THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS - 2001

SECOND SEMESTER EXAMINATIONS

SCHOOL OF ENGINEERING

1.	CE 219	-	Statics and Introduction to Strength of materials
2.	CE 312	-	Theory of Structures
3.	CE 369	-	Fluid Mechanics 1
4.	CE 421	-	Soil Mechanics and Foundation Engineering
5.	CE 442	-	Highway and Traffic engineering
6.	CE 512	-	Structural Dynamics
7.	CE 535	-	Structural Steel Design
8.	EA 402	-	Final Examinations
9.	EE 209	-	Principles of Electricity 1
10.	EE 342	-	Electronic Engineering 1
11.	EE 442	-	Electronic engineering II
12.	EE 452	-	Electric Power System
13.	EE 541	-	Electronic Engineering III
14.	EE 552	-	Electrical Power Systems II
15.	EE 572	-	Telecommunication System
16.	EG 212	-	Workshop Technology
17.	EG 269	-	Information Technology
18.	EG 475	-	Engineering, Management and Society I
19.	EG 575	-	Engineering Mangement and Society
20.	EM 212	-	Engineering Mathematics II
21.	EM 312	-	Mathematics - Engineering Mathematics iv
22.	ME 252	-	Properties of Engineering materials
23.	ME 332	-	Strength of materials
24.	ME 375	-	Dyamics
25.	ME 442	-	Thermodynamics II and Heat Engines
26.	ME 452	-	Properties of Engineering materials II
27.	ME 512	-	Manufucturing systems Management

28.	ME 585	-	Automobile Engineering
29.	SE 332	-	Photogrammetry 1
30.	SE 352	-	Land Law, Cadastre and survey regulations
31.	SE 412	-	Numerical methods and programming for surveyors
32.	SE 531	-	Photogrammetry III
33.	SE 562	-	Land Resources Planning.

THE UNIVERSITY OF ZAMBIA.

UNIVERSITY SECOND SEMESTER EXAMINATION – JULY/AUGUST 2001.

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. To test the deflection of the uniform 100 kg beam the 50 kg boy exerts a pull of 150 N on the rope rigged as shown in Fig: 1. Compute the force supported by the pin at the hinge O.

2. (a) Determine the force in member CF of the truss shown in Fig: 2 in terms of load L. All triangles are equilateral.

   (b) Knowing the external reaction at E for the same truss, determine the force in member BF from only one additional equilibrium equation applied to one additional free-body diagram.

3. A uniform semicircular rod of radius r is supported by a smooth bearing at its upper end A and is free to swing in the vertical plane. Calculate the angle θ made by the diameter with the vertical at A for the equilibrium position. (Fig: 3).

4. For a certain coefficient of friction μ and a certain angle α, the force required to raise the block M is 4 kN and that required to lower M at a constant slow speed is 1.6 kN. (Fig: 4). Calculate the mass of M.

Section – B.

5. A 400 mm long circular bar has 50 mm diameter for the middle half of its length, and a reduced diameter for the two end portions . Determine the diameter of the end portions if the bar is subjected to a tensile load of 100 kN, and the maximum stress is limited to 150 N/mm^2 while the total allowable extension is not to exceed 0.3 mm. Given, E = 200 kN/mm^2 .
   Determine the total strain energy stored in the bar.

6. A 20 kN load is supported by a central aluminium rod and two symmetrically placed steel rods as shown in Fig: 5. The diameter of each rod is 20 mm. Find the stresses in each rod.

If this assembly heats up uniformly under hot summer sun, find the temperature increase when all the rods will have equal stress.

Given: $E_s = 205\ kN/mm^2$, $E_a = 70\ kN/mm^2$.
$\alpha_s = 12 \times 10^{-6}/°C$, $\alpha_a = 20 \times 10^{-6}/°C$.

7. A steel bolt 25 mm diameter is subjected to a direct tension of 15000 N and a shearing force 10000 N. Determine the intensities of normal and shearing stresses across a plane inclined at an angle of 60° to the longitudinal axis of the bolt.

