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THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS - 1996 -98-99
FIRST SEMESTER & SECOND SEMESTER
SCHOOL OF ENGINEERING

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1. CE 219 - Statics And Introduction to Strength of Materials
2. CE 219 - Statics And Introduction to Strength of Materials (Supp)
3. CE 219 - Statics And Introduction to Strength of Materials (Deff)
4. CE 219 - Statics And Introduction to Strength of Materials.
5. ✓CE 369 - Fluid Mechanics
6. ✓CE 442 - Highway And Traffic Engineering
7. ✓CE 512 - Structural Dynamics
8. ✓CE 532 - Structural Engineering - Steel Design
9. ✓CE 582 - Construction Techniques + Management
10. EA 402 - Energy Sources And Utilisation in Agriculture II.
11. EA 421 - Fundamentals of Farm Structures
12. EE 209 - Principles of Electricity
13. EE 309 - Principle of Electricity II
14. EE 309 - Principles of Electricity II
15. EE 311 - Electric Circuits
16. EE 342 - Electronic Engineering I
17. EE 392 - Electrical Engineering Practice I
18. EE 431 - Electronics
19. EE 452 - Electric Power System I

20.	EE 552	-	Electrical Power System II
21.	EE 562	-	Control Systems
22.	EE 572	-	Communication Systems
23.	EE 581	-	Telecommunication System Theory
24.	EE 581	-	Communication Principles
25.	EG 212	-	Engineering Workshop Technology (Deff)
26.	EG 212	-	Engineering Workshop Technology
27.	EG 212	-	Engineering Workshop Technology (Deff)
28. ✓	EG 279	-	Introduction to Computing
29.	EG 475	-	Engineering, Management And Society I
30.	EG 475	-	Engineering, Management And Society I (Deff)
31. ✓	EM 212	-	Engineering Mathematics II
32. ✓	EM 212	-	Engineering Mathematics II (Deff)
33. ✓	EM 312	-	Engineering Mathematics II
34. ✓	EM 312	-	Engineering Mathematics II (Deff)
35.	ME 252	-	Engineering Materials I
36.	ME 332	-	Strength of Materials I
37.	ME 365	-	Fluid Mechanics And Thermodynamics/ Thermodynamics Component
38.	ME 365	-	Fluid Mechanics And Thermodynamics
39.	ME 375	-	Dynamics
40.	ME 405	-	Machine Design I
41.	ME 405	-	Machine Design II
42.	ME 442	-	Thermodynamics II And Heat Engines
43.	ME 442	-	Thermodynamics II And Heat Engines (Supp)

44.	ME 452	-	Properties of Engineering Materials II
45.	ME 452	-	Properties of Engineering Materials II (Deff)
46.	ME 515	-	Production Technology II, Paper I
47.	ME 515	-	Production Technology II, Paper II
48.	ME 582	-	Automobile Engineering
49.	SE 352	-	Land Law, Cadastre And Survey Relations
50.	SE 412	-	Numerical Methods And Programming For Surveyors
51.	SE 441	-	Geodesy
52.	SE 472	-	Principle And Methods of Surveying II
53.	SE 481	-	Introduction to Gis: Basic Principles And Applications
54.	SE 471	-	Engineering Surveying
55.	SE 571	-	Engineering Surveying (Deff)

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY SECOND SEMESTER EXAMINATIONS - AUG/SEP. 1998.

CE 219.

STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours. **ANSWER:** Any THREE from Section A, and Any TWO from Section B.

SECTION - A.

1. The bar AB of Fig: 1 has a uniform cross-section, a mass of 25 kg and length of 1 m. Determine the angle θ when the bar assumes equilibrium position within the V-shaped supporting block.

2. Three bars are connected with smooth pins to form the frame shown in Fig: 2. The pin at B is located inside a smooth slot. Determine :-

   (a) The force exerted by the pin at D on member CDE,
   (b) The reactions at supports A and E.

3. A rotating shaft with a belt type brake is shown in Fig: 3. If $\mu = 0.2$ between the drum and belt and an applied force of P = 75 N prevents rotation of the shaft, determine the maximum torque that can be resisted by the brake when the shaft is tending to rotate :
   (a) anti-clockwise,
   (b) clockwise.

4. Locate the centroid of the uniform slender rod bent as shown in Fig: 4.

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SECTION - B.

5. Applied loads W = 5 kN are suspended by ropes as shown in Fig: 5a and 5b. In both cases the ropes have cross-sectional areas of 800 mm^2 and the value of E = 0.98 kN/mm^2. In 5a, the rope ABC is continuous and W is suspended from a smooth pulley of negligible dimension. In 5b, AB and CB are seperate ropes joined to a rigid block from which W is suspended in such a way that both ropes stretch by the same amount.

   For both cases, determine:-

   (i) the stresses in ropes, (ii) the downward movement of pulley, or block, due to load W.
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6. A rod 1 m long is 10 cm^2 in area for a portion of its length and 5 cm^2 in area for the remainder. The strain energy of this stepped bar is 40 % of that of a bar 10 cm^2 in area and 1 m long under the same maximum stress. What is the length of the portion with 10 cm^2 area?

7. A composite bar made up of aluminium and steel is rigidly fixed between supports as shown in Fig: 6. The two bars are free of stress at 60° C. Determine the stresses in these bars when the temperature drops to 40° C, if:-

(a) the supports are unyielding, and (b) the supports come nearer by 0.1 mm.

GIVEN, $\alpha_s = 11.7 \times 10^{-6} / {}^0C$ $E_s = 210$ kN/mm^2

$\alpha_a = 23.4 \times 10^{-6} / {}^0C$ $E_a = 70$ kN/mm^2

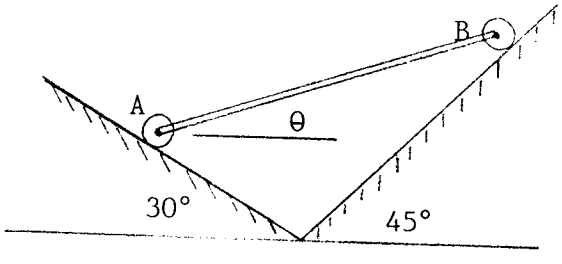

FIG: 1.

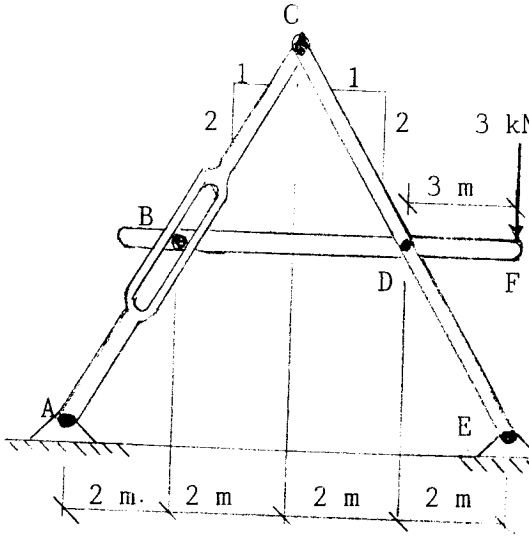

FIG: 2.

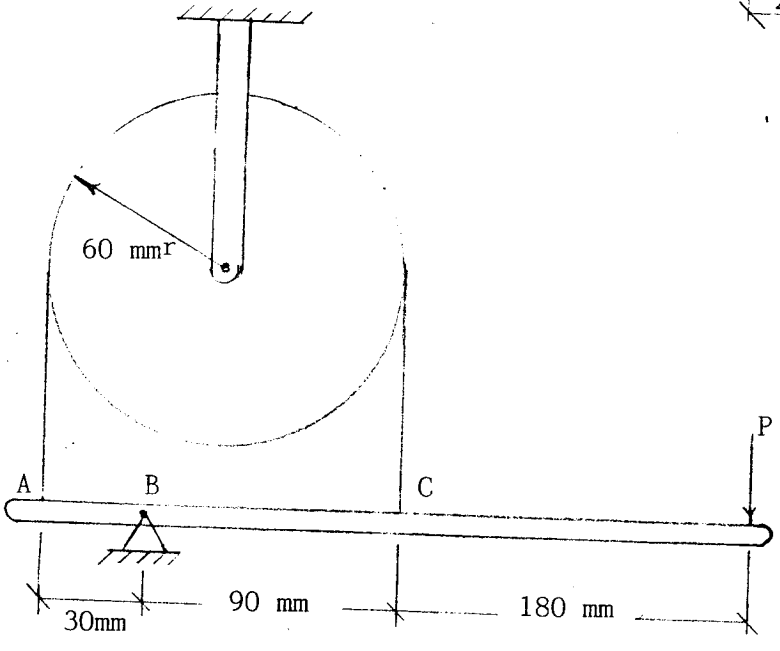

FIG: 3.

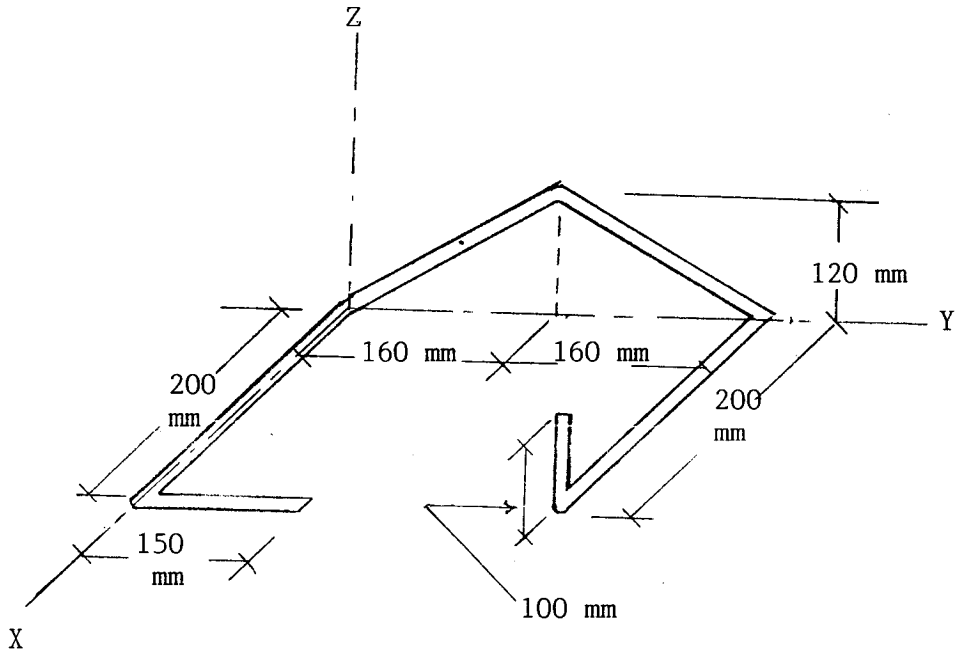

FIG: 4.

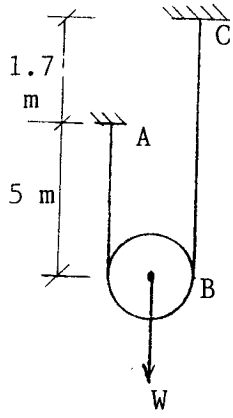

FIG: 5a.

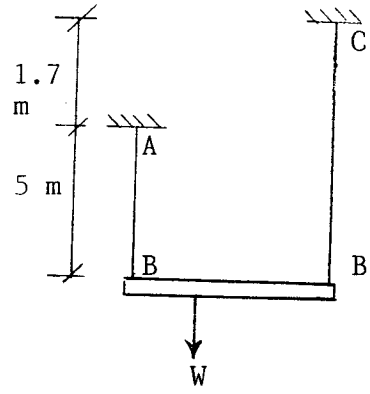

FIG: 5b.

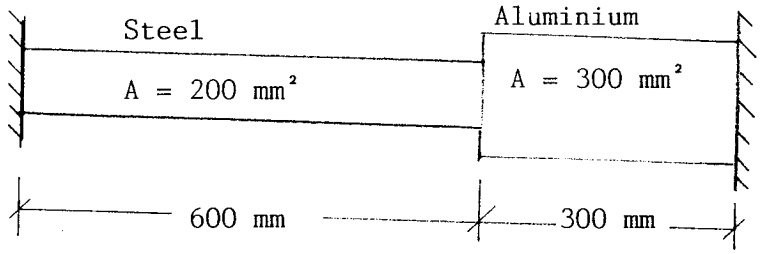

FIG: 6.

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END OF EXAMINATION.

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THE UNIVERSITY OF ZAMBIA.

UNIVERSITY SECOND SEMESTER SUPPLEMENTARY/DEFERRED EXAMINATION. OCTOBER - 1998.

CE 219
STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours.

ANSWER: Any THREE from Section A, and Any TWO from Section B.

SECTION - A.

1. Two slender prismatic bars AC and BC, each of length *l* and weight *W*, are hinged together at C and supported in a vertical plane by two pegs at D and E as shown in Fig: 1. Neglecting all friction, find the angle θ that each bar will make with the horizontal in the condition of equilibrium.

2. Determine all forces acting on member ABCD of the frame shown in Fig: 2. Draw a free body diagram of this member and show these forces with appropriate directions.

3. The block A weighing 200 N is resting on the plate B which weighs 100 N as shown in Fig: 3. A and B are connected by a chord passing over a pulley C as shown.

   The coefficient of friction is 0.2 for all contact surfaces.

   Determine the smallest force P required to move the plate B to the left if :

   (a) the pulley C is free to rotate on frictionless bearing,
   (b) the pulley C is locked in place with a locking pin.

4. (a) Where $I_x = I_y$ for an area which is symmetrical about either the X- or the Y-axis, prove that the moment of inertia is the same for all axes passing through the origin. What happens to the Mohr's circle of inertia in this case?

   (b) Using this knowledge, or otherwise, calculate the polar moment of inertia of the shaded area about the centre O of the square shown in Fig: 4.

SECTION - B

5. The vertical steel bar shown in Fig: 5 has a cross-sectional area of 500 mm^2 over the top 1 m length and an area of 400 mm^2 for the bottom 1.2 m length. A load of 400 kN is applied at the end A of the bar. A horizontal beam hinged at C is connected to the bar at B, and a load P is applied at the other end D of the beam. Determine the value of load P for which the vertical displacement of point A is zero.

6. On a certain plane in a piece of stressed material, there ia a tensile stress of 1000 N/mm^2 and a shearing stress of 550 N/mm^2 as shown in Fig: 6. On a plane making 30° to this plane, there is a tensile stress of 200 N/mm^2, and an unknown shear stress. Find the position of the principal planes and the magnitude of the principal stresses.

7. A steel cube block of 50 mm sides is subjected to a force of 6 kN (tension), 8 kN (compression) and 4 kN (tension) along X- , Y- and Z- directions respectively. Determine the change in volume of this block.
Given E = 200 kN/mm^2 and Poisson's ratio = 0.3

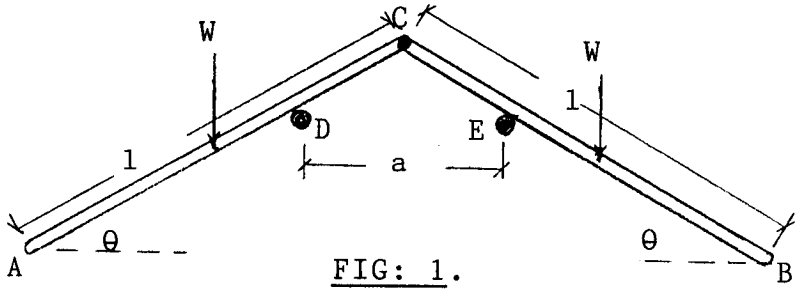

FIG: 1.

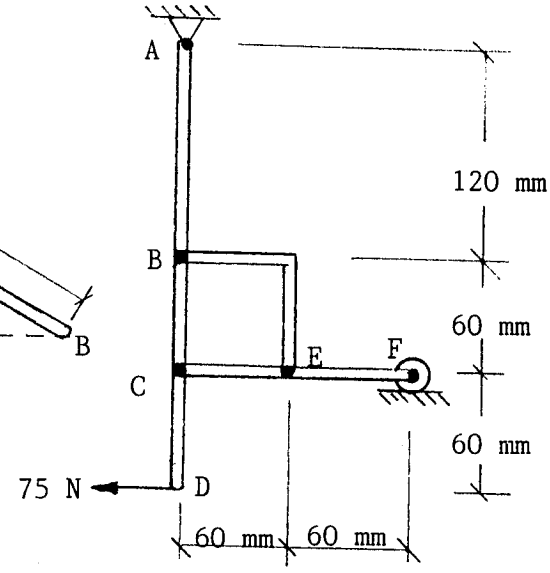

FIG: 2.

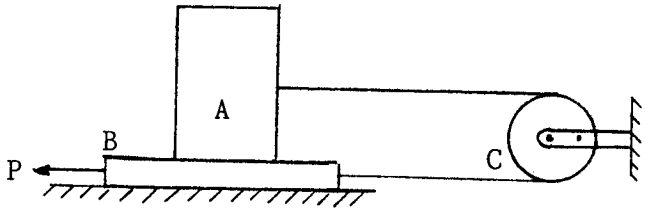

FIG: 3.

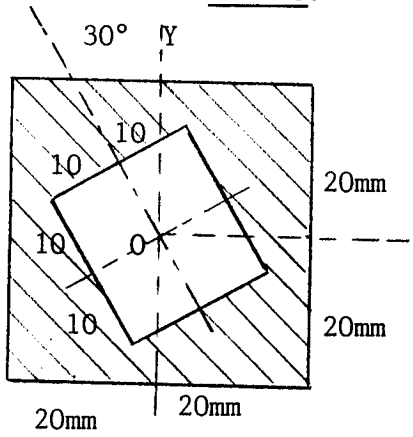

FIG: 4.

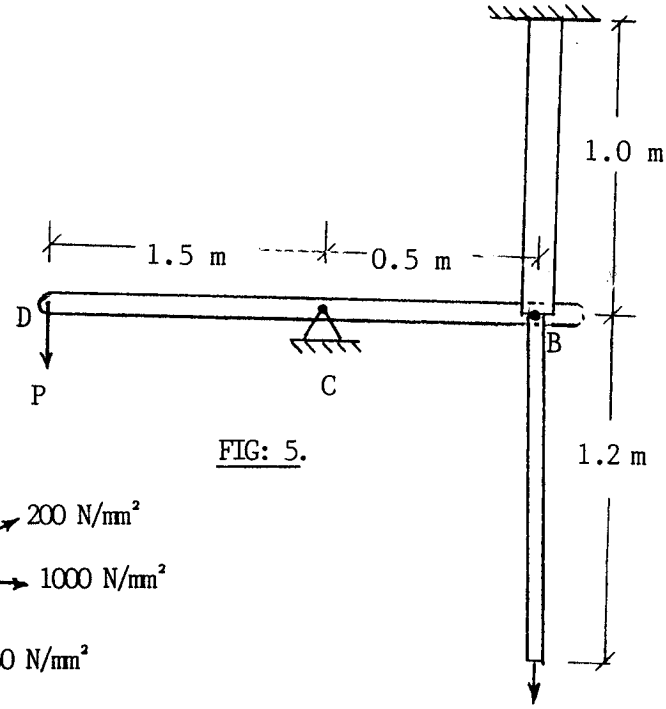

FIG: 5.

FIG: 6.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY FIRST SEMESTER SUPPLEMENTARY/DEFERRED EXAMINATION. NOVEMBER - DECEMBER 1999.

CE 219

STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours.

ANSWER: Any THREE from Section A, and Any TWO from Section B.

SECTION - A.

1. (a) Locate the centroid of a semi-circular arc of radius r.

   (b) A semi-cylindrical shell of uniform thickness, radius r, and mass m rests on a horizontal surface with coefficient of friction = 0.2. It is pulled at right angles to its longitudinal axis by a horizantal force P applied to its left rim at mid-length. Using the result obtained in (a) or otherwise, calculate the angle θ through which it rolls, before it begins to slip on the horizontal surface. (FIG: 1).

2. The 5 m uniform steel beam has a mass of 600 kg and is to be lifted by a hook attached at B with two chains, AB of length 3 m and CB of length 4 m. Determine the tensions in chains AB and BC when the beam is clear of the ground. (FIG: 2).

3. Determine by any method the forces in each of the members CJ, IH and DH in the truss shown in Fig: 3.

4. Determine the horizontal force P required to rotate the cylinder in its V-support, considering all possibilities. (FIG: 4). The bar and cylinder have a combined mass of 40 kg, and the coefficient of static friction for the contacting surfaces is 0.3.

SECTION - B.

5. A hollow steel cylinder of length 300 mm, inside diameter = 150 mm and uniform wall thickness = 3 mm is filled with concrete and compressed between rigid parallel plates by a load of 500 kN. Calculate the compressive stress in each material and shortening of the cylinder if $E_s = 200\ kN/mm^2$ and $E_c = 20\ kN/mm^2$. (FIG: 5).

Page 2 .....

6. A steel measuring tape is 50 m long, calibrated at normal temperature. If the temperature in field is 10^0 C below normal and the pull on the tape is 200 N, determine the correction necessary for each 50 m of field measurement. Given :

$$\alpha_s = 12 \times 10^{-6} / {}^0C, \quad E_s = 200 \text{ kN/mm}^2. \quad A_S = 10 \text{ mm}^2.$$

7. A rigid slab weighing 600 kN is symmetrically placed upon two bronze rods and one steel rod, each of 6000 mm^2 cross-sectional area, at a temperature of 15° C as shown in FIG: 6. Determine the temperature of the system at which stress in the steel rod will be zero. Given:

E_s = 200 kN/mm^2 and E_b = 80 kN/mm^2

$\alpha_s = 12 \times 10^{-6}$ / °C and $\alpha_b = 18 \times 10^{-6}$ / °C

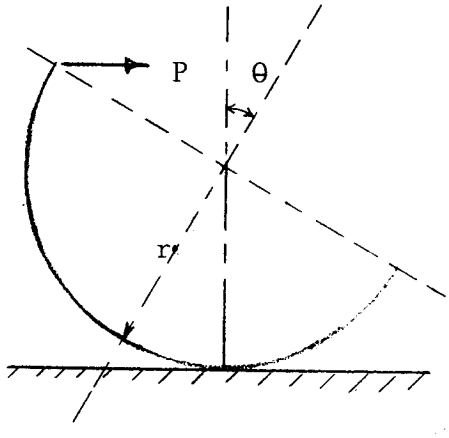

FIG: 1

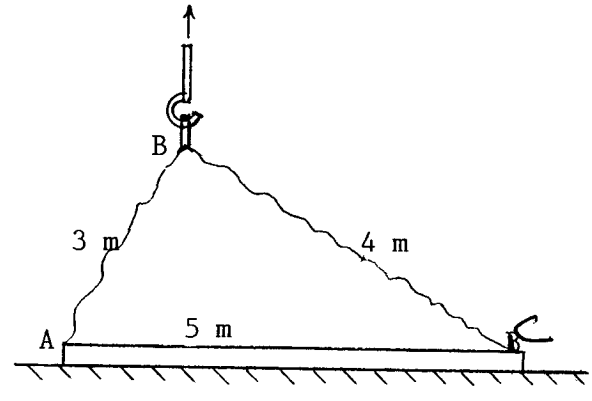

FIG: 2.

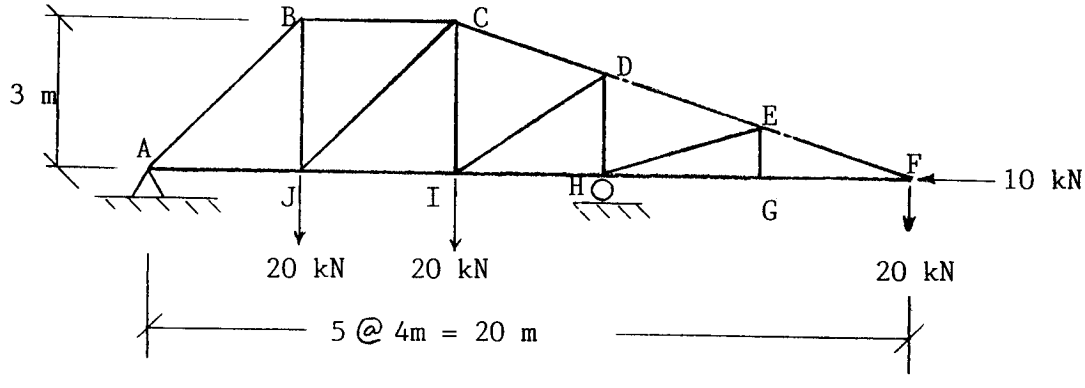

FIG: 3.

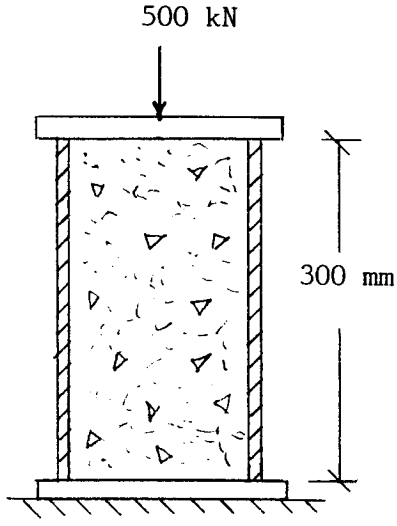

FIG: 5 .

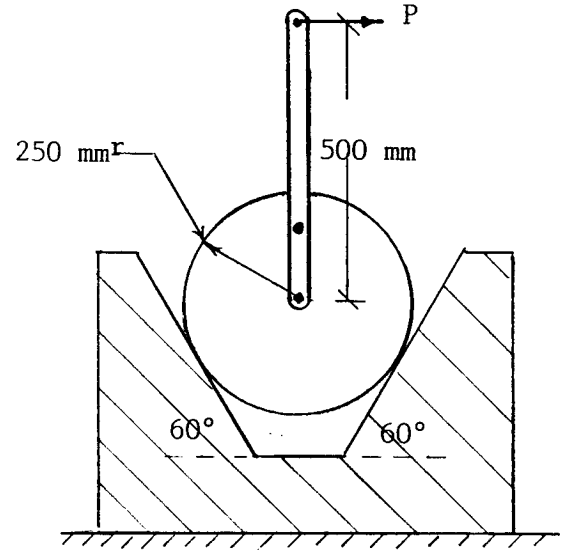

FIG: 4.

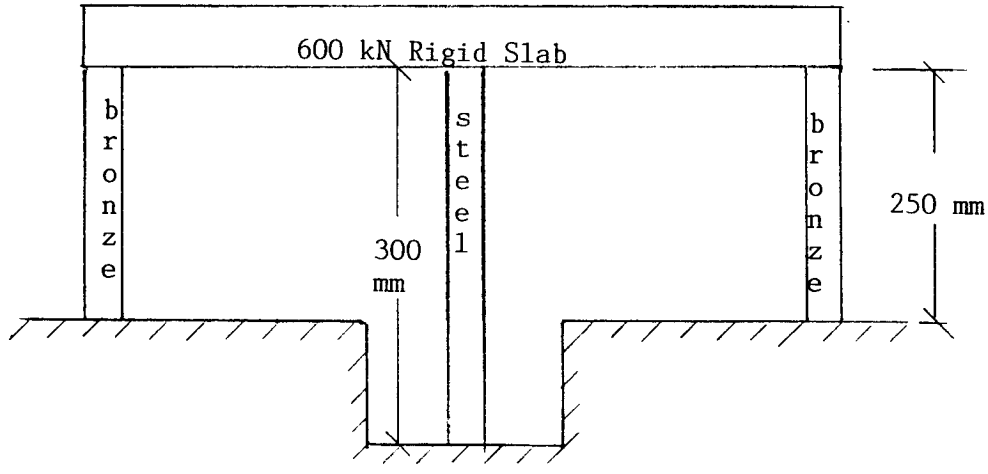

FIG 6.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY FIRST SEMESTER EXAMINATION - MAY 1999/October 1999

CE 219

STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours. **ANSWER:** Any THREE from Section A, and Any TWO from Section B.

SECTION - A.

1. Compute the forces supported by pins A and C of the frame loaded by the 80 Nm couple as shown in Fig:1.

2. The screw press shown in Fig: 2 has a single square thread with mean radius of 10 mm and thread pitch of 10 mm. If a 12 Nm torque is applied to the handwheel what compressive force Q is exerted on the body B ? Assume a coefficient of friction of 0.2 for the thread and neglect pivot friction at the lower end of the screw.

   What is the smallest coefficient of friction for which the screw press will be self-locking ?

3. The products of inertia of the shaded area with respect to the X - Y and X' - Y' axes are $8(10^6)$ mm^4 and $-42(10^6)$ mm^4, respectively. (Fig: 3). Compute the shaded area of the figure whose centroid is G.

4. A rectangular piece is removed from the square metal plate of side a as shown in Fig: 4. Determine the value of h which will result in the mass centre of the remaining plate being as far to the left as possible.

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SECTION - B

5. A steel bar of circular cross-sections is acted on by forces as shown in Fig: 5. The left and right parts are each 500 mm long and 30 mm diameter. If E_s = 210 kN/mm^2,

   (a) what should be the diameter of the middle part if it is 600 mm long and has a uniform tensile stress of 5.197 N/mm^2 under the given axial loading ?

   (b) find the cross-sectional stresses in the left and right parts.

   (c) calculate the change in length of the bar under the applied loads.
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6. A point in a strained material is subjected to mutually perpendicular stresses of 6000 N/mm^2 tensile and 4000 N/mm^2 compressive. It is also subjected to a shear stress of 1000 N/mm^2.

   By Mohr's circle or otherwise, determine the pricipal stresses with their orientation and the maximum shear stress.

7. The composite bar shown in Fig: 6 is attached to the end supports and has properties given below:-

Portion	Material	Cross-Sectional Area (mm^2)	Length (mm)	E (kN/mm^2)	α (/°C)
AB	Copper	1500	500	100	16×10^{-6}
BC	Aluminium	1000	500	70	20×10^{-6}
CD	Steel	2000	1000	200	12×10^{-6}

If the temperature of this bar is raised by 50° C, determine the thermal stresses in the three portions of the bar assuming:-

(a) the end supports are unyielding,
(b) the supports may yield by 0.5 mm.

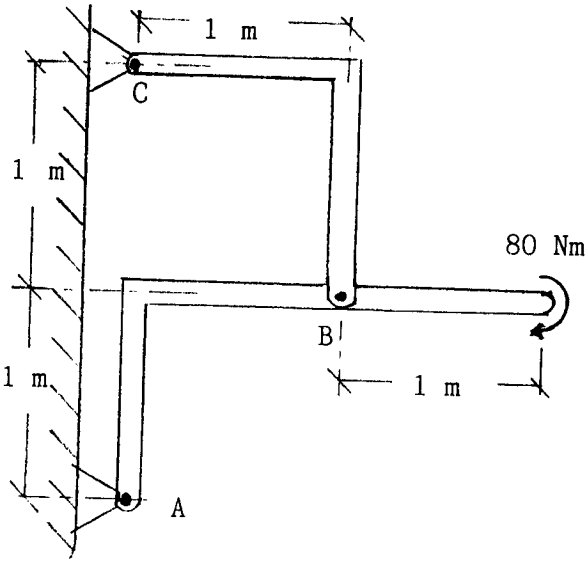

FIG: 1.

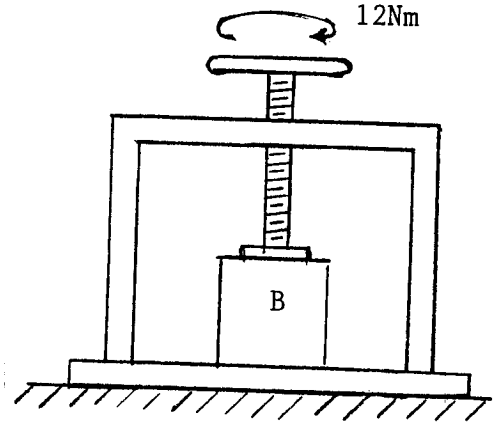

FIG: 2.

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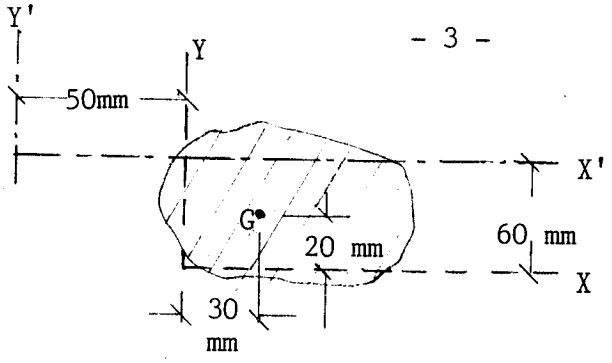


FIG: 3.

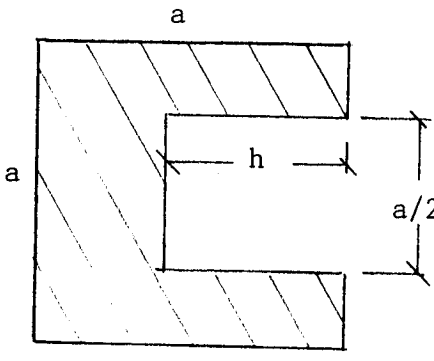


FIG: 4.

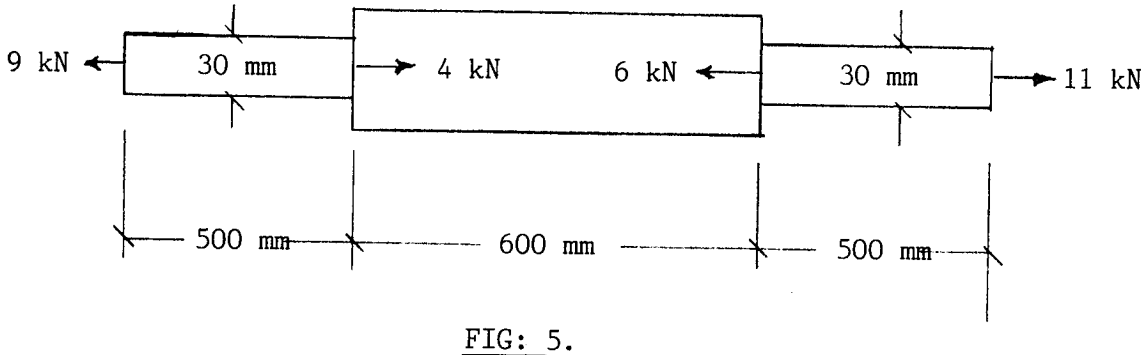


FIG: 5.

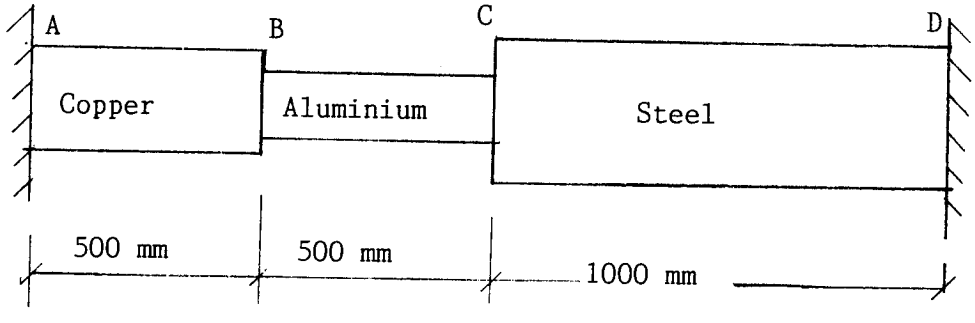


FIG: 6.

********** END OF EXAMINATION **********

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS - AUG/SEPT,1998
CE369
FLUID MECHANICS

TIME : THREE(3) HOURS
INSTRUCTIONS: ATTEMPT ANY FIVE(5) QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

Q1. (a) State Bernoulli's equation for a liquid.

(b) What is meant by (i) potential head, (ii) pressure head, (iii) velocity head, (iv) total head for a liquid in motion?

(c) A jet of water from a 25mm diameter nozzle is directed upwards. Assuming that the jet remains circular and neglecting any loss of energy, what will be the diameter of the jet at a point 4.5m above the nozzle if the velocity with which the jet leaves the nozzle is 12m/s. (5+5+10)

Q2. (a) State Chezy's equation for open channel flow. To what type of open channel flow is the Chezy equation applicable?

(b) A rectangular open channel has a width B of 4.5m and a slope of 1 vertical to 800 horizontal. Find the mean velocity of flow v and the discharge Q when the depth D of water is 1.2m, if C in the Chezy formula is 49 in SI units.

(c) An open channel has a cross-section in the form of a trapezium with a bottom width of 4m and side slopes of 1 vertical to 3/2 horizontal. Assuming that the roughness coefficient n is 0.025, the bed slope is 1 in 1800 and the depth of the water is 1.2m, find the volume flow rate using the Chezy formula with C determined from the Manning formula.(4+8+8)

Q3. (a) A diver descends from the surface of the sea to a depth of 30m. What will be pressure under which the diver would be working above that of the surface assuming that the density of sea water is $1025kg/m^3$ and remains constant.

(b) A cylinder contains a fluid at a gauge pressure of $350kN/m^2$. Express this pressure in terms of a head of (i) water(density=$1000kg/m^3$), (ii) mercury(relative density 13.6). What would be the absolute pressure if the atmospheric pressure is $101.3kN/m^2$? (10+10)

Q4. (a) Water flows through a pipeline 60m long at a velocity of 1.8m/s when the

pressure difference between the inlet and outlet ends is $25kN/m^2$. What increase of pressure difference is required to accelerate the water in the pipe at the rate of $0.02m/s^2$. Neglect elasticity effects.

(b) A jet of water from a fixed nozzle has a diameter of 25mm and strikes a flat plate inclined to the jet direction. The velocity of the jet is 5m/s, and the surface of the plate may be assumed to be frictionless.

(i) indicate in tabular form the reduction in the force normal to the plate surface as the inclination of the plate to the jet varies from 90^0 to 10^0.

(ii) indicate in tabular form the force normal to the plate surface as the plate velocity changes from 2m/s to -2m/s in the direction of the jet, given that the plate is itself perpendicular to the approaching jet. (8+12)

Q5. (a) Show that the intensity of pressure at a point in a fluid is the same in all directions.

(b) A circular lamina 125cm in diameter is immersed in water so that the distance of its perimeter measured below the water surface varies between 60cm and 150cm. Find the total force due to the water acting on one side of the lamina, and the vertical distance of the centre of pressure below the surface. (10+10)

Q6. (a) A pipeline connecting two reservoirs having a difference of level of 6m is 720m long, and rises to a height of 3m above the upper reservoir at a distance of 240m from the entrance before falling to the lower reservoir. if the pipe is 1.2m in diameter and the frictional coefficient f =0.01, what will be the discharge and the pressure at the highest point of the pipeline?

(b) show that the loss of head when a pipe undergoes a sudden increase in diameter is given by $(v_1 - v_2)/2g$, where v_1 is the velocity in the smaller pipe upstream of the enlargement and v_2 that in the larger pipe. (10+10)

Q7. (a) What is meant by continuity of flow and under what conditions does it occur.

(b) Distinguish between steady and unsteady flow; and between uniform and non-uniform flow.

(c) Explain clearly how provision can be made in bernoulli's equation for loss of energy occurring between two points in a stream of liquid.

(d) Show that for fluids at rest, there can be no shear stresses.
(5+5+5+5)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS - 1996/98 ACADEMIC YEAR

CE 442 - HIGHWAY AND TRAFFIC ENGINEERING

TIME: **THREE (3)** HOURS

ANSWER: ANY **FIVE** TAKING NOT MORE THAN **THREE** QUESTIONS FROM EITHER SECTION.
ALL QUESTIONS CARRY EQUAL MARKS

DESIGN CHARTS ARE PROVIDED.

SECTION A

Q1. (a) Briefly explain the following:

(i) Superelevation runoff
(ii) Modulus of Subgrade reaction (K).

(b)(i) Determine the reinforcement (areas of steel) required for a two-lane concrete pavement 200 mm thick, 6.7m wide and 18 m long. The pavement has a longitudinal joint in the centre. The following constants are given:

$\gamma_c = 23.6$ kN/m^3
$f_s = 297$ MPa
$f_a = 1.5$

For the tie bars, assume billet steel ($f_S = 186$ MPa).

(ii) If 6 mm diameter bars are used for the tie bars, what bar length should be used? Allowable bond stress = 2.4 MPa

(c) What are the problems associated with expansion joints in rigid pavements?

Q2. (a) What are the criteria used for the design of crest curves?

(b) A circular curve connects two tangents. The deflection angle is 22^{o}, the PI is at station (76+092) and the design speed is 120 Km/hr. Determine the following:

(i) The stationing of the PC and PT.
(ii) The deflection angle to the first whole station after the PC.

