence list five main parts of this fuel system. **[5 Marks]**

Question 2

(a) A six cylinder two stroke I.C (internal combustion) diesel engine has been designed to be used for running a power generator to power a small farming community. With the aid of sketches, describe the events that occur in this engine. **[13 Marks]**
(b) Why does a camshaft run at half the speed of the crankshaft in a four stroke engine? Illustrate. **[7 Marks]**

END OF AGRICULTURAL ENGINEERING SECTION

SECTION B: CIVIL ENGINEERING

ANSWER QUESTION 3 OR QUESTION 4

Question 3

(a) What is meant by curing concrete? **[3 Marks]**
(b) How can you cure a concrete column? **[3 Marks]**
(c) Why are earth bases and forms wetted before placing the concrete? **[2 Marks]**
(d) Why is coarse aggregate added to sand and cement when making concrete? **[4 Marks]**
(e) With the aid of a sketch, distinguish between a beam and a column **[4 Marks]**
(f) Discuss the cause(s) of sagging of concrete floors (slabs) **[4 Marks]**

Question 4

(a) What is a pitched roof? **[3 Marks]**
(b) What other advantage does a pitched roof provide apart from costing less than a flat roof? **[3 Marks]**
(c) What is a ridge of a roof? **[2 Marks]**
(d) Name four (4) types of rafters? **[4 Marks]**
(e) Explain the need to have an eave in a roof? **[2 Marks]**
(f) Mention four (4) basic requirements for roof covering materials? **[2 Marks]**
(g) If a client is concerned with the health risk attached to use of asbestos cement sheets, how would you respond based on the current arguments. **[4 Marks]**

END OF CIVIL ENGINEERING SECTION

SECTION C: ELECTRICAL ENGINEERING

ANSWER ALL QUESTIONS

Question 5

State whether each of the following statements is TRUE or FALSE **[10 Marks]**

(a) Arc welding is an example of Non-fusion Welding
(b) Spot, Butt and Seam Welding are examples of Electro-slag Welding
(c) Electricity is used in welding for generating heat at the point of welding in order to melt the material which will subsequently fuse and form the actual weld point
(d) AppleTalk and Ethernet are examples of LANS
(e) AC copper and aluminium conductors are stranded because of the skin effect
(f) Fibrous coverings consist of either braids, wraps or tapes and are primarily used in high-voltage wires and cables
(g) Thermoplastic jackets of polyvinyl chloride provide cable with ability to resist oils, acids, alkalis, sunlight, heat, weathering and abrasions
(h) Hypalon is a thermosetting cross-linked, chlorosulphonated polyethlene insulation material

(i) To prevent damage to cable from sidewall pressure which develops when a cable is pulled around a bend under tension must be kept as high as possible

(j) One very good insulation resistance measurement of a cable using a brand new Megger Testing instrument indicates the thermal class of the cable insulation

Question 6

State whether each of the following statements is TRUE or FALSE **[10 Marks]**

(a) Engineers must ensure that electrical systems are constructed and operated by qualified persons in such a manner employees and the general public are protected at all times

(b) Three kinds of bodily hazards to be protected against include: dearth or injury by electrocution; being burned by electrical arcs and sparks and injury to eyes.

(c) The 1 second limb-limb effect at 16 mA (60 Hz) is that this is the 'Let Go' current threshold

(d) If a current of 2 or 3 amperes flows from limb to limb through the heart for 1 second then intermittent sustained myocardiac contraction; temporary respiratory paralysis; and burns occur.

(e) One of the Code of Ethics for Members of the IEEE is: to avoid injuring others, their property, reputation, or employment by false malicious action.

(f) Bad power quality and low power supply reliability can have disastrous effects on the performance of critical electrical technology or dependent lifelines systems in a factory or hospital.

(g) If the system retirement and phaseout cost very small compared to the operation and maintenance cost, then it is not an important component of the system life-cycle cost.

(h) If system (A) with 10 parallel path components and system (B) with 10 series components have the same system failure rate. Then System (A) is more reliable than System (B).

(i) Failure rate is number of failures divided by the number of mission time or operating hours.

(j) Maintainability like reliability is a design parameter, but maintenance is a result of design.

END OF ELECTRICAL ENGINEERING SECTION

SECTION D: MECHANICAL ENGINEERING

ANSWER QUESTION 7 THEN ANSWER QUESTION 8 OR QUESTION 9

Question 7.

An aluminium drinking mug with a handle has an internal diameter of 70 mm and a depth of 95 mm. The wall thickness of the mug is 8mm.

The mug is to be manufactured by casting. With help of clearly labeled diagrams, describe the process of manufacture.

Give an outline of the likely defects to be encountered on the mug. **[10 Marks]**

Question 8.

(a) Discuss the importance of safety in factories. **[4 Marks]**

(b) What are the roles played by each one of the following in promoting industrial safety?

(i) Management. **[2 Marks]**
(ii) Workers. **[2 Marks]**
(iii) Government. **[2 Marks]**

Question 9

With the help of clearly labeled sketches, give an account of each of the following:

(i) Turning.
(ii) Drilling.
(iii) Thread cutting using a die.
(iv) Thread cutting using a tap.
(v) Filing.

[10 Marks]

END OF MECHANICAL ENGINEERING SECTION

SECTION E: SURVEYING

ANSWER QUESTION 10 OR QUESTION 11

Question 10.