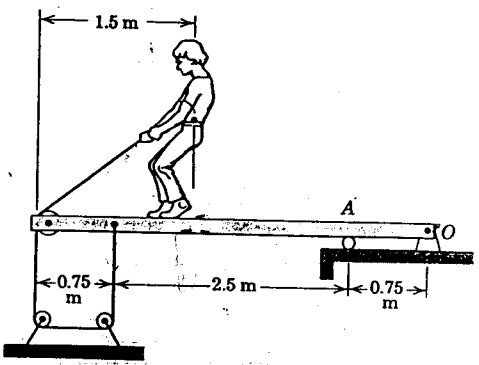


FIG: 1.

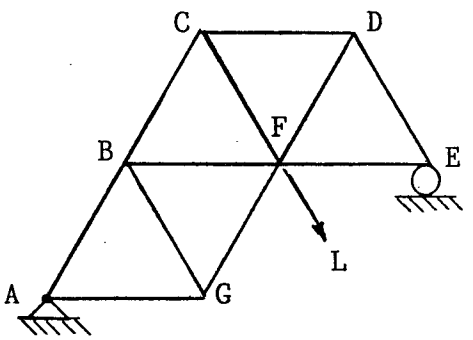


FIG: 2.

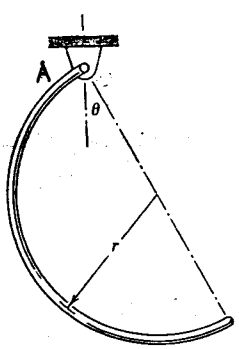


FIG: 3.

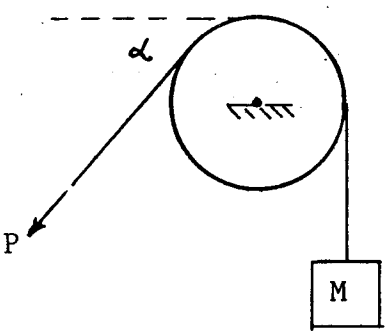


FIG: 4.

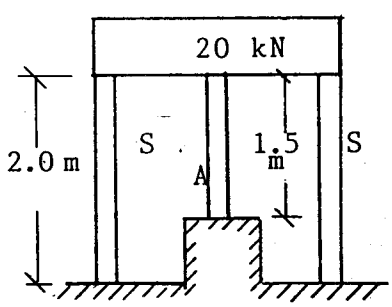


FIG: 5.

**** END OF EXAMINATION ****

THE UNIVERSITY OF ZAMBIA
UNIVERSITY EXAMINATIONS-1999/2001 ACADEMIC YEAR

CE 312 Theory of Structures

Time: 3 Hours
Closed Book
Answer any 5 Questions. All questions carry equal marks.

Q1 Figure1 shows a beam supported at four points. Analyze the beam using the Slope deflection method. The relative stiffnesses are shown for members. E is constant for all members.

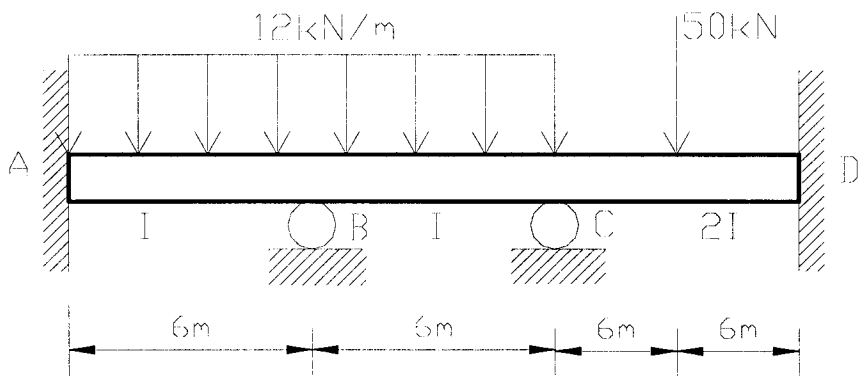


Figure 1

Q2 For the frame shown in Figure 2, use the Moment Distribution Method to obtain support moments. Draw the bending moment diagram. The relative stiffnesses are shown for members. E is constant for all members.