$\mu_R = 0.09$ and the curve is not superelevated.

(c) A Crest vertical curve joins a 2% and a -3% grade. If the PVI of the grades is at station (470+223) and has an elevation of 1113m, determine:-

(i) The stationing and elevation of the PVC and PVT.
(ii) The length of the curve.

$\mu_T = 0.34$, $H_1 = 1m$, $H_2 = 0.1m$, V_d (Design Speed) = 100 km/hr.

Q3.(a) How can the amount of erosion control and maintenance be minimised in side road ditches?

(b) A ditch cross-section has the following information:-

Natural slope of the ground 0.03%
Design flow 3 m^3/s
n = 0.24
$V_{max} = 0.8$ m/s

Determine the required ditch cross-section

(c) Briefly discuss the design of culverts. Show the necessary steps and the kind of information required.

Q4. Write briefly notes on the following:

(a) Attainment of superelevation by rotating a pavement about its centreline. (show sketches).
(b) Passing Sight-Distance
(c) Widening of horizontal circular curves
(d) Assumptions of Boussinesq's elastic layer theory.
(e) Residual value of a highway.

SECTION B.

Q5.(a) Describe the CBR test as performed in the laboratory to evaluate the sub-grade strength. How do you decide the moulding water content for compacting the laboratory CBR specimen? Indicate the use of CBR values in the design of flexible pavements.

(b) Briefly explain the Group Index Method of calculating the thickness of various elements in a flexible pavement.

(c) Design a pavement using the GI method using the following information:-

GI = 5,
Existing number of commercial vehicles = 200

Q6.(a) Discuss the conventional route location process.

(b) A gravel road is to be upgraded to paved road standards. The road is scheduled to have five-year interval reseals. The current and projected costs are given in the table below:

YEAR	COST	MAINTENANCE COST	VEHICLE OPERATING COST BENEFITS
1999	175		
2000		1.0	35.79
2001		1.0	37.58
2002		1.0	39.46
2003		1.0	41.43
2004		13.0	43.00
2005		1.0	45.68
2006		1.0	47.96
2007		1.0	50.36
2008		1.0	52.88
2009		13.0	55.52

Was the exercise worth undertaking? $r \approx 12\%$

Q7.(a) Define the following:-

(i) Layer coefficient
(ii) Initial and terminal serviceability.

Design a pavement using the AASHTO design procedure. The average equivalence factors for the commercial traffic are given in the table below:-

GROUP	DESCRIPTION	EQUIVALENCE FACTOR
3	2 axle/tandem truck	2.0
4	Rigid truck + trailer	6.0
5	Articulated Unit	6.0
6	Bus	1.0

The traffic ADT is 2200. The traffic distribution is as follows:-

50% - Group 3
20% - Group 4
21% - Group 5
9% - Group 6

$\Delta PSI = 2.1$, Reliability (R) = 90%, overal standard deviation (S_o) = 0.35.
Design period = 15 years, traffic growth rate = 3%. The materials and layer coefficients are as given below:-

LAYER/MATERIAL	LAYER COEFFICIENT
Wearing course	
Single surface dressing	0.2
Double surface dressing	0.2
Asphalt concrete	0.35
Base	
Natural gravel	0.12
Crushed gravel	0.13
Subbase	
Natural gravel	0.11

E (psi)

400,000 psi

30,000 psi

36,000 "

11,000 psi

(1psi = 6.9 kpa)

$M_R = 5700$ psi

Q8.(a) Explain how the penetration and ductility tests are carried out in the laboratory. Indicate their significance in highway engineering practice.

(b) What are the differences between penetration grade and cut-back bitumens.

(c) Write brief notes on the following:

(i) Sealing coats
(ii) Tack coats

END OF CE-442

THE UNIVERSITY OF ZAMBIA

DEFERRED/SUPPLEMENTARY EXAMINATION

1996/1998 ACADEMIC YEAR

CE 512 STRUCTURAL DYNAMICS

==========

TIME:Three hours

ANSWER: Three(3)questions from section A and two(2) questions from section B. All questions carry equal marks.

==========

SECTION A

Q1. The radius of cuvature of a bridge at point A is 60m.Determine the velocity with which the pressure exerted on the bridge at point A by an automobile of mass M is equal to zero.(fig.1)

Q2. A rigid body with mass M at the end can pivot about the other end. It is supported by four springs as shown in fig.2. Determine the natural frequency. K and L are given.

Q3. A body of mass M=2000kg supported by a column as shown in fig.3 has a horizontal displacement of 3 cm and a velocity of 30 m/s at t=0. Determine the displacement at t=1 sec. Assume h=4 m, $EI=5\times10^4$ n.m^2

Q4. For the system shown in fig.4 determine the natural frequency. Assume the beam and springs are massless.

SECTION B

Q5, For the system shown in fig.5 determine the natural frequencies and characteristic shapes of both modes. $EI=4\times10^6$ n.m , $M_1=M_2=100$ kg, $K=2\times10^4$n/m, L=3m.

Q6, Demonstrate the validity of the Lagrange Equation by using it to write the equation of motion for the two-degree system shown in fig.6.

Lagrange Equation: $\frac{d}{dt}\left(\frac{\partial K}{\partial \dot{q}_i}\right)-\frac{\partial K}{\partial q_i}+\frac{\partial U}{\partial q_i}-\frac{\partial W_c}{\partial q_i}=\frac{\partial W_e}{\partial q_i}$

Q7, Determine the maximum dynamic values (in terms of p) of midspan bending moment and end shear for the beam of the fig.7 due to a suddenly applied constant pressure of magnitude p n/m. The mass of the beam M=30kg/m, $EI=2\times10^5$ n.m^2, L=12m.

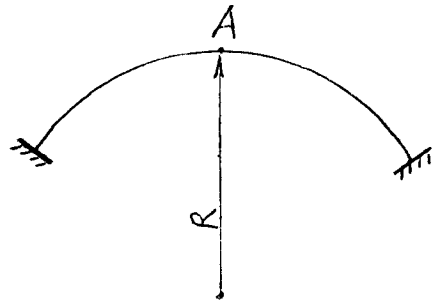


Fig. 1

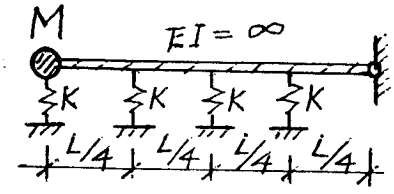


Fig. 2

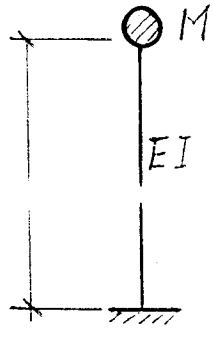


Fig 3

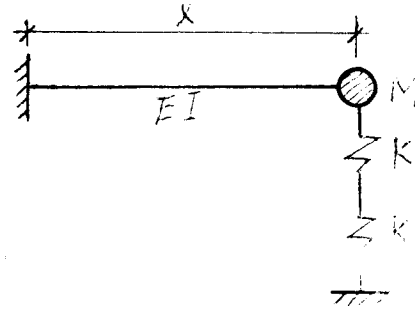


Fig 4

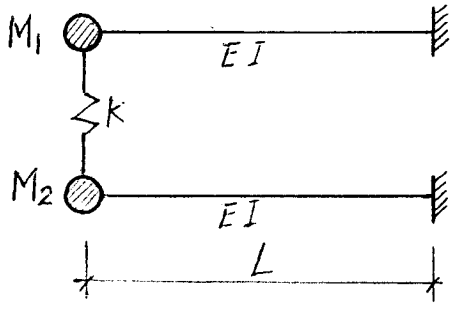


Fig 5

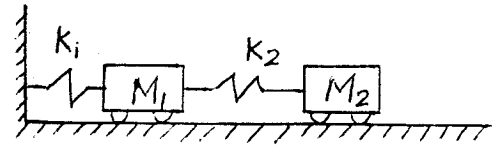


Fig 6

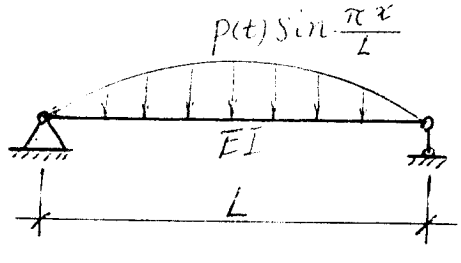


Fig. 7

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SUPPLEMENTARY EXAMINATIONS
2nd SEMESTER 1996/98
CE 532
STRUCTURAL ENGINEERING-STEEL DESIGN

TIME: FOUR HOURS

INSTRUCTIONS TO CANDIDATE

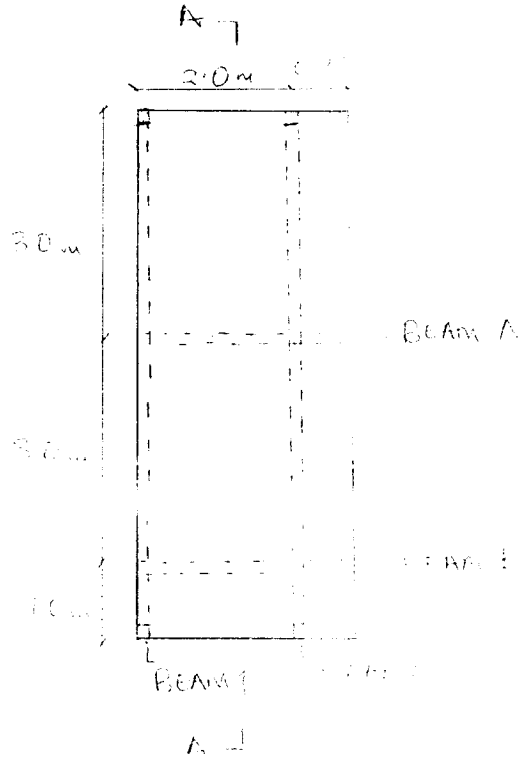
(a) Candidates must ensure that their computer numbers are clearly written on each answer booklet used and that the number of questions answered are entered in the space provided on the front cover of the answer booklet.
(b) Answer ALL questions.
(c) The total mark is 100.
(d) Mathematical gadgets, drawing instruments and reference books are allowed.
OPEN BOOK

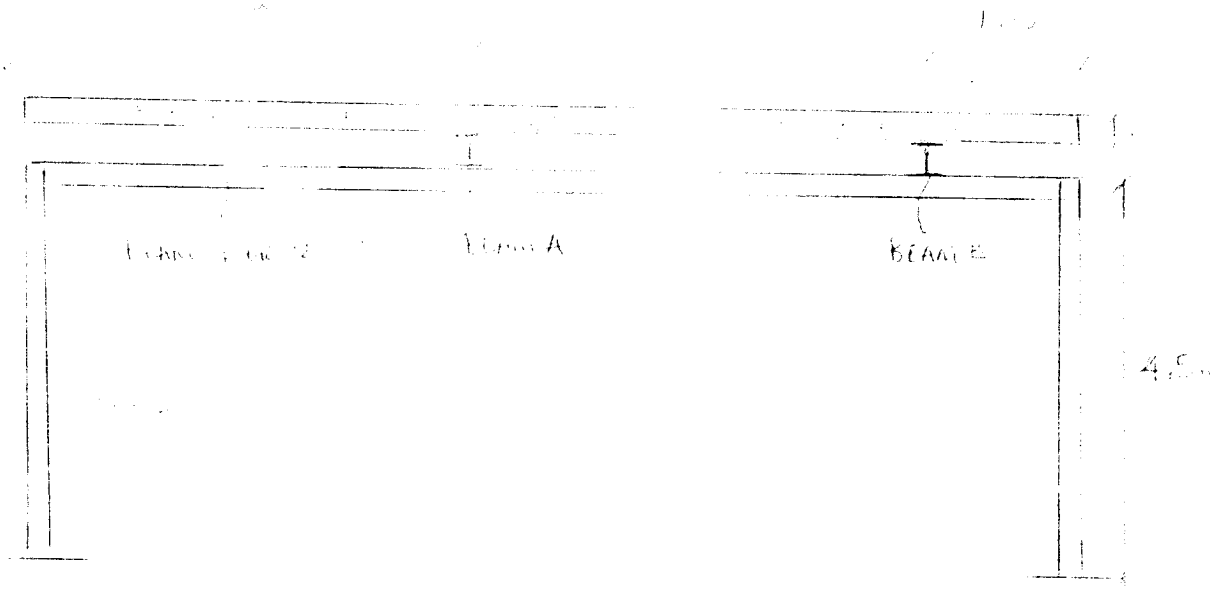
Q1. Study **Figure 1** and answer the following questions taking the following assumptions

i. The structure is to be constructed as simple construction.
ii. The live load on the concrete slab is to be taken as 2.0 kN/m²(unfactored).
iii. All steel used will be of grade 43 only.
iv. The slab offer full restraint to the flanges on which the rest while the beams carrying point loads are restrained at the support and at the points of load application.
v. The structure will rest on concrete plinths of concrete grade C20.
vi. The effect of sway will be ignored.

(a) Provide **one type (size) of section** for the Beam 1 and Beam 2 checking that they can support their loads and deflection is acceptable.(20)
(b) Design for the columns providing one type (size) of section for all the four columns.(20)
(c) Provide a suitable base plate for the columns.(10)
(d) Design for a connection to be used between the columns and the beams.(20)

Q2. A point load of **7 000 kN** (factored) is to be supported by a beam of two metres clear span and rests on supports that are 450 mm wide each. The beam **can not** extend over the supports and its maximum height allowed is **600 mm**. If this beam is fully restrained over the entire length, design for this beam member and try to make the member **economical**. (30)


A
3.0m
BEAM A
BEAM B
A


BEAM A
BEAM B
4.5m

UNIVERSITY OF ZAMBIA, LUSAKA

SCHOOL OF ENGINEERING

CE 582 - Construction Techniques + Management
1996/1998 Examination, 7th September 1998

Time: Three Hours

Answer any five of the questions. All questions carry equal marks.
In order to attract maximum points the calculative answers should show the sample of methodology adopted.

---

1. i) For projects of Civil Engineering Works state the major parties involved and their roles. (10)

ii) Mention two minor parties to projects of Civil Engineering works and show their interrelationship with the major parties. (4)

iii) Discuss the stages in a project cycle from identification to commissioning the works. (6

2. i) Mention the two main tendering methods and give their advantages and disadvantages. (8)

ii) In choosing a contractor what should be examined:

a) from past experience? (3)
b) From the submitted tender? (3)

iii) Describe the term fixed sum contract and give its advantages and disadvantages. (6)

3. i) What are the advantages and uses of project planning in construction? (4)

ii) List the basic steps involved when producing a construction Programme (6)

iii) Explain the difference between construction stages and construction operations and give two examples for each. (6)

iv) What information would you need to determine the duration for implementing an activity? Give an example. (4)

4. As a Project Manager you are programming a project and you have determined the activities, the workload for the activities, the manpower inputs for each activity and the sequence as shown below.

Based on a 45 hour week and using the precedence network analysis (PNA) determine:

i) The activity durations in weeks

ii) the total project duration in weeks

iii) the critical path

iv) the effect on the project plan if the manpower for activity B was halved

Activity	Work load (Man/hours)	Assigned gang (men)	Dependant only on completion of activity
A	540	2	-
B	1080	4	D
C	675	3	A
D	90	2	A
E	645	3	C
F	450	2	B and E
G	270	2	F and I
H	270	3	D
I	180	2	A

Note:: G and H are the concluding Activities.

5. i) Outline the important factors to be considered in selecting construction equipment.

ii) Why it necessary to use construction equipment?

iii) Your company has a policy of working out the book value of equipment. It is decided to purchase a power excavator costing K200 million to work an average of 2000 hours per year. The life of the machine is expected to be 10 years after which the salvage value would be K16 million.

Assuming negligible inflation and devaluation of the kwacha work out the book value for the machine for the ten years using the declining balance depreciation-method.

6. i) List five items project costs can be divided into. Mention which one should be controlled in order to have the greatest impact on the overall reduction of the project cost and discuss one technique used in controlling the cost of the item.

ii) What is the objective of value engineering?

iii) Name and explain two stages at which value engineering may be applied in a civil engineering project.

7. i) List four types of accidents that may be experienced on a construction project and state the four possible consequences of such accidents.

ii) State the differences between risk transfer and risk retention.

iii) What are benefits of insuring projects?

iv) Discuss six types of insurances for a civil engineering construction project.

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

TIME : 3HOURS **DATE : 11th SEPTEMBER 1998**

ANSWER ANY FIVE QUESTIONS.

ALL QUESTIONS HAVE TWENTY POINTS EACH

(ALL FIGURES ARE ON PAGE 2)

1. Use nodal analysis to determine the voltage across the 5Ω resistance and the current in the l source in fig 1.

2. Sketch the waveforms for the average current and power if the voltage across a 6μF capacitor is a shown in fig 2.

3. (a) Draw an equivalent circuit of a practical (non-ideal) transformer.
   (b) Name two transformer losses and their causes.
   (c) A 1:10 step-up transformer is used to match a 500Ω line to a circuit. Find the impedance of circuit.

4. (a) Draw a low-pass filter and a high pass filter circuits.
   (b) In the parallel LC circuit of fig 4. Find the resonant frequency, the impedance(Z_T) of the ci and the quality factor Q

5. For the network of fig 5.
   (a) Find the mathematical expression for the transient behaviour of the voltage V_c following the closing of the Switch.
   (b) What will be the voltage across the capacitor after 4ms of closing the Switch?

6. (a) Sketch and label the voltage-current characteristics curve of a non-ideal rectifier diode.
   (b) Write short notes on any 3 of the special diodes listed below.
      (i) LED
      (ii) Photo diode
      (iii) Schottky diode
      (iv) Laser diode
      (v) Tunnel

7. (a) Name and explain three types of multiplexing in electronic communication.
   (b) What does PCM stand for in electronic communication? Briefly describe how PCM is achieve in communication system.

8. (a) What is a Transducer?
   (b) Mention areas in which each of the following Transducers could suitably be used.
      (i) Tachometer
      (ii) Resistance strain-gauge
      (iii) Hot-anemometers
      (iv) Capacitor microphone
      (v) Thermocouple
   (c) Draw a block diagram of a feedback control system indicating the five elements common to a feedback control systems.

END OF QUESTIONS

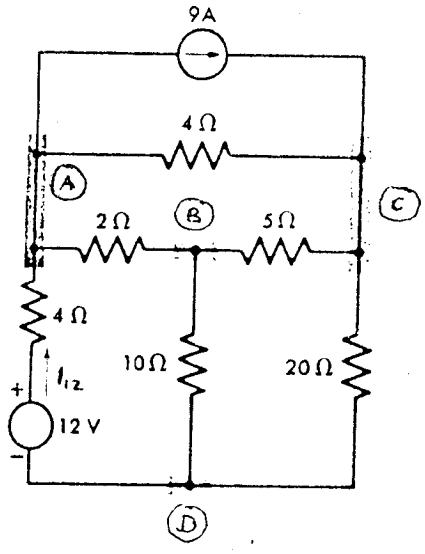


FIG 1

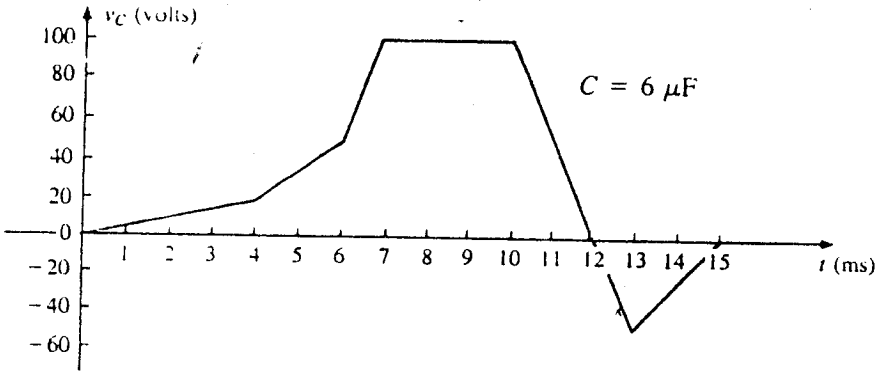


FIG 2

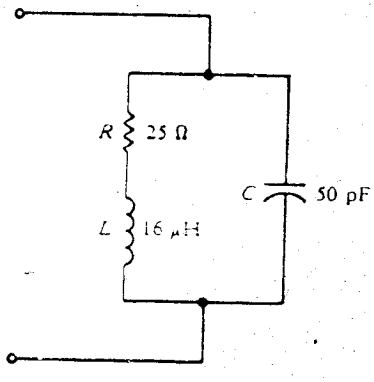


FIG 4

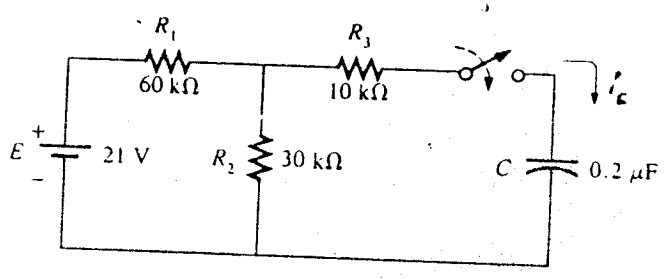


FIG 5

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
AGRICULTURAL ENGINEERING DEPARTMENT

EA 402 ENERGY SOURCES AND UTILISATION IN AGRICULTURE II

SEMESTER II FINAL EXAMINATION **August, 1998.**

INSTRUCTIONS
Answer any five questions
Time allowed: 3 hours

Question 1

a) Write short notes on Beam and Diffuse radiation. (3 points)

b) What are the reasons for the variation in the solar radiation between that reaching the earth and that received at the outside of the atmosphere? (3 points)

c) (I) *Calculate* the angle made by the beam radiation with the normal to the flat plate collector, pointing due south located at 28° 38' N, 77° 17' E at 9:00 hours solar time on December 1. The collector is tilted at an angle of 36° with horizontal. (8 points)

(ii) *Calculate* the sunset hour angle and day length at the same location and day. (6 points)

Given that the relationship between the incidence angle θ and the other angle is as given in equation (1),

$$\cos\theta = \sin\phi(\sin\delta\cos\beta + \cos\delta\cos\gamma\cos\omega\sin\beta) + \cos\phi(\cos\delta\cos\omega\cos\beta - \sin\delta\cos\gamma\sin\beta) + \cos\delta\sin\gamma\sin\omega\sin\beta \quad (1)$$

Where ϕ = Latitude angle
δ = Declination angle
ω = Hour angle
γ = Surface azimuth angle
β = Slope angle

Question 2

a) What is meant by wet fermentation and dry fermentation? (3 points)

b) What are the factors that must be considered while selecting the site for a biogas plant? (7 points)

C) The following data are given for a family biogas digester suitable for the output of five cows:

the retention time is 20 days,
temperature 30 C,
dry matter consumed per day = 2 kg

The biogas yield is 0.24 m^3 per kg,
The efficiency of burner is 60% ,
Methane proportion is 0.8, and
Heat of combustion of methane = 28 MJ/m^3.

Calculate: (I) the volume of the biogas digester, (5 points)
(ii) the power available from the digester. (5 points)

Question 3

a) Describe the main considerations in selecting a site for wind generators (8 points)

b) Wind at standard atmospheric pressure and 15 C temperature has velocity of 10 m/s. The turbine has diameter of 120 m and its operating speed is 40 rpm at maximum efficiency.

Calculate:

(I) the total power density in the wind stream,
(ii) the maximum obtainable power density assuming $\eta = 40\%$,
(iii) the total power produced (in kW) and
(iv) the torque and axial thrust. (Total 12 points, 3 points each)

Question 4

a) Discuss the relative merits and demerits of hydro-power as compared to other sources. (8 points)

b) The 95 percent dependable discharge of a river is 20 m^3/s. If the utilisable head is 25 m,

Calculate:

(I) The theoretical kW of power from the flow for 95 per cent of time ($P_{p\,95}$)
(ii) The approximate actual amount of power output.
(iii) Total yearly developable energy.
(iv) The actual capacity that may be installed to utilize all the average flow and the corresponding energy. (Total 12 points, 3 points each)

Question 5

Prove that in the case of horizontal axis wind turbine, maximum power can be obtained when:

Exit velocity = ⅓ wind velocity and

$$P_{max} = 8/27\ \rho A V^3 \qquad \text{(20 points)}$$

Question 6

a) With the help of two simple sketches describe what is meant by renewable and non renewable energy. (5 points)

b) What are the five ultimate sources of useful energy? Indicate which of these are renewable and nonrenewable. (5 points)

c) What are the advantages and obstacles to the implementation of renewable energy systems? (10 points)

THE UNIVERSITY OF ZAMBIA1

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

COURSE: EA 421- FUNDAMENTALS OF FARM STRUCTURES

FINAL EXAMINATION

TIME: 3 Hours DATE:.....

INSTRUCTIONS

Attempt Question 1 and any other three questions.

Q1. a) An extension officer is about to retire. Her plot is located in the waterlogged area. As an expert in farm structures advice the extension officer how to cast the floor slab given the following:

- nominal mix: 1:2:4,
- size of the slab is: 22.4m x 18.2m x 150mm,
- natural aggregates are to be used to which 0.05m³ of water is to be added,

(10 marks)

b) determine the water- cement ratio,

(10 marks)

c) the aggregate- cement ratio and the volume of the mix if 2 bags of cement are used.

Additional Data:

- moisture content of sand: 3.5%
- moisture content of stone: 1.7%
- Bulk density of the sand:1400kg/ m³
- Bulk density of the stone: 1600kg/m³
- Solid density of aggregate materials: 2650kg/m³
- solid density of cement: 3100kg/m³

(10 marks)

d) What factors affect the quality of concrete?

(5 marks)

Q2. a) What precautions should one observe when siting a pit latrine?

(5 marks)

b) With the aid of a simple sketch, discuss the operation of a pit latrine.

(5 marks)

c) Distinguish a ventilated pit latrine from a conventional pit latrine.

(5 marks)

d) Given the following information:

- sludge accumulation rate per year: 0.03m³ per head,

- filling period: 36 months
- household size: 6 persons.

Find the most optimum dimensions of the pit of this latrine given that the water table is located at 3.5m

(10 marks)

Q.3. You have been given a 5-sow herd pig unit to manage. An 8- weeks weaning period is practised,

a) determine the number of the farrowing pens required in this situation,

(10 marks)

b) establish the number of places required in the growing/finishing pen if the one stage finishing is to be practised,

(5 marks)

c) in pig housing, what objectives should one achieve to ensure that the housing is economically utilised?

(5 marks)

Q4. a) Distinguish blocks from bricks.

(5 marks)

b) What are the significance of bonding in brickwork, give some examples of the different types of bonding.

(5 marks)

c) Mortar maybe used for two major functions in building constructions, list down these and state the criterion which the mortar should fulfil to achieve its objectives.

(10 marks)

Q5. Tobacco is harvested with very high moisture content. This is put in the barn where the drying process takes place using blower heaters.

Suppose the initial air temperature is 17°c at 60% relative humidity and after the drying process the RH of air rises to 90% at the same enthalpy levels. Using the psychrometric chart:

a) what would be the temperature of air going out?

(5 marks)

b) how much of the moisture would have been removed in the process,

(5 marks)

c) illustrate sensible heating and sensible cooling using a well labelled graph, give examples where this is applied.

(10 marks)

Q6. a) Discuss the factors influencing the design of the crop storage structures.

(5 marks)

b) What merits and demerits does the bulk storage offer in comparison to bag storage.

(5 marks)

c) What features makes an improved storage bin superior to

the traditional one, give some typical examples.

(10 marks)

d) Discuss the properties of the semi perishable and perishable crops.

(5 marks)

Carrier

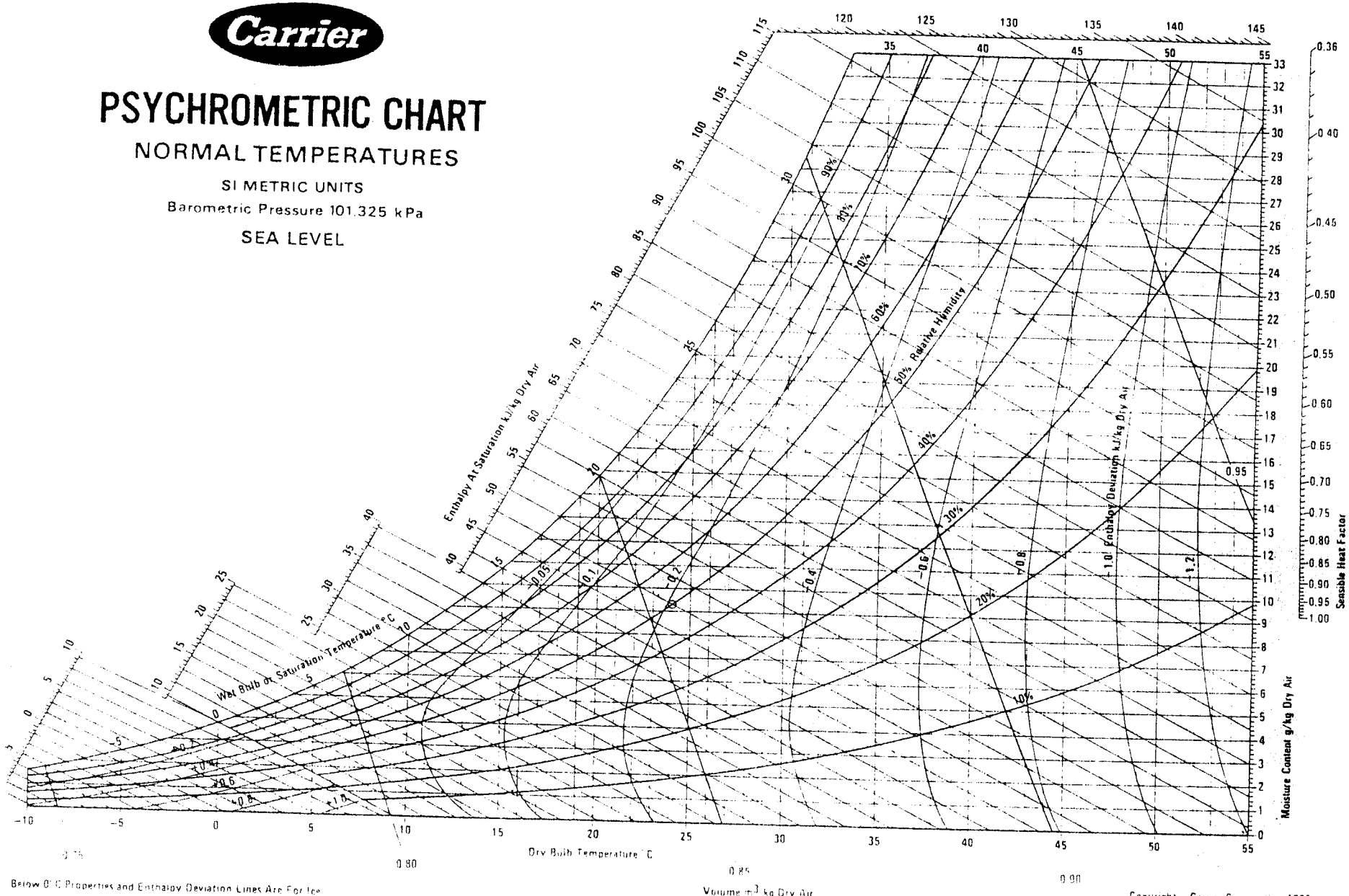
PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101.325 kPa

SEA LEVEL



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Rev. 6-81

EXAMINATION - II SEMESTER, SEPTEMBER 1998.

EE309 : PRINCIPLES OF ELECTRICITY II

Time: **three** hours
Answer: any **four** questions.
each question carries **25 marks** .

Question 1 .

(i) If **E** is zero throughout a region , must be the potential V also be zero throughout the region ? Why or why not ? If the potential V is zero throughout a region , must **E** also be zero throughout the region ? Why or why not ? *(8 marks)*

(ii) Suppose that a battery charger supplies a 2 A constant current to a car battery for 3 h. With a voltmeter , we measure the battery voltage to rise with the time according to the formula (10 + t/2) V, where t is in hours. Thus every 2 h it gains a full extra volt .

a) Find how much charge was delivered to the battery in 3 hours. *(4 marks)*
b) What is the terminal voltage of the battery after this time ? *(5 marks)*
c) How much energy was added to the auto storage during this 3 h of charging *(5 marks)*
d) How much money did it cost to charge the battery for these 3 h , neglecting losses in the battery charger and assuming that home electricity costs 1000 Kwacha /kWh? *(3 marks)*

Question 2

(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 $I_1 = I_2$ and then for I_1 diferent to I_2. *(12 marks)*

(ii) Explain how the energy losses in a sample of ferromagnetic material subjected to an alternating magnetic field depend on the frequency and the flux density . What particular property of the material can be used as a measure of the magnitude of each type of loss.? *(5 marks)*

The area of a hysteresis loop plotted for a sample of a steel is 67.1 cm^2, the maximun flux density being 1. 06 T. The scales of B and H are such that 1 cm = 0.12 T and 1cm = 7.07 A/m. Find the loss due to hysteresis if 750 g of this steel were subjected to an alternating magnetic field of maximum density 1.06 T at frequency of 60 Hz . The density of the steel is 7700 kg/m^3. *(8 marks)*

Question 3.

(i) A single phase transformer has 480 turns on the primary and 90 turns on the secondary . The mean length of the flux path in the core is 1.8 m and the joints are equivalent to an air gap of 1 mm. If the 2200 V at 50 Hz is applied to the primary , calculate: the cross sectional area of the core; the secondary voltage on no load; the primary current and the power factor on no load ; Assume that the value of the magnetic field strength for 1.1 T in the core to be 400 A/m , the corresponding core loss to be 1.7 W/kg at 50 Hz and the density of the core to be 7800kg/m^3. *(12 marks)*

(ii) With the secondary of a 7.92 kV / 240 V transformer shorted circuited, we measure $V_{sc} = 600$ V, Isc = 3 A , and the average power $P_{sc} = 300$ W . With a finite load $Z_{load} = 1\Omega + j\,0.5\Omega$ connected ,

a) Find the net impedance seen by the source ; *(6 marks)*

b) Determine the power factor seen by the source , and ; *(4 marks)*

c) Compare the values with those we would obtain when we neglect leakage. *(3 marks)*

Question 4.

(i) The linear generator shown in Fig.4 - a is used to measure the magnetic density and power load a R_{load} .

a) If the conducting bar is moving at a speed of 10 cm/s and the measured voltage is 10 mV, what is the magnetic flux density ? What is the flux passing through the generator at the time shown? What is the magnetic force opposing our movement of the bar ? *(6 marks)*

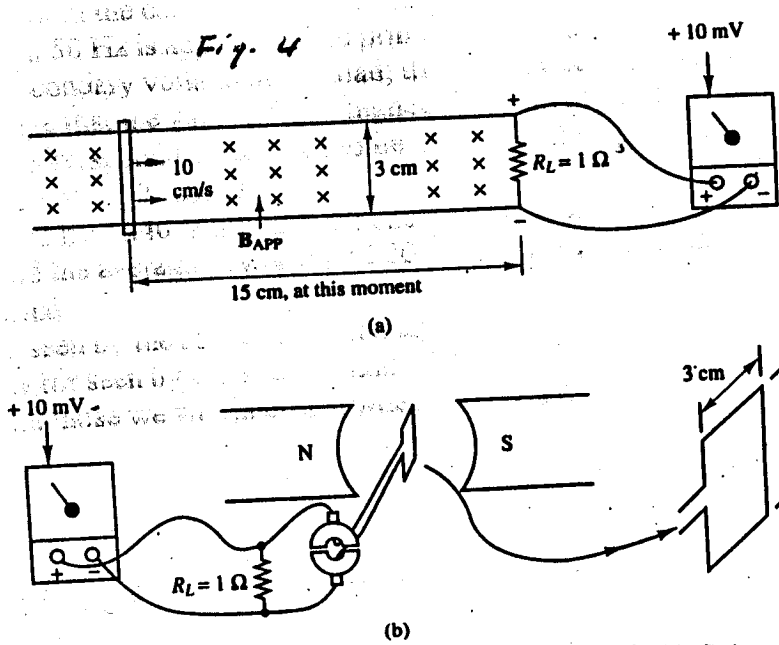
b) Now suppose that we use a single - loop rotating generator as shown in Fig.4 – b. If the flux is equal to that calculated in part a), how many revolutions per minute must the rotor be cranked to measure 10 mV(as average voltage) ? What is the average developed torque? *(7 marks)*

(ii). A shunt wounded motor has a field resistance of 350Ωand an armature resistance of 0.2 Ωand runs off a 250 V supply . The armature current 55 A and the motor speed is 1000 r/min. Assuming a straight line magnetization curve , calculate :

a) The additional resistance required in the field circuit to increase the speed to 1100r/min for the same armature current; *(6 marks)*

b) the speed with the original field current and an armature current of 100 A. *(6 marks)*

Fig. 4

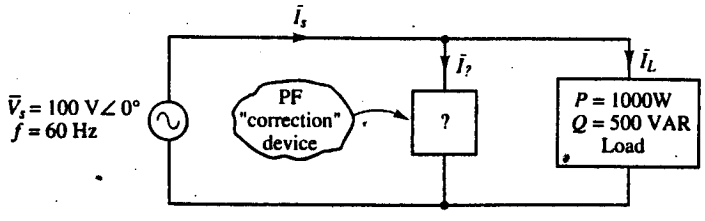


Question 5.

(i) In the circuit in fig. 5 , in which Vs is an effective voltage phasor :

a) Find the apparent power drawn by the load ;
b)Find tha power factor of the load , and whether it is leading or lagging;
c)Find the type of device (inductor or capacitor in the box with the a question mark in it) and its numerical value that should be placed in parallel with the load to change the power factor seen by Vs to 0.95 leading.

Fig. 5.



(ii) For a balanced wye – connection load in int two wattmeter method , show that $W_1 = V_{line} I_{line} \cos(\varphi + 30^0)$ and $W2 = V_{line} I_{line} \cos(\varphi - 30^0)$, where φ is the impedence angle of the load.

(iii) If $W_1 = 219$ kW and $W_2 = 185$kW , find the power factor

Question 6.

(i) Use only NAND gates to implement the the following logic function :

$$F = A + C + BD + \bar{B}\bar{D}$$

(ii) Employ only NOR gates to implement the following logic functions :

$$F = (\bar{A} + \bar{B} + \bar{C})(A + B + C)$$

(iv) Give the truth table in the table 1 :

a) Find a logic for F;
b) Simplify your expression using a Karnaugh map;
c) Draw a logic circuit that implements the simplified expression for F.

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

SUPPLEMENTARY EXAMINATION -october 1998
EE 309 PRINCIPLES OF ELECTRICITY II

Time: **three** hours
Answer: any **four**_ questions.
each question carries **25 marks** .

Question 1 .

(i)Obtain from the first principles an expression for the capacitance of a single-dielectric , parallel- plate capacitor in terms of the plate area, the distance between plates and the permittivity of the dielectric. *(5 marks)*

A sheet of mica ,1mm thick and of relative permittivity 6, is is interposed between two parallel brass plates 3 mm apart . The remainder of the space between the plates is occupied by air . Calculate the area of each plate if the capacitance between them is 0.001μF. Assuming that air can withstand a potential gradient of 3MV/m, show that a p.d. of 5 kV between the plates will not cause a flashover. *(8 marks).*

(ii)A variable capacitor having a capacitance of 800 pF is charged to a p.d. of 100 V The plates of the capacitor are then separated until the capacitance is reduced to 200 pF. What is the change of p.d. across the capacitor ? Also, what is the energy stored in the capacitor when its capacitance is : (a) 800 pF; (b) 200 pF? How has the increase of energy been supplied. *(12 marks)*

Question 2

(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 is equal to zero for $I_1 = I_2$ and then for I_1 diferent to I_2 ? *(10 marks)*

(ii) a) The flux density in air at a point 40 mm from the center of a long straight conductor A is 0.03 T. Assuming that the return conductor is a considerable away , calculate the current in A. *(7 marks)*

b) In a certain magnetic circuit , having a length of 500 mm and a cross-sectional area of 300 mm^2, an m.m.f.of 200A produces a flux of 400 μWb. Calculate the reluctance of the magnetic circuit and the relative permeability of the core. *(8 marks)*

Question 3.

(i) The parameters of the equivalent circuit of a 150 kVA , 2400 V/240 VA transformer , shown in Fig.3 are $R_1 = 0.2\ \Omega$, $R_2 = 2\ m\Omega$, $X_1 = 0.45\ \Omega$, $X_2 = 4.5\ m\Omega$, $X2 = 4.5\ m\Omega$, $R_c = 10\ k\Omega$, and $Xm = 1.55k\Omega$. Using the circuit referred to the primary , determine the

a) The voltage regulation *(6 marks)*

b) the efficiency of the transformer operating at rated load with a p.f.of 0.8 lagging *(6 marks)*

The turns ratio being $a = N_1/N_2$.