(a) Discuss at least four disciplines of Surveying. Furthermore, describe the distinction between the two branches of surveying and the two ways of carrying out surveys.

[4+ 2 + 2 Marks]

(a) A mining conglomerate has been granted mining rights in an area with the following coordinates:

A	3000.35	4278.43
B	2758.43	4569.74
C	2860.57	5005.06
D	3220.86	4790.68

You are required to calculate the distances and bearings of lines AB, BC, CD and DA. The reference direction for the bearings is the south. You are further required to give the bearings in both the sexagesimal and centesimal systems. **[8 + 4 Marks]**

Question 11.

Along the centreline of a proposed dam for a water reservoir the RL's of pegs A, B, C, D and E should be determined as accurately as possible. The results of the survey are as indicated on the booking form provided.

RL of BM1 : 1208.728 m above datum
RL of BM2 : 1208.469 m above datum

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
1	1.736			43.8					BM
A	2.144		1.902	56.1	44.0				CP
B	2.005		2.481	19.3	54.8				CP
C	1.597		1.639	50.8	20.6				CP
D		1.048							
E	0.971		0.621	31.5	50.4				CP
2			2.084		31.8				BM

(a) Complete the levelling form provided using the Rise and Fall method and apply the necessary checks. **[8 Marks]**

(b) Due to the existence of random errors in measurements (errors that remain after gross and systematic errors have been eliminated); the measured height difference will differ from the known. This resulting discrepancy is known as the Misclosure. You are required to calculate the actual misclosure for the levelling circuit above. **[4 Marks]**

(c) Why is it advisable to level from the middle and was this rule adhered to in the booking form provided? **[8 Marks]**

END OF SURVEYING SECTION

EXAMINATION COORDINATOR:	Mr. M.O. Goma
EXAMINER AGRICULTURAL ENGINEERING:	Mr. J. M. Chileshe
EXAMINER CIVIL ENGINEERING:	Mr. L. Handia
EXAMINER ELECTRICAL ENGINEERING:	Dr. L. Nyirenda
EXAMINER MECHANICAL ENGINEERING:	Dr. H. M. Mwenda
EXAMINER SURVEYING:	Mr. R. Zimba

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
EG 365 - FLUID MECHANICS AND THERMODYNAMICS - APRIL 2002.

UNIVERSITY SEMESTER I FINAL EXAMINATIONS – 2001 - 2002

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

INSTRUCTIONS

ANSWER FIVE (5) Questions only. Answer AT LEAST TWO (2) Questions from each section. Use separate answer books for each section. Steam Tables, Mollier Charts, Freon Tables and charts may be used. All Question Carry Equal Marks.

SECTION A: Answer question ONE (1) and Any other Question from this section

---

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

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

(i) According to the first law of therrnodynamics, for a system undergoing a process, from state 1 to state 2, the network transfer is equal to the net heat transfer. T F

(ii) The coefficient of performance of a heat pump is given by $\beta_{HP}=1-1/(q_1-q_2)$, where q_1 is heat output to high temperature reservoir. T F

(iii) For a non-cyclic process of an isolated system, difference in energy input and output is equal to the change in internal energy, with finite value given by $\delta q-\delta w = du$. T F

(iv) A wet vapour is an ideal gas and the equation of state applies. T F

(v) An irreversible adiabatic process promotes a rise in entropy. T F

(vi) Within the liquid-vapour envelop, pressure and temperature are clearly no longer independent properties of the substance. T F

(vii) For the same compression ratio, the efficiency of the Diesel cycle is lower than that of the Otto cycle. T F

(viii) Heat energy is an intensive property of a system, and represents energy in transfer. T F

(ix) In thermodynamics, the energy E of a system is defined more generally as an intensive property of the system, representing its capacity to change the state of its environment by interactions at the boundary. T F

(x) An unresisted process, or free expansion, is reversible, with no resistance offered to the system boundary as work is done. T F

(xi) A system undergoes a cyclic process if it passes through a series of states in such a way that its final and initial states are identical in all respects, with only a finite change occuring in the energy of the system. T F

(xii) An internal constraint of a thermodynamic system at a given state is any circumstance that prevents the uniform application of any property throughout the system. T F

(xiii) For a perfect gas in an adiabatic process which is reversible steady flow, work transfer is given as $({}_1W_2) = C_p(T_1-T_2)$. T F

(xiv) In a non-work process for a closed system, the heat transfer is equal to the change of enthalpy. T F

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

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

Q2. (a) An inventor claims to have developed an engine that operates on cycle that consists of two reversible adiabatic processes and one reversible isothermal heat addition as follows:

1 – 2 Isothermal heat addition,
2 – 3 Adiabatic expansion,
3 – 1 Adiabatic compression.

Explain whether the engine violates either the first or second laws of thermodynamics.

[6 marks]

(b) A given system is capable of receiving heat continuously at a rate of 1 kW from an infinite source. What are the two additional requirements for continuous output of 300 W of mechanical work?

[6 marks]

(c) A mass of perfect gas exists initially at pressure 200 kN/m^2, temperature 300 K, and specific volume 0.5 m^3/kg. The value of γ is 1.4. What are the specific heats of the gas, and what are the changes in entropy when the gas is expanded to pressure 100 kN/m^3 first with polytropic index n=1.3, and second over the same pressure range with n=1.5 (for example, by the application of a cooling jacket during the process)?