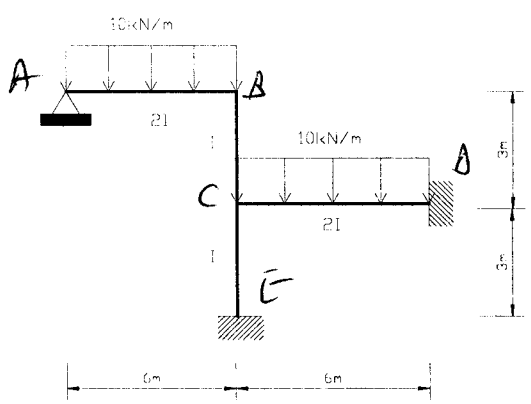


Figure 2

Q3 For the beam shown in Figure 3. AE is constant, draw the Influence lines for the following:

(a) Reaction at A
(b) Reaction at B
(c) Reaction at C
(d) Moment at E

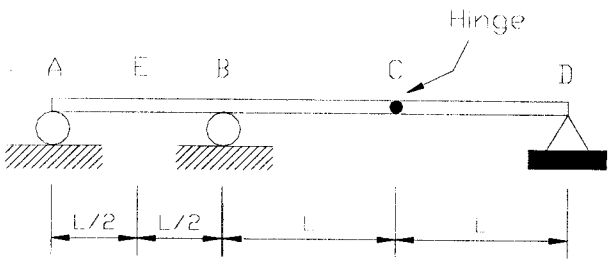


Figure 3

Q4 Analyze the frame shown in Figure 4 using the Portal Method of Analysis.

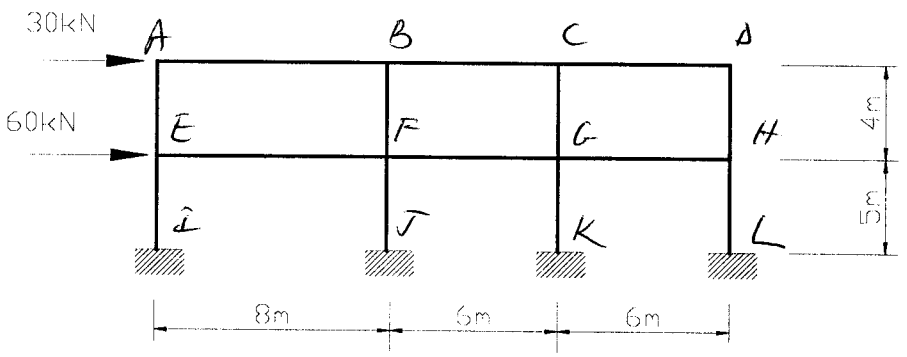


Figure 4

Q5 For the structure shown in Figure 5:

(a) Draw the Axial, Shear and Bending Moment Diagrams, indicating values at the critical sections.
(b) Sketch the deflected shape.

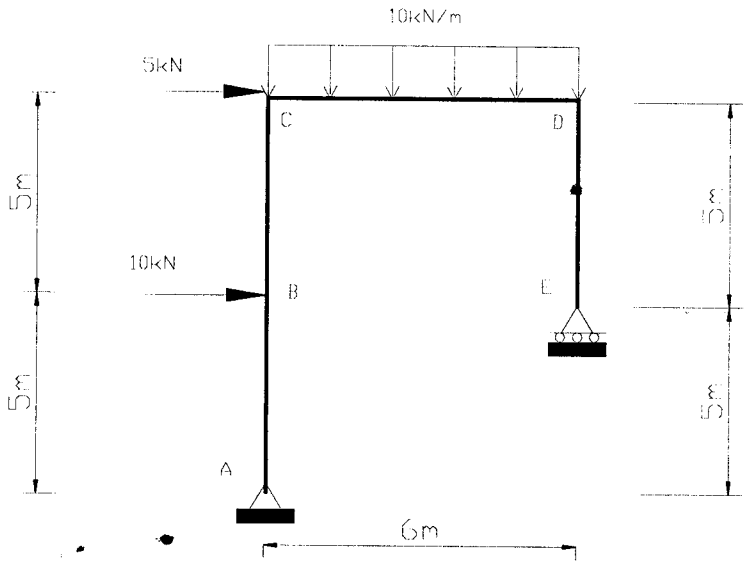


Figure 5

Q6 Using the Moment Area Method, compute the displacement and rotation of point C on the beam shown in Figure 6. E=200,000 N/mm^2, I=5000x10^4 mm^4.