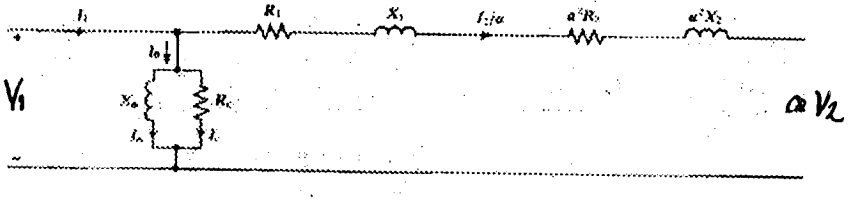


Figure3:Transformer Equivalent Circuit.

(ii) With the secondary of a 7.92 kV / 240 V transformer shorted circuited, we measure $V_{sc} = 600$ V, Isc = 3 A , and the average power $P_{sc} = 300$ W . With a finite load

$Z_{load} = 1\Omega + j\ 0.5\Omega$ connected ,

a) Find the net impedance seen by the source ; *(5 marks)*

b) Determine the power factor seen by the source , and ; *(5 marks)*

c) Compare the values with those we would obtain when we neglect leakage.*(3 marks)*

Question 4.

(i) Give three practical applications of the mechanical force exerted on a current-carrying conductor in magnetic field. *(3 marks)*
A conductor of active length 30 cm carries a current of 100 A and lies at right-angles to magnetic field of density 0.4T. Calculate the force in newtons exterted on it. *(2 marks)*
If the force causes the conductor to move at a velocity of 10 m/s, calculate : the e.m.f. induced in ; and the power in watts developed *(5 marks)*.

(ii) A six- pole motor has a magnetic flux of 0.08 Wb per pole and the armature is rotating at 700 r/min. Calculate the average e.m.f. generated per conductor *(5 marks)*.

(iii) A four pole armature is to generate an average e.m.f.of 1.4 V per conductor, the flux per pole being 15 mWb. Calculate the speed at which the armature must rotate*(5 marks)*

Question 5.

(i) Explain the three advantages of the three phase supply distribution purposes *(3 marks)*
Three similar inductors , each of resistance 10Ω and inductance 0.019 H,
are delta-connected to three phase ,415V-50 Hz sinusoidal supply. Calculate the line current ; the power factor ; and the active power input to the circuit *(11 marks)*

(ii) Discuss the importance of the power factor in a .c. systems*(3 marks)*
A three -phase distribution system of 415V-50 Hz supplies a 20 kVA , three induction motor load at a power factor of 0.8 lagging, and a star connected set of impedances , each of resistance 10Ω and inductive reactance of 8Ω. Calculate the capacitance of delta-connected capacitors required to improve the overall power factor to o.95 lagging.*(8 marks)*

Question 6.

(i) Simplify the following logic functions and hence draw diagrams of circuits which will generate the functions using (a) AND, OR and NOT gates ; (b) NAND gates ; (c) NOR gates *(13 marks)*.

$F = A\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}BC$

$F = B\bar{C}\bar{D} + A\bar{B}D + BC\bar{D} + \bar{A}\bar{B}D$

(ii) Given the truth table in the table 1 *(12 marks)* :

a) Find a logic for F;

b) Simplify your expression using a Karnaugh map;

c) Draw a logic circuit that implements the simplified expression for F.

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

UNIVERSITY EXAMINATIONS MAY 1999

EE 311 ELECTRIC CIRCUITS

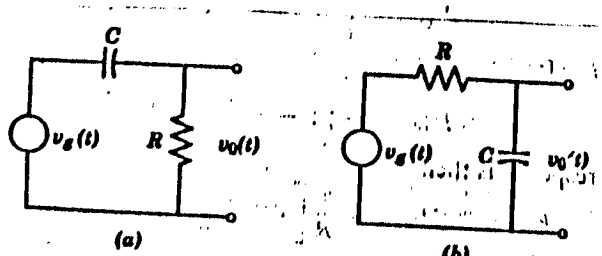
Time: Three hours

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.

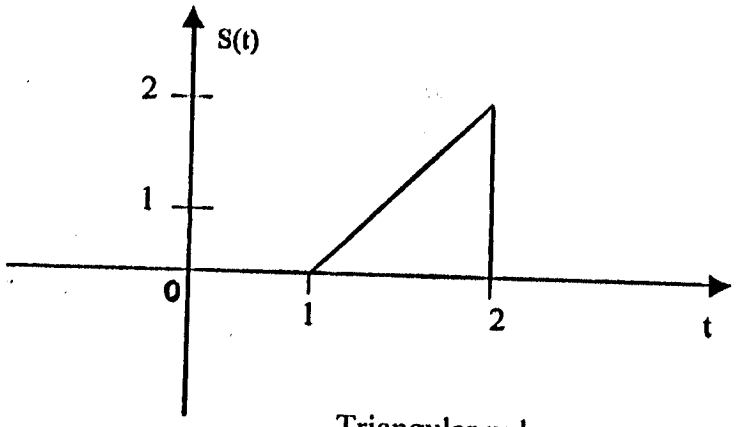
Q2. (a) Sketch neatly the function defined by the expression

$$f(t) = 2u(t) - u(t-1) - u(t-2) + (3-t)\left(u(t-2) - u(t-3)\right)$$

(b) Find the first derivative of the function $f(t)$

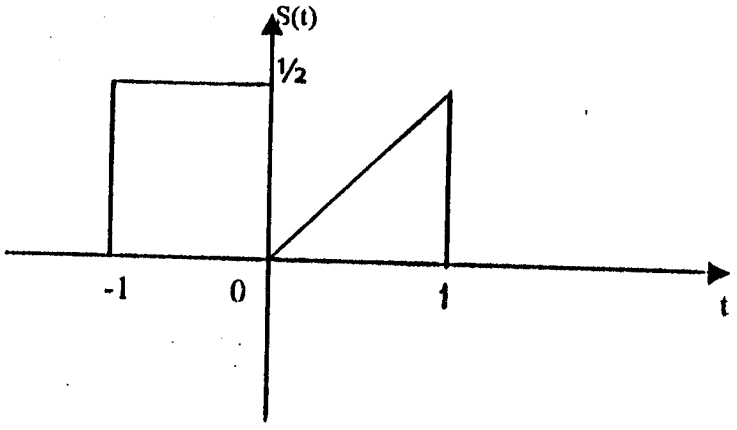
i.e. $f'(t)$

(c) Express the triangular wave below in terms of unit step function.



Triangular pulse

(d) Resolve the waveform in the figure into odd and even components



Q3. Solve the following equation

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

using step and impulse response method

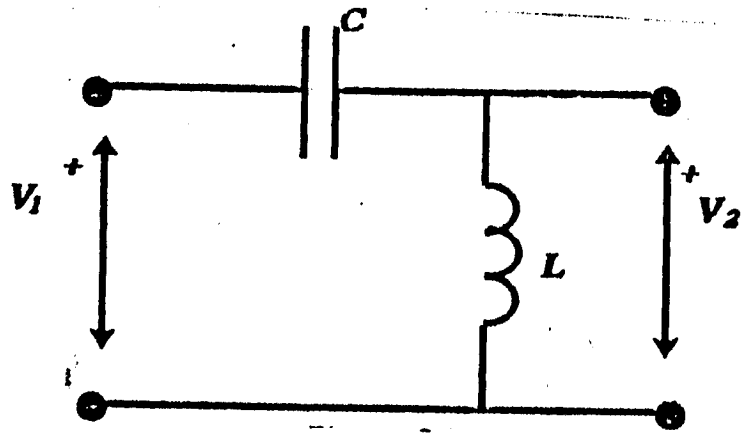
(c) find the impulse response for the equation

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

the initial conditions at t = 0- are

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

Q4. Consider the network in figure

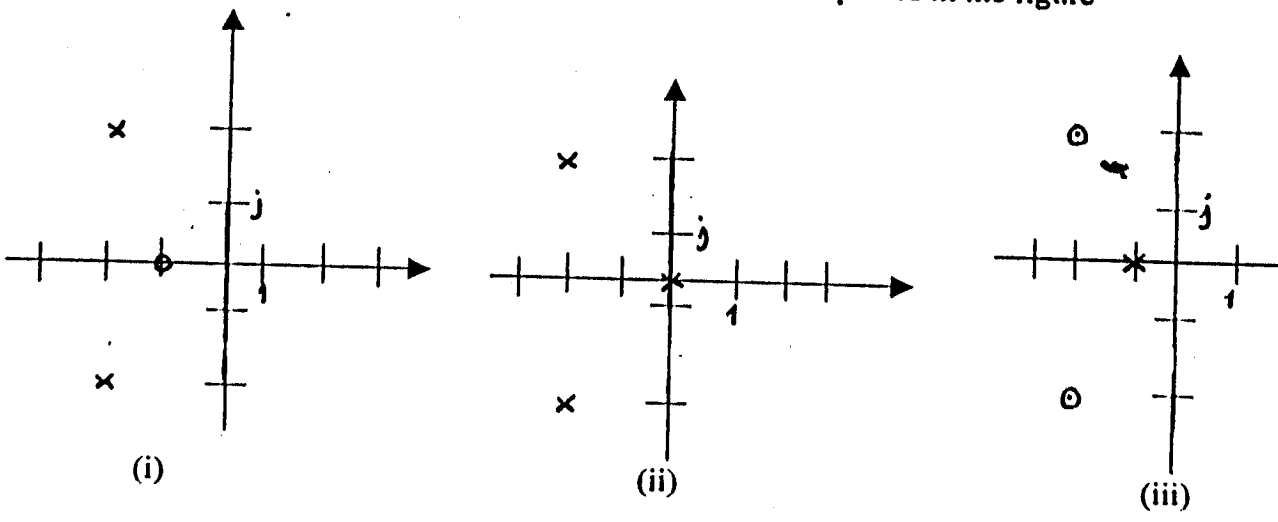


(*a*) Find the transfer function $H(s) = \frac{V_2(s)}{V_1(s)}$

(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



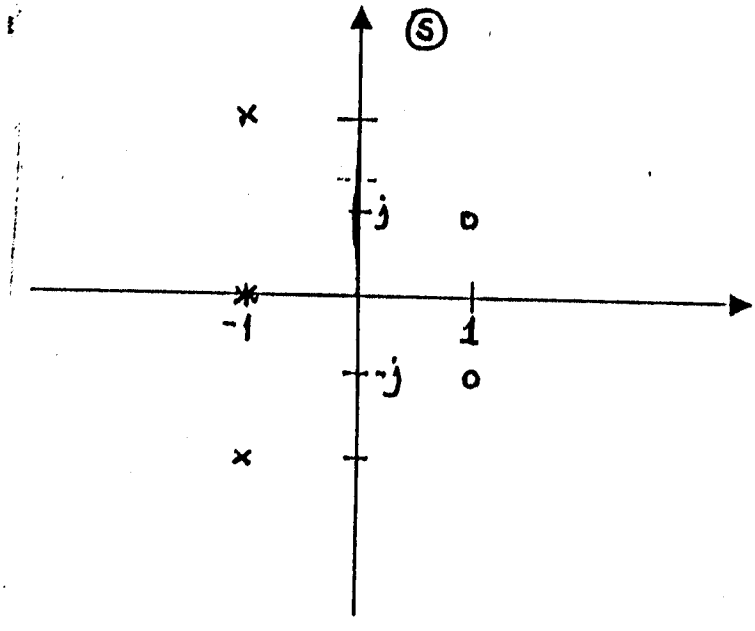
(a) Find the transfer function H(i), H(ii) and H(iii)

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

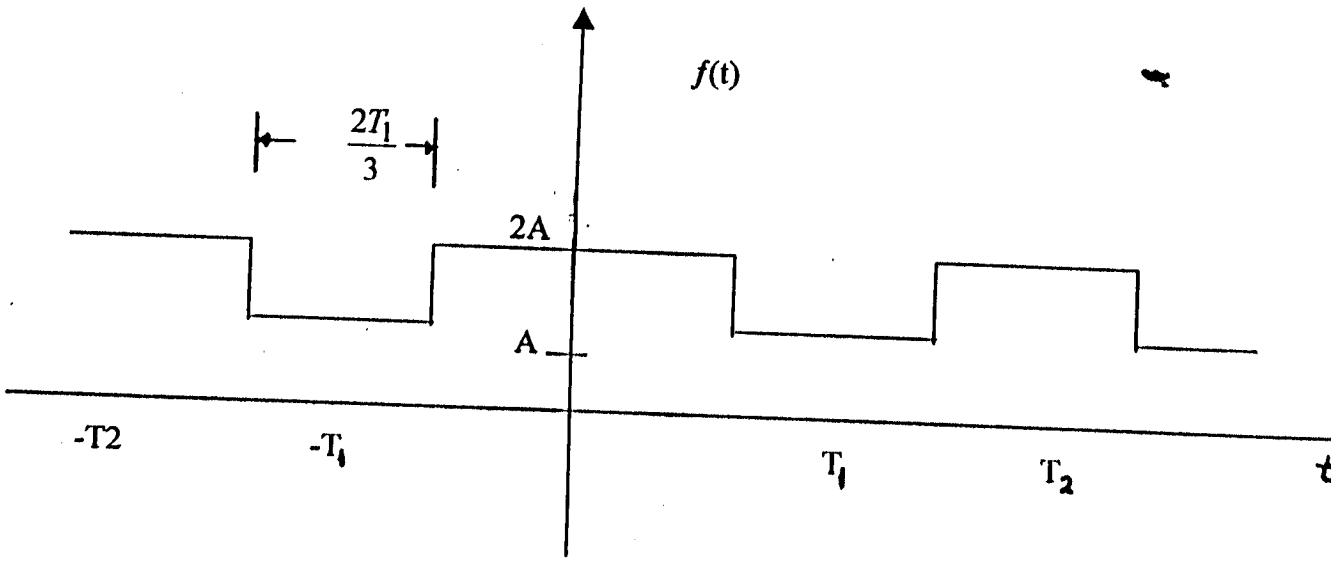
(c) Which transfer function (i) (ii) or (iii) perform integration.

(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)	$\Gamma(k+1)$

Q3(a)
Given initial Conditions

$x(0-) = -2$

$x'(0-) = -1$

$x''(0-) = 7$

THE UNIVERSITY OF ZAMBIA
School of Engineering

Final Examinations - September, 1998

EE 342 - Electronic Engineering I

TIME: **THREE Hours**
Answer: **FIVE Questions**

Boltzman's constant: $k = 1.38 \times 10^{-23}$ J/K
Electronic charge: $q = 1.6.\ 10^{-19}$C
Ambient Temperature: $T = 300$K

Q1 (a) Explain what is meant by the terms semiconductor devices, energy band model, conduction and valence bands, band gap energy, covalent bond, n-type and p-type semiconductors, intrinsic and extrinsic semiconductors.

(b) Describe how a PN junction is formed and electrons and holes diffusions across a PN junction.

(c) Explain what is understood by the terms donor and acceptor impurities, potential barrier, minority carrier injection, dynamic resistance of a PN junction, reverse and forward biasing a PN junction.

Q2 (a) State Ebers - Moll equations for a n-p-n bipolar junction transistor (BJT) and develop equations for emitter current IE, and collector current. IC as functions of base emitter junction voltage VBE and base collector junction voltage V_{BC}. Also express base emitter junction voltage VBE and base collector junction voltage V_{BC} as functions of emitter current I_E and susturation current I_{EO} and collector current I_C and suturation current I_{CO}.

(b) Explain in detail with the help of relevant Ebers - Moll equations operations of a bipolar junction transistor in three regions namely, cut-off, suturation and active regions.

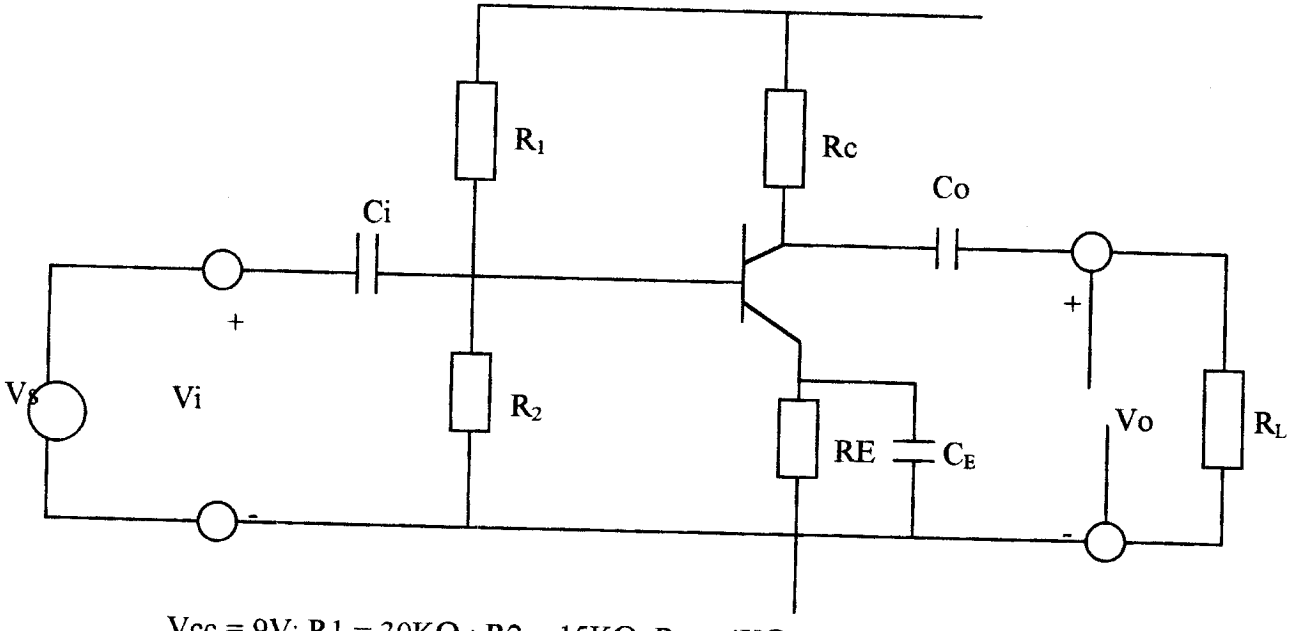
(c) Show, with the help of mathematical expressions, the relationship between h and hybrid - π parameters for a common - emitter transistor configuration.

Q3 (a) Draw a circuit diagramme for the hybrid - π model useful for all frequencies.

(b) Establish the relationship between h and hybrid - π parameters by using the low frequency hybrid - π circuit together with two current sources and choosing the emitter as a reference point.

(c) Derive an expression for current gain β (w) as a function of frequency for the hybrid - π model with two admittances which decide the high frequency behaviour of the bipolar junction transistors (BJT)

Q4 (a) Calculate collector emitter voltage Vce, base current I_B, collector current IC and the DC - loadline for the common - emitter CE amplifier circuit shown below.

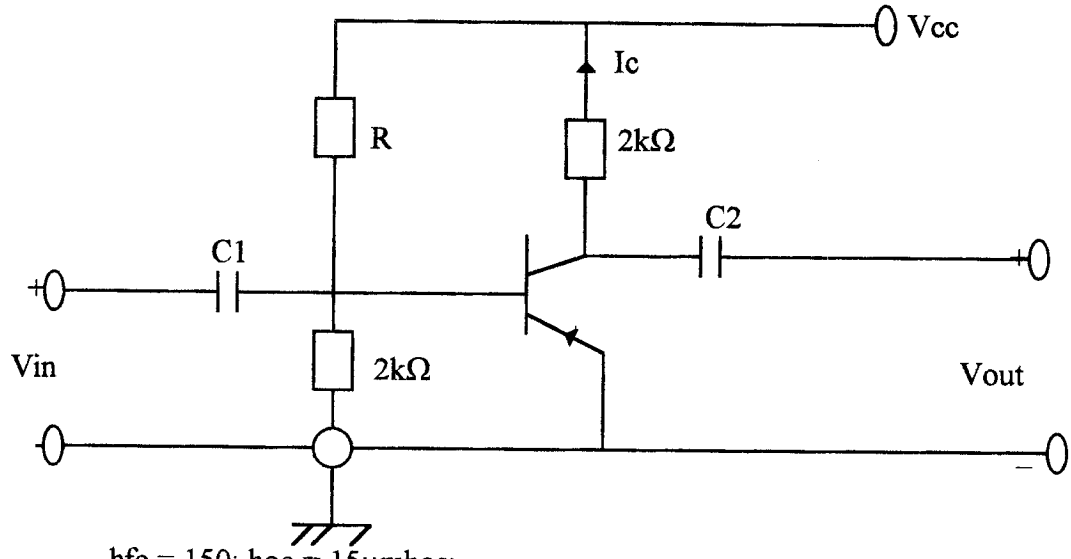


Vcc = 9V; R1 = 30KΩ ; R2 = 15KΩ; R_C = 4KΩ;

RE = 2KΩ; R_L = 1KΩ; C_i = 1μF; Co = 1μF;

CE = 50μF; β = 50; V_{BE} ≃ 0.72 V.

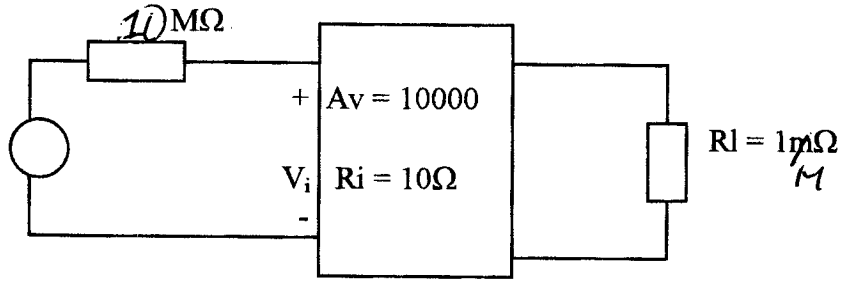
(b) For the circuit shown below, find the supply voltage Vcc, the biasing resistance R, and the voltage gain. Note that capacitors C_1 and C_2 are alternating current (ac) short circuit



hfe = 150; hoe = 15μmhos;
hie = 4.5KΩ; hre - 1.75 x 10^{-4};
Ic = 1mA; V_{BE} = -0.6V;
V_{CE} = -10V; transistor is pnp.

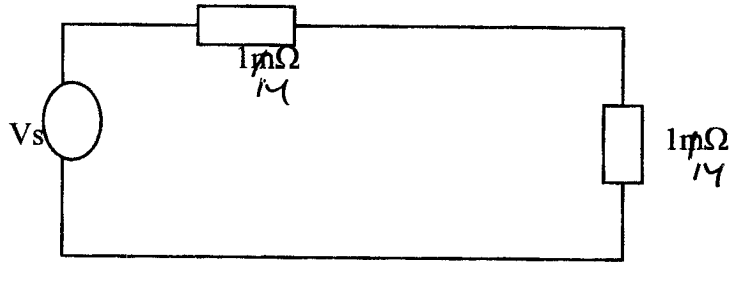
(c) Calculate the power gain for two circuits shown below.

(i)

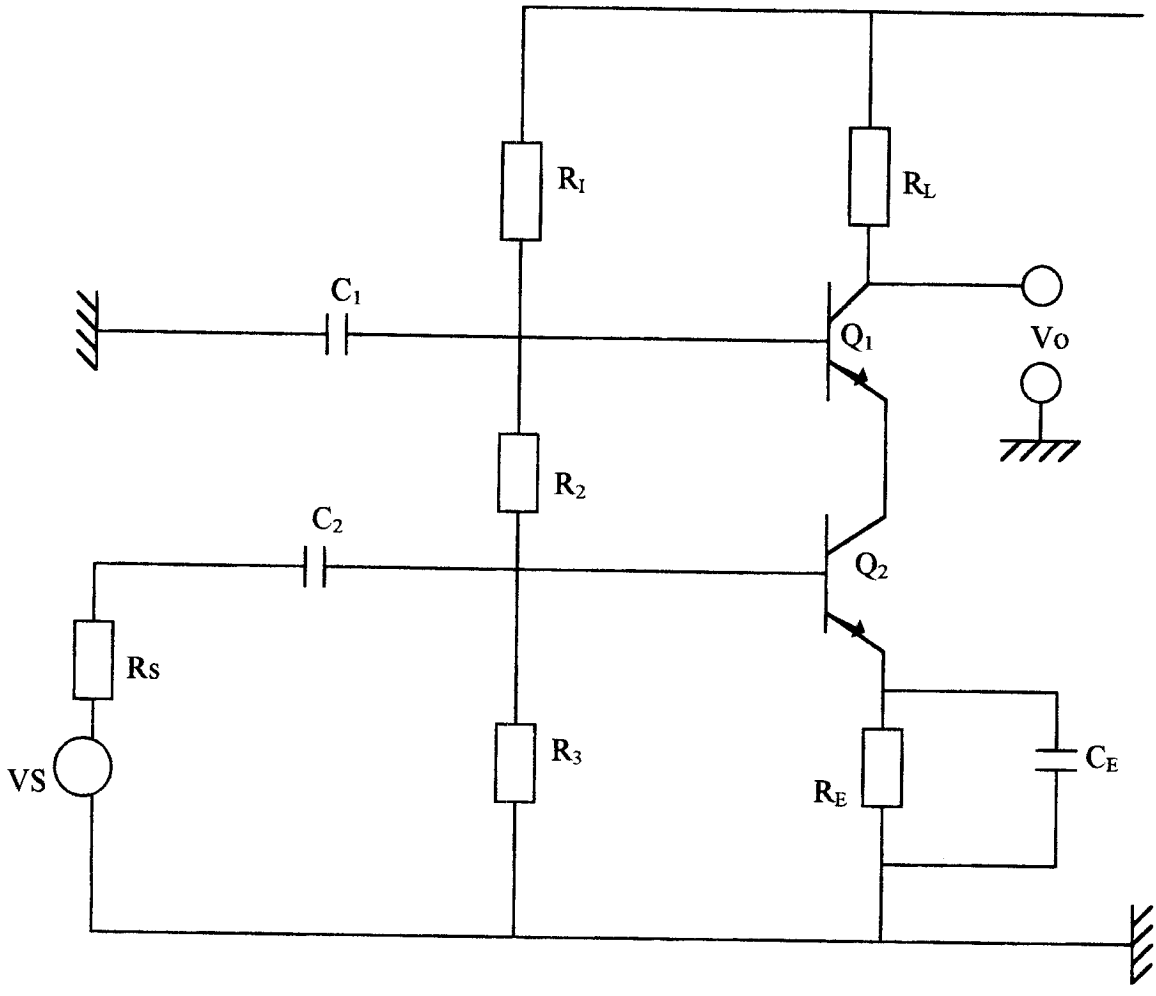


Where Av is the voltage gain
Ri is the input resistance
Vi is the input voltage
Vs is the signal voltage sources.

(ii)



Q5 (a) Derive expressions for, low varying small signal, input resistance current gain, voltage gain and output resistance for a casode amplifier consisting of a common emitter amplifier as first stage followed by a common base output stage. The circuit diagramme is shown below.

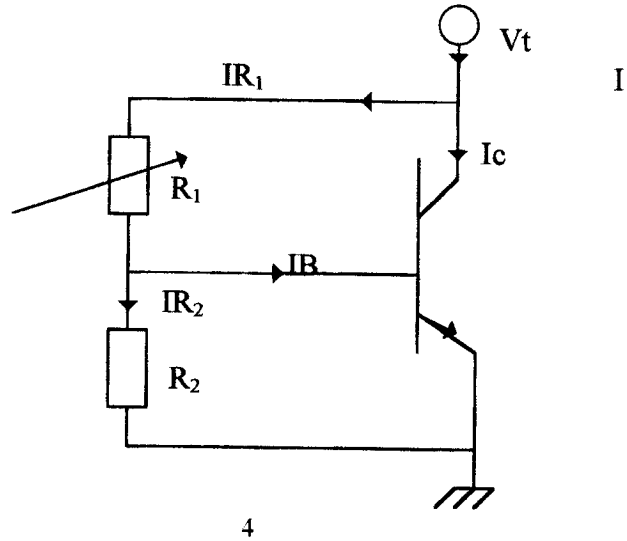


(b) (i) What role do resistors R_1, R_2 and R_3 play?

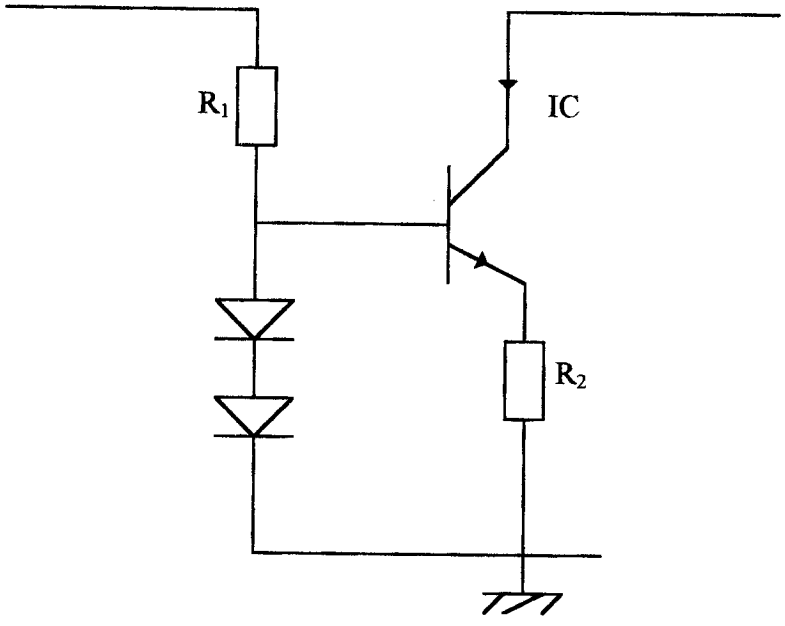
(ii) Is it really necessary to have capacitors C_E and C_2 and C_1 in the Circuit?

(C) What is the main advantage of a cascode amplifier in comparison with other amplifiers.

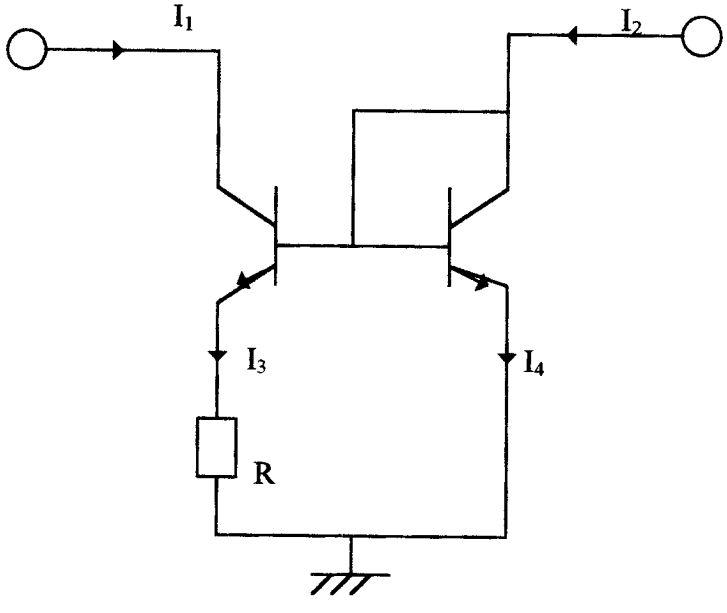
Q6. (a) Derive an expression for the voltage V_t for the circuit shown below.



(b) Derive an expression for the collector current Ic for the circuit diagramme shown below.



(c) Using Ebers - Moll equations derive an expression $\frac{I_2}{I_1}$ for a circuit shown below which transforms input direct current I_1 to a desired output current I_2.



Q7. (a)

Draw a circuit diagramme for a differential amplifier with emitters of the two transistors forming the amplifier joined and connected to a constant current source I.

(b) Explain how a circuit functions.

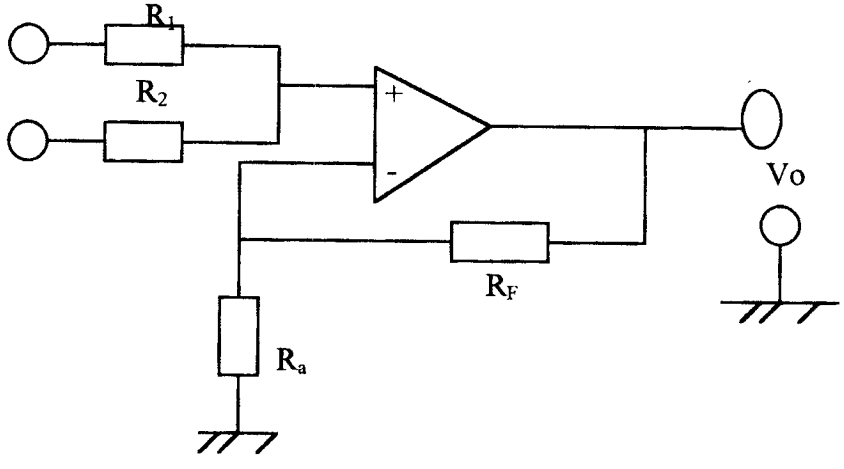
(c) Find an expression for output voltage and an expression for input impedance at each input if.

(i) $Vi_1 = Vi_2 = Vic$
(ii) $Vi_1 = - Vi_2 = \frac{1}{2} Vid.$

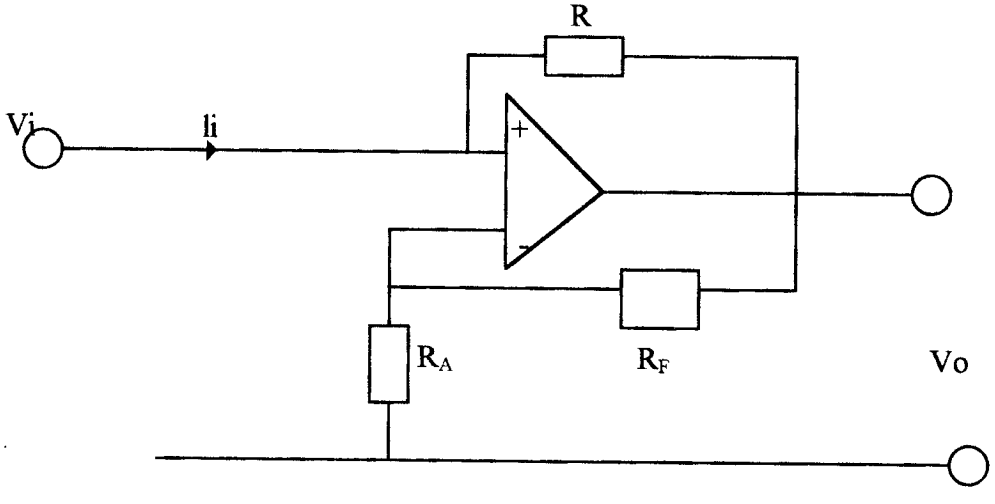
Where Vi_1 is input voltage 1
Vi_2 is input voltage 2
Vic is the common mode input voltage
Vid is the difference mode input voltage.

8. (a) Show that an expression for the output voltage Vo of an operational amplifier with multiple inputs shown below is given by

$$Vo = (R_1//R_2)\left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right)\left(1 + \frac{R_f}{R_a}\right)$$



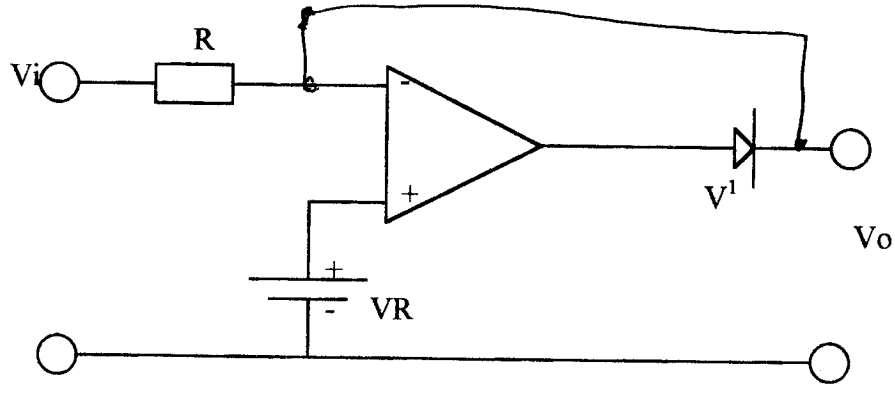
(b) Derive an expression for negative input impedance for the circuit of operational amplifier shown below.



(c) Show that output voltage Vo for a precision operational amplifier clamp whose circuit diagramme is given below is

$$Vo = \frac{AV_R}{1+A} - \frac{V_r}{1+A} = \frac{AV_R}{1+A} - \frac{Vr}{1+A}$$

Where A is the gain of the operational amplifier
Vr is the diode voltage



THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

EXAMINATION - SEPTEMBER 1998

EE 392 ELECTRICAL ENGINEERING PRACTICE

TIME : Three hours .

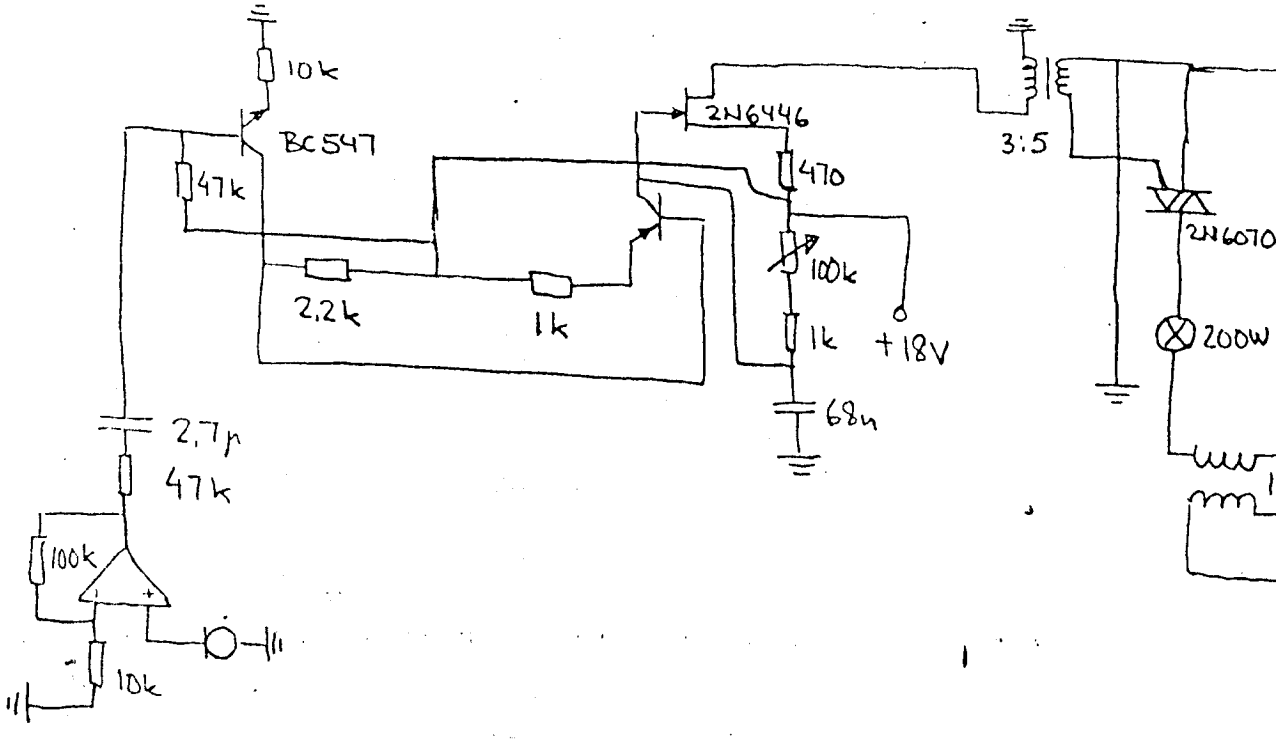
ANSWER : - Any two questions from each section.
- Each section must be answered in separate set of answer booklets.

SECTION I : Drawing and Design.

Question 1 (20 *marks*).

i) Present six of some rules that usually will improve the redability of the electronic drawing; (9 marks).

ii)Redraw the following electronic drawing according to a good drawing rules (11 marks)



Question 2 (20 *marks*).

i) Draw the single line wiring diagram and the schematic wiring diagram for the following lighing circuits

- multi - circuit switching (a double break switchswitching on /off two bulbs ;
- two - way switching to switch on /off a one tube.