[8 marks]

Q3. (a) What is work ratio, and what is its significance?

[5 marks]

(b) A sample of wet steam at a pressure of 6 bar is throttled to atmospheric pressure and resultant temperature 100 °C. Determine the temperature drop due to throttling, and the quality of the initial sample.

[15 marks]

Q4. Calculate the cycle efficiency, work ratio, and specific steam consumption of the Rankine Cycle in Fig Q4. working between pressures of 30bars and 0.04bar for:

(a) The Ideal Cycle
(b) The actual cycle when irreversibilities result in efficiencies of expansion and compression processes to be each 0.80.
(c) Explain why ideal cycles are not possible.

Assume saturated steam at state 2. Calorimetry tests revealed that the dryness fraction at states 3 and 4 are 0.716 and 0.276, respectively.

Discuss the results obtained in (a) and (b), and also draw the T-s diagram.

[20 marks]

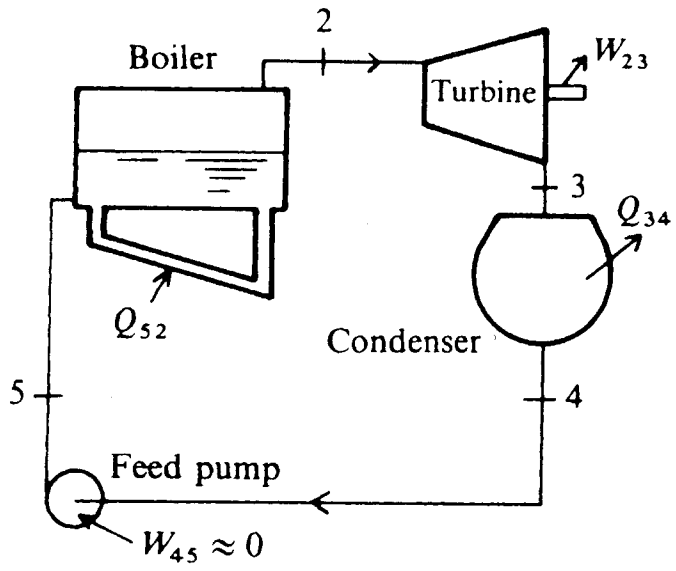


Fig Q4: Rankine Cycle

END OF SECTION A

SECTION B: Answer AT LEAST TWO (2) questions from this section

---

Q.5 (a) Define the following

(i) Fluid Mechanics
(ii) Hydraulics
(iii) Fluid

(b) Draw a rheological diagram representing the classification of various fluids

(c) A certain machine of power rating 1.256 kW and Shaft speed 200 RPM, employs a 500mm diameter shaft rotating in a bearing of length 120mm and diameter of 504mm. Determine the viscosity of the oil the machine uses.

(d) Outline the general procedure for dealing with density and pressure in manometric problems

(e) Find the pressure difference (in N/m^2) between L and M in Figure Q.5e.

(3 + 4 + 6 +3 + 4 = 20 marks)

Q.6 (a) Show that the hydrostatic force exerted by a liquid on a plane area is given by

$$P = \rho g h_{cg} A$$

(b) Figure Q.6b shows an isosceles triangle of base 3m and altitude 6m, immersed vertically in water, with its axis of symmetry horizontal. If the water head above it is 9m, determine:

(i) The total pressure on the plate
(ii) The position of the centre of pressure

(c) Briefly explain the with the help of diagrams the phenomenon of floatation, clearly highlighting the following terms:

(i) Centre of displaced volume
(ii) Centre of buoyancy
(iii) Metacentre
(iv) Metacentric height
(v) Condition of stability and instability

(d) A large bus full of passengers (total weight = 157 kN) is to cross the Zambezi river on a rectangular pontoon of 15m length, 10m width, 4m depth, and weight 1412kN as shown in figure Q6d. Assuming that the bus is parked exactly at the centre of the pontoon such that its centre of gravity lies in the same vertical line as that of the pontoon, determine whether the system is stable or not. (Take river water density = 1020kg/m^3).

(5+3+6+6=20 Marks)

Q.7 (a) (i) Show that the discharge through a horizontal venturimeter is given by:

$$Q_{act} = C_d A_1 A_2 / [A_1^2 - A_2^2]^{0.5} * [2gh]^{0.5}$$

Where C_d = Coefficient of discharge

(ii) Figure Q7a shows a 300mm x 150mm venturimeter connected in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the venturimeter is 300mm. The differential U-tube mercury manometer shows a gauge deflection of 250mm. Calculate the discharge of oil and the pressure difference between the entrance section and the throat section. (Take the coefficient of the meter as 0.98 and the specific gravity of mercury as 13.6).

(b) Find the discharge of water and conveyance through the channel section shown in Figure Q7b. Take Chezy's constant C = 58 and the slope of the bed as 1 in 950. Also state whether the flow is tranquil or rapid.

(c) Explain what a boundary layer is and how its formation differs from a fluid flowing over a flat plate from that flowing through a pipe.

(6+4+5+5=20 Marks)

Q.8 (a) Briefly explain how minor energy losses take place in a pipe having

(i) Sudden enlargement
(ii) Sudden contraction

(b) Figure Q8b shows a water supply system comprising two sections.