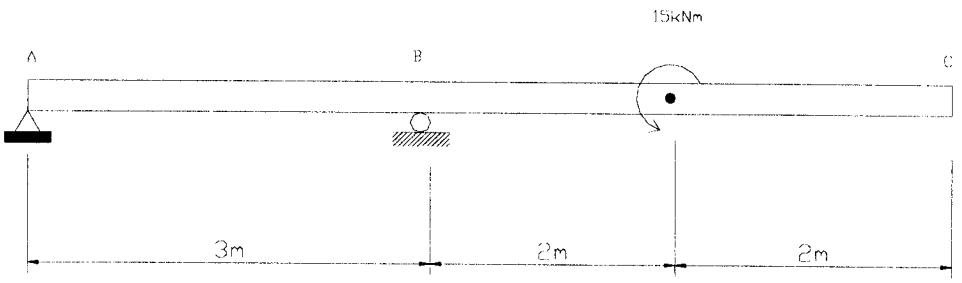
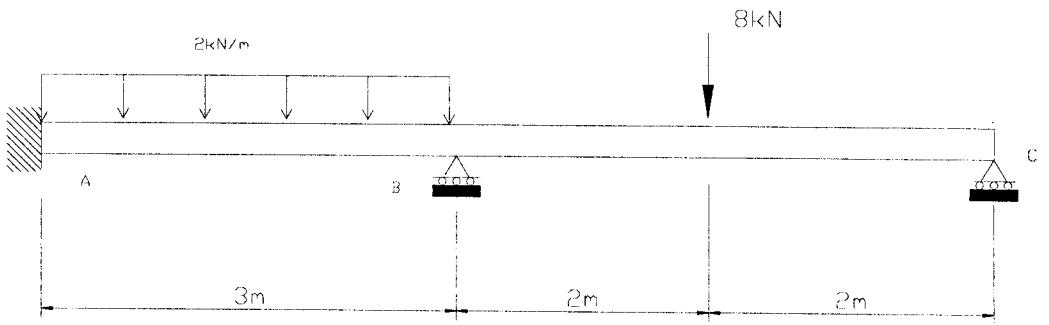


Figure 6

Q7 Use the Direct Stiffness Method to solve the continuous beam shown in Figure 7. Draw the bending moment and shear force diagrams. EI is constant. EI is constant.



THE UNIVERSITY OF ZAMBIA
CE 369 Final Examination
Fluid Mechanics I
26th July 2001

CLOSED BOOK Examination

Instructions to candidates:

1. The time allocated to this examination is THREE (3) HOURS.
2. Candidates must ensure that their computer numbers are clearly written on each answer booklet used and that the numbers of questions answered are entered in the space provided on the front of the booklet.
3. Answer any FIVE questions out of SEVEN.
4. All questions carry equal mark (20 %).

Question 1

An 80 Newton vertical force is required to accelerate a homogeneous object at a constant rate of 1.2 m/sec^2 vertically upward at the earth's surface where gravitational pull is 9.8m/sec^2. The mass of the object is 7.3kg at the earth's surface and the object has a volume of 0.01m^3. Answer the following questions.

(a) What is the density of the object?

(b) What is the specific gravity of the object?

(c) If the gravitational acceleration is reduced from 9.8m/sec^2 to 3m/sec^2 by locating the object at a higher elevation from the earth's surface, what will be the reduction in the mass of the object?

Question 2

An oil storage tank is built onto the side of a breakwater wall as shown in cross-section in figure 1. A three dimensional view of the tank is shown in figure 2. All dimensions are in meters.

Figure 1

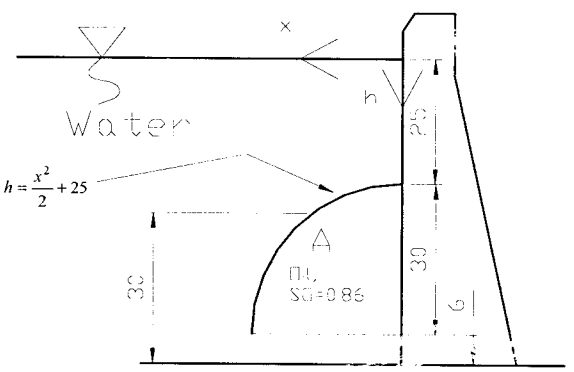
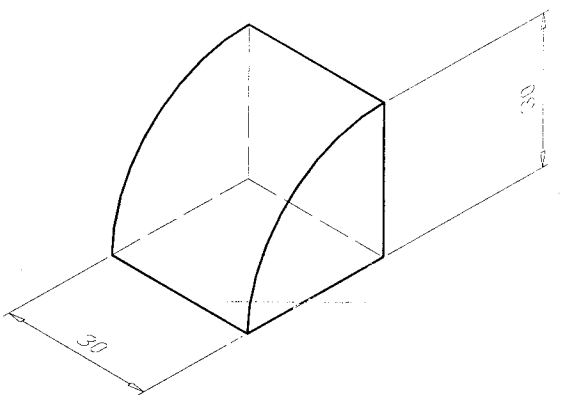