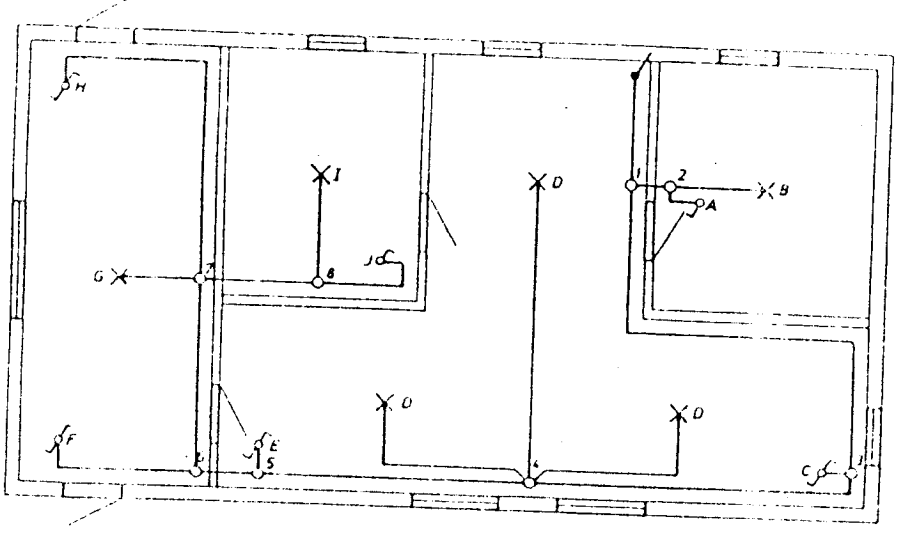
(8 marks)

ii) The following draw Fig. 2 is the plan of electric installation of the Resident building ingineer .

- complete this unline wiring diagram ; then draw its multi - line wiring diagram;
- how many junction boxes (minimum number of them)will you need to buy

(12 marks)

Fig 2



Figur

Qn 1 : Draw the single - line wiring diagram and the schematic

Question 3 (20 *marks*).

Make a neat drawing of the electronic circuit and name the components:

-At the left hand side we have two terminals for 220 V A.C. To the right, they are connected to a single phase transformer through a fuse and a switch. The transformer has an iron dust core. The secondary transformer is connected to the A.C. terminals of a diode rectifier bridge, diodes D_1 to D_4 .

- The plus of the bridge is connected to an electolytic capacitor, C_1 and two resistors R_1 and R_2. The other end of C_1 is connected to the minus terminalof the bridge - ground. The other hand of R_2 is connected to the capacitor C_2, the doide zener D_6 and the minus input of the operational amplifier. The other ends of C_2 and D_6 are connected to ground.

- The operational amplifier gets its supply from the plus terminal of the bridge and the ground. The output of the amplifier goes to the base of a PNP transistor,T1.The emitter of T1 is connected to the base of an NPN transstor , |T2 . The collector of T2 is connected to the plus terminal of bridge, and the emeter is connected to an incadescent lamp, L_1 and to an LDR, R_3. The other end of R_3 is connected to a potentiometer , R_4. The othe end of the potentiometer is connected to a nonlinear resistor R_5, which in turn is connected to ground. Theother end of L1 is connected to ground. The slider of R_4 is connected to the plus input of the amplifier.

SECTION II : Instrumentation and Fault Finding.

Question 4 (20 *marks*).

i) In the the ciruit of Fig. 4 no d.c. bias voltages are given. Instead the input and output wave forms are displayed.In each case one component can be considered to be faulty.State which component and type of fault.(10 marks)

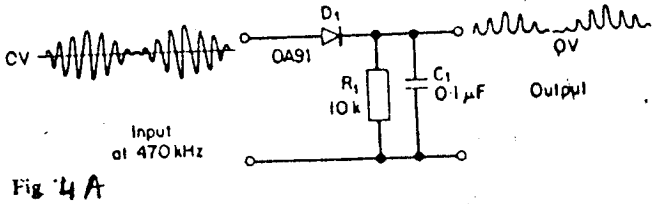


Fig 4A

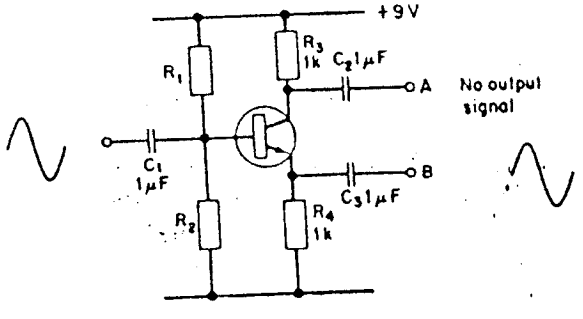


Fig. 4B

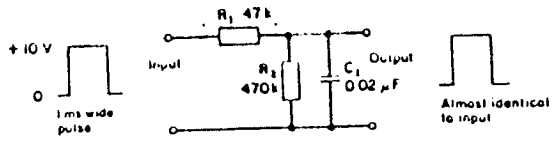


Fig 4C

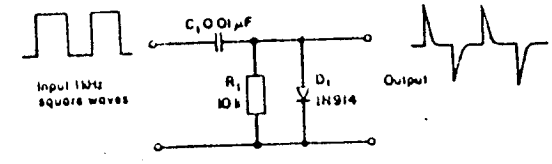


Fig 4.D

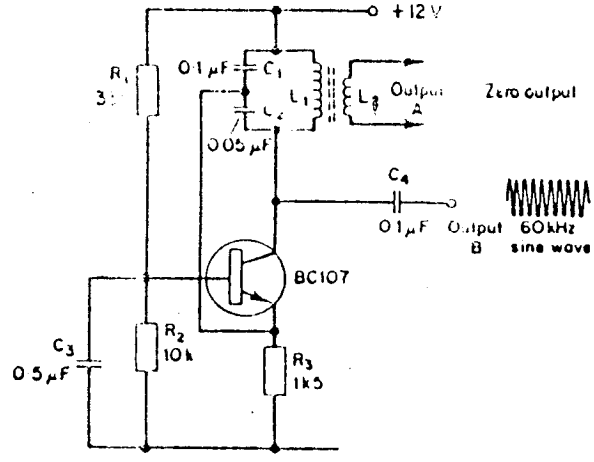
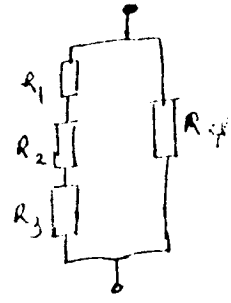


Fig 4.E

ii) A resistor is burnt in your equipement and you need a replacement. The value of the resistor is 120 Ω ± 5%, 5 W. As you do not have this value ,you use a standard resistors in acoupling as shown in the following figure 3 to replace the defect resistor and;



$R_1 = R_2 = 68\ \Omega \pm 2\%$, 2 W

$R_3 = 15\ \Omega \pm 10\%$, 0.5 W;

$R_4 = R2 = 560\ \Omega \pm 10\%$, 1 W;

Will the replacement satisfy the specification of the original resistor? (10 marks)

Question 5 (20 *marks*).

i) Explain what we mean by halving method in fault finding. *(6 marks)*

ii) How would you use the ohmmeter to determine the type of transistor (on a good one) *(7 marks)*

iii) The circuits shown below in Fig.5 are set up to check that both emitter base and collector base junctions in n-p-n transistor . Assume it is good , comment on the measurements of junction resistance for this one and for that of p-n-p transistor.Black means the positive terminal polarity of the internal battery and red the negative one *(7 marks)*

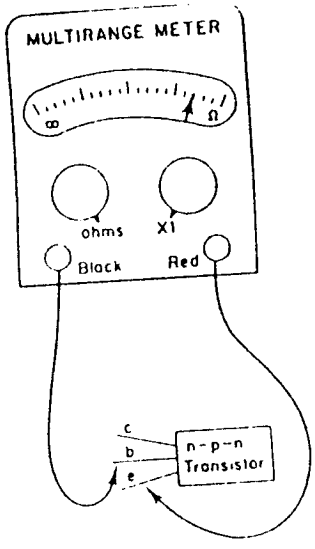


Fig. 5 A

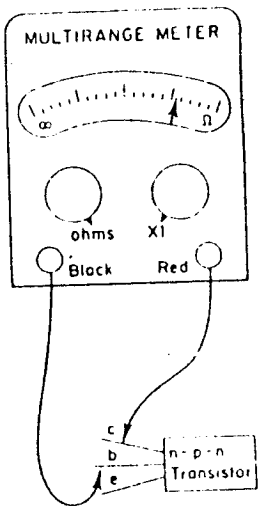


Fig. 5 B

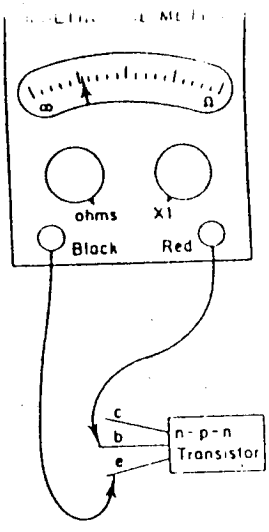


Fig 5. C

Question 6 (20 *marks*).

i) You have a moving coil instrument with internal resistance 2 kΩ and full scale deflexion 50 μA.Use this to design an amperameter with 3 ranges, 100 μA., 1mA and 10 mA. Sketch the circuit and calculate the resistors. *(5 marks)*

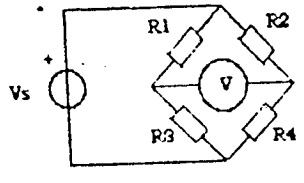
ii) A digital voltemeter has an error limit of ± (0.04% of reading + 2 LSD). Maximum reading is 199.9 V.Calculate relative error limit when the reading is 35.2 V. *(5 marks)*

iii) Calculate the error limits of y when $X = 13 \pm 1\ \%$; $Z = 0.3 \pm 1.5\ \%$ and

$K = 2 \pm 2\ \%$. *(5 marks)*

(a) $y = 2\dfrac{xz^2}{k^3}$ (b) $y = x + 2z + k$ (c) $y = x(z + k)$

iv) A digital voltemeter is used to measure the voltage of the output of a Wheastone brige as shown in Fig 6. The voltemeter was used in the 10 range and has a 5 digit display . Its uncertainty is defined as ± (5% of reading + 1 LSD). It reads 00.171 V. Determine the voltage at the output inclusive absolute error and the relative error of the voltemeter reading. *(5 marks)*



R1 = 1 kΩ ± 2% R2 = 5 kΩ ± 2%
R3 = 2.00 kΩ ± 1% R4 = 11 kΩ ± 2%
Vs = 10 V ± 1%

Figure 6

SECTION C: STATICS AND DYNAMICS

ANSWER ANY TWO (2) QUESTIONS

Q7. A simply supported beam of span 25m carries 5 concentrated loads, 3kN at 2m, 15kN at 6m, 20kN at 9m, 12kN at 17m and 25kN at 22m from one end. Calculate the maximum deflection given that E = 250,000 N/mm^2 and I = 2.2 x 10^{9}mm^4.

Q8. a) You are a racetrack suspensions expert with a formula one racing team. Your suspension employs close coiled helical springs. At rest the load on each spring is 2kN. The maximum estimated load on each spring due to cornering forces is 27kN. The maximum allowable change in compression of each spring, from rest to maximum load, is 2 cm. Determine the wire diameter of each spring and the maximum shear stress given, the coil diameter is 15cm, there are 6 coils, (G = 190,000 N/mm^2)

b) Determine the ratio of the mass of a solid shaft to that of a hollow one of the same length which will be required to transmit a given torque for the same maximum shear stress if the inside diameter of the hollow shaft is three-quarters of the outside diameter.

Q9. a) A heavy-duty truck engine weighing 640kg operates at 2500 rpm. The rotating parts are well balanced. If the reciprocating parts produce a harmonic force function of F = 4000cosωt in kN, and the damper for the engine mounting introduces a damping factor ζ=0.23.

(i) Determine the natural frequency of vibration of the system and specify the spring stiffness for the engine mounting such that only 15% of the resultant force is transmitted to the truck chassis.

(ii) Determine the magnitude of the transmitted force

b) A rotating shaft has four masses A, B, C, D attached to it, with centres of mass lying at radii at 80, 90, 120, and 60mm respectively. The planes in which the masses rotate are spaced, A to B 0.4m, B to C 0.8m, C to D 0.6m the masses of A, B, and C are 18, 20, and 15 kg respectively. Find the value of D and the relative angular settings for the shaft to be in complete balance.

END OF SECTION C
Mr M. O. Goma

END OF EXAMINATION – EE392

THE UNIVERSITY OF ZAMBIA
School of Engineering, Dept of Electrical & Electronic Eng.
UNIVERSITY EXAMINATION SECOND SEMESTER 1998
ELECTRONICS EE431
Prof. Dr. A.J. Mouthaan
time: 3 HOURS
ANSWER 5 QUESTIONS OUT OF 8
ALL QUESTIONS CARRY 20 POINTS

The following constants and equations may be used

Constant	Symbol	Unit	Value
Thermal voltage	$V_{th}=kT/q$	mV	25 (room temperature)
Bandgap silicon	E_g	eV	1.12

Diode equation: $\mathbf{J = J_n + J_p = n_i^2 q\left(\frac{L_n}{N_A \tau_n} + \frac{L_p}{N_D \tau_p}\right)\left(e^{\frac{V}{V_{th}}} - 1\right)}$, if it is assumed that the length of the neutral regions is larger than the diffusion lengths, $L_{n,p}$, in the p- and n-material resp.

MOST current equation, linear region: $\mathbf{I_D = K(V_{GS} - V_T)V_{DS}, K = \frac{W}{L}\mu C_{ox}}$,

saturation: $\mathbf{I_D = K\frac{(V_{GS} - V_T)^2}{2}}$.

(Use the appropriate signs for n- and pMOST).

Q1. **Solid state physics.**

a)Describe the difference in band structure between an insulator, semiconductor and a metal and describe possible electrical conduction mechanisms and forces that can cause conduction. (12 points).

b) Sketch in one graph of resistance against temperature, the curve of the resistance of a piece of metal, a piece of intrinsic silicon and a piece of extrinsic silicon. Use a temperature range of 0 ^oK to 500 ^oK. Explain the shape of the three curves. (8points).

Q2. Solid state physics.

a) Give a definition of the Fermi energy level. If the number of intrinsic carriers in silicon is known, how can the number of extrinsic carriers always be found from this? (10 points).

b) In a semiconductor doped with acceptor atoms draw the position of the Fermi energy level as function of temperature starting from 0 ^{o}K to 500 ^{o}K and explain the curve. (10 points).

Q3. PN diodes.

a) For a pn diode, explain that the width of the depletion region increases when the doping concentration on both sides is decreased. Will the junction breakdown voltage increase or decrease? Explain your answer. (8 points).

b) Give a high frequency AC equivalent circuit diagram of a junction diode and explain the origin of all components and indicate the way they can be calculated. (12 points).

Q4. Bipolar transistors.

Given is a npn transistor, biased in the active mode, with doping concentrations N_{De}, N_{Ab}, N_{Dc}, in emitter, base and collector resp. and with a base width, L_B. When one parameter at the time is decreased, while the others are kept at their set values, complete the table below to indicate the effect that it will have on the indicated transistor parameters. As an example the effect of decreasing L_B is indicated. Briefly explain each entry. (20 points).

	effect on I_C	effect on β	effect on f_T
decrease N_{De}			
decrease N_{Ab}			
decrease N_{Dc}			*no effect*
decrease L_B			*f_T increaces*

Q5. MOS transistors.

Given is a pMOST, operated in the saturation region, with oxide thickness, t_{ox}, and doping concentrations in the source, drain and bulk resp., N_{As} , N_{Ad} and N_{Db} operating at room temperature, T. When one parameter at the time is changed, while the others are kept at their set values, complete the table below to indicate the effect that it will have on the indicated transistor parameters. Material properties like μ and τ can be considered independent of temperature. For an example entry see Q4. Briefly explain each entry. (20 points).

	effect on V_T	effect on g_m	effect on f_T
decrease t_{ox}			
increase N_{As}, N_{Ad}			
increase N_{Db}			
increase T			

Q6. CMOS transistors.

a) Explain the meaning of the acronym "CMOS". Make a sketch of the circuit CMOS represents and explain why this is such a good circuit to be used in digital electronics. (8 points).

b) An inverter can be made in CMOS. Sketch the V_{out} - V_{in} characteristic of such an inverter. If both transistors in the circuit are of exactly the same dimensions, which one will be the fastest in switching? To make the circuit behave 'symmetrically' (the same transient for switching on as for switching off) both transistors must roughly have the same I-V characteristics. If both transistors have the same value of L, what should roughly be the ratio of their widths; W_n:W_p? (12 points).

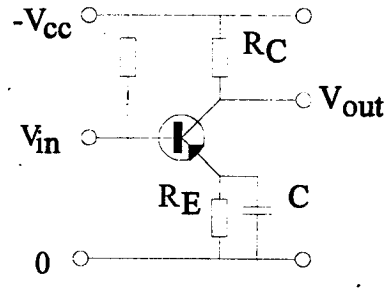
Q7. Transistor circuit.

Given below is a circuit configuration for a pnp transistor.

a) Name the configuration and explain why it is thus named. This circuit leads to a stable biasing situation, even when e.g. the temperature changes. Explain why. (5 points).

b) For a large negative value of the input voltage the transistor will go into saturation. Explain what happens. What will be the collector saturation current in the circuit? (10 points).

c) Why does it take a relatively long time for a transistor to be switched from saturation to active mode? (5 points).



Q8. Thyristors.

a) Sketch the basic construction of a thyristor and explain the working of the device. (8 points).

b) Show how a thyristor can be used to regulate the power delivered to a light bulb. (12 points).

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
UNIVERSITY EXAMINATIONS OCTOBER 1998

EE452: ELECTRIC POWER SYSTEMS I

Answer four questions.
Time: Three hours
Take $\mu_0 = 4\pi \times 10^{-7}$ H/m and $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m

---

1.

A three-phase transmission line has resistance and reactance per phase of 5 Ω and 25 Ω, respectively. The load at the receiving-end is 15 MW, 33 kV, 0.8 power factor lagging. Find the capacity of the compensation equipment needed to deliver this load with a sending-end voltage of 33 kV.

[15]

Calculate the extra load of 0.8 lagging power factor which can be delivered with the compensating equipment installed of the capacity as calculated above, if the receiving-end voltage is permitted to drop to 28 kV.

[10]

2.

Show how an unsymmetrical three-phase line can be made equivalent to an equilaterally spaced line in relation to the properties of inductance and capacitance.

[10]

A 450-km long transposed 3-phase transmission line has one conductor per phase, each c radius 25.2 mm. All the phase conductors are supported at a height of 15 m and the spacing between adjacent conductors is 10 m. Find the inductance per phase and, taking into consideration the effects of earth, the capacitance per unit length per phase. Hence determine its exact ABCD parameters if its series resistance is 0.13 Ω/km/phase and the system frequency is 50 Hz.

[15]

3.

Describe the main considerations in the design of an overhead line concerning the conductors, insulators and towers, and the range of materials that can be used. In your discussion include the classification of these considerations under electrical, mechanical or other concerns.

[15]

At a river crossing an overhead transmission line has a span of 610 m with the two supports of the lowest conductor at 18 m and 105 m above water level. The weight of the conductor is 8.33 N/m. If the tension of the conductor is adjusted to 3.34×10^4 N, determine the clearance of the conductor above the water at a point 230 m from the base of the higher tower.

[10]

4.

A 3-phase dead short occurs on the 33-kV busbar at F as shown in the power system of Fig. 1. The system information is as in tables 1 and 2. Calculate the steady-state fault current, giving brief explanations and stating any assumptions. For this fault, what currents flow in generators G1 and G2?

[19]

Describe qualitatively the practical consequences of replacing the reactor either by a direct connection, or by an open circuit. [6]

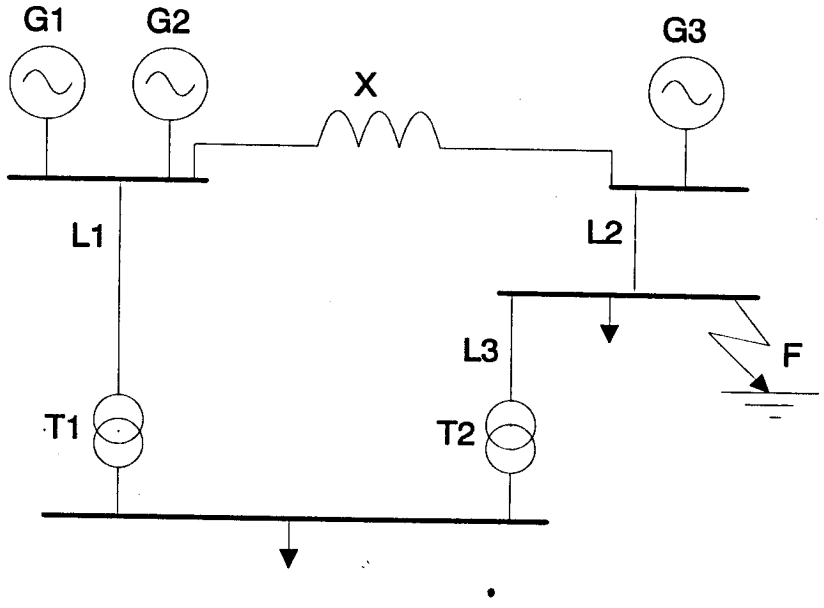


Fig 1

Table 1

Item	MVA Rating	P.U. Reactance
Generator G1	10	0.3
Generator G2	20	0.3
Generator G3	50	0.4
Transformer T1	25	0.1
Transformer T2	25	0.1
Reactor X	50	0.3

Table 2

Item	Voltage (kV)	Length (Km)	Reactance (Ω/km)
Line L1	33	50	0.2
Line L2	33	40	0.2
Line L3	33	10	0.2

5.

Derive a general equation which describes the time-current characteristics of the induction disc relay. The expression should incorporate the effects of eddy current braking and restraining spring force. With reference to the derived equation, briefly comment on the application of the plug setting multiplier and time setting multiplier on induction disc relay to produce a flexible operating characteristic.

[10]

A 33-kV radial distribution feeder ***ABC*** (Fig. 2) which is fed at substation ***A*** has 3-phase fault levels of 300, 260 and 210 MVA at busbars ***A***, ***B*** and ***C***, respectively. There are current transformers with ratios 300/5, 400/5 and 300/5 at ***A***, ***B*** and ***C***, respectively. Calculate the settings to be applied to these relays which give a discrimination of 0.4 s between each relaying point and which achieve a plug setting multiplier close to but less than 20.0 for 3-phase faults close to the relaying points.

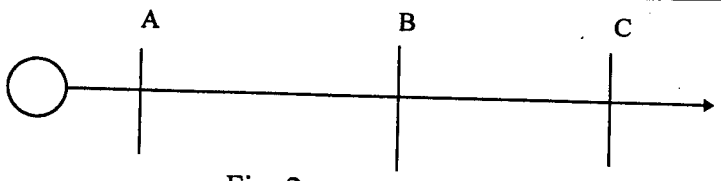


Fig. 2

The required trip time at busbar ***C*** is 0.5 s. The relays have plug settings of 50% to 200% in 25% steps and the time multiplier is variable from 0.1 to 1.0.

The standard IDMT characteristic is $t = \dfrac{0.14}{PSM^{0.02} - 1}$.

6. [15]

(a) Describe the amplitude comparator circuit which can be used to realize the off-set mho distance protection relay. By referring to this circuit diagram, derive the marginal operating characteristic equation of this type of relay.

[9]

(b) Describe the arrangement and the operating principle of a power direction balance scheme as applied in unit protection schemes to protect a transmission line which has circuit breakers at both ends.

[7]

(c) Derive, with a definition of terms, the optimum power factor to which a lagging load can be improved to.

[9]

END OF EE452 EXAMINATION

UNIVERSITY OF ZAMBIA

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

AUGUST 1998 SEMESTER II

EE552 ELECTRICAL POWER SYSTEMS II

TIME: THREE HOURS

ANSWER: FOUR QUESTIONS. ALL QUESTIONS CARRY 25 MARKS.

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1. (a) Describe the conceptual power system control model in terms of the system operating states with the aid of a schematic diagram. How can we identify the Alert state and the Emergency state? (10 Points)

(b) State the eight functions of a modern Energy Management System in a Central Control Centre. (5 Points)

(c) An area of an interconnected 60Hz power system has three turbine-generator units rated 100, 200, and 500 MVA. The regulating constants for the units are 0.04, 0.05, and 0.06 per unit, respectively, based on their ratings. Assume the reference power setting of each turbine-generator remains constant. Neglect losses and the dependence of load on frequency. Each unit is initially operating at one half its own rating when the load suddenly decreases by 50 MW. Determine :(i) the unit area frequency response characteristic β on a 100 MVA base, (ii) the steady-state increase in area frequency, (iii) the MW decrease in mechanical power out of each turbine.

2. (a) Give the circuit diagram , phasor diagram and swing equation for a simplified synchronous machine model for transient stability studies. Also state the tree assumptions on which the model is based. (10 Points)

(b) Define and find the critical clearing time t_{cr} and the critical clearing angle δ_{cr} using the equal area criterion. If $P_m = 1$ pu and $\delta_0 = 0.4179$ rad, $P_e = 2.4638 \sin \delta$, and $\delta_3 = 2.7236$ rad and $\omega_{syn} = 2\pi\ 60$ rad/s. (15 Points)

3. (a) Give the time line of the development milestones of the history of the electric utility industry. (5 points)

(b) Briefly describe the cyclic transformation and regroupings of the electric power undertakings in Zambia from 1959 to 1998. What are the proposed licence classes under the energy regulation board. (10 Points)

(c) Using a schematic diagram , show how a solar energy electric power source can be used to feed ac loads. Give six benefits of renewable energy not captured in standard economic accounts. (10 Points)

4. (a)Define the steady state load flow problem in a power system . State the requisite input data for different types of buses. (10 Points)

(b)Give the mathematical model for the Newton-Raphson load flow model. Draw and Describe the iterative procedure in which this model can be used to solve the load flow problem. Show how the N-R model can be transformed into a Fast- Decoupled load flow model. (15 Points)

5. (a) Define the three phase symmetrical components analysis and synthesis equations in matric form using the a-operator. (5 Points)

(b) Under what conditions of voltage phasor imbalance can neutral displacement and inversion occur? (5 Points)

(c) Show that the complex power delivered to a three phase network is equal to 3 times the total complex power delivered to the sequence networks. (5 Points)

(d) Given a balanced Y impedance load. The impedance of each phase is designated Z_y, and neutral impedance Z_n is connected between the load neutral and ground. Define the line-to-ground voltage matrix $\mathbf{V_p}=\mathbf{Z_p}\ \mathbf{I_p}$. Find the sequence impedance matrix $\mathbf{Z_s}=\mathbf{A^{-1}Z_pA}$. Does $\mathbf{Z_p}$ satisfy the conditions for a symmetrical load impedance? (10 Points)

6. (a) State the three types of over-voltages encountered by power system equipment. Among these three which one is the greatest single cause of overhead transmission and distribution outages? (5 Points)

(b) What is the name of the geographical map which gives contours of equal frequency of occurrence of thunderstorms in thunderstorm-days/ year. State the four factors which affect the design goal for an overhead line with a specified voltage rating. What is the typical design goal in terms of lightning outages per year per 160 km of transmission line. (5 Points)

(c) Define over-voltage insulation co-ordination. Draw a generic Peak-Voltage Versus Time co-ordination curve. Draw the standard T1 X T2 impulse voltage waveform showing T1 and T2. What is the significance of the peak voltage of the impulse waveform? (10 Points)

(d)How can a transformer be protected against over-voltages higher than its BIL. What four criteria should a protective device satisfy? (5 Points)

END EXAMINATION EE552

THE UNIVERSITY OF ZAMBIA
School of Engineering, Dept of Electrical & Electronic Eng.
EXAMINATION SECOND SEMESTER 1998
CONTROL SYSTEMS EE562
time: 3 HOURS
ANSWER 5 QUESTIONS OUT OF 8 **ALL QUESTIONS CARRY 20 POINTS**

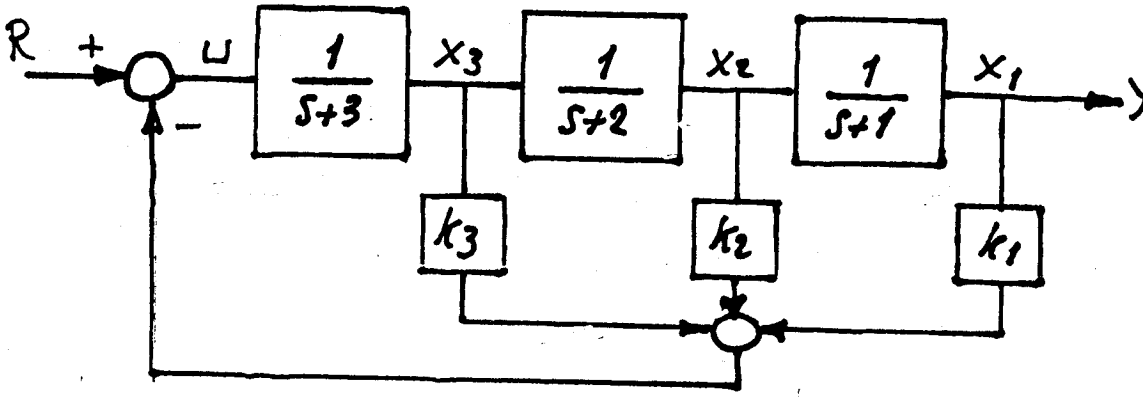
Question 1.

It takes 1 minute and 10 seconds for a thermometer to indicate the response to a temperature step input.
This thermometer may be assumed to be a first order system.

a. Determine the time constant of the thermometer. (4 points)
The thermometer is put in a bath whose temperature rises l with 12°C/minute.
b. Determine the response in the time domain. (8 points)
c. What will in this case be the error in the indicated temper after a long time? (steady state error, ramp input) (8 poir

Question 2.

Following third order system will get a total state feedback wi constants k1, k2 and k3.



a. Give the resulting transfer function. (10 points)
b. Find the three k constants for pole locations -2 and -5 (2x (10 points)

Question 3.

One of the ways to obtain an optimal PID controller has been des by the Ziegler Nichols oscillation method.

a. Explain the procedure exactly. (10 points)
b. Describe the main effects of respectively P-, I- and D-Actions. (10 points)

Question 4.

Given is a process with the transfer function

$$H = \frac{1}{(s+1)(s+10)(s+100)}$$

a. How to choose an appropriate integrating network with a factor a=10? (10 points)
b. What will be the transfer function of this network? (10 poin

Question 5.

The position of a computer disc head as a function of the steering input is defined by the transfer function:

$$H = \frac{1}{s(s+1)}$$

A first order PD controller has to be designed to meet the followi specifications:

1. **tpeak = 0.5 π** sec.
2. relative damping **z = 0.7**

Controller and disc head are part of a unity feedback system.

a. Translate these specs into pole positions. (2 points)
b. What is the location of the controller's pole, given that its zero is at -1? (4 points)
c. Find K'(root locus gain).(4 points)
d. Find K (system gain) of the PD controller. (4 points)
e. Sketch roughly the response to a unit step input. (6 points)

Question 6.

State space notation.

a. Give the standard state space notation for a single input singl output (SISO) system and indicate the used symbols as either matrix, vector or something else. (4 points)
b. Name the three different standard forms. (8 points)
c. What are the main advantages of the state space approach? (8 points)

Question 7.

Routh Hurwitz.

a. For what positive values of K does the polynomial

$$s^4 + 8s^3 + 24s^2 + 32s + K$$

have roots with zero real parts? (10 points)
b. What are these roots? (10 points)

Question 8.

For sampled systems often the z-transform is used.
Suppose a sample frequency of **ω**.

a. Define the primary strip in the s-plane. (8 points)
b. This strip can be mapped into the z-plane.
Perform this mapping procedure, indicating at least 4 correspon ding positions in both planes. (8 points)
c. What is the criterion for stability in the z-plane? (4 points)

END OF EE562 EXAMINATION

DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING

UNIVERSITY EXAMINATIONS AUGUST 1998
EE572 COMMUNICATION SYSTEMS

Time : Three hours
Answer : Five questions

Q1. (a) What is a Parabola? With sketches, show why its geometry makes it a suitable basis fo antenna reflectors. Explain why an antenna using a parabloid reflector is likely to be highly directive receiving antenna.

(b) Discuss bandwidth, as applied to the two major parameters of antenna. Also define beamwidth.

(c) A halfwave dipole antenna is capable of radiating 1Kw and has a 2.15dB gain over an isotropic antenna. How much power must be delivered to the isotropic (omini directional) antenna, to match the field strength directional antenna?

(d) To produce a power density of 1m w/m^2 in a given direction, at a distance of 2km, an antenna radiates a total of 180w. An isotropic antenna would radiate 2400w to produce the same power density at that distance. What is, the directive gain of the practical antenna.

Q2. (a) For what reasons are high frequency antennas likely to differ from antennas used at Lower frequencies? What is an antenna array? What properties does it have that make It so useful at HF.

(b) Explain the difference between drivers and parasitic elements in an antenna array, what is the difference between a director and a reflector?

(c) Describe the end fire array and its radiation pattern and explain how the pattern can be made unidirectional.

Q3. (a) The electric and magnetic wave equations in frequency domain for rectangular wave guides are given as

$$\Delta^2 E = \gamma^2 E \quad \text{and}$$
$$\nabla^2 H = \gamma^2 H$$

The solution of which give a propagation constant

$$\gamma_g = \pm j \sqrt{\omega^2 \mu\varepsilon - k^2 c}$$

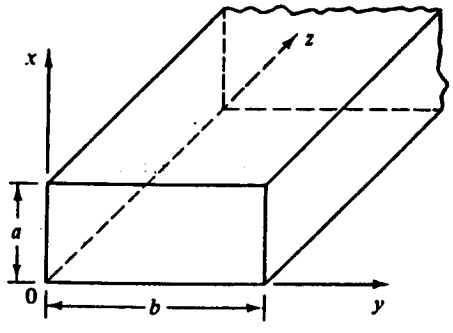
where

$$kc = \sqrt{kx^2 + ky^2}$$

Discuss the three possible cases for the propagation constant γg in the waveguide.

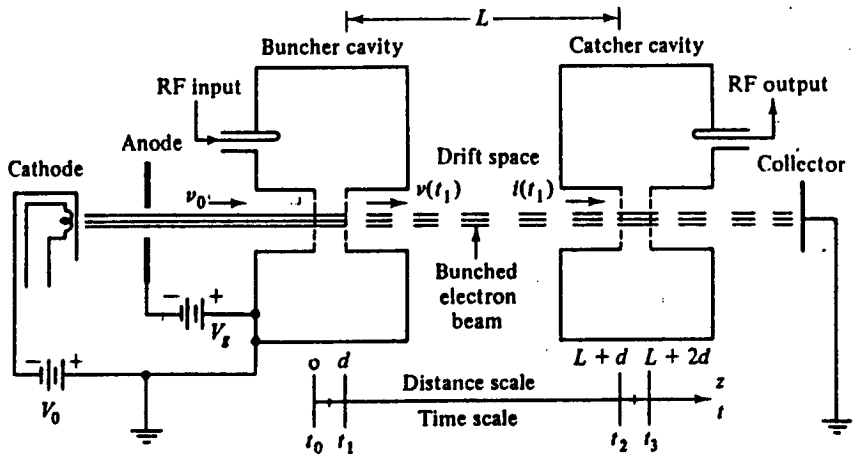
(b) TE_{01} in rectangular wave guide. An airfilled rectangular waveguide of inside dimensions 3.5 x 7cm operates in the dominant TE_{01} mode shown, below.

i) Find the cut-off frequency
ii) Determine the phase velocity of the wave in the guide at a frequency of 3.5 Ghz
iii) Determine the guided wavelength at the same frequency



. Coordinates of rectangular guide.

Q4. (a) Describe the operation of the two-cavity klystron amplifier whose sketch is given below.



Two-cavity klystron amplifier.

(b) If this two-cavity amplifier has the following parameters

V_0 = 1000V;
I_0 = 25mA;
R_0 = 40kΩ
F = 3GHz

Gap spacing in either cavity : d = 1mm
Spacing between the two cavities: L = 4cm
Velocity of electrons just leaving the cathode is

$$v_o = \sqrt{\frac{2eVo}{m}}$$

(a) Derive and calculate the average transit time through the buncher gap d
(b) The average gap transit angle θg
(c) The beam coupling coefficient β_i

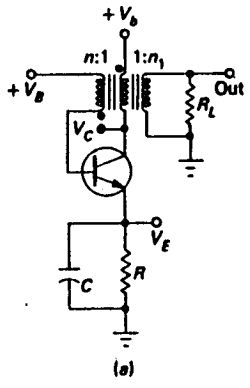
Q5. (a) Draw a block diagram of a basic pulsed radar system and explain its functions.

(b) Calculate the maximum range of a radar system which operates at 3cm with a peak power 500kW, if its antenna is $5m^2$ and the radar cross sectional area of the target is $20m^2$.

(c) A low power, short range radar is solid state throughout, including a low noise RF amplifier which gives it an overall noise figure of 4.77dB. If the antenna diameter is 1m, the IF bandwidth is 500kHz, the operating frequency is 8GHz and the radar set is supposed to be capable of detecting targets of 5-m^2 cross sectional area at a maximum distance of 12km, what must be the peak pulse power.

Q6. (a) Draw a block diagram of the tuner arrangement in a VHF/UHF television receiver.

(b) Given a diagram of a basic blocking oscillator below explain how the circuit functions by drawing the emitter and collector waveforms.



Q7. (a) Draw a sketch diagram of a super heterodyne receiver and in summary form describe from the input to output the function of each block.

(b) Calculate the image frequency rejection of a double conversion receiver which has first IF of 2MHz and a second IF of 200KHz, an RF amplifier whose tuned circuit has a Q of 75 (the same as that of the mixer) and which is tuned to a 30MHz signal. The answer is to be given in decibels

Q8. (a) Sketch and discuss the Yagi-Uda antenna
(b) The Rhombic antenna
(c) Explain polarisation in antennas and directive gain
(d) The AN/FPS-16 guided missile radar operates at 5GHz, with a 1MW peak power output. If the antenna diameter is 3.66m(12ft) and the receiver has bandwidth of 1.6MHz and an 11dB noise figure. What is its maximum detection range for $1m^2$ targets?

$A(dB) = 10\log_{10}\left(\frac{P_2}{P_1}\right)$

$r_{max} = \left[\frac{P_t A_p^2 \lambda^2 S}{(4\pi)^3 P_{min}}\right]$

$r_{max} = \left[\frac{P_t A_0^2 S}{4\pi\lambda^2 k T_0 \delta f (F-1)}\right]^{1/4}$

$r_{max} = \left[P_t D^4 S / \delta f \lambda^2 (F-1)\right]^{1/4} \times 48$

5. $erp = P_0 \cdot \text{field gain}^2$

6. $\varphi = \frac{70\lambda}{D}$

7. $A_p = G\left(\frac{D}{d}\right)^2$

8. $k_c = \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2} = \omega_c\sqrt{\mu\epsilon}$

9. $f_c = \frac{1}{2\sqrt{\mu\epsilon}}\sqrt{\frac{m^2}{a^2} + \frac{n^2}{b^2}}$

10. $\beta_g = \omega\sqrt{\mu\epsilon}\sqrt{1 - \left(\frac{f_c}{f}\right)^2}$

11. $v_g = \frac{\omega}{\beta_g} = \frac{v_p}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$

12. $v_p = \frac{1}{\sqrt{\mu\epsilon}}$

13. $Z_g = \frac{\eta}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}}$

14. $\eta = \sqrt{\mu/\epsilon}$

15. $\tau \sim \frac{d}{v_0}$

16. $r_{max} = \left(\frac{P_t A_0^2 S}{4\pi\lambda^2 P_{min}}\right)^{1/4}$

17. $\alpha = \sqrt{1 + Q^2\rho^2}$

18. $\rho = (f_{si}/f_s - f_s/f_{si})$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Department of Electrical and Electronic Engineering
UNIVERSITY EXAMINATIONS - MAY 1999
EE581: TELECOMMUNICATION THEORY

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

Q1. (a) What is Dirac delta function? State its properties.
(b) What is a time -invariant system?
Consider a system with input x(t) and output y(t) given by

$$y(t) = x(t)\delta_T(t) = x(t)\sum_{n=-\infty}^{\infty}\delta(t-nT)$$

Is this system time-invariant ?
(c) State four important properties of the Fourier's series. What is Parseval's theorem?
Define the power spectral density $G_x(f)$ of a periodic power signal.
(d) Discuss a frequency domain model for an aperiodic power signal x(t). Derive a relation for the power spectral density (psd) $G_x(f)$ of x(t). Show the detailed derivation.
[3+4+6+7]

Q2. (a) Consider a random process X(t). Discuss in detail its stationarity ,time averages and ergodicity with necessary mathematical expressions.
(b) Introduce Markoff sequence after considering a random process X(t). What is a homogeneous Markoff sequence ? Discuss a stationery Markoff process.
(c) Binary data are transmitted over a noisy communication channel in blocks of 16 binary digits. The probability that a received binary digit is in error due to channel noise is 0.2. Assume that the occurrence of an error in a particular digit does not influence the probability of occurrence of an error in any other digit within the block (i.e., errors occur in various digit positions within a block in a statistically independent fashion).