In section 1, water is pumped at a rate of $0.05m^3/s$ to an overhead tank A through a 200mm diameter and 300m long pipe having a friction coefficient, f equal to 0.0075. The pipe discharges freely into the tank, 15m above the pump. For this section, determine the:

(i) Pressure developed by the pump on the delivery side
(ii) Power delivered to the water by the pump

In section 2, the water is supplied at the same rate from tank A to tank C, having a level difference of 15.5m and connected by a pipeline ABC. The elevation of point B is 4m below the level of water in reservoir A. The length AB of the pipeline is 250m, while BC has a length of 450m. Both length are of the same diameter 200mm, but made of different materials. A partially closed valve is located in the length BC at a distance of 150m from reservoir C. If the pressure head at B is 0.5m and the head loss at the valve is 5.0m, determine for this section:

(i) The friction coefficients of pipes AB and BC.

For both sections, draw the hydraulic grade lines of the pipeline and indicate on the diagram head loss values at significant points.

(For section 1, assume the first 285m of delivery pipe to be horizontal and the rest vertical. For section 2, take into account loss at the entrance and exit points of the pipeline)

(c) State four differences between fluid flow through pipes and flow through open channels.

(4+12+4=20Marks)

END OF SECTION B

END OF EG 365 - FLUID MECHANICS & THERMODYNAMICS
SEMESTER 1 FINAL EXAMINATION, APRIL 2002.

Prepared by: Mr. C. Siakachoma, Mr E. Matsika and Mr S.S. Virdy.

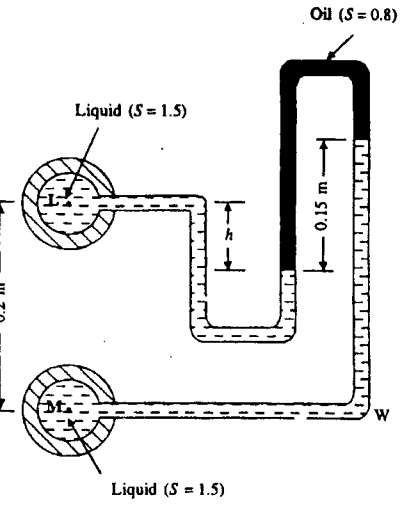


Figure Q.5e

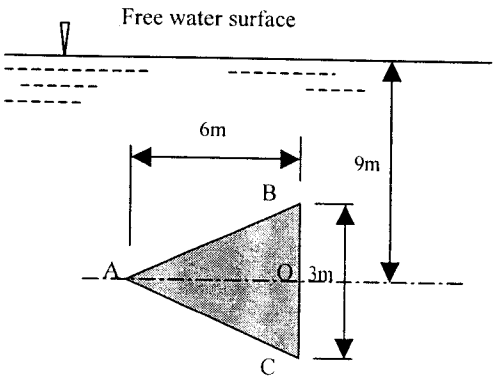


Figure Q.6b

Figure Q.6d

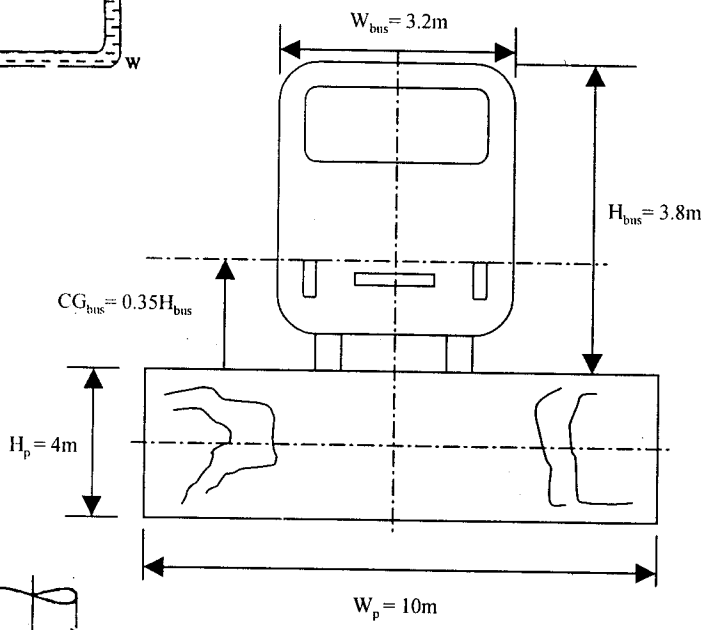
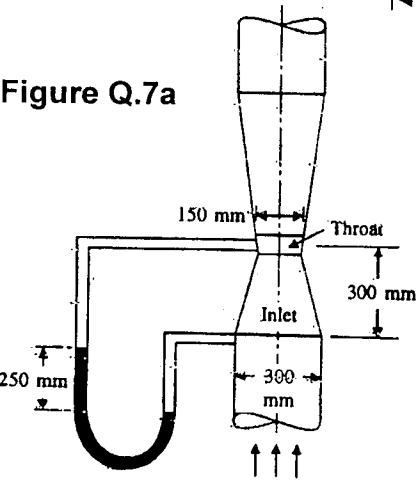