Figure 2



Note: the tank is open along the bottom where there is a water-oil interface.

(a) Determine (show all your work) the centre of pressure of the horizontal force on the outside wall of the tank due to water only.

(b) Calculate the pressure at point A on the inside wall of the tank.

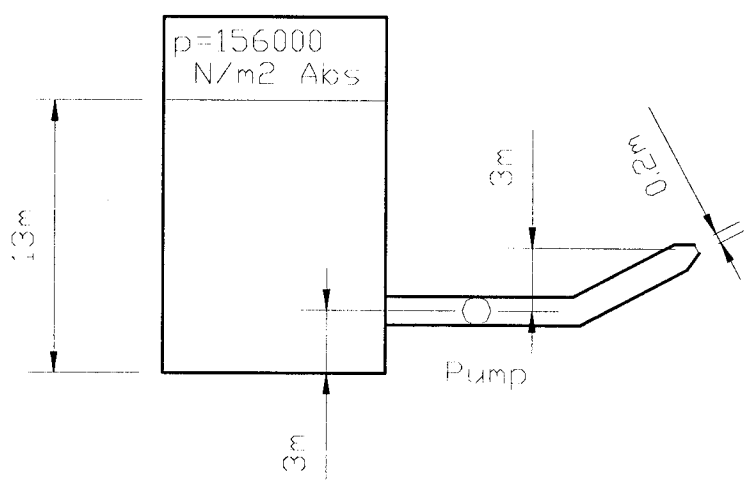
Question 3

Refer to figure 3 below.

(a) The pump in the system adds a head of 10m to the water (ρ=1000kg/m^3) flowing through the pipe. Assuming no losses, determine the discharge from the nozzle.

(b) If the pump has an overall efficiency of 60%, determine the motor power needed to get 0.5m of head from the pump.

(c) Is the pump necessary if only 0.5m^3/s? flow was needed at the pipe outlet?.

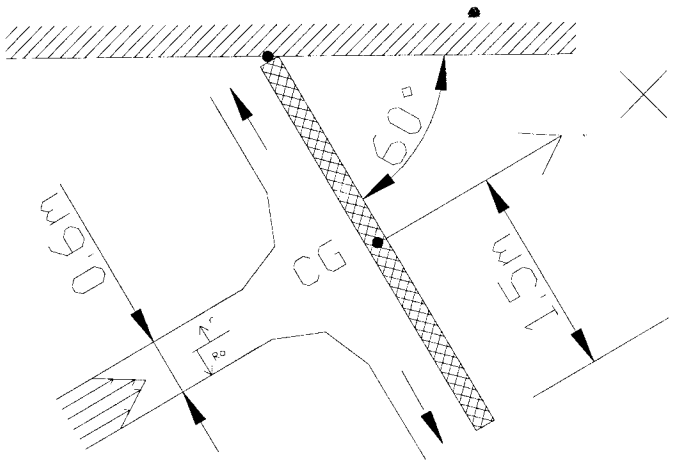


Question 4

The figure below shows a steady circular jet of water (ρ=1000kg/m^3) impinging perpendicularly at the center of a rectangular plate (2mX3m). The plate is connected to the ceiling by a frictionless hinge. The incoming jet is at 30° with the horizontal. The velocity distribution of the incoming jet is given by $V = (4R_o - r)$ m/sec where r is the radial distance from the center line of the jet and R_o is the radius of the jet as shown on the sketch.

a) Neglecting the weight of the water, determine the force produced by the jet of water along the x-axis shown in the sketch.

b) For the equilibrium situation shown in the sketch, determine the weight of the plate, Wp, if the center of gravity of the plate is located as shown on the sketch.