(i) Find the average (or expected) number of errors per block.
(ii) Find the variance of the number of errors per block.
(iii) Find the probability that the number of errors per block is greater than or equal to 5.
[7+6+7]

Q3. (a) How can you develop a definition for the measure of information ? What is the entropy of an information source ? Give a quantitative definition of entropy. Is your definition valid for an ergodic source ? State reasons.
(b) Consider a telegraph source having two symbols, dot and dash. The dot duration is 0.2 second. The dash duration is 3 times the dot duration. The probability of the dot's occurring is twice that of the dash, and the time between symbols is 0.2 second. Calculate the information rate of the telegraph source.
(c) State Shannon-Hartley theorem. Discuss its implications in the design of communication systems.
[7+6+7]

Q4. (a) What is Hamming distance ? Calculate the Hamming distance of a code for correcting triple errors. How many errors it can detect.
(b) The generator matrix for a (6,3) block code is given below.

$$G=\begin{bmatrix} 1\,0\,0 & 1\,1\,0 \\ 0\,1\,0 & 1\,0\,0 \\ 0\,0\,1 & 0\,1\,1 \end{bmatrix}$$

Find the code vectors for the message blocks D= (111) and D= (001). Show the procedure for the computations.

(CONTINUED IN PAGE 2)

Q4 (c) What do you mean by error syndrome ? Show that the syndrome of a received vector R is zero if R is a valid code vector.

(d) Calculate the syndrome if the received vector in a (7,4) block code is R=(1001001). The parity check matrix H is given as

$$H = \begin{bmatrix} 1110\ 100 \\ 1101\ 010 \\ 1011\ 001 \end{bmatrix}$$

[4+6+5+5]

Q5. (a) Define: (i) Protocol (ii) Peer processes (iii) Network architecture
(b) What is a SAP ? Comment on services and protocols.
What are the SAP's in FM radio broadcasting ?
(c) Show by means of a suitable diagram how virtual communication is supported between two application layers in a network having ISO/OSI architecture.
(d) In a data communication system voltages 0,1,2,3,..... ,6,7 are used as signal values. If the bit rate in the system is 36 Mbps,calculate the baud rate.

[6+4+7+3]

Q6. (a) Explain the principles of Pulse Code Modulation (PCM). Draw the block diagram of a PCM System.
(b) Explain the T1 carrier system. Calculate the overall bit rate of T1 carrier.
(c) Calculate the capacity of a Gaussian channel with a bandwidth of 1 MHz and S/N ratio Of 30 dB.

[8+7+5]

Q7. (a) Discuss pure and slotted ALOHA protocols. Derive their formulae for throughputs. Compare them.
(b) A group of N stations share a 56-kbps pure ALOHA channel. Each station outputs a 1000-bit frame on an average of once every 100 second, even if the previous one has not been sent (e.g., the stations are buffered). What is the maximum value of N ?
(c) Discuss briefly the Markoff statistical model for information sources. Present a discrete stationary Markoff source in a graph form. The source emits one of three symbols, A,B,C. The state transition and symbol generation can also be illustrated using a tree diagram. Draw the tree diagram for the source. Show the procedure for calculating the probability of generating various symbol sequences taking an example ,say the symbol sequence AC. Indicate how you have used the Markoff property in the procedure. Make any necessary assumptions.

Q8. Write short notes on any four : [8+4+8]
(a) Circuit switching , message switching , and packet switching (b) ASK and FSK
(c) CSMA/CD (d) ARPA network (e) Gaussian bandlimited white noise (f) ISO/OSI and TCP/IP reference models (g) Probability density function (h) Sampling (i) Persistent and nonpersistent CSMA (j) Discrete random variables and probability mass functions.

[20]

END OF QUESTION PAPER.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Department of Electrical and electronic Engineering

UNIVERSITY EXAMINATIONS - AUGUST 1998

COMMUNICATIONS PRINCIPLES

EE581

ANSWER FIVE QUESTIONS
TIME THREE HOURS

Q1 (a) In one application, an exchange switch uses two identical duplexed computer systems for its operations and billing. Each computer system has an exponential time to failure with a mean of 2000 hours and each has a built-in redundancy so failures are rare. The system fails only if both computers fail.
What is the probability that the system will not fail during *one week* of continuous operation? **[8]**

(b) A digital communication system transmits data in binary code using 8-bit word. The digits '0' and '1' occur at random and are equiprobable.
Find: **[12]**

(i) The probability that a word contains four '1's and four '0's.
(ii) The probability that at least 4 digits in a word are '1's.
(iii) The probability that the first 4 digits in a word are all '1's.
(iv) The probability that the first 4 digits in a word are '1's and the remaining digits are all '0's.
(v) The probability that a message comprising of 8 words will contain exactly 4 words in which at least 4 of the digits are '1's.

Q2 (a) Briefly describe the process involved in generating a PCM signal. In a binary PCM system, it is desired that the output signal-to-quantizing-noise ratio is held to a minimum of 40 dB. Determine the number of levels required, and find the corresponding output signal-to-quantizing-noise ratio. **[10]**

(b) An on-off binary system uses the pulse waveforms **[10]**

$$s_i(t) = \begin{cases} s_1(t) = A \sin \pi t / T & 0 \le t \le T \\ s_2(t) = 0 & 0 \le t \le T \end{cases}$$

Let A=0.2 mV and T = 2 μs. Additive white noise with power spectral density $\eta/2 = i \times 10^{-15}$ W/ Hz is added to the signal. Determine the probability of error when $P(s_1) = P(s_2) = 0.5$.

Q3 (a) Define the terms Entropy and Equivocation and discuss their significance in regard to a discrete communication channel. **[3]**

(b) A quaternary transmission channel has forward probabilities $P(y_j / x_i)$ as follows:-

		Output symbol			
		y_1	y_2	y_3	y_4
	x_1	0.988	0.01	0.002	0
	x_2	0.01	0.978	0.01	0.002
input symbol					
	x_3	0.002	0.01	0.978	0.01
	x_4	0	0.002	0.01	0.988

Source symbols are a priori equiprobable.

Calculate the source entropy, the equivocation and the mutual information. **[12]**

(c) What proportion of the received symbols will be in error? **[5]**

Q4 An automated process is monitored at millisecond intervals to determine which of 8 possible mutually-exclusive states the process is in at each interval. Over the course of 1 minute, the process is, on average, found to be in each state as follows:

state 1: 30000	2: 12000	3: 7200	4: 3600
5: 3000	6: 1800	7: 1200	8: 1200

(a) Derive a Huffman low-redundancy code that can be used to transmit the information to the central controller and calculate the code efficiency. Compare this with the Shannon-Fano code. **[10]**

(b) What transmission rate is required to convey the coded data to the central controller? **[1]**

(c) A parity-check code has the parity-check matrix given as follows: **[9]**

$$H = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \end{bmatrix}$$

i) Determine the generator matrix G.

ii) If the received word is 110110. Decode this received word.

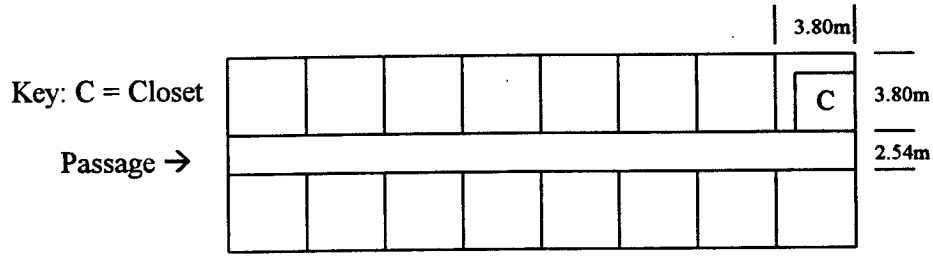
Q5 (a) Briefly describe the operation of the following link protocols: **[12]**

- Idle RQ
- Selective repeat
- Go-back-N

(b) A series of 1000-bit frames is to be transmitted across a data link 100 km in length at 20 Mbps. If the link has velocity of propagation of 2×10^8 ms^{-1} and a BER of 4×10^{-5}, determine the link utilization using the link protocols in (a) above with a send window of 10. **[8]**

Q6 (a) Discuss the concept of Open Systems for Interconnection (OSI) and describe its seven-layers, stating briefly the underlying functions of each layer. **[7]**

(b) A 10-story office building has the floor plan shown below for each floor. A local network is to be installed that will allow attachment of a device from each office on each floor. Attachment is to take place along the outside wall at the baseboard. UTP or Optical cables can be run vertically through the indicated closet or horizontally along the baseboards. The height of each story is 3m. Make a design of the network based on Intermediate and header Ethernet Hubs assume a 10Mbps data rate. **[13]**



Q7 With reference to the CSMA/CD protocol: [20]

a) Discuss the basic operation of CSMA/CD both for non-persistent, 1-persistent and p-persistent modes

- the purpose of the jamming signal
- the operation of the backoff algorithm

b) What performance measures are often used for LANs?

c) Given a LAN segment of length 200m and a data rate of 10Mbps, how many bits would have been transmitted before a collision is detected? Assuming a frame of 1000 bits. What effects do these bits have in the operations of the protocol?

Q8 With respect to the TCP/IP protocol, discuss the following: [20]

- TCP/IP Layering
- Internet address format
- Encapsulation and MTU
- Address resolution protocol
- IP routing principles
- Domain Name System
- The difference between UDP and TCP (give examples of application for each service)

END OF EE581 EXAMINATIONS

The Complementary Error Function $Q(z)$

$$Q(z) = \frac{1}{\sqrt{2\pi}} \int_z^\infty e^{-\lambda^2/2}\, d\lambda$$

$$Q(0) = \tfrac{1}{2} \qquad Q(-z) = 1 - Q(z) \qquad z \geq 0$$

$$Q(z) = \tfrac{1}{2} - \operatorname{erf}(z)$$

$$\operatorname{erf}(z) = \frac{1}{\sqrt{2\pi}} \int_0^z e^{-\lambda^2/2}\, d\lambda$$

$$Q(z) \approx \frac{1}{\sqrt{2\pi}\, z} e^{-z^2/2} \qquad z \gg 1 \ (z > 4)$$

Table C-1 $Q(z)$

z	$Q(z)$	z	$Q(z)$	z	$Q(z)$	z	$Q(z)$
0.00	0.5000	1.00	0.1587	2.00	0.0228	3.00	0.00135
0.05	0.4801	1.05	0.1469	2.05	0.0202	3.05	0.00114
0.10	0.4602	1.10	0.1357	2.10	0.0179	3.10	0.00097
0.15	0.4404	1.15	0.1251	2.15	0.0158	3.15	0.00082
0.20	0.4207	1.20	0.1151	2.20	0.0139	3.20	0.00069
0.25	0.4013	1.25	0.1056	2.25	0.0122	3.25	0.00058
0.30	0.3821	1.30	0.0968	2.30	0.0107	3.30	0.00048
0.35	0.3632	1.35	0.0885	2.35	0.0094	3.35	0.00040
0.40	0.3446	1.40	0.0808	2.40	0.0082	3.40	0.00034
0.45	0.3264	1.45	0.0735	2.45	0.0071	3.45	0.00028
0.50	0.3085	1.50	0.0668	2.50	0.0062	3.50	0.00023
0.55	0.2912	1.55	0.0606	2.55	0.0054	3.55	0.00019
0.60	0.2743	1.60	0.0548	2.60	0.0047	3.60	0.00016
0.65	0.2578	1.65	0.0495	2.65	0.0040	3.65	0.00013
0.70	0.2420	1.70	0.0446	2.70	0.0035	3.70	0.00011
0.75	0.2266	1.75	0.0401	2.75	0.0030	3.75	0.00009
0.80	0.2169	1.80	0.0359	2.80	0.0026	3.80	0.00007
0.85	0.1977	1.85	0.0322	2.85	0.0022	3.85	0.00006
0.90	0.1841	1.90	0.0287	2.90	0.0019	3.90	0.00005
0.95	0.1711	1.95	0.0256	2.95	0.0016	3.95	0.00004
4.00	0.00003						
4.25	10^{-5}						
4.75	10^{-6}						
5.20	10^{-7}						
5.60	10^{-8}						

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY SPECIAL DEFERRED EXAMINATIONS OCTOBER 1997

EG 212 - ENGINEERING WORKSHOP TECHNOLOGY

TIME: THREE (3) HOURS

ANSWER: ALL 4 SECTIONS **CLOSED BOOK**

ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET

The University of Zambia
School of Engineering
EG212 – Engineering Workshop Technology
University Deferred Examinations – October 1997

Section Surveying Engineering (25 marks) (Closed book)

Answer this section on a separate answer booklet
Answer all four questions

1. Give definitions of the following terms:

   a. Photogrammetry
   b. GPS

(5 marks)

2. Solve the following problem:

   Given the co-ordinates of point F (643550,8298066) and the following bearing and distance to point G:

   φ_{FG} = 31.4 degrees , D_{FG} = 288.12 m,

   calculate the co-ordinates of G. Round off the co-ordinates to meters.

(6 marks)

3. What are the basic measurements we can obtain from a

   a. Theodolite
   b. Level
   c. Image scanner

(2+2+2 marks)

4. Indicate whether the statements below are 'TRUE' or 'FALSE'. Give an explanation for each answer.

   a. In geodetic surveying we assume the earth is a spheroid.
   b. Repetition of measurements is carried out to eliminate possible errors.
   c. In photogrammetry photos are always taken vertically from the aircraft.
   d. GIS integrates different outputs from surveying sources.

(2+2+2+2 marks)

End of section Surveying Engineering

SECTION B: ELECTRICAL ENGINEERING WORKSHOP (25 MARKS)

ANSWER ALL THREE QUESTIONS.

1. Give five practical applications of electronic circuits and five applications for electric motors in domestic, commercial and industrial environments. (10 marks)

2. Describe the major differences between TN-S, TN-C and TT forms of earthing of an electrical distribution system in terms of the neutral and protective functions. Clearly show differences using sketches. (10 marks)

3. Why are circuit breakers and fuses used in supplies for electric power and electronic circuits. How can we ensure that the step and touch potentials are within safe limits for all equipment in workshop or laboratory. (5 marks)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

SPECIAL DEFERRED EXAMINATIONS
EG 212 - ENGINEERING WORKSHOP TECHNOLOGY

SECTION C: CIVIL ENGINEERING WORKSHOP
ANSWER ONLY ONE QUESTION FROM THIS SECTION

Q1. (a) What types of masonry units may be used for construction of walls? Briefly explain the relative advantages of using each compared to others. (5 marks)

(b) List four main uses of timber in Zambia. (4 marks)

(c) What are the four common defects of Timber? (4 marks)

(d) Write short notes on the following: (12 marks)

(i) Lump-sum contract
(ii) Cost-Reimbursable contract
(iii) Direct-Labour contract

Q2. (i) Define the term `design' as used in civil engineering . (5 marks)

(ii) State and briefly explain the different stages involved in the process of design. (6 marks)

(iii) Where do loads on engineering structures come from? Explain why we use factors of safety in design. (6 marks)

(iv) List the common construction materials used in civil engineering and for each material indicate its general material properties. (8 marks)

SECTION D: MECHANICAL ENGINEERING WORKSHOP (25 MARKS)
ANSWER BOTH QUESTIONS.

Q1. (a) List any 8 of the 12 most common methods of accident reduction. (8 marks)

(b) List the 5 areas safety deals with, according to the Factories' act and safety provision. (5 marks)

(c) State the 6 most important hazard prevention tenets, when operating a lathe machine. (6 marks)

Q2. (a) State the 4 main types of forging. (4 marks)

(b) State 2 advantages of forging over machining. (2 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
UNIVERSITY EXAMINATIONS - SEMESTER II
SEPTEMBER 1998

EG 212 - ENGINEERING WORKSHOP TECHNOLOGY

TIME: THREE (3) HOURS
ANSWER: ALL 4 SECTIONS **CLOSED BOOK**
ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET

SECTION A: SURVEYING **(25 MARKS)**

ANSWER ALL THREE QUESTIONS.

Question 1

(a) State three angular measurement systems used in surveying. (3 marks)

(b) Given that the coordinates of A and B are (62578.89m, 86543.76m) and (62425.21m, 86765.98m) respectively.
Compute:

(i) The bearing of line AB (3 marks)
(ii) The length of line AB (3 marks)

Question 2

(a) Define 'Levelling'. (2 marks)

(b) In order to determine reduced levels of points, a level survey was conducted between BM1 and BM2 and the following data was obtained.

Pnt	BS	IS	FS	RISE	FALL	RL	REMARKS
BM1	1.21					**1248.323**	**BM1**
1		0.654					
2		0.987					
3	2.876		0.473				**CP**
4		1.89					
BM2			2.122			**1249.814**	**BM2**

Complete the table, apply the usual checks and state the actual misclosure. (10 marks)

Question 3

Mention two advantages of each of the following: -

(a) GIS over paper maps (3 marks)

(b) GPS over traditional field survey methods (3 marks)

SECTION B: ELECTRICAL ENGINEERING WORKSHOP (25 MARKS)

ANSWER ALL THREE QUESTIONS.

Question 4

(a) Briefly describe the three-letter designation of an earthing system. (3 marks)

(b) Draw sketches for the TN-C and TN-C-S earthing system. (3 marks)

(c) Why is it important to effectively earth all metallic bodies of electrical appliances and machines in the home and workshops. (3 marks)

(d) If your mother is complaining of the pots giving her electric shocks when cooking. How would you solve the problem? (3 marks)

Question 5

(a) Draw a labeled diagram of the hierarchical structure of a National Public Switched Telecommunication Network (PSTN). (4 marks)

(b) Using a sketch show the relationship between Tele-services and the Transmission Bearer Network. (3 marks)

Question 6

(a) Draw a typical reliability failure-rate curve for a technological system with three regions of service life. Define failure rate. (3 marks)

(b) Give the reliability expressions for n-series components and m-parallel components of different constant failure rates (3 marks)

SECTION C: CIVIL ENGINEERING WORKSHOP (25 MARKS)

ANSWER BOTH QUESTIONS.

Question 7

(a) Describe the major groups of activities that members of the civil engineering profession are engaged n. Give specific examples under each group. Use sketches wherever helpful. (7 marks)

(b) Define or describe the following: (5 marks)

(i) Architecture
(ii) Specifications
(iii) Concrete
(iv) Termite proofing of houses
(v) Zoning

Question 8

(a) List the kind of information / data you would need to gather if you were planning to put up a block of flats. Present the information in categories such as market information, user information, social and recreational, etc. (7 marks)

(b) Sketch a cross-section of a wall in a typical one storey concrete-cum-brick building. Label all the significant parts. (6 marks)

SECTION D: MECHANICAL ENGINEERING WORKSHOP (25 MARKS)

ANSWER BOTH QUESTIONS.

Question 9

With help of clearly labeled sketches, discuss green sand casting. (13 marks)

Question 10

(a) Give an outline of commonly used workshop processes for metal removal. (7 marks)

(b) Discuss the importance of workshop safety. (6 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEFERRED EXAMINATIONS
OCTOBER 1998

EG 212 - ENGINEERING WORKSHOP TECHNOLOGY

TIME: THREE (3) HOURS
ANSWER: ALL 4 SECTIONS CLOSED BOOK
ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET

SECTION A: SURVEYING (25 MARKS)
ANSWER ALL FOUR QUESTIONS.

Q1. There are two distinct areas in photogrammetry. Briefly describe these two areas.

(5 marks)

Q2. A levelling exercise was done near the Goma lakes and data collected was as shown below:

Pt	READINGS			DIST				RED.	
Nr	BS		FS	BS	FS	RISE	FALL	LEVEL	
A	0.538			40.2				1193.438	
1	1.170		1.397	35.4	39.7				
2	2.436		2.633	33.2	36.0				
3	2.415		2.198	31.7	34.3				
4	1.300		1.967	25.7	30.9				
B			1.528		24.9			1191.574	

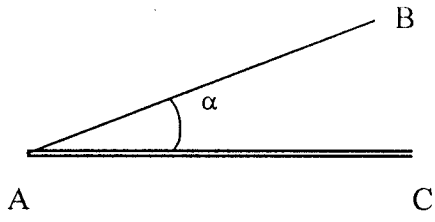
Fill in the form and determine the reduced levels of points 1 to 4.

(8 marks)

Q3. In map making five essential features can be noted viz: 1) PROJECTION 2) REDUCTION 3) GENERALISATION 4) ENHANCEMENT 5) EXPLANATION
Describe your understanding of 3 of these terms.

(6 marks)

Q4. Measurement was made from a known point (A) as follows



The distance between A and B is 60.00m and angle $\alpha = 30°$. The bearing A to C is 75°. Find the coordinates of point B given that the coordinates of A (E=100.00m, N=50.00m).

(6 marks)

SECTION B: ELECTRICAL ENGINEERING WORKSHOP (25 MARKS)

ANSWER ALL THREE QUESTIONS.

Q5. (a) Draw a labelled diagram of the hierarchical structure of a National Public Switched Telecommunication Network (PSTN). (4 marks)

(b) Using a sketch show the relationship between Teleservices and the Transmission Bearer Network. (2 marks)

Q6. (a) Briefly describe the three letter designation of an earthling system. (3 marks)

(b) Draw sketches for the TN-C and TN-C-S earthling system. (3 marks)

(c) Why is it important to effectively earth all metallic bodies of electrical appliances and machines in the home and workshops. (3 marks)

(d) If your mother is complaining of the pots giving her electric shock when cooking. How would you solve the problem? (3 marks)

Q7. (a) Draw a typical reliability failure-rate curve for a technological system with three regions of service life. Define failure rate. (4 marks)

(b) Give the reliability expressions for n-series components and m-parallel components of different constant failure rates (3 marks)

SECTION C: CIVIL ENGINEERING WORKSHOP (25 MARKS)

ANSWER THE QUESTION.

Q8. It is proposed to put up a 2-roomed store room just adjacent to the new school of engineering building. Sketch the drawings required to put up the structure. You are free to make reasonable assumptions. (25 marks)

SECTION D: MECHANICAL ENGINEERING WORKSHOP (25 MARKS) – ANSWER BOTH QUESTIONS.

Q9. Discuss each of the following:

a. Aluminum scrap selection, preparation and melting for non-ferrous casting. (4 marks)

b. Mould preparation for casting a solid block. (4 marks)

c. Defects associated with aluminum castings. (4 marks)

Q10. With help of clearly labeled sketches, discuss the following:

a. Drilling (6 marks)

b. Single point turning. (7 marks)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

UNIVERSITY EXAMINATIONS - SEPTEMBER 1998

EG 279 - INTRODUCTION TO COMPUTING

TIME: **THREE HOURS**

INSTRUCTIONS: **ANSWER ANY FIVE (5) QUESTIONS.**

QUESTION ONE:

A) Write brief notes on the following:

(i) Computer Hardware
(ii) System Software
(iii) Application Software
(iv) Fourth Generation Languages (4 GLs)
(v) Expert Systems

B) Answer all the five (5) questions, (i) to (v), below:

(i) Name any TWO (2) types of Spreadsheet Packages.
(ii) Name any TWO (2) types of Word Processing Packages.
(iii) Name any TWO (2) Operating Systems.
(iv) What is a DATA BASE MANAGEMENT SYSTEM (DBMS)?
(v) What is the meaning of the term, "High Level Language"?

QUESTION TWO:

A) With the help of a diagram, describe the FLOW of data and commands in a Computer System.

B) Why is storage divided into main storage and backing storage, especially with respect to the way data is stored and processed?

C) What is CACHE memory and how is it used in Data Processing?

D) Outline possible advantages and disadvantages of using a BATCH PROCESS.

QUESTION THREE:

A) A Computer System is said to be input/output (I/O) bound if the CPU has to wait for the input/output (I/O) devices to complete their work. It is said to be Processor bound if input/output has to wait for the Processor to process instructions. Both input/output (I/O) and Processor boundedness hinder the productivity of a Computer System.

(i) State any TWO (2) techniques that can resolve one or both the high-lighted problems.
(ii) Explain CLEARLY and in DETAIL how each of the suggested techniques, in (i) above, can be used to resolve the problem(s).

B) A Computer Science department in a certain University has written to you for advise on the choice of a translator program to be used with a programming language for teaching computer programming to first year students. Their aim is to teach a high level language such as pascal in a microcomputer environment. They expect the translator program together with its entire software environment to support interactive program debugging, traceable program execution and ease of control of programs during execution. You are further informed that the microcomputers have a reasonable big internal memory and have a high processing speed.

You are expected to advise on whether a Compiler or an Interpreter should be bought for the programming language. List five (5) main reasons, explaining each of them briefly, in support of your choice.

QUESTION FOUR:

A) Construct a flowchart to read from an input file and report how many characters are in the file. The number of characters counted and reported should not include spaces.

B) The company only offers 10% discounts to trade customers who have been customers for over one year, but other trade customers receive 5% discount. Those who are not trade customers receive NO discount at all. Construct a pseudocode and a flowchart for the above narration.

C) A person should never go to work if it is raining and in december. If he does go to work, he should take an umbrella when it is raining and an overcoat when it is windy. Unless it is windy, he must always take his hat when going to work. If it is windy and in december he should switch on his central heating. Construct a decision table for the above narration.

QUESTION FIVE:

A) State and briefly explain six (6) programming aims which programmers try to achieve when constructing good and efficient programs.

B) State and briefly explain any four (4) data types used in pascal programming.

C) State and briefly explain three (3) types of errors found in programming.

D) State any four (4) advantages/reasons which make sub-programs important and powerful tools in Computer Programming.

E) Explain the following terms:
   (i) A compound statement
   (ii) A null statement
   (iii) An identifier

QUESTION SIX:

A) a) What is the syntax of each of the following repetitive statements?
   (i) WHILE – STATEMENT
   (ii) REPEAT – STATEMENT
   (iii) FOR – STATEMENT

   b) State the differences among the three (3) repetitive statements above, with respect to the situations/conditions in which each one of them could be used.

B) (i) Trace the following program and give its output, EXACTLY as it would appear on the screen.

```
PROGRAM HELLO;
VAR  COUNT: INTEGER;
BEGIN
        COUNT := 1;
        WHILE  COUNT  <=  5  DO
        BEGIN
                WRITELN ('HELLO AND GOODBYE!');
                COUNT := COUNT + 1
        END;
        WRITELN;
        WRITELN ('THIS IS THE END!')
END.
```

(ii) Re-write the program in (i) above using a REPEAT – STATEMENT.

(iii) Re-write the program in (i) above using a FOR – STATEMENT.

QUESTION SEVEN:

A) Write a pascal program that reads a list of real numbers on one line and prints the smallest number in the list. The output should be similar to the following format:

The smallest number in the list is 'a'.

Where 'a' is the smallest number in the list.

B) Write a pascal program that uses an internal SUB-PROGRAM to calculate the area of a circle. The program should ask for the radius and the calculated area should be output by the main program.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS - SEPTEMBER, '98
EG 475
ENGINEERING, MANAGEMENT AND SOCIETY I

INSTRUCTIONS **ATTEMPT FIVE QUESTIONS WITH AT LEAST ONE QUESTION FROM EACH SECTION. ANSWER EACH SECTION IN A SEPARATE ANSWER BOOKLET.**

TIME: **THREE (3) HOURS**

SECTION A

Q1. (a) What do you understand by the term 'development'? Why is a strictly economic definition of development inadequate? (7 MARKS)

(b) Describe two ways of measuring development, indicating their advantages and disadvantages? (6 MARKS)

(c) *"'Inequality' in a word characterizes the relationship between the developed world and the developing world."*

Elaborate on this statement (7 MARKS)

Q2. (a) *The Harrod-Domar equation – the core of the Harrod-Domar growth model – reads as follows:* $\frac{\Delta Y}{Y} = \frac{s}{k}$

What does the equation say? (5 MARKS)

(b) *The fundamental trick in linear growth models - such as the Harrod Domar model - is to simply increase the proportion of national income not consumed and to re-invest this proportion in additional capital goods such as, for example, machines.*

If growth of the national economy is apparently so easy to achieve, why is it that so many African countries struggle to achieve acceptable growth percentages of their economies? (7 MARKS)

(c) *In the 1960s and 1970s economist designed growth models based on the European experience with the transition from an agricultural to an industrial society. One of these growth models is the two-sector surplus labour theory (Lewis).*

Give a brief description of the two-sector surplus labour (8 MARKS)

Q3. (a) *Human resources, rather than the passive factors of production capital and natural resources determine the character and speed of emancipatory development. The major mechanism to develop human resources is through formal education.*

State and briefly explain the variables which affect the demand for education in a country. (12 MARKS)

(b) *Education involves opportunity costs for the parents. For example the choice of letting a child go to school or to let it help to harvest the maize crop. Usually, the opportunity costs of education in rural areas are high because at certain times in the year parents need all available hands for agricultural work.*

How do these high opportunity costs affect students from traditional –poor- backgrounds as compared to students from elite families? (8 MARKS)

SECTION B

Q4. (a) Describe the process of industrial transformation as observed from 1780 onwards in the Western world. Use hypothetical data to illustrate the shifts in the shares of labour force in agriculture, industry and services? (7 MARKS)

State and explain reasons why countries consider industrial development desirable? (7 MARKS)

(b) *The shares in national income of the Zambian agricultural, industrial and services sectors are respectively 18%, 34% and 48%. The share of the Zambian manufacturing sector in national income equals 12%. In total 18.5% of the formal sector labour force is employed in industry.*

Would Sutcliffe consider Zambia an industrialized country? Explain your answer. What could account for a 'high' industrial share of Zambia's income and yet a small manufacturing sector share. (6 MARKS)

Q5. (a) Which options does a developing country have to accumulate capital? (5 MARKS)

(b) Define import substitution industrialization. (2 MARKS)
Discuss reasons why import substitution, combined with public investment, generally fails to boost industrial development. (7 MARKS)

(c) What strategy elements would you incorporate in a Zambian industrial policy? Justify your answer. (6 MARKS)

Q6. (a) *Deterioration of the environment has become a major threat to the biosphere in the last 20 years.*

Outline the major areas of concern due to industrialization. (8 MARKS)

(b) *In seeking Ecologically Sustainable Industrial Development (ESID), the United Nations Industrial Development Organization (UNIDO) proposes as one of the criteria, 'promotion of equity'.*

In this context, discuss the various aspects of this issue of equity? (8 MARKS)

List the hierarchy of pollutant reduction measures advocated in the new concept of 'cleaner production' (4 MARKS)

SECTION C

Q7. (a) Define the following terms
(i) know-how
(ii) appropriate technology
(iii) technology capability
(iv) invention
(v) innovation

(5 MARKS)

(b) A number of models have been proposed to delineate the process of indigenous technology development.

Outline two linear models and indicate the policy implications of these models. (8 MARKS)

(c) List and define five channels of international technology transfer. (7 MARKS)

SECTION D

Q8. (a) Briefly outline the history of the Engineering Institution of Zambia (8 MARKS)

(b) Briefly explain the main components of the code of ethics. What are the main barriers to adherence? (6 MARKS)

(c) How did the Engineering Registration Board (ERB) evolve and what are the main advantages of being registered with ERB? (6 MARKS)

END OF EXAM

UNIVERSITY OF ZAMBIA
UNIVERSITY DEFERRED/SUPPLEMENTARY EXAMINATIONS - OCTOBER, '98
EG 475
ENGINEERING, MANAGEMENT AND SOCIETY I

INSTRUCTIONS **ATTEMPT FIVE QUESTIONS WITH AT LEAST ONE QUESTION FROM EACH SECTION. ANSWER SECTION D IN A SEPARATE ANSWER BOOKLET.**

TIME: **THREE (3) HOURS**

SECTION A

Q1. (a) What is development and how can it be measured?
(5 MARKS)

(b) *The fundamental trick in linear growth models - such as the Harrod Domar model - is to simply increase the proportion of national income not consumed and to re-invest this proportion in additional capital goods such as, for example, machines.*

If growth of the national economy is apparently so easy to achieve, why is it that so many African countries struggle to achieve acceptable growth percentages of their economies?
(7 MARKS)

(c) *In the 1960s and 1970s economist designed growth models based on the European experience with the transition from an agricultural to an industrial society. One of these growth models is the two-sector surplus labour theory (Lewis).*

Give a brief description of the two-sector surplus labour
(8 MARKS)

Q2. (a) State and distinguish three types of unemployment. (6 MARKS)

(b) What are the major causes of unemployment in the Third World?
(8 MARKS)

(c) What measures can the Zambian Government take to try to reverse the growth of unemployment?
(6 MARKS)

SECTION B

Q3. (a) Describe in quantitative terms the typical transformation process from the agrarian society into the post-industrial society?

(7 MARKS)

(b) Why is it that late starters in the industrialization race do not get the same high benefits as the earlier starters of the 19th century?

(7 MARKS)

(c) *The shares in national income of the Zambian agricultural industrial and services sectors are respectively 18%, 34% and 48%. The share of the Zambian manufacturing sector in national income equals 12%. In total 18.5% of the formal sector labour force is employed in industry.*

Would Sutcliffe consider Zambia an industrialized country? Explain your answer. What could account for a high industrial share of Zambia's income and yet a small manufacturing sector share.

(6 MARKS)

Q4. (a) *Deterioration of the environment has become a major threat to the biosphere in the last 20 years.*

Outline the major areas of concern due to industrialization.

(b) *In Sachs' Ecologically Sustainable Development [illegible] equity*

In this context, discuss the various aspects of this issue of equity?

(8 MARKS)

List the hierarchy of pollutant reduction measures advocated in the new concept of 'cleaner production'

(4 MARKS)

SECTION C

Q5. (a) In most technology transfer deals, a developed country sells technology and the developing country buys it. Why, then, do we normally speak of 'transfer' and not 'purchase'?

(5 MARKS)

(b) Some countries have achieved high rates of success in development vis-à-vis technology transfer.

List six factors that favour technology transfer. (8 MARKS)

(c) What policies would you recommend to the Zambian Government to promote indigenous technology development? Give reasons for your policies.

(7 MARKS)

SECTION D

Q6. (a) What are the main differences between a Graduate Engineer and a Professional Engineer in Zambia? (4 MARKS)

(b) List the various classes of membership in the Engineering Institution of Zambia (EIZ). (3 MARKS)

Describe in detail the requirements for:

(i) Student Member (2 MARKS)

(ii) Member (2 MARKS)

(c) How did the Engineer's Registration Board (ERB) evolve? What are the roles of the ERB? (4 MARKS)

(d) Assume you are a fresh graduate Civil Engineer from UNZA, employed by a Registered Consulting Engineering firm. You are given full responsibility (design and supervision) for construction of a two-storey residential block of flats. Three months after completion of the project, a floor collapses killing three people. The owner and family sue your company. On what basis would your company be liable? (5 MARKS)

END OF EXAM

UNIVERSITY OF ZAMBIA
SECOND SEMESTER FINAL EXAMINATIONS
AUGUST/SEPTEMBER, 1998
EM 212 ENGINEERING MATHEMATICS II

INSTRUCTIONS: ATTEMPT ANY FIVE (5) QUESTIONS
TIME:THREE (3) HOURS

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1. Given the matrices

$$A = \begin{pmatrix} 1 & 0 & -1 \\ 3 & 4 & 5 \\ 0 & -6 & -7 \end{pmatrix} \quad , \quad B = \begin{pmatrix} 1 & -1 & 2 & -5 \\ -1 & 0 & 3 & 0 \\ 2 & 1 & 0 & 1 \end{pmatrix}$$

   (a) Find (i) adj A, (ii) A^{-1}.

   (b) Find the reduced echelon form of B, indicating at each step the row operation being used. Hence, or otherwise, solve the system of equations

$$\begin{aligned} -x \quad\quad + 3z &= 0 \\ 2x + y \quad\quad &= 1 \\ x - y + 2z &= -5 \end{aligned}$$

   (c) Find the general solution of

$$ye^{x+y}dy = dx$$

2. (a) Given the transformation

$$x = \ln(u+v) \quad , \quad y = \ln(uv),$$

   (i) compute the Jacobian $J(u,v)$,
   (ii) evaluate the partial derivatives $\frac{\partial u}{\partial x}$ and $\frac{\partial v}{\partial x}$ in terms of u and v.

   (b) Given that

$$w(x,y,z) = \sqrt{x^2+y^2+z^2} \ , \ x = e^r \cos\theta, \ , \ y = e^r \sin\theta \ , \ z = e^\theta,$$

   Find (i) $\frac{\partial w}{\partial \theta}$, (ii) $\frac{\partial w}{\partial r}$ and (iii) $\frac{\partial^2 w}{\partial r \partial \theta}$.

(c) If $w = f\left(\frac{u-v}{v}\right)$, evaluate $u\frac{\partial w}{\partial u} + v\frac{\partial w}{\partial v}$.

3. (a) Show that $(x^2+y^2)^{-1}$ is an integrating factor for the equation

$$xdx + ydy = (x^2+y^2)dx$$

. Hence find the particular solution of the equation if $y(0) = \sqrt{e}$.

(b) Find the particular solution of

$$(1-x^2)y' + xy = 2x \; ; \; y(0) = 1$$

(c) Find the general solution of

$$y'' + y' = x + 2.$$

4. (a) Let $A = \frac{1}{2}ab\sin\theta$ (the area of a triangle with sides a and b seperated by angle θ.) Suppose $\theta = \frac{\pi}{6}$ and a is increased by 4% while b is decreased by 3%. Estimate the percentage change in A.

(b) Suppose $z = f(x,y)$, where $x = at$ and $y = bt$ for constants a and b. Assumming all necessary differentiability, show that

$$\frac{d^2z}{dt^2} = a^2\frac{\partial^2 z}{\partial x^2} + 2ab\frac{\partial^2 z}{\partial x \partial y} + b^2\frac{\partial^2 z}{\partial y^2}$$

(c) Let

$$z = \frac{e^{u-v}}{e^{u+v}} \; ; \; u = \ln\left(\frac{x}{y}\right), v = \ln(xy).$$

Find (i) $\frac{\partial z}{\partial x}$, (ii) $\frac{\partial z}{\partial y}$.

5. (a) Let V be an n-dimensional vector space over a field K.
(i) Define a basis of V.
(ii) If V=$\mathbb{R}^4$, determine whether u, v and w are linearly independent in V, where

$$u = (1,2,2,1) \; , \; v = (3,4,4,3) \; , \; w = (1,0,0,1).$$

(b) Find all the eigenvalues of A and an eigenvector corresponding eigenvalue where

$$A = \begin{pmatrix} 2 & 0 & 1 \\ -1 & 4 & -1 \\ -1 & 2 & 0 \end{pmatrix}$$

6. (a) i. Determine whether the set of polynomials $\{x+2, x^3-2x, x^3+4\}$ is linearly independent in P_3.

ii. Given that $H = \{(x,y) : y = mx^2, x \in \mathbb{R}$, and m is a fixed number$\}$; $V = \mathbb{R}^2$, determine whether or not H is a subspace of V.

(b) Show that if

$$P(x,y)dx + Q(x,y)dy = 0$$

is not exact, $e^{\int r(x)dx}$ is an integrating factor of the differential equation provided

$$\frac{1}{Q}\left(\frac{\partial P}{\partial y} - \frac{\partial Q}{\partial x}\right) = r(x)$$

is a function of x alone.

(c) Find the general solution of

$$\sin x \sin y dy = 2\cos x \cos y dx.$$

7. (a) Use differentials to approximate

$$\ln[(1.02)^{\frac{1}{4}} + (0.96)^{\frac{1}{6}} - 1].$$

(b) Given

$$z = x\sqrt{x+y},$$

(i) find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$, (ii) find $f(x,y)$ if $z = f(x,y)$ is the equation of the tangent plane to the surface $z = x\sqrt{x+y}$ at the point $P_0(1,3,2)$.

(c) A level curve of the surface $z = x^2 + 3xy + y^2$ contains the point P, where $x = 1$ and $y = 1$. Find the slope of the tangent line to this curve at P.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER UNIVERSITY EXAMINATIONS
DEFERRED/SUPPLEMENTARY EXAMINATIONS
OCTOBER 1998

EM212 - ENGINEERING MATHEMATICS II

INSTRUCTIONS: 1. Attempt any five(5) questions.
2. Indicate the questions attempted on the answer booklet.

TIME ALLOWED: Three (3) hours.