Figure Q.7a



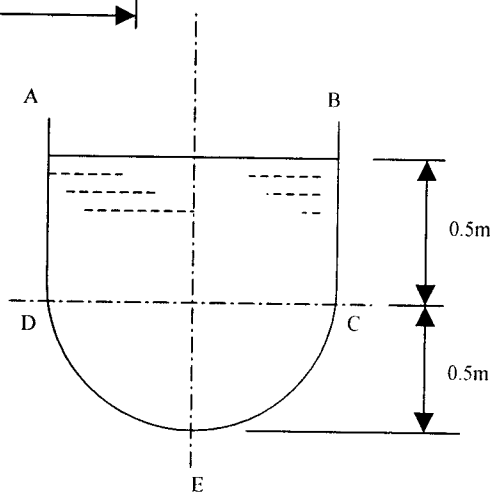


Figure Q.7b

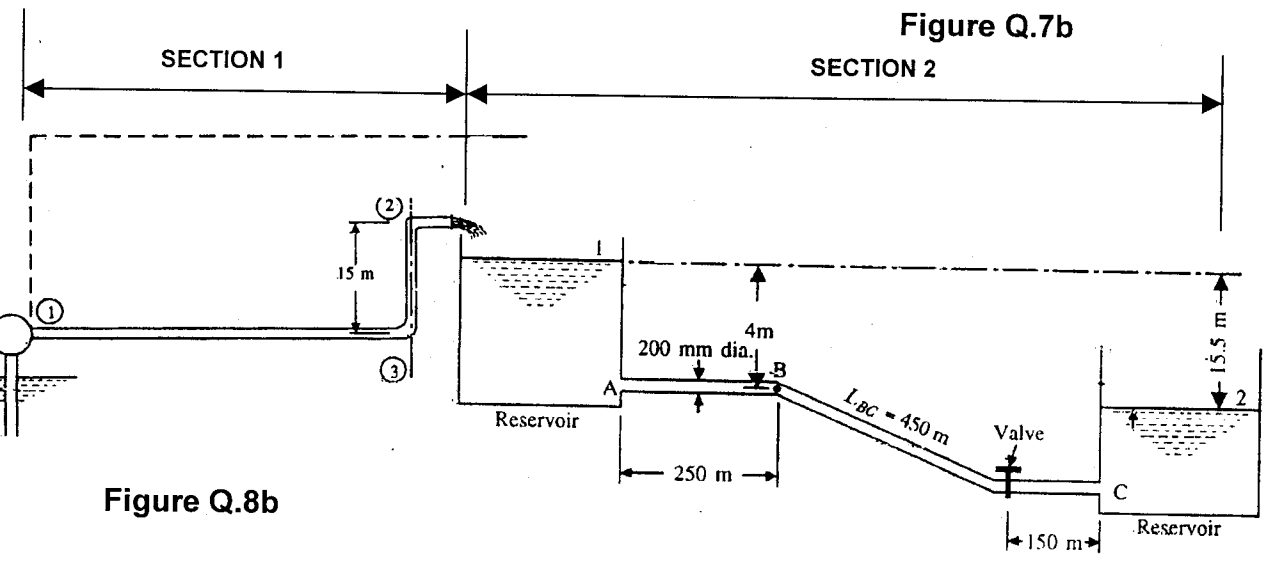


Figure Q.8b

UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATIONS

APRIL 2002

EM211 – ENGINEERING MATHEMATICS I.

INSTRUCTIONS

1. Attempt any **five (5)** questions.
2. Show ***all your work*** to earn full credit.
3. All the questions carry equal marks.
4. You may use calculators to confirm your calculations.
5. This examination has 2 pages and each page is printed.

TIME ALLOWED: Three (3) hours

---

[1] Given the equation $17x^2 - 12xy + 8y^2 - 80 = 0$

(a) **Simplify** the equation by a rotation of axes and **describe** the conic section.

(b) Draw a **sketch** of the graph of the equation showing both sets of axes.

[2] **(a)** Given the following series $\sum_{k=0}^{\infty} ar^k$

(i) Show that $\sum_{k=0}^{\infty} ar^k = \frac{a}{1-r}$, for $|r| < 1$

(ii) Show that 2.88888... can be expressed as a sum of a constant and a series of the form above, and hence find its sum.

(b) Let $\{x_n\} = \left\{\frac{2^n}{1+2^n}\right\}$, $n \in N$, be a sequence.

(i) Show that for every $\varepsilon > 0$ there exist an N such that $|x_n - 1| < \varepsilon$ for all $n \geq N$.

(ii) Find the smallest N for the problem in (i) when $\varepsilon = 0.001$

(c) Determine whether $\sum_{n=1}^{\infty} \frac{n!}{(n+2)!}$ converges or diverges, if it converges find its sum.

[3] **(a)** Given $2x + y - z = 0$ and $x + 3y + 5z = 0$, find:

(i) Parametric equations for a line through the point (2, 0, -4) and parallel to the planes above.

(ii) Symmetric equations for the line in (i).

(b) Find an equation of the plane containing the given intersecting lines.

(i) $\frac{x}{2} = \frac{y-2}{3} = z-1$ and $x = 2-y = z-1$

(ii) $\frac{x-2}{4} = \frac{y+3}{-1} = \frac{z+2}{3}$ and $\begin{cases} 3x+2y+z+3=0 \\ x-y+2z-1=0 \end{cases}$

[4] **(a)** The equation of a plane is given by $ax + by + cz + d = 0$, where $P(x,y,z)$ is a point on the plane, [a, b, c] are direction numbers. Let $P_0(x_0, y_0, z_0)$ be any point not lying in the plane and $\mathbf{N} = a\mathbf{i} + b\mathbf{j} + c\mathbf{k}$.