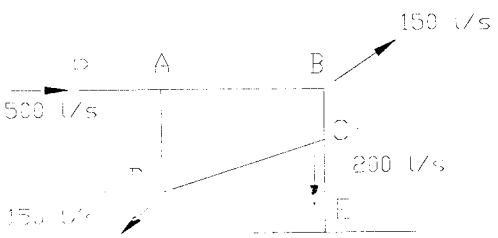
Question 5

(a) Show that $\phi = xy$ satisfies the Laplace equation for two dimensional flow.
(b) What is the physical significance of the result part (a) as far as the flow pattern is concerned?
(c) Determine the stream function for the above flow pattern.
(d) Will the stream function in (d) also satisfy Laplace equation? Explain your answer without any calculation.
(e) Show that equi-potential lines and streamlines are perpendicular to each other.

Question 6

A pump is installed at P to pump water through the network as shown in the figure below. The dimensions of all the pipe elements are shown below, and the friction factor is 0.003 for all pipes. The flow at the junctions of the network are shown in the figure. If the flow at P is 500l/s how much power is required to overcome friction between points P and E of the network? Assume that the friction headloss in pipe element is given by the Darcy-Weisbach formular.

Pipe	Length(m)	Diameter(mm)
PA	500	600
AB	1850	300
BC	610	200
CD	1990	200
DA	1000	250
CE	920	250



Question 7

A 3m wide rectangular channel is carrying 10m3/s of water. If the slope So is 0.0025 and Manning's coefficient n is 0.016, answer the following questions about the flow conditions.

(a) What is the critical depth of flow?
(b) What is the normal depth of flow?
(c) What is the specific energy of flow?
(d) Is the flow subcritical or supercritical? Explain your answer.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS-AUGUST 2001
CE 421
SOIL MECHANICS AND FOUNDATION ENGINEERING

TIME: THREE (3) HOURS

INSTRUCTIONS: READ QUESTIONS AND UNDERSTAND THEM BEFORE ATTEMPTING ANY QUESTION. ANSWER QUESTIONS AS PER INSTRUCTIONS GIVEN IN EACH QUESTION

SECTION A

Attempt not more than **five (5)** questions from this section. Where possible explain all symbols and show steps on how you arrive at your answers with some illustrations.

Q1. LATERAL EARTH PRESSURE

A retaining wall having a smooth vertical back retains soil for a depth of 12m. The soil mass consists of two horizontal layers which after investigations were found to have no cohesion. The two layers differed by a thickness of 2m. The lower layer was smaller but stronger than the overlying layer. The water table was well below the base of the wall. If the effective angles of shearing resistance were 28° and 34° while the buoyant unit weights should have been 8kN/cu.m and 10kN/cu.m had the soil mass been submerged; determine the magnitude and position of the resultant active thrust from top of the wall. You are also required to draw a detailed soil profile and variation of pressure distribution.

(10 marks)

Q2. PERMEABILITY

In a variable head permeability test, the following values were given:

- length of specimen was 200mm;
- area of piezometer was 40sq.mm;
- head difference at initial time was 500mm;
- head difference after 3min. was 300mm.

(a) Determine the coefficient of permeability of the soil
(b) Sketch the falling head permeability test apparatus
(c) What type of soil would be used suitable for this test?

(10 marks)

Q3. SHEAR STRENGTH

The results of a drained triaxial test for a normally consolidated clay are:

- chamber confining pressure is 16kN/sq.m;
- deviator stress at failure is 25kN/sq.m;

(a) Find the angle of internal friction;
(b) Determine the angle θ;
(c) Graphically, determine the above parameters with the use of Mohr circle on the failure envelope.

(10 marks)

Q9. BEARING CAPACITY

Explain concisely your understanding of bearing capacity with emphasis on:

- ultimate bearing capacity;
- safe bearing capacity;
- allowable bearing capacity.