1. a) Given the matrices

$$A = \begin{pmatrix} 2 & 4 & 6 \\ 4 & 5 & 6 \\ 3 & 1 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 4 & 6 & 18 \\ 4 & 5 & 6 & 24 \\ 3 & 1 & -2 & 4 \end{pmatrix},$$

find (i) adjA, (ii) A^{-1}.

b) Find the reduced echelon form of B in (a) and hence, or otherwise, solve the system of equations

$$\begin{aligned} 2x + 4y + 6z &= 18 \\ 4x + 5y + 6z &= 24 \\ 3x + y - 2z &= 4 \end{aligned}$$

c) Find the general solution of

$$x(x - y)\frac{dy}{dx} = y(x+ y).$$

2. a) Given the transformation

$$x = ulnv, \quad y = vlnu,$$

compute the Jacobian J(u,v).

b) If $w = \sqrt{x^2 + y^2 + z^2}$, $x = e^r \cos\theta$, $y = e^r \sin\theta$ and $z = e^\theta$, find

i) $\frac{\partial w}{\partial \theta}$, (ii) $\frac{\partial w}{\partial r}$, (iii) $\frac{\partial^2 w}{\partial r \partial \theta}$.

c) If $z = xy + f(x^2 + y^2)$, show that

$$y\frac{\partial z}{\partial x} - x\frac{\partial z}{\partial y} = y^2 - x^2.$$

3. Find the general solution of

a) $\frac{dx}{dy}\ln x = \frac{x}{y}$,

b) $(x^2 + y^2)dx = 2xydy$,

c) $y'' - y = \left(\frac{2x-1}{x^2}\right)e^x$.

4. a) Use differentials to approximate the change in the hypotenuse of a right - angled triangle of legs 6m and 8m when the shorter leg is lengthened by $\frac{1}{4}m$ and the longer leg is shortened by $\frac{1}{8}m$.

b) If $z = \frac{e^{u-v}}{e^{u+v}}$, $u = \ln\left(\frac{x}{y}\right)$, $v = \ln(xy)$,

find (i) $\frac{\partial z}{\partial x}$, (ii) $\frac{\partial z}{\partial y}$.

c) If $w = f(u,v)$, where $u = e^x\cos y$, $v = e^x\sin y$, show that

i) $\frac{\partial w}{\partial x} = e^x\left(\frac{\partial w}{\partial u}\cos y + \frac{\partial w}{\partial v}\sin y\right)$, and

ii) $\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} = e^{2x}\left(\frac{\partial^2 w}{\partial u^2} + \frac{\partial^2 w}{\partial v^2}\right)$.

5. a) Define a basis of an n-dimensional vector space V over a field K.

b) Determine whether

$u = (1,2,2,1)$, $v = (3,4,4,3)$, $w = (1,0,0,1)$ are linearly independent in $\mathbf{R}^4$.

c) Find all the eigenvalues of A and an eigenvector corresponding to each eigenvalue where

$$A = \begin{pmatrix} 5 & 4 & 1 \\ -6 & -2 & 3 \\ 8 & 8 & 3 \end{pmatrix}.$$

6. a) Determine whether the set of polynomials $\{x - 2,\ x^3 - x,\ x^3 + 4\}$ is linearly independent in P_3.

b) Determine whether on not H is a subspace of V if

i) $H = \{(x,y): y = 3x + 1,\ x \in \mathbf{R}\}$; $V = \mathbf{R}^2$.

ii) $H = \left\{\begin{pmatrix} 0 & x \\ y & 0 \end{pmatrix} : x, y \in R\right\}$; $V = M_{22}$.

iii) $H = \left\{\begin{pmatrix} 1 & x \\ y & 1 \end{pmatrix}; x, y \in R\right\}$; $V = M_{22}$.

c) Show that $\phi(x) = e^{\int p(x)dx}$ is an integrating factor of the equation

$$P(x)ydx = Q(x)dx - dy,$$

provided $P(x) \neq 0$.

Hence, or otherwise, find the particular solution of

$$(x^2 + 1)\frac{dy}{dx} + 2xy = x;\ \ y(0) = 1.$$

7. a) Find the equation of the tangent plane to the surface

$z = x\sqrt{x+y}$ at the point $P_o(1,3,2)$.

b) A level curve of the surface $z = x^2 = 3xy + y^2$ contains the point P, where $x = 1$, $y = 2$. Find the slope of the tangent line to this curve at P.

c) Use differentials to approximate the volume of a box with square base 800.5mm and height 999.6mm.

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER FINAL EXAMINATIONS - AUGUST/SEPTEMBER, 1998

EM312 - ENGINEERING MATHEMATICS II

INSTRUCTIONS: Answer ANY five (5) questions.
Necessary working must be shown.
TIME ALLOWED: Three (3) Hours.

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1. (a) Find the directional derivative of the function $f(x, y) = \ln(x + 3y)$ at $(2, 4)$ in the direction of $\mathbf{v} = \mathbf{i} + \mathbf{j}$

   (b) Evaluate $\int_0^6 \int_{x/2}^3 e^{x/y}\, dydx$

   (c) Evaluate $I = \int_c [(2x - y + 4)dx + (5y + 3x - 6)dy]$
   around a triangle in the xy plane with vertices at $(0, 0)$, $(3, 0)$, $(3, 2)$ traversed in a counter-clockwise direction.

2. (a) Find the mass of the region corresponding to $x^2 + y^2 + z^2 \leq 4$, $x \geq 0$, $y \geq 0$, $z \geq 0$, if the density is equal to xyz.

   (b) Identify the quadric surface

   $$x - (y - z)\,[1 - (y + z)] = 0.$$

   (c) Find the critical points of the function $f(x, y) = \tan(xy)$ and determine their nature.

3. (a) Evaluate $I = \int_0^{\pi} \int_0^{z^2} \int_{\sqrt{y}}^{z} \frac{1}{x} \sin\frac{y}{x}\, dxdydz.$

   (b) Find a vector equation, parametric equations and symmetric equations for the line passing through $(1, 0, 3)$ and parallel to $\mathbf{i} - \mathbf{j}$.

   (c) Find the maximum value of $w = xyz$ among all pts (x, y, z) lying on the line of intersection of planes $x + y + z = 30$ and $x + y - z = 0$.

4. (a) A plane lamina has the shape of the triangle bounded by the lines $y = x$, $y = 2 - x$, and x - axis. Its density function is given by

$$\rho(x,y) = 4 + 2x + y.$$

Find the centre of mass of the lamina.

(b) Find the maximum and minimum values of xyz if (x, y, z) lies on the ellipsoid

$$\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2 + \left(\frac{z}{c}\right)^2 = 1.$$

(c) Convert $(4, \pi/6, \pi/4)$ from spherical to rectangular coordinates.

5. (a) Use double integration to verify that the area of the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \text{ is given by } A = \pi ab.$$

(b) Compute the divergence and curl of

$$\boldsymbol{F}(x,y,z) = xy\boldsymbol{i} + (z^2 - 2y)\boldsymbol{j} + cosyz\boldsymbol{k}$$

(c) Evaluate $\iint_S (\nabla \times \mathbf{F}).\mathbf{n}\,ds$ when

$\boldsymbol{F} = 2y\boldsymbol{i} + 3x\boldsymbol{j} - z^2\boldsymbol{k}$ where $\boldsymbol{n}$ is the unit normal to the surface S, the upper half surface of the sphere $x^2 + y^2 + z^2 = 9$.

6. (a) A lot of *100* semiconductor chips contains *20* that are defective. Two are selected at random without replacement from the lot.

(i) What is the probability that the first one selected is defective.
(ii) What is the probability that the second one selected is defective given that the first one was defective.

(b) Six married couples are standing in a room. If *4* people are chosen at random, find the probability p that *2* married couples are chosen.

(c) In how many ways can *14* men be partitioned into *6* committees where *2* of the committees contain *3* men and the others *2*?

7. (a) Show that the line integral

$$\int_C \left\{ \left[x^2 y \cos x + 2xy \sin x - y^2 e^x \right] dx + \left[x^2 \sin x - 2ye^x \right] dy \right\}$$

is independent of the path C. Hence evaluate the integral around the hypocycloid

$x^{2/3} + y^{2/3} = a^{2/3}$, where a is some constant.

(b) State the divergence theorem.

(c) Verify the divergence theorem given $\mathbf{v} = x\mathbf{i} + 2y\mathbf{j}$, over the cube

$|x| \leq 1, |y| \leq 1, |z| \leq 1$.

END OF EXAMINATION.

THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER UNIVERSITY EXAMINATIONS
DEFERRED/SUPPLEMENTARY EXAMINATIONS
OCTOBER 1998

EM312 - ENGINEERING MATHEMATICS II

INSTRUCTIONS: Answer any five(5) questions. Necessary working must be shown.

TIME ALLOWED: Three (3) hours.

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1. (a) Find the directional derivative of the function $f(x,y) = \ln[\sin 2xy]$ at the point $\left(1, \frac{\pi}{8}\right)$ in the direction of $\vec{v} = \vec{i} + \vec{j}$.

   (b) Evaluate $I = \int_0^2 \int_0^{z^3} \int_{\sqrt{y/z}}^{z} \frac{e^{y/x^2}}{x^2 z}\, dx\,dy\,dz$

   (c) There are 12 students in a class. In how many ways can the 12 students take 3 different tests if 4 are to take each test?

2. (a) Evaluate $\int_{(0,1)}^{(1,2)} \left[(x^2 - y)dx + (y^2 + x)dy\right]$ along the parabola $x = t, y = t^2 + 1$

   (b) Verify Green's theorem in the plane for

   $I = \int_c [(2x - y + 4)dx + (5y + 3x - 6)dy]$

   where c is a circle of radius 4 with centre at (0,0).

   (c) Convert $\left(\sqrt{6}, \sqrt{2}, 2\sqrt{2}\right)$ from rectangular to spherical coordinates.

3. (a) Two cards are drawn at random from an ordinary pack of 52 cards. Find the probability P that one is a heart and one is a clover given that there are 13 of each type.

   (b) Verify stoke's theorem for

   $\vec{A} = 2y\vec{i} + 3x\vec{j} - z^2\vec{k}$, where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 9$ and C its boundary.

(c) Compute the curl of

$$\vec{F}(x,y,z) = xy\vec{i} + (z^2 - 2y)\vec{j} + \sin yz\vec{k}.$$

4. (a) Find the centroid of the region R bounded by the parabolic cylinder $z = 4 - x^2$ and the planes $x = 0$, $y = 0$ $y = 6$, $z = 0$ assuming constant density.

(b) Find the point(s) on the line $x + 2y = 2$ that is (are) closest to the origin.

(c) Find the divergence of $F(x,y,z) = (z^2 - 2y)\mathbf{i} + \cos yzk$.

5. (a) Find the critical points of the function $f(x,y) = \ln xy$ and determine their nature.

(b) Prove that div curl $\vec{A} = 0$

where $\vec{A} = A_1\vec{i} + A_2\vec{j} + A_3\vec{k}$.

(c) In how many ways can 14 men be partitioned into 6 committees where 2 of the committees contain 3 men and the others 2?

6. (a) The voltage at any point P(x,y,z) on a metal structure is given by

$V(x,y,z) = \dfrac{1}{0.02 + \sqrt{x^2 + y^2 + z^2}}$. At the point (1,-1,2), in what direction does the voltage increase most rapidly?

(b) Identify the quadric surface

$y = x^2 - z^2$.

(c) Evaluate the surface integral

$\iint_s \vec{F}.\vec{n}dA$ by using the divergence theorem,

where $\vec{F} = \vec{i}e^x$ and s is the unit cube with corners at (0,0,0) and (1,1,1).

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS AUGUST 1998

ME 252 ENGINEERING MATERIALS I

ANSWER: FIVE QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

Q1. Describe in detail the various types of atomic bonding that may be found in materials.

Q2. (a) Discuss the effects of the following parameters on the possibility of any given materials to form a solid solution

(i) Relative atomic size
(ii) Chemical affinity
(iii) Relative Valency
(iv) Crystal type

(b) What are the differences between a eutectic system and a eutectoid system.

Q3. Discuss the following:

(a) The acid and basic processes of steel making
(b) Cast Irons

Q4. (a) Discuss the effect of sulphur and phosphorus on steel.

(b) State any two oxide ceramics and describe the differences between them and possible areas of application of each type.

Q5. (a) Sketch and discuss in detail the Iron Carbon phase diagram.

(b) Describe briefly

(i) Addition polymerization
(ii) Condensation polymerization

Q6. **(a)** What are amorphous polymers?
Give examples of at least two of this group of polymers.

(b) What is normalizing?

END OF EXAMINATION **AUGUST 1998**

Dr C K Wamukwamba

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

ME 332 - STRENGTH OF MATERIALS I
UNIVERSITY SUPPLEMENTARY EXAMINATIONS
October 1998

Time: 3 hours. CLOSED BOOK.
ANSWER ALL QUESTIONS!

May the Strength be with You!

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1. A beam, 12 m in length, is simply supported at both ends. It carries a distributed load which increases uniformly from zero value at the left hand end to 40 kN/m at a 3 m position away from the left hand end. Between 3 m and 6 m from the left end, the beam is subjected to a uniform distributed load of 40 kN/m. In addition there is a concentrated load of 3 kN, 2 m away from the right hand end.

   (a) Draw shear force and bending moment diagrams and give the equations for the different parts in terms of the x-coordinate, where x = 0 is at the left hand end.

   (b) Give the values for the greatest positive and negative shear force and bending moment.

(20 Marks)

2. A 50 mm diameter steel shaft XYZ shown in figure Q2 is coupled to an electric motor at X. The motor transmits 50 kW to the shaft at a frequency of 10 Hz. Along the shaft are fitted spur gears Y and Z which remove 30 kW and 20 kW respectively. Draw the torque diagram and calculate the following, taking G_{steel} = 80 GPa:

   (a) the maximum shear stress in the shaft;

   (b) the angle of twist ϕ between the ends of the shaft X and Z.

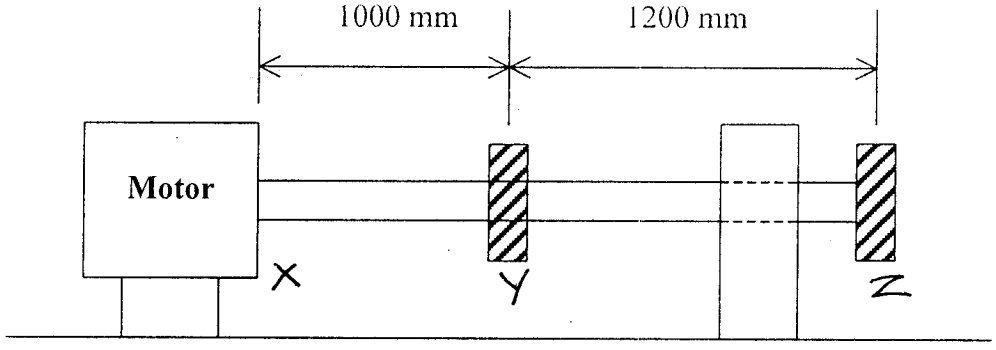

FIGURE Q2

(20 Marks)

3. The right-angled triangle ABC shown in figure Q3 represents planes in an elastic material. The stresses acting are as shown (all units in N/mm^2). There is no stress on the plane perpendicular to planes AC and CB.

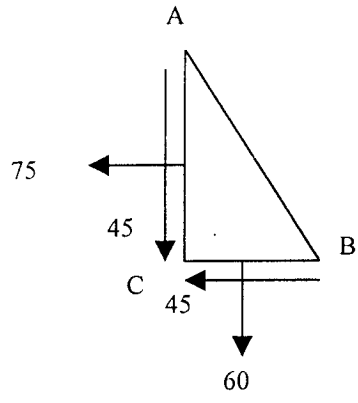

FIGURE Q3

Determine the position of the plane AB when the resultant stress on AB has:

(a) the greatest magnitude;
(b) the least magnitude;
(c) the greatest component normal to AB;
(d) the greatest tangential component along AB; and
(e) the least inclination to AB.

State for each plane found its angular position relative to AC and the magnitude of the stress referred to.

(20 Marks)

4. A steel bar 100 mm long and 20 mm diameter is subjected to an axial compressive stress of 60 MN/m^2 and a sleeve, fitted over the bar, reduces the lateral expansion to one half the unrestricted value. Determine:

(a) the change in diameter of the bar;
(b) the change in length of the bar;
(c) the change in volume of the bar.

Young's Modulus and poisons ratio of the bar material is 200 GN/m^2 and 0.25, respectively.

(20 Marks)

5. A long slender strut of length L is pin jointed at two ends and subjected to an axial compressive load F.

(a) Derive from first principles an expression for the displacement of the strut in the middle when it buckles and an expression for the critical load for the strut to buckle.

(b) If the strut has a rectangular cross-section 40 mm by 50 mm, determine the buckling load using Euler's formula. The strut is 2 m long and E = 200 GN m^{-2}.

(20 Marks)

END OF ME 332 EXAMINATION

Dr. L. Siaminwe

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY SEMESTER II EXAMINATIONS - SEPTEMBER 1998

ME 365 - FLUID MECHANICS AND THERMODYNAMICS
THERMODYNAMICS COMPONENT

TIME: TWO (2) HOURS CLOSED BOO

INSTRUCTIONS: - Answer **Question One** (1) and **Any Two** (2) Others.
- Steam Tables, Mollier charts, Freon Tables and Charts may be used

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

Marking:

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

(i) A control region is any region in space which is separated from its environment by a physica control surface (fixed in shape, position and orientation relative to the observer) across whic both matter and energy can flow. T F

(ii) The entropy change between two states is determined by the process which produces the change T F

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

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

(v) The Joule Cycle efficiency is lower than the Carnot efficiency but higher than the Rankin efficiency. T F

(vi) An isentropic process with a wet vapour can be expressed in terms of $PV^{\gamma} = Const.$ T F

(vii) The air standard cycle for a high-speed compression ignition reciprocating piston engine is th Otto Cycle. T F

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

(ix) 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

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

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

(xii) Generally, a change in internal energy (Δu) is associated with a change in temperature only.
T

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

(xiv) It is possible to device a thermodynamic machine which can function both as a refrigerator an as a heat pump.
T

(xv) At the same compression ratio, the efficiency of the Diesel Cycle is lower than that of the Ott Cycle.
T

(xvi) All vapour power cycle are open systems.
T
[32 marks

Q2. a) Briefly explain why "not all heat passing into (or from) a system is available for conversion int work on a cyclic basis" stating (give statements) any thermodynamic laws which support thi observation.

b) Show that, if feed pump work is neglected, the work done during the Rankine Cycle is given by

$$W = \frac{n}{n-1}(P_1 v_1 - P_2 v_2)$$

Where: P and v are pressure and volume
n is the index of adiabatic expansion
1 and 2 refer to initial and final conditions of the steam

c) Neglecting feed pump work, find the work done in a Rankine Cycle if steam is supplied at 7 ba and 0.95 quality and the condenser pressure is 0.5 bar. Assume the expansion follows the law $Pv^{1.138}$ = Constant. At 7 bar, v_g = 0.273 m³/kg.

[34 marks

Q3. a) Identify the proper type of system (isolated, closed or open) to be used in the analysis of each of the following, and explain (briefly) your reasons.

i) the universe
ii) an electrical generator
iii) a kitchen refrigerator.

b) A mass of gas travelling at velocity 10m/s with free - stream specific enthalpy of 2kJ/kg is accelerated adiabatically to velocity 20m/s without doing external work. What is the resultan specific enthalpy and the final velocity if the isentropic efficiency of the accelerating device is reduced to 0.8?

c) A simple throttled refrigerator operates with Freon-12 between temperatures -20°C and +35°C Calculate

i) the refrigeration effect,

ii) the coefficient of performance,

iii) the coefficient of performance of a reversed Carnot Cycle operating between the sam temperatures.

The following data is available for Freon-12:

T°C	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kg.K)	s_g (kJ/kg.K)
-20	17.82	178.73	0.0731	0.7087
35	69.55	201.45	-	0.6839

[34 marks

Q4. a) A Nickel cylinder, initially at a temperature of 20°C, is introduced into an evacuated constant temperature enclosure and heated to 300°C. The enclosure is maintained at a constan temperature by an electric heater. The current is supplied by a generator. Show by logica thermodynamic argument that the heating process is irreversible.

b) An oil engine operates on the ideal air-Diesel Cycle. The compression ratio is 15:1. The intak conditions are 95kN/m² and 25°C. If the maximum temperature attained during the cycle i limited to 1484°C, show that the adiabatic expansion ratio will be of the order of 7.5:1 if at th end of expansion, the pressure is not to fall below 250kN/m².

Calculate also the thermal efficiency of the cycle. Take the adiabatic index as 1.4 and c_p a 1.004kJ/kg.K.

c) An engineer has invented an automobile engine that operates in a closed cycle, with the workin fluid receiving heat from combustion gases at 1500°C and rejecting heat to ambient air at 25°C He claims that for steady fuel flow of 0.0012 kg/s, his engine can produce 45kW. Evaluate thi claim. Assume that for each kilogram of fuel burned, 44 MJ of heat are transferred into th working fluid.

[34 marks

END OF EXAMINATION - ME365 (Thermodynamics)
Dr A N Ng'andu

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 QUESTION 1 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:

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

(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/m²

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 $c_v = 0.717$kJ/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

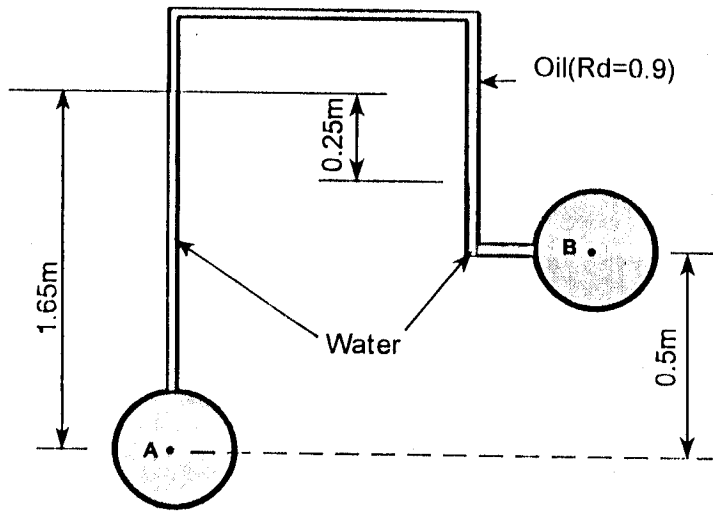


FIGURE1

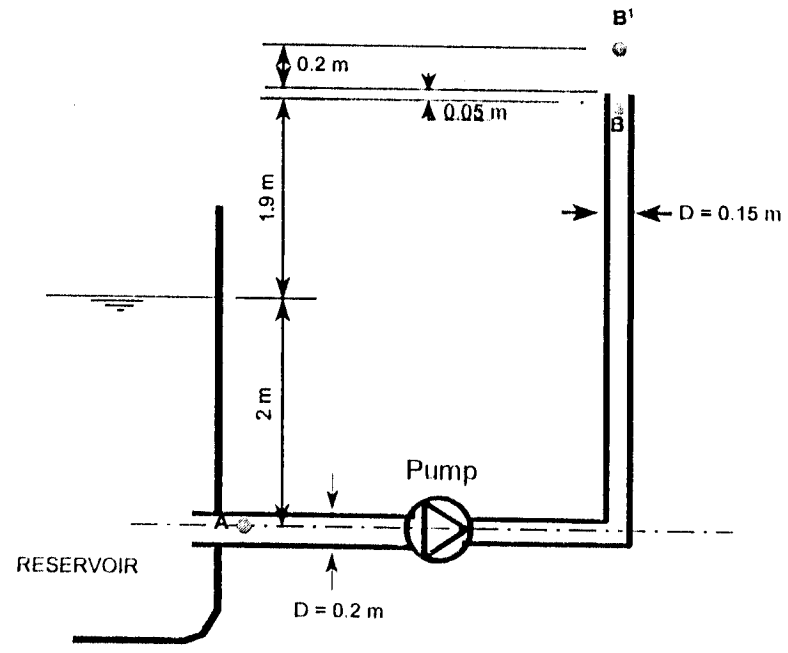


FIGURE 2

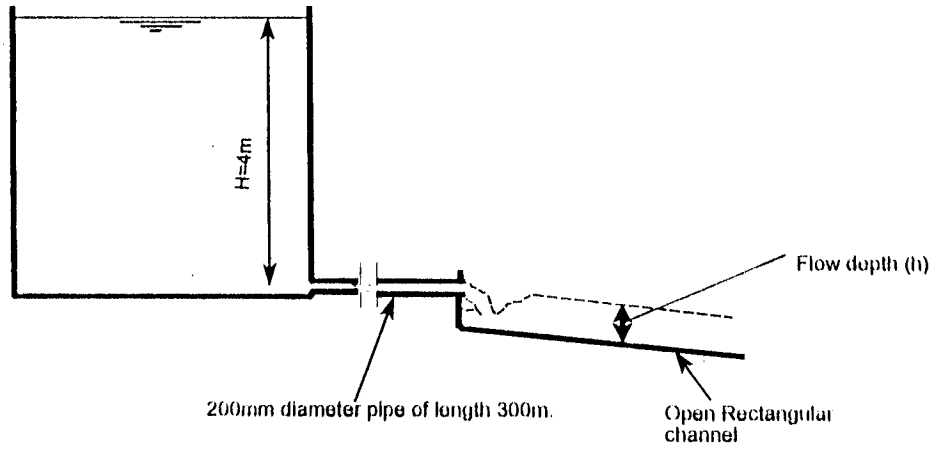

H=4m
Flow depth (h)
200mm diameter pipe of length 300m.
Open Rectangular channel

FIGURE 3

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY SEMESTER 2 EXAMINATIONS - SEPTEMBER 1998

ME 375 - DYNAMICS

ANSWER FIVE (5) QUESTIONS IN TOTAL: - **QUESTIONS 1 AND 2 ARE COMPULSORY;** - **ANSWER ANY THREE (3) OF THE REMAINING FIVE QUESTIONS.**

ALL QUESTIONS CARRY EQUAL MARKS **CLOSED BOOK**

---

note: for all questions, take $g = 9.81\ m/s^2$.

Q1 Given is the crank-slider mechanism shown in Fig. 1. The crank is rotating with a constant speed of 120 rev/min. Its length is 100 mm, while the connecting rod is 600 mm long.

(i) For a crank angle of 30°, determine the absolute velocity of the crosshead P using the method of the instantaneous centre of zero velocity.

(ii) Verify your answer using the method of relative velocity.

Q2 Refer to Fig. 2. In the instant shown, ball P moves downwards along the smooth slot with a velocity of 2 m/s and an upwards acceleration of 3 m/s^2. At the same time the disk rotates with an angular velocity of 3 rad/s clockwise and angular acceleration of 8 rad/s^2 counterclockwise. Determine the acceleration of ball P.

Q3 A particle of mass m = 3 kg slides down a frictionless chute and enters a "loop-the-loop" of diameter d = 300 mm, see Fig. 3. If the angle of the inclined plane $\theta = 50°$, calculate the height h at the start in order that the particle makes a complete circuit in the loop.

Q4 In the quick-return mechanism shown in Fig. 4, the crank AB is driven at a constant angular velocity of 3 rad/s. The slider at B slides along the rod OP, also causing it to oscillate about the hinge O. In turn, OP slides in and out of the slider at P and also moves the second slider pinned at P along the horizontal slot. A cutting tool attached to this second slider will be subjected to a reciprocating motion.
With OD = 500 mm, AB = 150 mm and OA = 300 mm, calculate the velocity of the cutting tool when $\theta = 30°$.

Q5 A block, assumed to be a particle and of mass 4.5 kg, rests on a smooth plane which can turn about the y-axis, see Fig. 5. The length of the cord l is 600 mm.

(i) Calculate the tension in the cord when the angular velocity of the plane and block is 10 rev/min.

(ii) Calculate the angular velocity necessary to cause the block to float just above the plane, and the corresponding tension in the cord.

Q6 In the instant shown in Fig. 6, block A with a mass of 75 kg is moving down with a velocity of 1.5 m/s. The cylinder B of mass 87.5 kg is considered a homogeneous solid, rotating in frictionless bearings. The spring of modulus 875 N/m is originally compressed by 150 mm. The coefficient of kinetic friction between the block C of mass 145 kg and the surface is 0.20.
Calculate the velocity of A after dropping 1.25 m.

p.t.o. for question 7

Q7 Refer to Fig. 7. The bar is assumed massless and the lower spring is attached to the bar midway the points of attachment of the upper springs. Determine the natural undamped frequency of the system, for the following details:
mass m = 5 kg; spring constants: k_1 = 1200 N/m; k_2 = 800 N/m; k_3 = 2000 N/m.

END OF EXAMINATION ME 375 - Ir. H.A. DE KEYZER

Figure 1

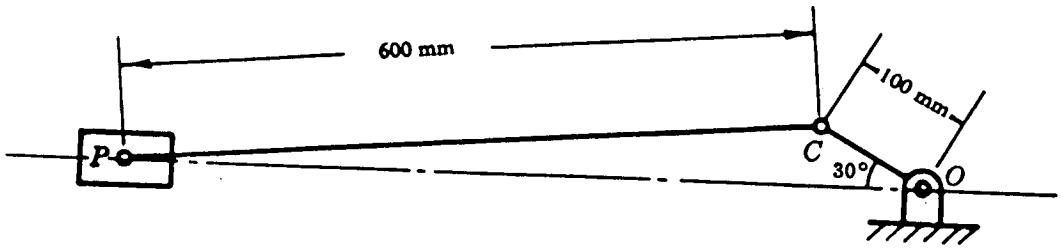
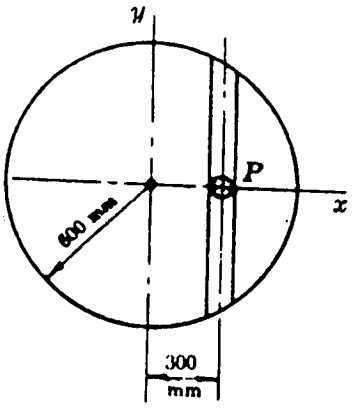


Figure 2



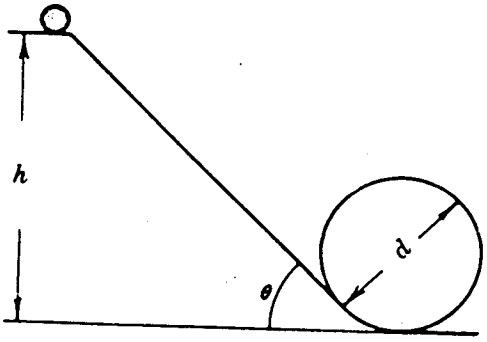


Figure 3

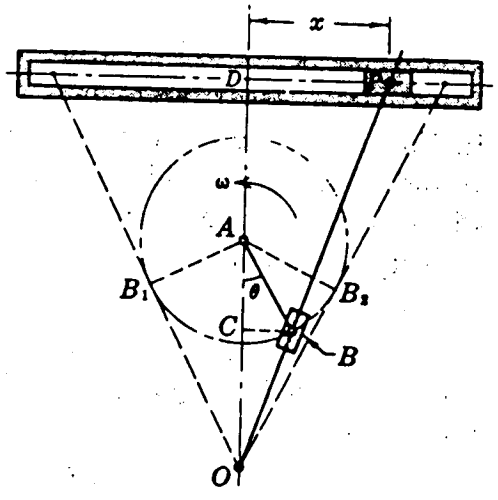


Figure 4

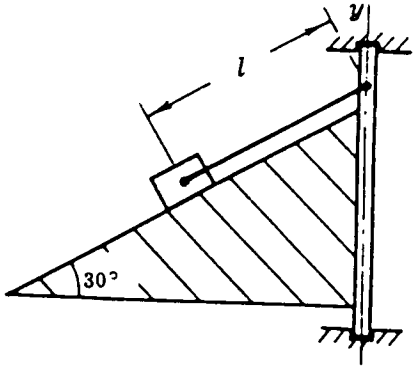


Figure 5

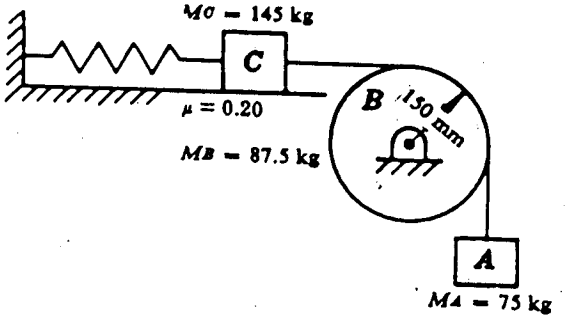


Figure 6

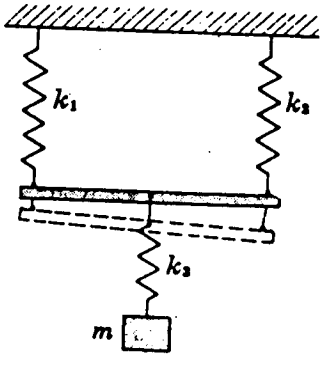


Figure 7

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

SEMESTER II SUPPLEMENTARY/DEFERRED EXAMINATIONS
OCTOBER 1998

ME 405 - MACHINE DESIGN I

PAPER I

TIME: THREE HOURS **OPEN BOOK**

ANSWER: QUESTION 1 AND ANY OTHER THREE QUESTIONS

Q1. (COMPULSORY)

The screw jack shown in Fig. Q1, on page 3, is to be used to jack up a light truck. The maximum load on the jack will not exceed 2 tonnes. The operating handle should be such that the overall operating arm does not exceed 350 mm. It is, further, required that the jack be self-locking under load.

By selecting your suitable and realistic coefficients of friction for the thread and between the nut and the base,

(a) Design a suitable square threaded screw for the above application. [35 marks]

(b) What would be the disadvantage if the screw pitch and OD remained unchanged but the thread were Acme? [5 marks]

Q2.

A 2 kW petrol engine drives the blades of a grass mower through a V-belt connection. The engine rotates at a speed of 2000 rpm while the rotor rotates at 3000 rpm. The engine and the rotor shafts are parallel, and have a centre distance of 50 cm.

(a) Specify the pulley sizes for this arrangement. [10 marks]

(b) Specify a suitable belt size for the mower. [10 marks]

Q3.

Fig. Q3, on page 4, is a schematic drawing of a countershaft supporting two V-belt pulleys. All belt pulls are tangential to their respective pulleys. Radial 02-series ball bearings are to be selected and located at O and E. The countershaft runs at 1100 rpm and the bearings are to have a life of 12 kh at 99% reliability using an application factor of unity. The belt tension on the loose side of Pulley A is 15% of the tension on the tight side.

(a) Determine the reactions at O and E specifying the angles at which they are acting. [10 marks]

(b) What size of bearings should be used if both sides are to be the same size? [10 marks]

Q4.

A helical compression spring made of hard-drawn spring steel wire of diameter of 2 mm has an outside diameter of 22 mm. The ends are plain and ground, and there are 8.5 total turns.

(a) The spring is wound with a free length such that, when the spring is compressed solid, the stress will not exceed the torsional yield strength. Find the free length. [5 marks]

(b) What is the pitch of this spring? [4 marks]

(c) What force is needed to compress the spring to its solid length? [4 marks]

(d) What is the spring rate [4 marks]

(e) Will the spring buckle in operation? [3 marks]

You may assume G = 80 GPa.

Q5.

A scotch cart with a capacity of 5 metric tonnes is mounted on two wheels of outside diameter 80 cm. The axle is mounted on the underside of the cart bed, equidistant between the front and the rear. The scotch cart is to be parked on a surface inclined at 20°.

You have been asked to design a hand brake mechanism for the cart such that it operates on the axle whose diameter is 7.5 cm.

(a) Make a sketch of your design with relevant dimensions. [5 marks]

(b) Specify the braking force required to stop the cart from rolling down the incline. [10 marks]

(c) What is the operating force? [5 marks]

Assume that the coefficient of friction between the axle and the ~~wheels~~ bearings is negligible, and that between the axle and the brake is 0.30.

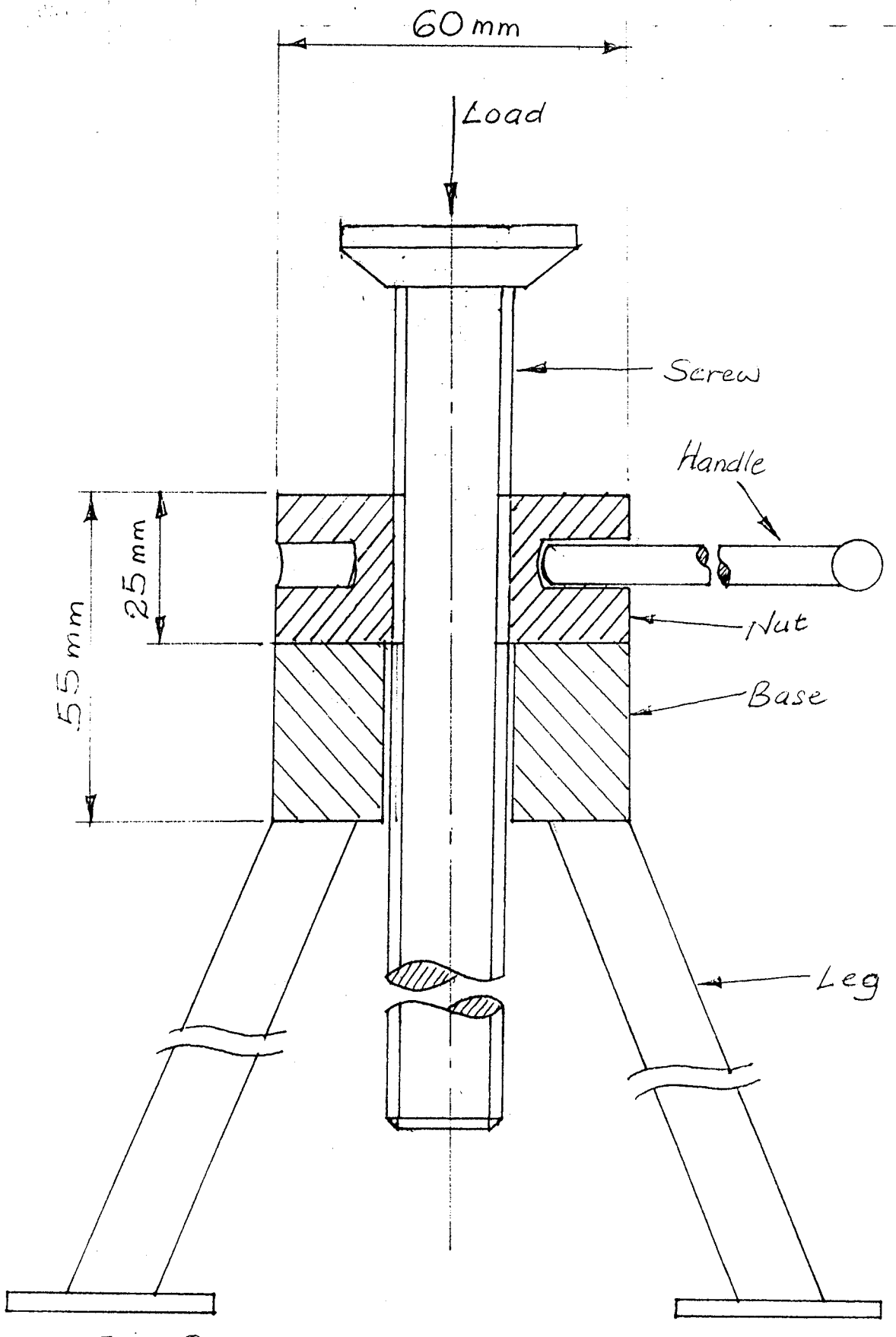
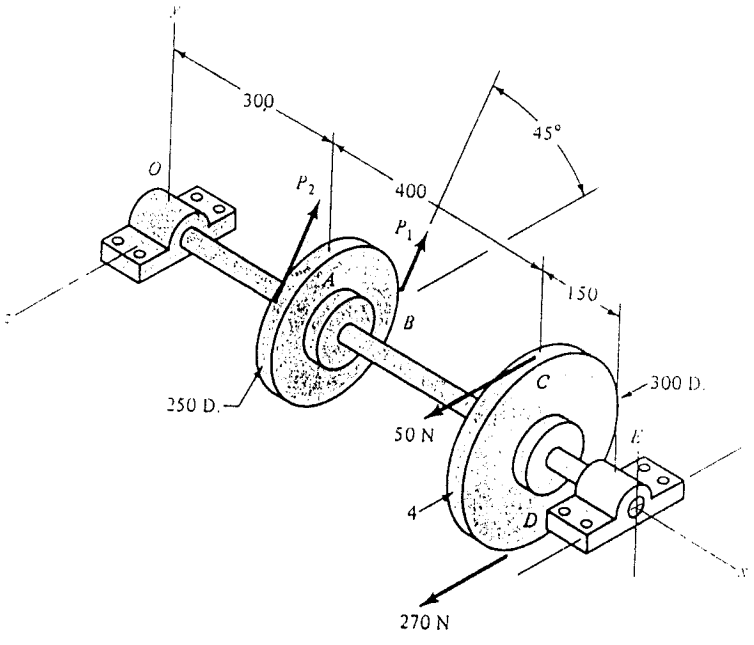


FIG. Q1 – FOUR-LEGGED SCREW JACK



UNLESS STATED, DIMENSIONS IN MM

FIG. Q3 – V-BELT PULLEY COUNTERSHAFT.