(i) Show that the projection of $\overline{PP_0}$ onto **N** is $\dfrac{|ax_0 + by_0 + cz_0 + d|}{\sqrt{a^2+b^2+c^2}}$

(ii) Find the distance from the point (2, 2, -4) to the plane $2x + 2y - z - 6 = 0$.

(b) Find the cosine of the measure of the smallest angle between the two lines

$x = 2y + 4,\ z = -y + 4$ and

$x = y + 7,\ 2z = y + 2$

[5] **(a)** Find the most general vector whose derivative has the given function values.

(i) $\mathbf{R}'(t) = t\mathbf{i} + t^2\mathbf{j}$

(ii) $\mathbf{R}'(t) = \ln(t)\mathbf{i} - \sin(t)\,\mathbf{j}$

(b) If $\mathbf{R}'(t) = e^t\sin(t)\,\mathbf{i} + e^t\cos(t)\,\mathbf{j}$, and $R(0) = [illegible]\,\mathbf{i} - \mathbf{j}$, find **R**(t).

[6] **(a)** A force represented by the vector $F = 3\mathbf{i} - \mathbf{j}$ acts on a particle and causes it to move along a straight line from the point A(2, 5) to the point B(7, 3) and then from B along a straight line to C(10, 2).

Find the work done by the force if force is measured in kilograms and distance is measured in meters.

(b) Let $\mathbf{R}(t) = f(t)\mathbf{i} + g(t)\mathbf{j}$ be a vector-valued function describing a curve C.

Given that f(t) and g(t) are differentiable for all values of t in the interval [a, b]

(i) **Write down** the formula for the arc length of C from t = a to t = b.

(ii) $\mathbf{R}(t) = (\frac{1}{2}t^2 + t)\,\mathbf{i} + (\frac{1}{2}t^2 - t)\,\mathbf{j}$ describes a curve C.

Find the length of an arc of C from t = 1 to t = 2.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS - SEMESTER I, 2001/02

EM 311 - ENGINEERING MATHEMATICS III

INSTRUCTIONS: Answer any five questions. Please show all necessary working. All questions carry equal marks.
TIME ALLOWED: Three (3) hours.

---

1. (a) Apply the transformation z = lnx to the differential equation

$$\frac{d^2y}{dx^2}+\frac{1}{x}\frac{dy}{dx}=\frac{12\ln x}{x^2}$$

to change it into a linear differential equation with constant coefficients. Hence find a general solution of the above differential equation.

(b) By substituting $y = u(x)e^{\frac{-x^2}{4}}$,

transform the differential equation

$$y''+(n+\frac{1}{2}-\frac{1}{4}x^2)y=0,$$ where n is a constant,

into

$$\frac{d^2u}{dx^2}-x\frac{du}{dx}+nu=0$$ and obtain two solutions of the second equation in the form of series of ascending powers of x.

2. (a) Find a complete solution of the differential equation

$$x\frac{d^2y}{dx^2}+(x-2)\frac{dy}{dx}-2y=x^3$$

given that $u(x) = e^{-x}$ is an integral of its complementary function.

(b) Let $y(t)= t\cos 2t$

Find (i) $y''(t)$.

(ii) $L(y(t))$

(iii) $L\{e^{2t}(t^3 + 5t\cos 4t)\}$

3. (a) (i) Define the unit step function $u_a(t)$, $a > 0$ and sketch its graph.

(ii) State the second shift theorem.

iii) Find the function f(t) whose Laplace Transform is

$$\frac{2e^{-s}}{s^3} + \frac{6e^{-4s}}{s^2 - 9}$$

(b) Solve the differential equation

$$y'' + 4y = u_o(t) - u_{\frac{\pi}{2}}(t)$$

given that $y(0) = 1$, $y'(0) = 0$

4. (a) Solve the following simultaneous differential equations.

$$2\frac{dx}{dt} + \frac{dy}{dt} - 2x - 2y = 5e^t$$

$$\frac{dx}{dt} + \frac{dy}{dt} + 4x + 2y = 5e^{-t}$$

subject to the initial conditions $x(0) = 2$, $y(0) = 0$

(b) (i) Show that for integers m and n,

$$\int_{-\pi}^{\pi} \sin mx \sin nx dx = \begin{cases} 0 \text{ when } m \neq n \\ \pi \text{ when } m = n \end{cases}$$

(ii) Determine if the following function is odd, even or neither.

$$f(x) = \frac{x}{(x+1)(x-1)}$$

5. (a) Let f(x) be an even periodic function with period 2π defined by $f(x) = x^2$ for $0 \leq x \leq \pi$. Sketch the graph of f(x) in the range $-3\pi \leq x \leq 3\pi$ and find its Fourier series. Hence derive the sum of the infinite series

$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \ldots.$$

(b) Find a half range Fourier sine series for $f(x) = x^2$, $0 < x < \pi$.

6. (a) Use separation of variables method to find solutions of the partial differential equation $\frac{\partial^2 \theta}{\partial t^2} = a^2 \frac{\partial^2 \theta}{\partial x^2}$ which are periodic in time.

(b) Find the general solution of the linear differential system

$$\frac{dy_1}{dx} = -3y_1 + y_2$$

$$\frac{dy_2}{dx} = y_1 - 3y_2$$

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

UNIVERSITY FIRST SEMESTER EXAMINATIONS, 2001/02

EM411 - ENGINEERING MATHEMATICS III V

INSTRUCTIONS: Answer any five questions with all necessary working shown. All questions carry equal marks.