END OF EXAMINATION - ME 405 PAPER I

Dr. SB Kanyanga.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

SEMESTER II SUPPLEMENTARY/DEFERRED EXAMINATIONS
OCTOBER 1998

ME 405 - MACHINE DESIGN I

PAPER II

TIME: THREE HOURS **OPEN BOOK**

QUESTION

A cylindrical bin is to be positioned against a wall with the bin lid being opened until it is in the vertical position. The simplest method would be to use a counterweight as indicated in Figure 1. In the present layout, however, this is not possible because the bin is very close to the wall.

The important lid and bin dimensions are indicated in the figure. Assume also that the lid, of 1600-mm diameter, has a thickness of 3 mm.

(a) Provide a design brief and specifications [10marks]

(b) Make two functional designs of the opening arrangement, one operated by foot and the other by hand, showing how the counterweight of this lid may be positioned. [50 marks]

(c) Select the better of the designs and refine it such that the weight of the lid is exactly balanced in every position. Specify the materials for design. [15 marks]

(d) Redesign the bottom with a mechanism so that the contents can be drop loaded into a truck without tilting the bin. [25 marks]

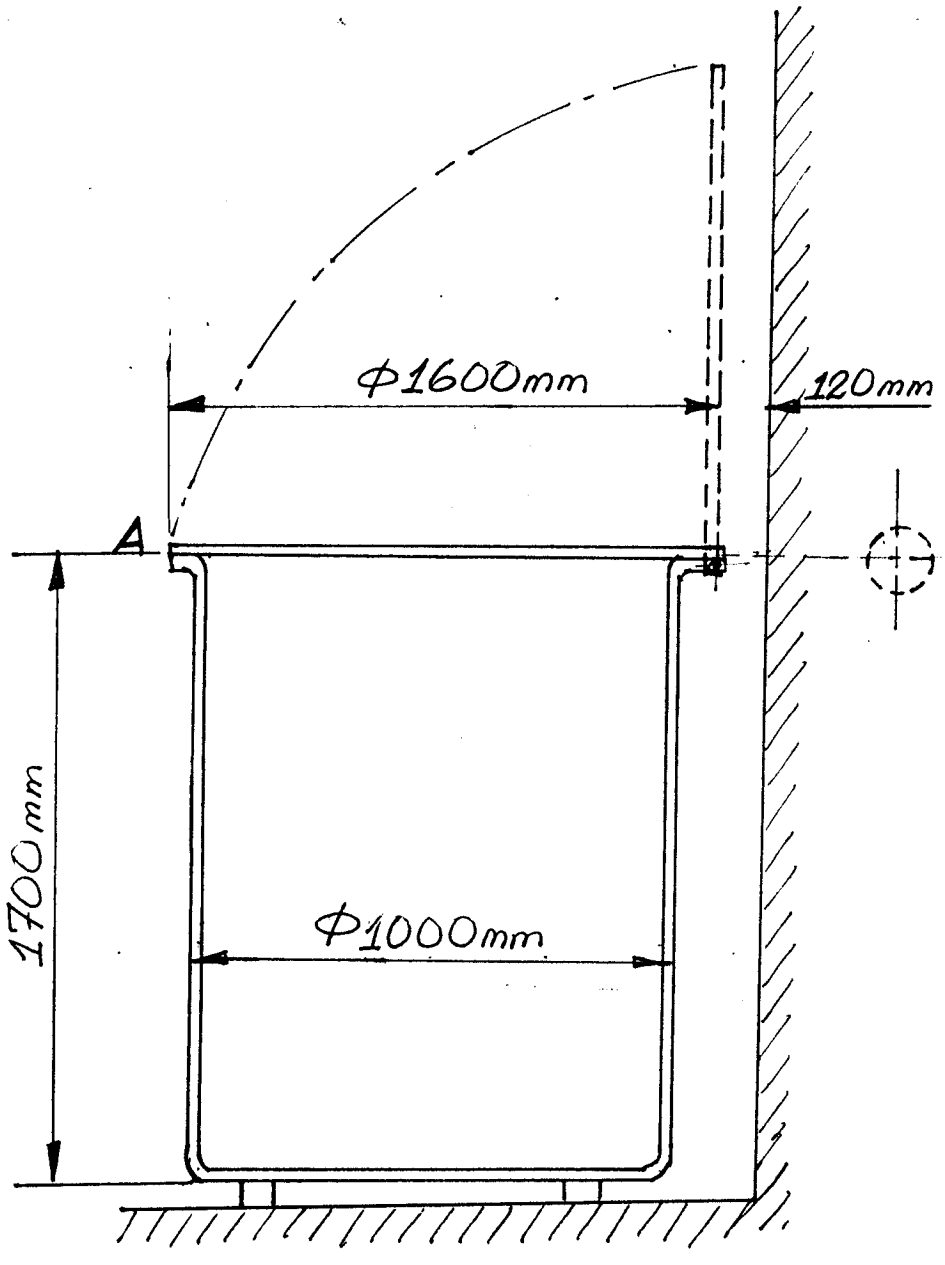


FIG. 1 - Cylindrical Bin with Lid

END OF EXAMINATION - ME 405 PAPER II

Dr. SB Kanyanga.

The University of Zambia
School of Engineering
Department of Mechanical Engineering

ME 442- Thermodynamics II and Heat Engines 1996-1998
Semester II Examination August 1998

Time: Three (3) hours

Instructions: Answer Two (2) questions from section A and Three (3) questions from section B

SECTION A

Question 1

Describe in detail, with the aid of suitable sketches, the following:

1.1 The main metering system of a modern carburattor
1.2 The Tranzistorized Coil Ignition System (TCI)
1.3 Thermosyphon cooling system

Question 2

2.1 Sketch the flow chart of petroleum refining process and discuss in detail cracking and polymerization.

2.2 Define the following:

2.2.1 Bore
2.2.2 Stroke
2.2.3 Displacement volume
2.2.4 Clearance volume
2.2.5 Compression ratio

Mention the units in which they are normally measured.

Question 3

3.1 Discuss in details dry sump lubrication lubrication system of a four (4) stroke internal combustion Engine

3.2 Mention the functions of lubricants in internal combustion engines and the necessary properties that lubricants should posses.

3.3 Discuss in detail the rating of compression ignition engine fuel using the laboratory method.

Section B

Question 4

A four (4) cylinder, four (4) stroke square engine running at 40 rev/s has been purchased to drive an irrigation pump. As an engineer you are required to fit a carburattor, with three (3) centimeter (cm) venturi throat, on it. Assuming the engine bore to be ten (10) centimeter (cm), volumetric efficiency of 75 %, the density of air to be 1.15 Kg/m^3 and coefficient of air flow to be 0.75. Calculate the suction at the throat.

Question 5

A sample of dry anthracite coal has been submitted to you for composition analysis. Upon carrying out the analysis you obtain the following results:

C	90 %
H	3 %
O	2.5 %
N	1%
S	0.5 %
Ash	3%

5.1 Calculate the stoichiometric A/F ratio for the combustion of the submitted dry anthracite sample.

5.2 Also determine the dry and wet analysis of the products of combustion by volume, of the submitted dry anthracite sample, when 20 % excess air is supplied.

Question 6

A turbo-jet aircraft is flying at 800 k/m at 10 700 m where the pressure and temperature of the atmosphere are 0.24 bar and – 50 ° C respectively. The compressor pressure ratio is 10/1 and the maximum cycle temperature is 820 ° C. Calculate the thrust developed and the specific fuel consumption in Kg/kN thrust s, using the following data:

Entry duct efficiency	0.9
Isentropic efficiency of the compressor	0.9
Total head pressure loss in the combustion chamber	0.14 bar
Calorific value of fuel	43 300 KJ/Kg
Combustion efficiency	98 %
Isentropic efficiency of the turbine	0.92
Mechanical efficiency of the drive	98 %
Jet pipe efficiency	0.92
Nozzle outlet area	0.08 m^2
Specific heat capacity at constant pressure for compression process	1.005 KJ/KgK
The polytropic exponent for compression process	1.4
Specific heat capacity at constant pressure for combustion process	1.15 KJ/KgK
The polytropic exponent for combustion process	1.33

Assume that the nozzle is convergent.

Question 7

The velocity of steam leaving the nozzles of an impulse turbine is 900 m/s and the nozzle angle is 20 °. The blade velocity is 300 m/s and the blade coefficient is 0.7. Calculate for a mass flow of 1kg/s, and symmetrical blading:

7.1 The blade inlet angle.
7.2 The driving force on the wheel.
7.3 The diagram power.
7.4 The diagram efficiency.

Question 8

An Otto cycle engine operates on a four (4) stroke cycle and has eight (8) cylinders with a total displacement of 1200 cm^3 and a compression ratio of 6:1. Air enters the engine at 27 °C and 101 KPa pressure. The fuel-air mixture during combustion releases 3000 KJ/kg air of heat when the engine is under a constant load and running at 2200 rpm. Determine the P, V, and T properties at the four (4) corners of the cycle and the power produced by the engine. Also calculate the mean effective pressure and the cycle efficiency for the engine. Assume that air standard analysis (Perfect gas).

TABLE B–4 Gas constants (SI units)

Substance	Symbol	M	R $\frac{J}{kg \cdot K}$	c_p kJ/kg · K at 25°C	c_v kJ/kg · K at 25°C	k $\frac{c_p}{c_v}$
Acetylene	C_2H_2	26.038	320	1.687	1.368	1.234
Air		28.967	287	1.007	0.719	1.399
Ammonia	NH_3	17.032	488	2.096	1.607	1.304
Argon	Ar	39.944	208	0.521	0.312	1.668
Benzene	C_6H_6	78.114	106	1.045	0.939	1.113
n-Butane	C_4H_{10}	58.124	143	1.676	1.533	1.093
Isobutane	C_4H_{10}	58.124	143	1.666	1.523	1.094
1-Butene	C_4H_8	56.108	148	1.527	1.374	1.111
Carbon dioxide	CO_2	44.011	189	0.844	0.655	1.288
Carbon monoxide	CO	28.011	297	1.040	0.744	1.399
Carbon tetrachloride	CCl_4	153.839				
n-Deuterium	D_2	4.029				
Dodecane	$C_{12}H_{26}$	170.340	49	1.646	1.597	1.031
Ethane	C_2H_6	30.070	277	1.751	1.475	1.188
Ethyl ether	$C_4H_{10}O$	74.124				
Ethylene	C_2H_4	28.054	297	1.552	1.256	1.236
Freon, F-12	CCl_2F_2	120.925	69	0.573	0.504	1.136
Helium	He	4.003	2079	5.196	3.117	1.667
n-Heptane	C_7H_{16}	100.205	83	1.656	1.573	1.053
n-Hexane	C_6H_{14}	86.178	96	1.660	1.564	1.062
Hydrogen	H_2	2.016	4124	14.302	10.178	1.405
Hydrogen sulfide	H_2S	34.082				
Mercury	Hg	200.610				
Methane	CH_4	16.043	519	2.227	1.708	1.304
Methyl fluoride	CH_3F	34.035				
Neon	Ne	20.183	412	1.030	0.618	1.667
Nitric Oxide	NO	30.008	277	0.995	0.718	1.386
Nitrogen	N_2	28.016	297	1.040	0.743	1.400
Octane	C_8H_{18}	114.232	73	1.653	1.581	1.046
Oxygen	O_2	32.000	260	0.917	0.657	1.396
n-Pentane	C_5H_{12}	72.151	115	1.666	1.551	1.074
Isopentane	C_5H_{12}	72.151	115	1.663	1.548	1.074
Propane	C_3H_8	44.097	189	1.667	1.478	1.128
Propylene	C_3H_6	42.081	198	1.519	1.279	1.187
Sulfur dioxide	SO_2	64.066	130	0.621	0.491	1.264
Water vapor	H_2O	18.016	462	1.864	1.402	1.329
Xenon	Xe	131.300	63	0.158	0.095	1.667

Source: Data selected from J. F. Masi, *Trans. ASME*, 76:1067 (October, 1954); National Bureau of Standards (U.S.). Circ. 500, February 1952; "Selected Values of Properties of Hydrocarbons and Related Compounds," American Petroleum Institute Research Project 44, Thermodynamics Research Center, Texas A & M University; College Station, Texas (Loose Leaf Data Sheets, extant 1972).

The University of Zambia
School of Engineering
Department of Mechanical Engineering

ME 442- Thermodynamics II and Heat Engines 1996-1998
Semester II Supplementary Examination October, 1998

Time: Three (3) Hours **Closed book**

Instructions: Answer Two (2) questions from section A and Three (3) questions from section B

SECTION A

Question 1

1.1 Briefly discuss the important qualities of compression ignition engine fuel.
1.2 Discuss in detail the centrifugal advance mechanism of an ignition system

Question 2

2.1 Define and discuss carburation and factors affecting it.
2.2 By means of a sketch, discuss the air mixture in which an internal combustion engine can operate.

Question 3

3.1 Besides the Battery and Magneto Ignition Systems, which other types of ignition systems are commonly used in automotive engines.

3.2 Compare the Battery to Magneto Ignition System.

3.3 Name the engine shown in Fig. 3.1. List the items numbered and discuss in detail the operation principles of the engine depicted in the figure.

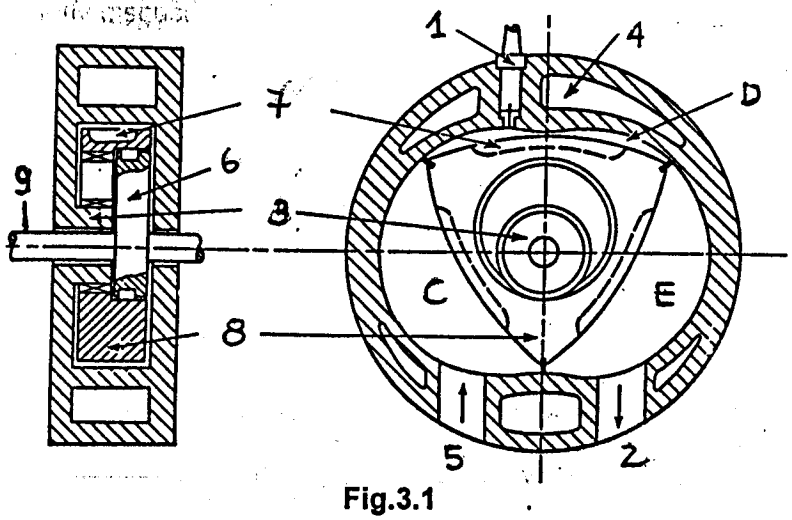


Fig.3.1

SECTION B

Question 4

A four cylinder, four-stroke SI engine, having a bore of 10 cm and stroke of 9 cm runs at 4000 rpm. The fuel used has a carbon content of 84.5 % and hydrogen content of 15.5 % by weight. The volumetric efficiency of the engine at 75 % of full throttle and at 4000 rpm is 0.85 referred to 300 K and 1 bar. The engine is to be supplied with a mixture of air coefficient 0.95 when running at 75 % full throttle. Calculate the throat diameter of the venturi if does not exceed the air velocity at throat 200 m/s under the above operating conditions. Also calculate the rate of fuel flow in Kg/s associated with pressure drop at the venturi throat. The discharge coefficient for the venturi is 0.8 and the area ratio of the venturi is 0.8. Take R for air as 0.287kJ/KgK and the fuel vapour is 0.09 KJ/KgK.

Question 5

A mechanical engineering class was conduction engine trials on a four stroke and single cylinder oil engine. The Following observations were recorded during the trials:

Duration of the trial	30 min
Oil calorific value	43 MJ/kg
Oil consumption	4 liters
Specific gravity	0.8
Average area of the indicator diagram	8.5 cm^2
Length of the indicator diagram	8.5 cm
Spring constant	5.5 bar/cm
Brake load	150 Kg
Spring balance reading	20 Kg
Cylinder diameter	30 cm
Effective brake wheel diameter	1.5 m
Speed	200 rpm
Stroke	45 cm
Cooling water flow rate	10 Kg/min
Water temperature rise	36 °C

Calculate:

Indicated power
Brake power
Mechanical efficiency
Brake specific fuel consumption in Kg/kW hr and
Indicated thermal efficiency

Question 6

You are required to carry out analysis of combustion products whose reactants are hydrogen and air mixture. After analyzing the flue gas you obtain the following volumetric percentage of products as your results:

Carbon monoxide 2.5, Carbon dioxide 12.5 and nitrogen 85.0

Determine the C/H mass ratio of the fuel, and the air/fuel mass ratio of the reactant mixture assuming that no fuel remains unreacted.

Question 7

During experiments on a stream engine it is observed that stream is admitted to the engine at a pressure of 5.6 kg/cm^2 abs. and 0.9 dry. The cut off occurs at one-half stroke, and pressure at release is 2.56 kg/cm^2. The back pressure is 1 kg/cm^2 abs. Determine the modified Rankine efficiency of the engine, assuming the pressure drop at release take place at a constant-volume. Neglect the clearance volume.

Question 8

A gas turbine, for the generation of thermal electricity, installed at ZESCO in Lusaka has a pressure ratio of 12:1 and a maximum cycle temperature of 1000 °C .The isentropic efficiencies of the compressor and turbines are 0.82 and 0.85 respectively. Determine the power output in kilowatts of a Hitachi electric generator geared to the turbine. Air enters the turbine at the flow rate of 20 kg/s and the temperature of 20 °C. Assume that

C_p = 1.005 kJ/k and γ = 1.4 for the compressor process and
C_p = 1.11 kJ/k and γ = 1.33 for the expansion process

End of ME 442- Thermodynamics and Heat Engines Supplementary Examination Oct. 1998.
Prepared by Dr. P.C Chisale© Mech. Eng. Dept. Unza.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS **AUGUST 1998**

ME 452 PROPERTIES OF ENGINEERING MATERIALS II

ANSWER: FOUR QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

Q1. (a) Describe Bragg's Law and with the help of diagrams derive a mathematical relationship of this law.
(b) What are edge dislocations?

Q2. (a) Discuss the deformation of metallic materials by the process of slip by dislocation movement.
(b) Discuss briefly the phenomenon of dislocation climb.

Q3. (a) Describe the critical resolved shear stress.
(b) What is Polygonization?

Q4. (a) Discuss the Griffith Criterion.
(b) Describe briefly the main stages that comprise brittle fracture.

Q5. Discuss the following:

(a) Strain aging.
(b) Yield-point elongation.
(c) Solid Solution Strengthening

Q6. (a) Discuss the fracture of metallic materials in relation to their theoretical cohesive strength.

(b) What is a slip system?
Explain in what way a materials ability to deform is affected by the type of slip system.

END OF EXAMINATION
Dr C K Wamukwamba **AUGUST 1998**

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY DEFERRED AND SUPPLEMENTARY EXAMINATIONS

OCTOBER 1998

ME 452 PROPERTIES OF ENGINEERING MATERIALS II

ANSWER: FOUR QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

Q1. **(a)** Describe in detail what dislocations are and the types that there are.

(b) Discuss the process of diffusion based on dislocation climb.

Q2. With the help of diagrams, describe the process of deformation called "Twinning". Give typical examples of crystal structures and the names of the metallic materials in which twinning can readily occur.

Q3. **(a)** What is the crystalline state? Give four examples of crystal systems and the differences in the parameters that describe them.

(b) What are the typical properties of metals?
Discuss what distinguishes metals and metallic alloys from other crystalline or amorphons bodies.

Q4. Discuss in detail:

(a) The effect of grain boundaries on the deformation of metallic materials.

(b) Ordered and disordered solid solutions.

END OF EXAMINATION

Dr C.K Wamukwamba
October 1998

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS - SEMESTER II, SEPTEMBER 1998

ME 515 PRODUCTION TECHNOLOGY II, PAPER I

TIME: THREE (3) HOURS CLOSED BOOK
ANSWER: FIVE QUESTIONS, AT LEAST TWO (2) FROM EACH SECTION
ALL QUESTIONS CARRY EQUAL MARKS

SECTION A

Q1. (a) Using the work formula method, derive the expression to give the limiting reduction ratio for wire drawing. State all assumptions.

(15 marks)

(b) A copper wire is drawn from a diameter of 2.5 mm. What is the smallest diameter to which it could theoretically be drawn?

What will be the drawing load at the minimum reduction ratio? The mean yield stress in uniaxial tension for the material is given as 300 N mm^{-2}.

(5 marks)

Q2. (a) State the Upper Bound Theorem for metal deformation. Give and outline of the basis for this theory and assumptions made when applying the theorem.

(7 marks)

(b) Using the Upper Bound Theory, determine the indentation force on the material given the following:-

- indentation tool dimensions: 10 mm length with unit depth;
- indenting tool speed is 2 m sec^{-1};
- material yield shear stress in plane strain 250 N mm^{-2}.

A suitable shear field and kinematically admissible hodograph should be given.

(13 marks)

Q3. (a) With help of sketches, discuss the process of sheetmetal blanking. Sketch the basic tooling arrangement and the shape of the blanked out material. Give an outline of the force/displacement relationship in blanking.

(14 marks)

(b) Suggest a method for reducing punch forces in the blanking process. Show qualitatively how force reduction is achieved.

(6 marks)

Q4. (a) Derive an expression for maximum drawing force in the deep drawing process. State assumptions. (12 marks)

(b) Use the derived expression for force to determine the maximum load for deep drawing a square shaped container with the following dimensions: sides 190 mm and depth 65 mm. The material flow stress is given as 200 MNm-2 and the sheet thickness is 2 mm. (8 marks)

SECTION B

Q5. (a) Briefly explain with diagrams, the principles of blow moulding (10 marks)

(b) List the three main forms of vacuum forming. Describe with help of clearly labelled diagrams , drape forming.

(10 marks)

Q6. (a) State the four steps in powder metallurgy; (4 marks)
(b) Give an example of a finishing process used in powder metallurgy; (1 mark)
(c) State six (6) main methods of metal powder production; (6 marks)
(d) State five (5) main advantages of powder metallurgy; (5 marks)
(e) State four (4) main advantages of powder metallurgy. (4 marks)

Q7. (a) State the three (3) types of EDM processes and briefly explain their working. (6 marks)

(b) Determine the t/RC ratio for which the capacitor voltage is 75% the supply voltage. (6 marks)

(c) Given:

Resistance (R)	4.8 Ω
Capacitance (C)	180 μF
Supply voltage (V_s)	220 V
Breakdown voltage (V_b)	170 V

Determine:

(i) The time taken from zero voltage for the capacitor to reach the breakdown voltage. (4 marks)

(ii) What would the supply voltage be adjusted to in order to half the yielded in (i)? (4 marks)

Q8. Describe with diagrams, the following CNC tool pathing methods:

(a) Zig Zag milling; (5 marks)

(b) Zig milling; (5 marks)

(c) Spiral in milling; (5 marks)

(d) Spiral out milling. (5 marks)

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS - SEMESTER II, SEPTEMBER 1998

ME 515 PRODUCTION TECHNOLOGY II, PAPER II

TIME: THREE (3) HOURS CLOSED BOOK
ANSWER: ALL QUESTIONS
NOTES: A table of SELECTED ISO FITS is provided.
Read questions carefully before attempting to answer questions.

A. INTRODUCTION

The attached drawings ME 515-1 to ME 515-4 indicate both the assembly and components of a given design of a paper punch. Production quantity of the paper punch is put at 500 units per week.

The components making up the punch include a base (Item 1), lever (Item 2), die plate (Item 3), two spacer brackets LH and RH (Item 4), two punches (Item 5), two sets of pins with one set for pivoting and the other to drive punch (Item 6), and two coil springs (Item 7).

In order for the punch to perforate paper, the edge of the paper is located in the gap provided between the die plate and the spacer brackets. The lever is then depressed, which in turn, drives the punches down through the holes in the brackets and the die holes. Shearing of two round holes on the paper takes place as the punch moves against the die holes. Upon release of the lever, the springs restore the punches in the start position by forcing the lever back to the upper most position.

B. QUESTIONS

Q1. (a) Make separate freehand orthographic sketches to reasonable scale for the following components: item 2 (three views), item 3 (two views), item 4 (LH and RH brackets relative to each other as would be in the assembled product (three views), item 5. Sketches should be reasonably spaced on a number of pages.

(10 marks)

(b) Scale off important functional dimensions on drawings ME 515-2 to 4 and indicate these on the sketches you have made in (a) above. Indicate all important functional diameters.

(10 marks)

Q2. Suggest a general working tolerance for the dimensions identified in Q1 (b). Give tolerance grades and actual figures for important diameters on items 2, 3, 4, and 5.

Indicate tolerances of position and/or form that must be maintained to enable function for the paper punch. Briefly explain why the latter tolerances need to be maintained.

(20 marks)

Q3. Sketch an elevation of the sub-assembly, view XX in Drawing ME 515-1. Indicate on the sketch dimensional details of the punch pin, spacer bracket, die plate and lever. Using the general tolerance suggested in Q2, analyse and comment on limit stacks and their effects along the direction of the axis of the punch.

(20 marks)

Q4. For each of the underlisted components, develop a logical process sequence leading to complete manufacture of the component. Give reasons for choice of each process and state classifications. Suggest materials to be used and give reasons for your choice of each process and state classifications. Suggest materials to be used and give reasons for your choice.

(a) Base plate

(b) Punch pin

(20 marks)

Q5. Starting with graphic presentation for locator, holding force and tooling positions, develop fixtures for the following:

(a) Correct assembly of spacer brackets to die plate.

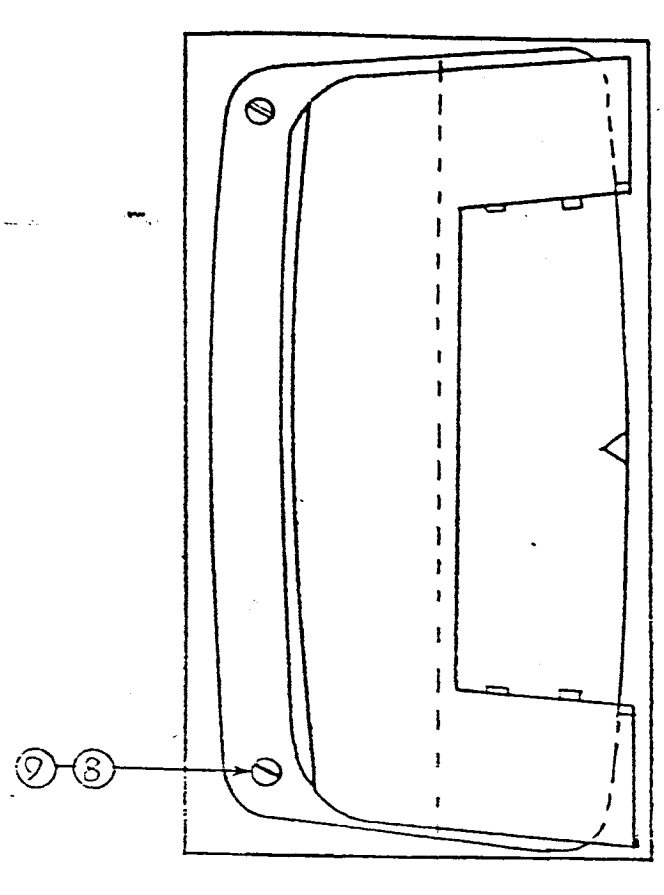
(b) Machining of the punch and profile.

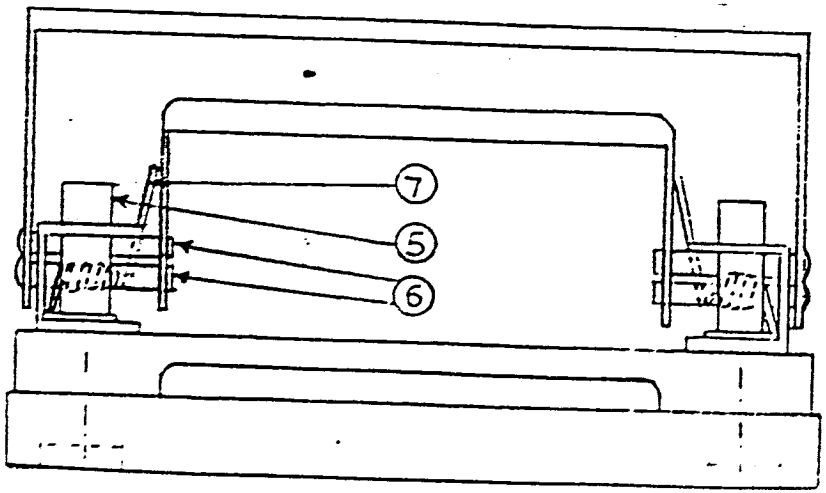
In (a) briefly discuss your method of assembling the two types of components.

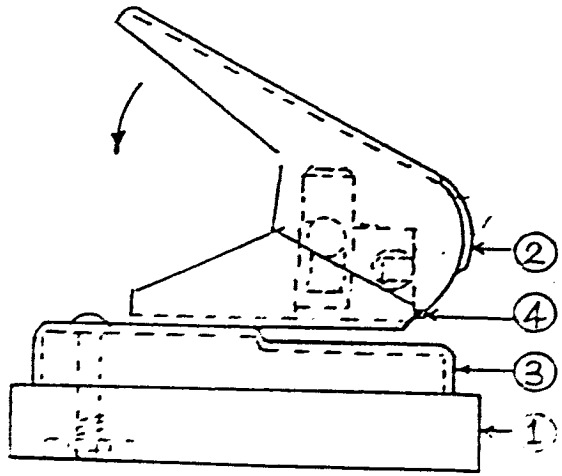
(20 marks)

END OF EXAMINATION ME 515
DR. H. M. MWENDA.

Drg. ME 515-1

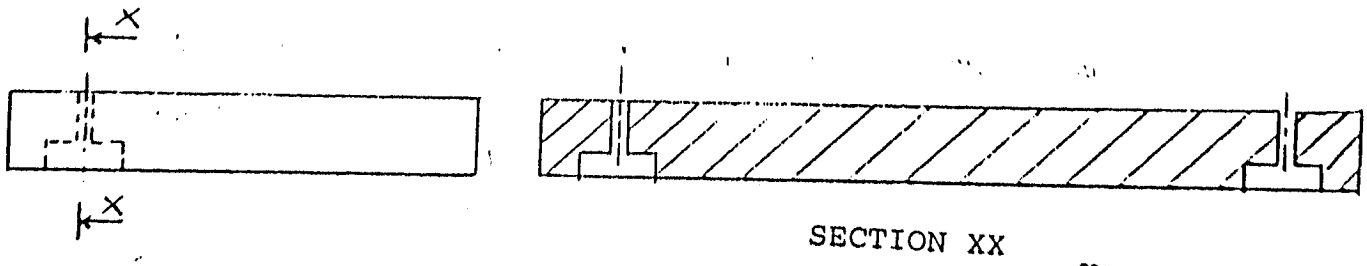






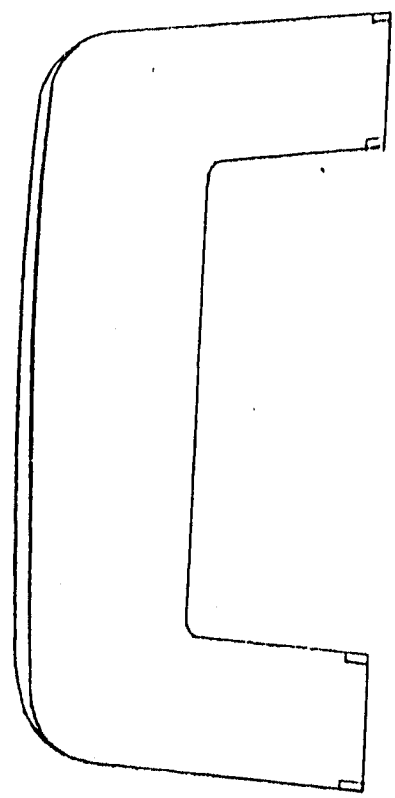
ALL DIMENSIONS IN MM

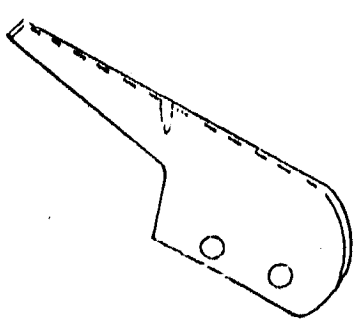
ITEM	QTY	DESCRIPTION	MATL	NOTE
9	2	Hex.nut M12		
8	2	Screw		
7	2	Spring		
6	4	Pin		
5	2	Punch rod		
4	2	Bracket		
3	1	Die plate		
2	1	Lever		
1	1	Base		
ME 515 PRODUCTION TECHNOLOGY II				
3RD ANGLE PROJECTION				SCALE 1:1
PAPER PUNCH				
UNZA - SCHOOL OF ENGINEERING				



SECTION XX

ITEM 1





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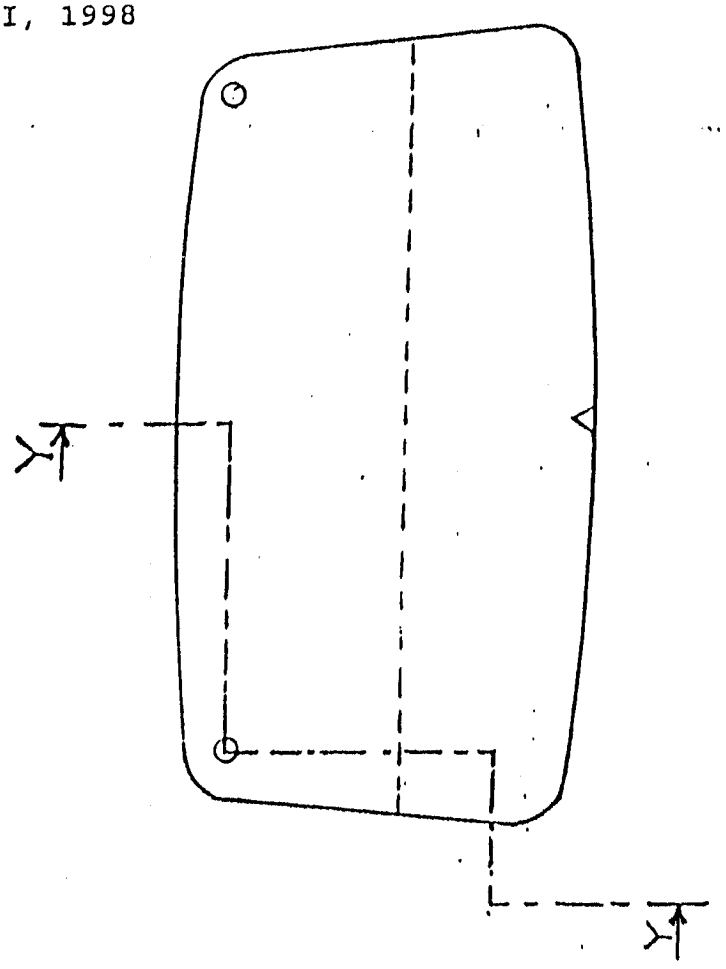
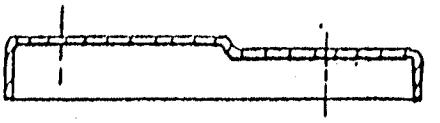
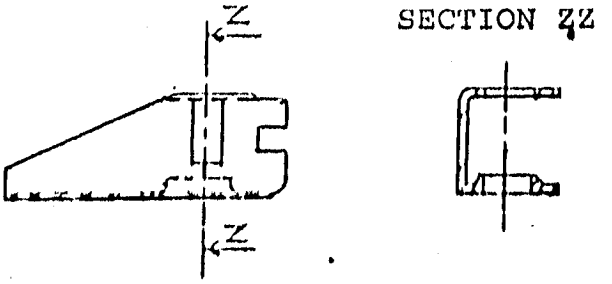


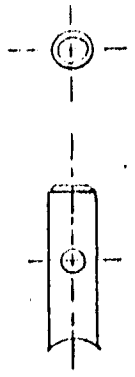
ITEM 3



SECTION YY



ITEM 4



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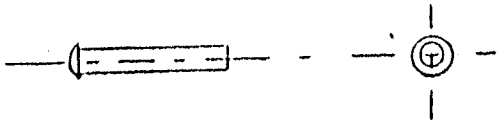
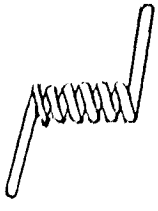


ITEM 6



ITEM 7

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS - SEMESTER II, SEPTEMBER, 1998

ME 585 - AUTOMOBILE ENGINEERING

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

INSTRUCTIONS: **Answer Two (2) Questions From Section A and Three (3) From Section B**

All Questions Carry Equal Marks

SECTION A

ANSWER TWO (2) QUESTIONS ONLY

Q1. a) Discuss the tractive force according to conditions of the grip between the tyre and the road and outline the factors affecting the grip coefficient. What are the conditions for driving?

b) Discuss the requirements for good steerability of a motor vehicle. What do you understand by the terms 'Oversteer' and 'Understeer' and what conditions determine the presence of one or the other?

[20 marks]

Q2. a) Describe the vehicle maintenance categories which exist today. Your answer should outline the operations which are performed in each category.

b) Discuss the areas which require special attention in the maintenance of the cooling system and the fuel system.

[20 marks]

Q3. ALNAMA MOTOR COMPANY has decided to change the drive train of their Mark I car, which is rear-wheel driven, to front wheel drive in the new Mark II. As a design engineer, outline the options for the new transmission layout highlighting the advantages and disadvantages of each option.

[20 marks]

END OF SECTION A.

SECTION B

ANSWER THREE (3) QUESTIONS ONLY

Q4. The management of a car manufacturing company has decided to introduce a new two-seater car based on an existing 4-door saloon. In order to improve the performance of the new two-seater car, its weight and aerodynamic resistance have been reduced. In order to keep the costs as low as possible, the same engine, transmission and differential have been used.

The following data is given:

Engine power at maximum angular velocity of 6000 rpm = 40kW.
Rolling Resistance coefficient = 0.020
Air density in testing zone = 1.2 kg/m^3

Transmission: top gear ratio = direct drive
Total Efficiency, η_{tr} = 0.90
Rear wheel drive

	4 - door	Two - seater (new)
Tyre Diameter (radial)	0.6 m	0.5 m
Mass	1400 kg	1200 kg
Frontal Area	1.8 m^2	1.6 m^2
Aerodynamic drag coefficient	0.40	0.35

a) Determine, for both models, a relationship from which the top speed can be immediately derived when the vehicles are moving up a gradient of 3° in still air during testing.

b) Estimate the top speed for each vehicle in still air and with no gradient and hence determine the best ~~overall~~ differential transmission ratio.

c) If the first gear ratio is 4:1, how long does it take the new two-seater car to accelerate from 0 to 20 km/hr in first gear given that there is no wind, no slip, no gradient and that acceleration is constant from the start. Assume that the coefficient accounting for rotating masses is 1.4.

[20 marks]

Q5. a) In an acceleration performance test on a flat asphalt road with a road resistance coefficient of 0.03, a motor vehicle is driven from rest to 100 km/hr in 6 seconds. During the test, the speed of the vehicle at the initial moment of the gear change from 2nd gear to 3rd gear is 56 km/hr. Given that the clutch inertia and torque are 0.5 kgm^2 and 10 Nrad-m respectively, determine the distance covered by the vehicle during the gear change time if the synchronising torque is 15 Nrad-m and the initial speed at the input side of the synchroniser is 50.5 rad/sec. The radius of the rolling wheel is 40 cm and the differential gear ratio is 1.0. Ignore information not supplied.

b) The same vehicle is subjected to an overtaking test from which the following are obtained:

Speed of overtaking vehicle	= 32 m/s
Speed of overtaken vehicle	= 26 m/s

Determine:

i) the distance and time required for overtaking to be successful.

ii) the safe intervals between overtaking and overtaken vehicles at the beginning and end of overtaking.