TIME ALLOWED: Three(3) hours.

---

1. a) Three approximate values of the number $\frac{5}{6}$ are given as 0.80, 0.83, 0.84. Determine which of these is the best approximation. Your answer should be based on some error analysis.

   b) By sketching the graph of $f(x) = 3x^3 + x - 1$, show that $f(x)$ crosses the *x-axis* only once as x-increases from 0 to 1. Hence starting with $x_o = 0$, approximate the real root of the equation $3x^3 + x - 1 = 0$ by the Newton Raphson method, giving the approximation to three decimal places.

2 a) Solve the following linear system by Gauss elimination method.

$$\begin{aligned} I_1 + I_2 - I_3 &= 0 \\ 2I_1 + \quad\; 5I_3 &= 6 \\ 2I_1 \quad 4I_2 \quad\; &= 4 \end{aligned}$$

   b) Given the initial value problem $y' = xy$, $y(0) = 1$, approximate y upto four decimal places at $x = 0.5$ using Runge-Kutta method of order 2 with $h = 0.1$. Determine the relative error of approximation.

3. a) The following table shows the short -wave radiation flux (R) at the outer limit of the atmosphere in gram-carolies per square centimeter per day for the month of September.

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

Derive an interpolating polynomial using Newton's method and estimate R at a latitude of 35°.

b) Find lagrange linear interpolation polynomial between the points $x_o = 1$ and $x_1 = 1.1$ for the function $f(x) = \ln(1 + x)$. Approximate value of $f(1.04)$ and obtain a bound on the truncation error. Find the true error of approximation.

4. a) The following table gives the water vapor capacity of air(Vc) 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°F using the forward, backward and the two step finite difference approximations.

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

Approximate the slope of the water vapor capacity curve at a temperature of 54°F using the three point formula

$$f'(x_o) = \frac{1}{2h}\left[-3f(x_o) + 4f(x_o + h) - f(x_o + 2h)\right]$$

b) Evaluate $\int_0^1 e^{-x^2} dx$ by Simpson's rule with 10 partitions of the interval of integration and estimate a bound on error

$$\frac{-(b-a)^5}{180(2m)^4} f^{(4)}(\xi), \quad 0 \le \xi \le 1$$

where 2m is the number of partitions of interval $[a,b]$

5. a) Show using the Cauchy Riemann theorem that the function $f(z) = \frac{i}{z}$ is not analytic over the entire complex plane. Determine the region over which *f(z)* is analytic.

b) (i) Find solutions of the equation $e^z = i$ and plot some of them in the complex plane.

(ii) Find values of z for which $cosz = 0$

6. (a) State Cauchy-Goursat theorem and verify it for the function $f(z) = z^3 - iz^2 - 5z + 2i$ if C is the circle $|z| = 1$

(b) (i) Evaluate $\oint \frac{z+1}{z^3 - 2z^2} dz$ around the circle $|z| = 1$

(ii) Evaluate $\int_c \ln z dz$

where C is the unit circle, the branch of lnz to be used is the one for which $lni = \frac{\pi}{2} i$ and the integration starts from z = i.

END OF EXAMINATION

The University of Zambia
School of engineering
Department of surveying

1st Semester Deferred Examinations

SE 481: Introduction to Surveying **June 2002**

Instructions

Time: Three (3) hours.
Answer four (4) questions in total
Three (3) from section A and One (1) question from section B

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

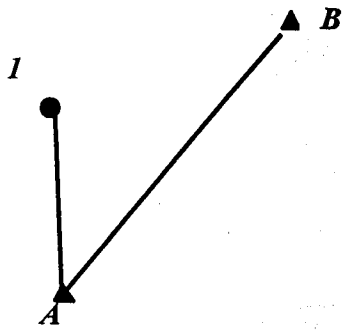
Section A: Answer any three (3) questions from this section

Question 1 (4+5+6+10)

Two points ***A*** and ***B*** have the following coordinates:

A	93158.73mE	87365.18mN
B	93345.61mE	87598.37mN

The following observations were made from point ***A***:



Station	Object	Direction (Red. Mean)	Slope Distance	Vertical angle
A	B	0.000 gon		
A	1	364.782 gon	82.46m	106.273 gon

a) What type of point determination is this?
b) Calculate the coordinates of point 1.

Question 2 (5+6+8+6)

A levelling circuit was run between two Bench Marks (BMs) to determine the minimum clearance under a bridge. Point ***B*** is vertically above point ***A*** and point ***C*** is vertically above point ***D***. Inverted staff readings were taken at points B and C. The raw data for this level circuit is given in the table below.

Name:
Date:

Instrument:
Weather:

LEVELLING

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
1	1.716			45.4				1127.610	BM
A	1.582		1.662	50.2	45.1				CP
B		-2.171							
D		1.566							
C		-2.171							
2	1.462		1.539	38.8	49.8				CP
3	1.253		1.460	49.6	38.7				CP
4		0.651							
5	1.876		1.017	46.7	49.1				CP
6			1.412		46.3				BM

a) Complete the booking form.

b) Compute the allowable and actual misclosure in the loop and state whether the latter is acceptable (assume σ = 30mm). The published RL of the last BM is 1128.423m

c) Calculate the adjusted RL's of all the points in this level loop.

d) With the aid of diagrams and formulas, describe how the level and horizontal lines relate to one another over short and long distances. How does the curvature of the Earth affect this relationship?