[20 marks]

Q6. OVERLAND TRANSPORT owns 5 vehicles each with a track width of 1.8 m and an overall height of 2.3 m, for transporting sand from a river 30km away from the building site. The engine has a mechanical efficiency and an indicated specific fuel consumption of 0.8 and 200 g/kWhr, respectively. The engine develops a maximum power of 160 kW at 2400 rpm and the fuel has a density of 0.75 kg/lt. The following additional information is given:

Wheel radius	=	0.5 m
Mass of one vehicle	=	1800 kg
Maximum vehicle load capacity	=	2000 kg
Air density	=	1.2 kg/m^3
Drag Coefficient	=	0.3
Transmission Efficiency	=	0.9
Rolling-resistance Coefficient	=	0.0325
Differential Gear Ratio	=	4.1

Determine:

a) the running fuel consumption at maximum vehicle load at the maximum power speed in direct drive for each vehicle.

b) the monthly (30 day) fuel bill for the fleet if the loading, unloading and idling time is taken as 30 minutes per cycle. The vehicles have a 10-hour work shift per day and the cost of diesel is K1000.00 per litre. Assume that the fuel consumption is constant throughout each cycle.

c) how the monthly bill is affected if the loading, unloading and idling time is reduced by 10 minutes, assuming a constant fuel consumption throughout each cycle. Is this reduction profitable to OVERLAND TRANSPORT in any way?

[20 marks]

Q7. As a graduate engineer, you have joined a transport organisation which has recently acquired a fleet of new vehicles to be used for transporting Kapenta from Mpulungu to the Copperbelt on asphalt roads with an average grip coefficient of 0.8. The vehicles have the following specifications:

Distance from CG to the front axle	= 1.80 m
Distance from CG to the rear axle	= 1.42 m
Height of CG	= 0.6 m
Track width	= 1.6 m
Mass	= 2000 kg
Wheel radius	= 0.5 m.
Allowable angular velocity of steerable wheels	=0.2 rad/sec.

a) In your capacity as the firm's automotive expert, what maximum speed would you recommend to your drivers to prevent any of the vehicles from toppling or skidding, particularly on a dangerous corner with an arc radius of 60 m?

b) Determine the transverse component of the centrifugal force that would act on one of the vehicles over a transition curve at a speed of 10 m/s.

i) at the initial moment of turn
ii) Four (4) seconds after the beginning of the turn.

c) If one of the vehicles is involved in an accident during operations, determine the speed at which the driver was travelling if investigations reveal that the time during which skidding occurred was 0.19 seconds. Comment on your answer.

[20 marks]

END OF EXAMINATION - ME 585
Dr. A.N. Ng'andu

SCHOOL OF ENGINEERING
DEPARTMENT OF SURVEYING

University Examinations - 1996/98

Land Law, Cadastre and Survey Regulations
(SE 352)

Time: Three hours
Answer all questions from section I and any other two (2) from section II

Section I

Question 1 (10 + 10 + 5)

a) An ideal cadastre should be established on the basis of a proper cadastral survey and be based on four principles which consequently facilitates establishment of an effective and efficient land registration system
   i. Name, and briefly compare and contrast the three various types of cadastre.
   ii. Name and briefly explain the four principles on which an ideal legal cadastre should be based
   iii. Discuss the objectives of cadastral surveying
   iv. State the functions of land registration

b) Discuss the surveyors perspective of the boundary concept and state your understanding of the principles of economy, independent check and maintenance as applied to boundary surveys

c) A surveyor defines the boundary of land parcels by monumentation. What is monumentation and what considerations should a surveyor make in selecting proper monuments?

Question 2 (5 + 20)

a) What is ownership?

b) Discuss the liberal concept of ownership and state why its application to the Zambian situation is limited.

Section II

Question 3 (25)

Explain and distinguish the concept of joint tenancy and tenancy in common. What are the advantages and disadvantages of each one of them?

Question 4 (15 + 10)

c) What is the difference between a lease and a licence? Which one confers better rights, if any, on the person holding it?

d) Name and explain three ways in which a lease may be terminated.

Question 5 (10 + 15)

a) Under mortgages, what is meant by:

i. the equitable right to redeem?

ii. foreclosure?

(b) What is an easement and how is it created?

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
SECOND SEMESTER UNIVERSITY FINAL EXAMINATIONS SEPTEMBER 1998

SE412 NUMERICAL METHODS AND PROGRAMMING FOR SURVEYORS

Instructions: *All questions carry all marks*
*Answer **Question 1** and **any other three** questions*
Total marks 100.

Question 1 (4+6+15)

(i) The names of the variables, constants, procedures, functions etc. used in a Turbo Pascal program are called identifiers.
Mention the four rules that govern the choice of these identifiers.

ii) Write a function in Turbo Pascal that evaluates the Euclidean norm of a vector x.
The algorithm for the Euclidean norm is given below:

$$\|x\|_2 = \sqrt{\sum_{i=1}^{n} x_i^2}$$

Assume that the type vector=array[1..10] of real; has already been declared.

Complete the solution below:

```
function Euclidean_norm(n:integer;x:vector):real;
var
{ local variables}
begin
{body of  function}
end; {end of function}
```

iii) Write a procedure in Turbo Pascal that multiplies a matrix A with a vector x to produce another vector y i.e. $Ax=y$.

Complete the solution below:

```
Procedure matrix_mult_vector(parameters);
Var
{local variables}
begin
{body of procedure}
end; {end of procedure}
```

Question 2 (3+2+5+5+5+5)

i) What is a singular matrix?

Given matrix

$$A = \begin{bmatrix} 1 & 3 \\ 4 & 2 \end{bmatrix}$$

Determine

ii) the trace of **A**

iii) the determinant of **A**

iv) the characteristic equation of **A**

v) the eigenvalues of **A**

vi) the associated eigenvectors **A**

Question 3(9+16)

a) Describe briefly the numerical methods used to solve the problem

$$\min_{x \in \Re^n} \|A - b\|_2^2 \qquad b \in \Re^m$$

Where A, an m x n, and the vector b are given.

b) The tidal height in the North Sea is determined mainly by the so-called M_2-tide, its period is about 12 hours and has therefore the form

$$H(t) = h_0 + a_1 \sin(2\pi t/12) + a_2 \cos(2\pi t/12)$$

where

t is given in hours.

Fit *H(t)*, using the Least Squares method to the following measurement series (*i.e. determine h_0, a_1 and a_2*):

t(hours)	0	2	4	6	8	10
H(metres)	1.0	1.6	1.4	0.6	0.2	0.8

Give the equation *H(t)* with the correct coefficients.

Question 4 (6+4+15)

a) Define the following terms as used in numerical methods

i) relative error
ii) error bound
iii) loss of significance
iv) overflow
v) "an iterative method is quadratically convergent"
vi) truncation error

b) Two of the most common methods used in finding the solution of the equation $f(x)=0$ are Secant and Newton's methods. Give their respective formula.

c)

$$f(x) = \sin x - \left(\frac{x}{2}\right)^2$$

Use the Newton's method to determine the approximate positive root of the equation given above, carry out two iterations giving the answer to five decimal places given that $x_0 = 1.5$

Question 5 (5+20)

i) State the main properties of an inner product.

ii) Carry out the LU-factorisation of matrix

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{bmatrix}$$

Determine x_2 when

$$x_0 = \begin{bmatrix} 1 \\ 5 \\ 9 \end{bmatrix}$$

and $Ax_1 = x_0$, $Ax_2 = x_1$

END OF EXAMINATION QUESTIONS

M. PHIRI, OFFICE F07
DEPT. OF SURVEYING

University of Zambia
School of Engineering
Department of Surveying

University Examinations - Second Semester 1996/98
SE 441 Geodesy I

Time : 3 Hrs
Answer all questions.

Q1. (15 + 3 + 5 + 2)

a) In joining the triangulation of a survey for a new settlement to the existing system, angles were observed from two stations ZP22 and ZP23 to a television mast UZ120. To carry out an adjustment, it is necessary to know the angle at UZ120 between the lines UZ120-ZP22 and UZ120-ZP23. For this, a station was setup at S 10.21m from the mast and the following angles measured:

Station	**Target**	**Observed direction**
S	ZP22	0° 00' 00"
S	ZP23	59° 29' 40"
S	UZ120	131° 53' 00"

If the distances of the lines UZ120-ZP22 and UZ120-ZP23 are 3530.476m and 8700.391m respectively, compute the angle ZP22-UZ120-ZP23.

b) Describe three classical triangulation figures used to establish a network

c) Describe the general procedure for establishing a control network for the first time.

d) How can scale and azimuth be mantained in a horizontal control network.

Q2. (10 + 7 + 8)

a) Using the attached field form, calculate the station mean for the four rounds of horizontal angle measurements given below:

Station	Target	FL	FR
ZT505	ZT500	0.1254	200.1301
	ZT38	38.5528	238.5530
	ZS39	92.8204	292.8201
	ZP40	205.6319	5.6325
ZT505	ZT500	50.2856	250.2864
	ZT38	88.7139	288.7130
	ZS39	142.9800	342.9812
	ZP40	255.7920	55.7918
ZT505	ZT500	100.5109	300.5121
	ZT38	138.9380	338.9370
	ZS39	193.2071	393.2062
	ZP40	306.0181	106.0188
ZT505	ZT500	150.8571	350.8577
	ZT38	189.2850	389.2842
	ZS39	243.5541	3.5528
	ZP40	356.3622	156.3601

b) Using the result in a) and the following data, compute the grid bearings for the following lines: ZT505 - ZT38 and ZS39 - ZT505 with the UTM27 coordinates for ZT505 and ZT500 being given as:

Station	Northing (m)	Easting (m)
ZT505	8298142.055	643617.898
ZT500	8294469.048	640677.553

c) What is the geodetic azimuth for the line ZT505 - ZT500 if the mean latitude is 15° 20' S? Assume the radius of the earth, R = 6371000m.

Q3. (10 + 5)

a) Two coordinate systems are employed in astronomical geodesy, these are the star-fixed equatorial system and the horizon system. Explain using a sketch and in a few words how these coordinate systems are defined.

b) Define the six elements of an astronomical triangle. Use a sketch in your answer.

Q4. (4 + 6)

Highlight the main features of precise traversing in terms of

a) Equipment

b) Observation procedures and network design.

Q5. (5 + 5 + 5 + 5 + 5)

a) What are the main advantages of satellite surveying methods compared to conventional terrestrial surveying methods.

b) Why is it important to employ phase differencing in satellite geodesy?

c) List at least four elements that are contained in a satellite ephemeris. Depict the elements by means of a sketch.

d) What is the difference between broadcast and precise ephemerides

e) For a single point positioning solution, only four satellites are needed, more so for navigation purposes. Justify the above statement using a relevant mathematical expression.

DOS-UNZA Field Book - Horizontal Angles				Date:	Page:
Survey of :			Theodolite:		Observer
Horizontal reading			Station:	Desc:	Booker
Object	FL	FR	Mean of Reduced FL	Reduced mean	Station Mean

University of Zambia
School of Engineering
Department of Surveying
SE472 Principle and Methods of Surveying II
Examinations- 1998

Time : 3 hrs
Answer: FOUR questions

---

1. a) Different methods of distance measurement are used in EDM instruments, one such method being that of phase comparison. Describe how distance is determined using this method.

(10 marks)

b) A Geodimeter is standardised at -4°C, 760 mm Hg, with an effective wavelength of 0.5500 μm. A distance of 2350.045m is recorded at a temperature of 14°C, and at an atmospheric pressure of 740 mm Hg. The height of instrument and reflector above Mean Sea level are 278.76m and 295.15m respectively. The scale factor for the line is 0.99973 and the radius of the earth can be assumed to be 6370km. Calculate the necessary corrections and thus the reduced distance.

(15 marks)

Where applicable you can use the following formulae

$$n_g = 1 + \left(287.604 + \frac{4.8864}{\lambda^2} + \frac{0.068}{\lambda^4}\right)10^{-6}$$

$$n_a = 1 + \frac{0.359474(n_g - 1)P}{273.2 + t} - \frac{1.5026E(10^{-5})}{273.2 + t}$$

2. Describe the Electronic Tacheometers in terms of:

(a) how analogue angles are converted into digital form.

(b) how data is registered and recorded

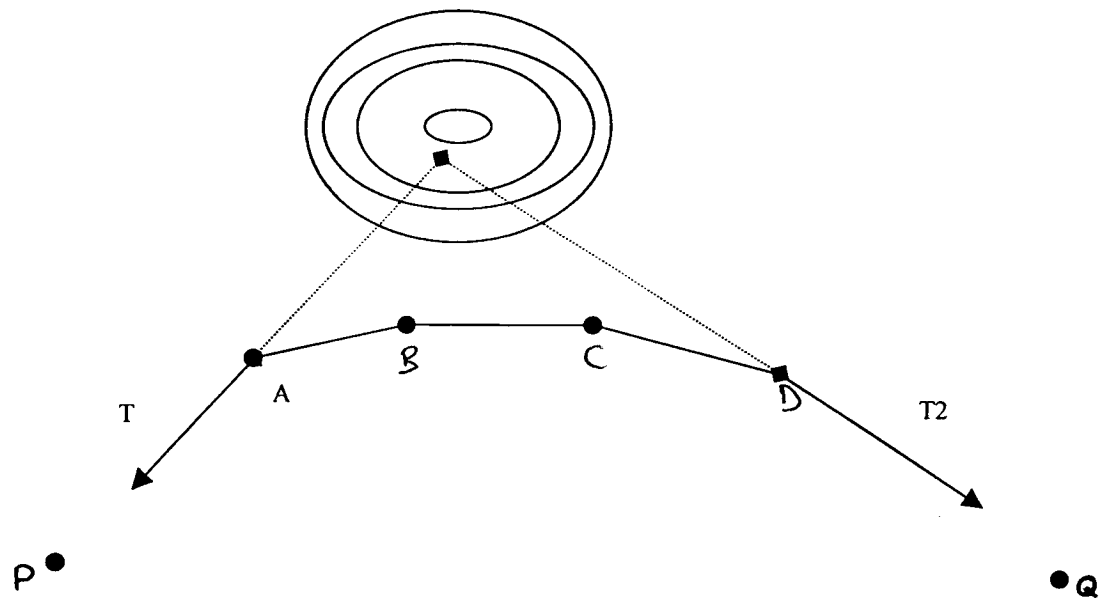
(15 marks)

(c) Field Survey Techniques are now moving towards what is known as Integrating Surveying. By some means of a flow chart explain what you understand by this.

(10marks)

3. Two straights of a railway are connected with a curve. The intersection point of the two straights is not accessible. To determine the deflection angle a traverse is carried out. The straights are taken as orientations.

The chainage of point A on the railway setting out plan is 1250. The radius of the curve is 500m.

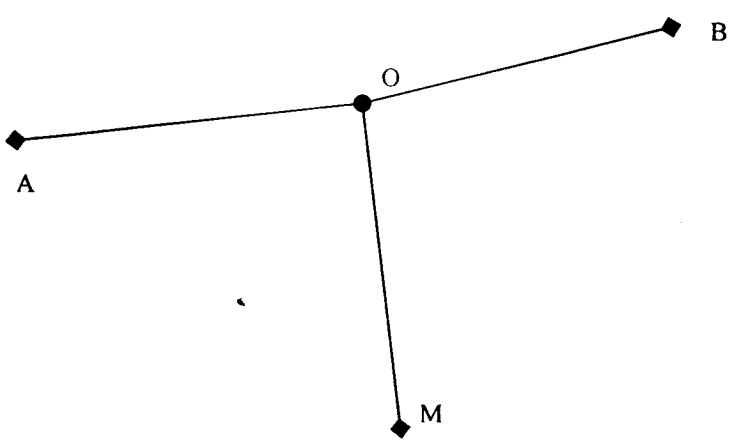


Left Hand Angle	Angle	Line	Length
PAB	189°40′	AB	89.30
ABC	191°10′	BC	112.45
BCD	199°35′	CD	95.30
CDQ	195°35′		

a) Make a sketch and calculate the tangent length.
b) Calculate the length of the curve and give the chainages of the tangent points T1 and T2. (HINT: choose a local coordinate system along the straight P-A-intersection point with the origin at A)

(25 marks)

4. Lusaka Water and Sewarage company is interested in determining the co-ordinates of a point which has been geophysically surveyed and found suitable for sinking a borehole. There are no control points in the vicinity and the only way out is to measure from the unknown point to three visible known points. See sketch below



Given the following compute the coordinates of the borehole point:

At station 0	Observation	Eastings	Northings
A	60°07'50"	46867.94	5537.00
B	265°18'22"	51293.86	6365.89
M	326°33'59"	49666.56	4448.58

(25 marks)

5 (a) Explain how you would transfer vertical and horizontal control from one level to another in a mine indicating the methods used.

(10 marks)

(b) Government is interested in establishing a new bridge across Luangwa River. As a surveyor what work are you required to undertake to see the project to fruition?

(5 marks)

(c) Create a User Defined Sequence(s) which will store Eastings , Northings and Elevations of detail points. It will also ask you to enter the station coordinates, the reference object and the bearing of your orientation. The measuring cycle should include entering the point number and point code. Remember the UDS(s) are meant to come up with a topographic map of an area. A list of labels is attached.

(10 marks)

========End of Examination=========

Label No	Text	Description
0	Info	Information
1	Data	Data used in INFO/DATA combination
2	Stn	Station No
3	IH	Instrument Height
4	Pcode	Point Code
5	Pno	Point Number
6	SH	Signal Height
7	HA	Horizontal Angle
8	VA	Vertical Angle
9	SD	Slope distance
10	DHT	Vertical Distance
11	HD	Horizontal distance
16	dH	Difference between C1 and C2 horizontal angles
17	HA2	Horizontal angle which was measured in C2 and stored
18	VA2	Vertical Angle which was measured in C2 and stored
19	dV	Difference between C2 and C1 vertical angles
20	Offset	Offset constant which can be added to or subtracted from the SD
21	HAref	Horizontal Reference Angle
22	Comp	Compensator ON=1, OFF=0
27	SHA	Setting - out bearing
28	SHD	Setting - out horizontal distance
29	SHT	Setting- out height
30	PPM	Atmospheric Correction, parts per million (PPM)
37	N	Northing - coordinates. Cleared when power OFF
38	E	Easting - coordinates. Cleared when power OFF
39	ELE	Elevation coordinates. Cleared when power OFF (39=49+STN HT)
40	dN	Relative to stored X (N) coord of set out point (P23)
41	dE	Relative to stored Y (E) coord of set out point (P23)
42	dELE	Relative to stored Z (ELE) coord of set out point (P23)
43	UTM SC	Universal Transverse Mercator Scale Factor.
44	Slope	Slope Ratio in Program P24 " Ref Line ".
45	dHA	Difference between calculated and measured closing traverse bearing in P80
46	S. Dev	Standard Deviation
49	VD	Vertical distance (IH and SH included) (49 = 10+3-6)
50	JOB No	Job No file for storage of raw and calculated data.
51	Date	Date
52	Time	Time
53	Operat	Operator identification
54	Proj	Project identification
55	Inst.No	Instrument Number
56	Temp	Temperature
58	EA Rad	Earth Radius
59	Refrac	Refraction Coefficient
60	Type	Type
61	C Code	Computing Code
62	Ref Obj	Reference Object
63	Diam	Diameter
64	Radius	Radius
65	Width	Width
66	Length	Length
67	SON	Northing Coordinate of setting out point (Not available in all units)
68	SOE	Easting Coordinate of setting out point (Not available in all units)
69	SOH	Height of setting out point (Not available in all units)
70	Obj Id	Object Identification
71	Obj No	Object Number
74	Press	Air Pressure
75	dHT	Difference between ELE and SHT (75=29-39)
76	dHD	Difference between setting-out distance and measured distance
77	dHA	Differnce between setting-out bearing and the present instrument pointing
79	END	Signifies the end of the User Definable Sequence
80-99	-	Labels which can be defined by the user

Note ! See note on next page regarding label functions

The label list containing Label Nos 0 - 79 possess certain functions in Geodimeter / GMD * operation. While creating User Defined Sequences, the operator can change the prompt text but the function of the label will remain the same. Labels 80 - 99 are reserved for arbitrary use by the user and can be defined with the program No 41 = Set Label, more about this program on the following pages. Due to the flexibility of the system, almost all label types can be used with all labels. Error 41 is shown if a wrong label type is used.

LABEL TYPES

The label "type" determines the function of the label. The options are listed below.

Type No	Label Type	Description
0	Registration of raw and/or calculated values from Geodimeter. (store type)	This type of label is chosen when measured and calculated values can be taken directly from Geodimeter e.g. HA, VA, SD, E, N, ELE, Time etc.
1	Prompting label (store type)	No display of a default value. Data must be entered manually. after the prompt,e.g. Stn =
2	Set (Non-store type)	These pre-set values e.g. Label No 21 = Hor. ref angle, Label No 30 = ppm can be set directly in Geodimeter.
3	Duplicating - automaticor manual (store type)	This label type is used for displaying both the prompt and the last registered value (e.g. SH = 0.75). This value can of course be changed by overwriting or accepted by pressing only ENT when in the manual duplicating mode.
4	incrementing /decrementing ** (Store-type)	The previously stored value belonging to the same label (prompt) e.g. Pno = 3 is automatically incremented / decremented and can be accepted and stored into GMD * either manually or automatically. Displayed values can of course be overwritten and/or accepted by keying in a new and pressing the ENT key.
5	Loop / Repeat END label (Non-store type)	Choice of this END label type will automatically return the User Defined Sequence to the first program step e.g. Pno, after registration of the last data items in the measurement sequence e.g. registration of E, N and ELE.
6	Single Program END label (Non-store type)	Choice of this END label type will return the UDS to the program No 0 in Geodimeter. This will occur after the last data item in the UDS has been registered in GMD *, e.g registration of project name in a general data sequence.
7	Link Program END label (Non-store type)	Choice of this END label type will link the present UDS to another UDS of the operators choice, allowing the field operation to be registered as one complete sequence.
		* Up to 20 UDS's (Nos 0 - 19) can be created and stored in Geodimeter System 400 with U.D.S. 400 installed.

The label type list cont. on next page.

* GMD = Geodimeter Memory Device

SCHOOL OF ENGINEERING
DEPARTMENT OF SURVEYING

University Examinations – 1999/2000

SE 481
Introduction to GIS: Basic principles and applications

Instructions

Time: Two (2) hours.
Answer five (5) questions, two (2) questions from section A and all questions from section B.

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

Question 1 (12)

Explain the different ways you can input data into a GIS?

Question 2 (3+9)

a) Explain the meaning of the term Buffering.
b) Give three (3) examples where you can use the buffering technique.

Question 3 (3+9)

a) Mention three (3) organisations in Zambia, which you think will do well to establish a GIS unit.

b) For each organisation listed in part a), mention the:
- Data types
- Analysis and
- GIS products.

Section B: Answer all questions from this section

Question 4 (12+10)

a) You have been asked to advise an organisation on the establishment of a GIS unit. What guidelines would you specify to them?

b) Describe (very briefly) the activities that would be involved in the unit once it is fully established.

Question 5 (12+6+8)

a) What distinguishes a GIS from other database systems is its capability to perform spatial operations. Mention four (4) types of operations and explain what they do on the data.

b) What factors influence the accuracy of GIS datasets?

c) What would you consider to be the major positive development in the GIS field and why?

Question 6 (28)

Given a spatial problem to determine a suitable site for a solid waste-dumping site with the following criteria:

- The area should be $500m^2$ and not reserved for cultivation.
- The underlying geology type should not be limestone, quartzite or dolomite.
- The soil must have clay content >30%
- The site should be atleast 5km away from built-up areas.
- The slope should be <20%
- Atleast 500m away from streams, rivers and boreholes
- Within 200m from roads

How would you go about locating the suitable site? Note: you may use flow diagrams to show the data interactions

*End of Examinations******** Good Luck*

University of Zambia
School of Engineering
Dept of Surveying

SE571- Engineering Surveying
Final Examination -September 1998

Time: 3 hours
Answer: Any **THREE** Questions from section I and any **ONE** Question from section II

Question 1 (6+6+6+5)

a. Briefly define the following terms used in deformation monitoring

   i. Relative network
   ii. Absolute network

b. What do the following terms oftenly encountered in earth works mean:

   i. Free haul distance
   ii. Overhaul distance

c. Give one application of a mass-haul diagram:

   i. at design stage of a highway project
   ii. during construction stage of a highway project

d. What is the most important aim of setting out at a construction site?

Question 2 (10+13)

a. Discuss the effect of earth's curvature and atmospheric refraction in levelling giving a compounded equation for their correction. (R= 12740 km)

b. Reciprocal levelling between two points X and Y 731.5 m apart on opposite sides of the river gave the following results:

Instrument at	Height of instrument	Staff at	Staff reading
X	1.463	Y	1.689
Y	1.436	X	0.991

Determine the difference in level between Y and X and the amount of collimation error in 100m.

You may use these tables for Question 5 and 6

SE571 Engineering Surveying Exam

Name..... **Computer No.....**

Question 3 (6+17)

a. State the two common methods of connecting underground surveys to the surface control and for each one state two observation procedures that can be used. **(NB*: no descriptions required)***

b. Grid bearing of a line AB is 326° 46′ 30″. A gyro-theodolite was calibrated on the line AB giving the gyro azimuth of a line equal to 327° 14′ 00″. The same gyrotheodolite was used at a station C in order to determine the grid bearing line CD. The gyro azimuth of CD was 172° 20′ 00″.

Calculate the grid bearing CD.

Given:

Mean latitude of AB = N 54°00′
Mean latitude of CD = N 55°13′
Local radius of earth = 6384 100 m
Central meridian 2°W and grid line 400,000m
Easting of A = 480 000.00
Easting of C = 390 000.00
(t-T) correction = 0°00′07″ at both A and C.

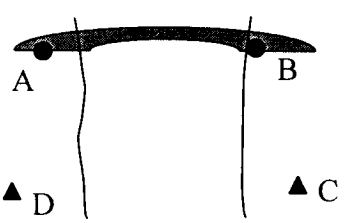
Question 4 (21+2)

Two points A and B were imbedded in the down stream face of the dam in order to monitor its movements as the reservoir was filled. Measurements were taken at regular intervals from two stable points C and D that were on the down stream side of the dam and generally to the south.

Measurements:

	February	**December**
Distance CB (m)	277.839	277.832
Distance AD (m)	225.229	225.221
Horizontal angle DCB	64°09′12.″	64°09′14″
Horizontal angle ADC	74°03′41″	74°03′40.″

Co-ordinates of C: 980.640E, 142.590 N
D: 743.940E, 156.820 N



Determine:

a. The amounts and directions by which A and B have apparently moved between February and December.

b. Which vital measurements do you think are missing in this situation.?

Section B: Answer only one Question from this section

Question 5 (8+8+5+11)

During a levelling operation carried out in connection with the construction of a proposed sewer, the consecutive staff readings given in table 5.1 were obtained.

Table 5.1

Staff Reading (m)	Distance (m)	Remarks
1.40		BM 44.20 AD
1.90	0	Ground level at outfall
1.19	40	Ground level
0.84	80	Ground level
1.15	120	Ground level Change point
2.96	120	Ground level Change point
1.49	160	Ground level
1.26	200	Ground level
1.68	-	TBM 45.73 AD

Details of the proposed sewer are in table 5.2

Table 5.2

Chainage	**Manhole**	**Invert level (m AD)**	**Remarks**
0	Outfall	41.98	Gradient of outfall to MH A to be 1 in 140
100	A	?	
150	B	43.50	
200	C	45.40	Outside diameter of sewer 0.4m

a. Book and reduce the levels carrying out appropriate arithmetical checks.

b. Draw a longitudinal section of the ground.

c. Calculate the invert level of MH "A" and show the sewer line on the section.

d. A traveller 3.0m long was used when the trench was excavated. Calculate the staff readings adopted when setting out the sight rails at the outfall from instrument position 1 and at the manholes A, B and C from instrument position 2. Assume the level was set up exactly as it was in (a).

Question 6 (15+6+5+6)

Volumes of excavation (+) and fill (-) between successive sections 100 m apart on a proposed road of length 1500m are given in the scheme below:

Chainage	0	100	200	300	400	500	600	700	800
Volume	909	2538	4131	5278.5	4612.5	2538	702	-1525	

Chainage	800	900	1000	1100	1200	1300	1400	1500
Volume	-4460	-6550	-5895	-3780	-2625	-1775	-650	

a. Draw the Mass Haul Diagram for this length of the road.

b. Determine the accumulated volume at the end of the proposed road and state whether it is a borrow or waste.

c. Determine the accumulated volume coinciding with the end of the cutting operation.

d. Determine the haul distance over which 10 000 m^3 of excavated material has to be moved to an area of fill so that the quantities of cut and fill balance.

Good Luck

University of Zambia
School of Engineering
Department of Surveying
SE571-Engineering Surveying

Supplementary & Deferred Examinations
October 1998

Instructions

Time allowed: 3 Hours
Answer all Questions

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1. (6+9+10)

   a. What is autocollimation and how would you know that it has taken place?

   b. Illustrate clearly how an autocollimation theodolite and prism can be used to transfer direction from one floor of the building to another.

   c. The potential hazard in the use of a laser is eye damage. List four precautions that should be taken to protect the user and other people at the site from this danger hazard.

2. (10+15)

a. Derive from first principles an expression for the combined correction for earth's curvature and atmospheric refraction in levelling assuming the earth is a sphere. (Use 12740km diameter of earth where necessary).

b. A level is set up at point X and readings of 0.219 and 1.674 are taken onto two benchmarks A and B respectively. The height of A is 166.84m above datum and that of B is 165.37m above datum. If the distances XA and XB are 87.6m and 33.8 m respectively, calculate the collimation error per 70m. If a reading of 3.512 is taken from X to a point P, 82.00 m from X calculate the height of P.

3. (10+15)

a. During the setting out of a tunnel the observations given below were made by a theodolite at a surface station S near to a vertical shaft.

Pointing	**Horizontal Circle Reading**	**Distance from theodolite**
Station A	198°18′12″	446.35 m
Station B	013°17′56″	170.60 m
Plumbwire P	106°50′20″	7.29m
Plumbwire Q	106°50′29″	

The plumb wires down the shaft were 5.345 m apart, P being the nearer of the two to the theodolite at S. If the whole circle bearing of PQ was 307°47′24″ deduce that of AB.

b. Explain in full one method of using the gyro theodolite to determine azimuth of AB.

4. (15+10)

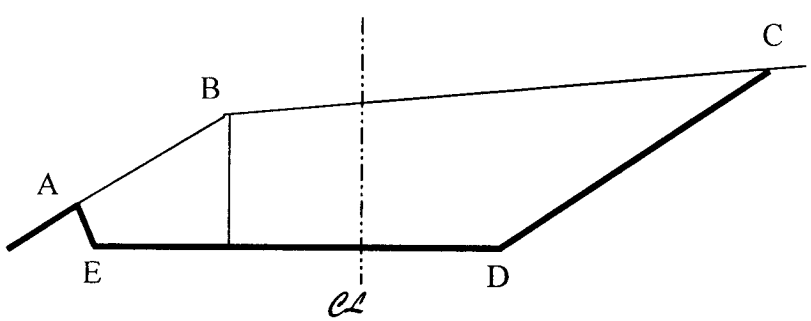

Fig 4.0

Fig 4.0 shows section 1 of a cutting for the proposed railway line. The following data is given:

Slopes: BA = 1 in 10; CB =1 in 16; CD = AE =1 in 2.5.

Distances: Width of formation 15.0m; height of B above formation 1.0m, B is 1m left of ℄.

a. Calculate the area of cut of section1 in fig 4.0.

b. The areas of further sections at successive 20m intervals along the line of a straight railway line have been calculated. These are:

Section:	2	3	4	5
Area of cut (m^2):	20.3	21.7	28.8	30.2

Calculate the volume of cut between sections 1 and 5 by the end areas and the prismoidal methods.

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY SECOND SEMESTER EXAMINATIONS - AUG/SEP. 1998.

CE 219.

STATICS AND INTRODUCTION TO STRENGTH OF MATERIALS.

TIME: Three Hours. **ANSWER:** Any THREE from Section A, and Any TWO from Section B.

SECTION - A.

1. The bar AB of Fig: 1 has a uniform cross-section, a mass of 25 kg and length of 1 m. Determine the angle θ when the bar assumes equilibrium position within the V-shaped supporting block.

2. Three bars are connected with smooth pins to form the frame shown in Fig: 2. The pin at B is located inside a smooth slot. Determine :-

   (a) The force exerted by the pin at D on member CDE,
   (b) The reactions at supports A and E.

3. A rotating shaft with a belt type brake is shown in Fig: 3. If $\mu = 0.2$ between the drum and belt and an applied force of P = 75 N prevents rotation of the shaft, determine the maximum torque that can be resisted by the brake when the shaft is tending to rotate :
   (a) anti-clockwise,
   (b) clockwise.

4. Locate the centroid of the uniform slender rod bent as shown in Fig: 4.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

SECTION - B.

5. Applied loads W = 5 kN are suspended by ropes as shown in Fig: 5a and 5b. In both cases the ropes have cross-sectional areas of 800 mm^2 and the value of E = 0.98 kN/mm^2. In 5a, the rope ABC is continuous and W is suspended from a smooth pulley of negligible dimension. In 5b, AB and CB are seperate ropes joined to a rigid block from which W is suspended in such a way that both ropes stretch by the same amount.

   For both cases, determine:-

   (i) the stresses in ropes, (ii) the downward movement of pulley, or block, due to load W.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

6. A rod 1 m long is 10 cm^2 in area for a portion of its length and 5 cm^2 in area for the remainder. The strain energy of this stepped bar is 40 % of that of a bar 10 cm^2 in area and 1 m long under the same maximum stress. What is the length of the portion with 10 cm^2 area?

7. A composite bar made up of aluminium and steel is rigidly fixed between supports as shown in Fig: 6. The two bars are free of stress at 60° C. Determine the stresses in these bars when the temperature drops to 40° C, if:-

   (a) the supports are unyielding, and (b) the supports come nearer by 0.1 mm.

GIVEN, $\alpha_s = 11.7 \times 10^{-6} / {}^0C$ $\quad E_s = 210\ kN/mm^2$

$\alpha_a = 23.4 \times 10^{-6} / {}^0C$ $\quad E_a = 70\ kN/mm^2$

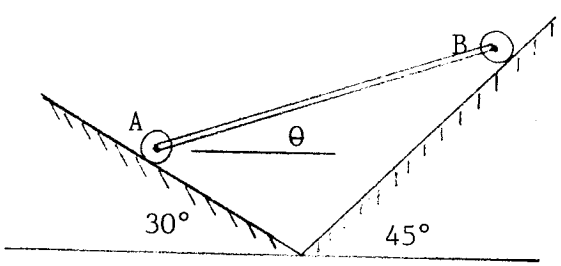

FIG: 1.

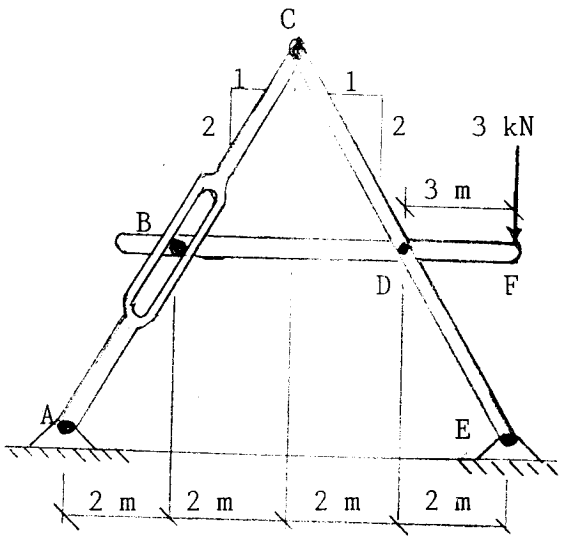

FIG: 2.

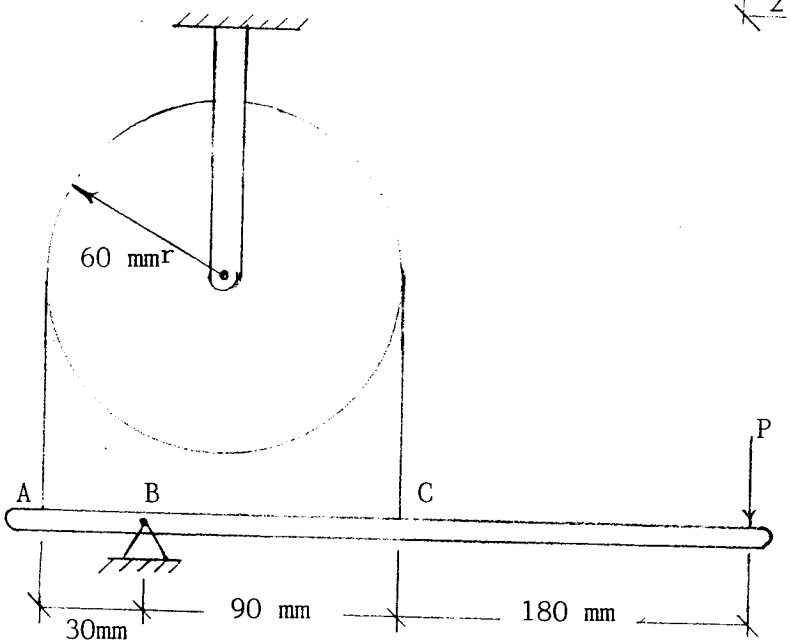

FIG: 3.

Page 3 .....

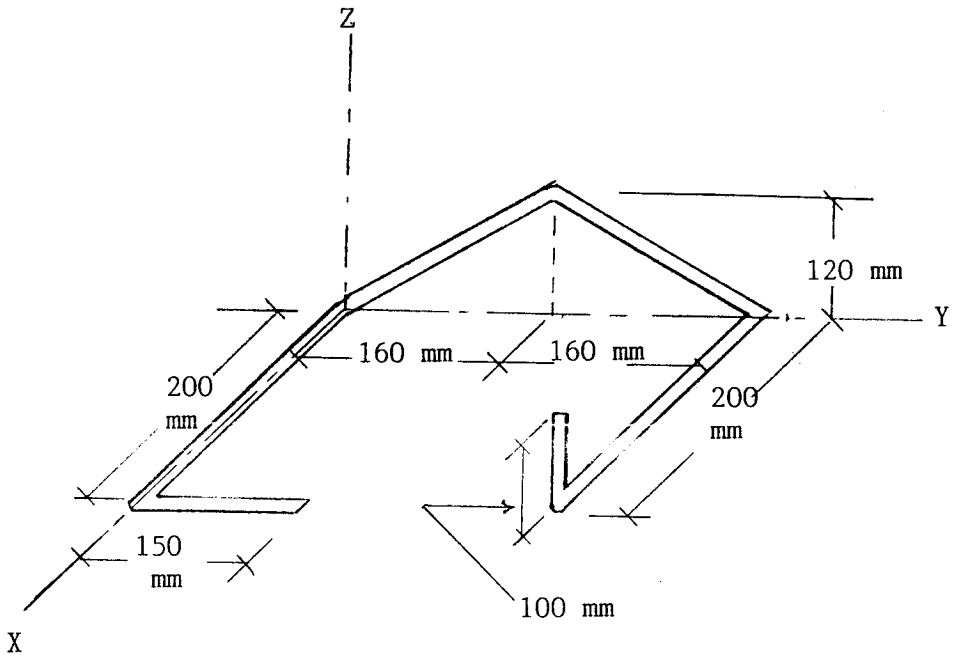

FIG: 4.

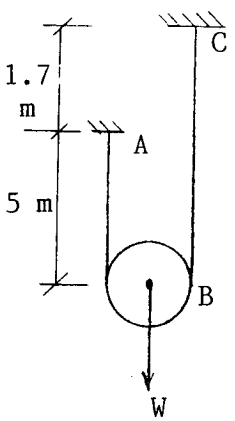

FIG: 5a.

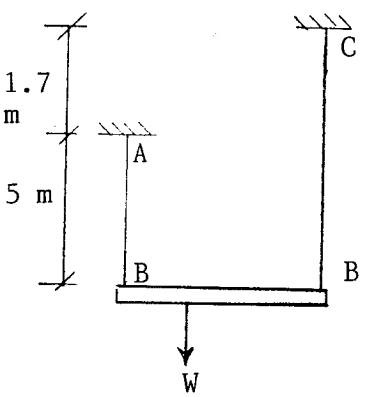

FIG: 5b.

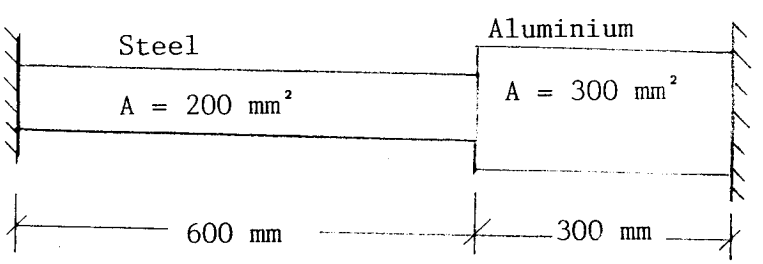

FIG: 6.

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END OF EXAMINATION.

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