Question 3 (8+9+8)

The four corners of a square building ***ABCD*** are set out on site using a theodolite and steel tape. The designed horizontal length of each side of the building is 20.000m.

At each corner a wooden peg is driven firmly into the ground and a nail is hammered into the top to mark the exact position. The RL's of the four corners ***A***, ***B***, ***C*** and ***D*** are 1179.61m, 1178.27m, 1177.14m and 1178.66m, respectively.

To check the setting out the diagonals ***AC*** and ***BD*** are measured between the centres of the nails using a correctly tensioned steel tape at a mean temperature of 14°C as 28.395m and 28.295m, respectively. The nominal tape length is 30m.

The tape had a standardized length on the flat of 29.995m at a temperature of 20°C and a tension of 50 N. The coefficient of expansion of the tape material was 0.0000112 / °C.

Calculate the error in the setting out of the horizontal lengths of the diagonals ***AC*** and ***BD***.

Question 4 (5+15+5)

Define surveying and discuss the various disciplines into which it is divided. How do you think surveying can be helpful in your profession?

Section B: Geology students only.
Answer any question from this section

Question 5 ***Geological Mapping Preparations*** *(9+6+10)*

a) Describe the uses of the following

I. Topographic map

II. Aerial photograph

III. Geological compass

b) Name two major purposes of a compass

c) Give a full description of one of the methods used in measuring geological planes.

Question 6 ***Geological Mapping Procedures*** *(10+5+10)*

a) Describe in full, stages involved in Geological mapping procedures, giving diagrams where necessary to support your answers.

b) What is the distinction between a **trend** and a **plunge**?

c) List four ways by which you determine your position in the field.

OF DEFERRED EXAM

The University of Zambia
School of Engineering
Department of Surveying

Semester I Final Examinations – April 2002

SE 561: Principles of Land/Geographic Information Systems

Instructions:

Time: Three (3) hours

Answer any two (2) questions from section A and all questions from section B

Section A: Answer any two (2) questions from this section

Question 1 (4+4+4+4)

Briefly define or explain each of the following terms:

a) Geographic Information System
b) Georeferencing
c) Entity
d) Cardinality
e) Edge matching

Question 2 (4+6+10)

a) Name and explain, with aid of diagrams, the two major types of spatial data models.

a) What are the guiding criteria for the choice of an appropriate spatial data input method?

b) Given below are two raster images (A) and (B) of two separate areas

	0	1	2	3
0	A	C	C	B
1	A	A	C	B
2	A	A	A	B
3	B	A	A	A

Image (A)

	0	1	2	3
0	A	A	A	C
1	A	A	C	C
2	A	C	C	C
3	A	A	A	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 value point encoding? Explain your answer.

Question 3 (2+4+6+8)

a) What is precision?
b) Distinguish the locational precision of coordinates for raster data against those of vector data
c) Give three advantages of maintaining national standards for spatial data.
d) Name and explain briefly the various ways of presenting spatial analysis results

Section B: Answer all questions from this section

Questions 4 (2+20)

a) Why is spaghetti data model not well preferred in vector based GIS?
b) How are these shortcomings overcome in a topological data model?
c) You have just carried out a survey of an area and subsequently plotted your results as shown in figure 1. Design and fill the tables for a topological data model of this area.

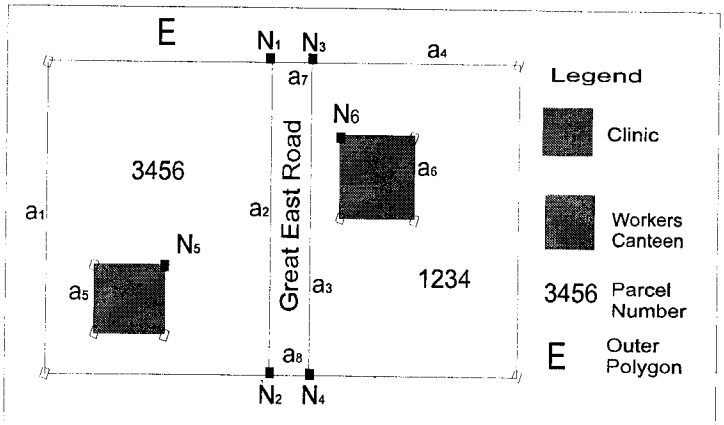


Figure 1

Question 5 (9+17+12)

Given below is a set of enterprise rules for establishing a database:

(i) A road may pass through more than one town.
(ii) There could be more than one road in a town.
(iii) A town must have atleast one cinema hall.
(iv) A cinema hall may show different films.
(v) A film can be shown in different cinema halls.
(vi) More than one staff manages a cinema hall.
(vii) A member of staff from one cinema hall cannot be a staff in another.

Based upon the foregoing information, design a database to support the film shows in the area by:

a) Identifying the entities and relationships among the given objects.
b) Formulating Entity-Relation (E-R) diagrams for the '*logical data models*' for this database (do not forget to indicate the cardinality).
c) Formulating corresponding well normalised skeleton tables (database schema), not forgetting to underline the identifiers (key attributes) with a solid line and posted identifiers (foreign keys) with a dotted line (Never bother to include the fully normalised tables).

End of Examinations

Good Luck