(5 marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

HIGHWAY AND TRAFFIC ENGINEERING
CE 442 DEFERRED/SUPPLEMENTARY EXAMINATION –SEPTEMBER 2001

DURATION: 3 HOURS

PLEASE ANSWER ANY FIVE OF THE FOLLOWING QUESTIONS

Q1. a) Describe the route location survey processes, high-lighting the importance of and what is done at each stage. Use of sketches where necessary should be made. **(10 marks)**

b) Describe the three most common traffic patterns with sketches and give the advantages and disadvantages of each pattern. **(10 marks)**

Q2. a) What do you understand by CBR, its significance and use. **(5 marks)**

b) What are the two most common methods of determining CBR of a material and on what type of material do you normally carry out CBR test? **(5 marks)**

c) If two tests are conducted on a material sample and two different values of CBR are obtained what would you take as the CBR value for the sample? **(5 marks)**

d) Besides road works what other engineering works make use of CBR? **(5 marks)**

Q3. List any 20 basic principles a road design engineer may take into account in locating a highway. **(20 marks)**

Q4. a) What are the most common ways of financing transportation infrastructure? **(10 marks)**

b) What is meant by AADT and how is it calculated? **(5 marks)**

c) Explain what is meant by 30^{th} heaviest hour traffic and how useful it is to highway design. **(5 marks)**

Q5. a) What are the main functions of road shoulders?

b) What is meant by road material stabilization and how is it commonly achieved in practice? **(5 marks)**

c) Discuss chemical and mechanical stabilization of road materials. **(10 marks)**

Q6. The driver of a vehicle travelling at 120 Km per hour takes 6 seconds to perceive and react to an obstacle on his way. If it takes 8 seconds to brake, determine the stopping distance. Note that stopping distance is the total distance traveled during perception, reaction and braking time. **(20 marks)**

Q7. a) Make a sketch of a typical of a:

i) Gravel road and
ii) Paved road , clearly labeling all the various road layers in the section. **(10 marks)**

b) How does CBR of the sub-grade affect pavement layers above it? **(10 marks)**

THE END

UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

CE 512 STRUCTURAL DYNAMICS

FINAL EXAMINATION

2nd August 2001

==========

TIME: Three hours

ANSWER: Select 5 from the two section as shown. All questions carry equal marks.

==========

SECTION A (Select any three from the four)

1, Determine the initial velocity, v_0, that should be imparted to a body projected vertically up from the surface of the earth for it to reach a given altitude H. Assume the gravitational force to be changing inversely to the square of the distance from the centre of the earth and neglect the resistance of the air. What is the value of initial velocity ? if the particle will be carried into infinity, assuming the mean radius of the earth to be R=6370 km. (fig.1)

2, The block has a mass, M. What is the frequency for the system given arrangement of springs in fig.2.

3, Determine the period of vibration of the load of weight P attached to two springs of stiffness k_1 and k_2 as shown in fig.3.

4, The rigid frame supports a rotating machine which exerts a horizontal force at the girder level of (1000sin20t) N. Assuming 5 percent of critical damping, what is the steady-state amplitude of vibration ? $EI_c=6x10^2$ N-m^2, M=10000 kg. (fig.4)

SECTION B (Select any two from the three)

5, The two-degree system has the following parameters: M_1=5 kg, M_2=1 kg, k_1=5000 N/m, k_2=1000 N/m. Using direct determination, obtain the natural frequencies and characteristic shapes of both modes. Demonstrate the orthogonality of the modes. (fig.5)

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

Lagrange' s equation: $$\frac{d}{dt}\left(\frac{\partial k}{\partial \dot{q}_i}\right) - \frac{\partial k}{\partial q_i} + \frac{\partial u}{\partial q_i} - \frac{\partial w_c}{\partial q_i} = \frac{\partial w_e}{\partial q_i}$$

7, Write the series expression (in terms of F_1 and DLF) for the deflection at each of the two loads on the beam of fig.7. EI= $1.5x10^8$ N.m^2, m=30 kg/m, L=12 m.

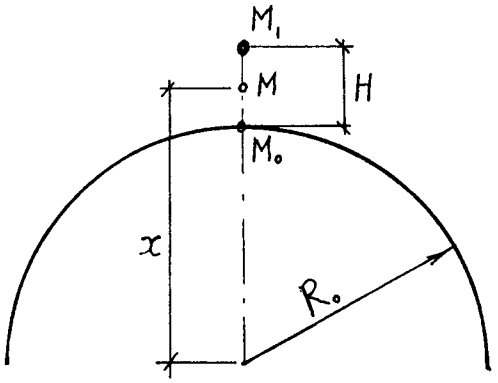


Fig. 1

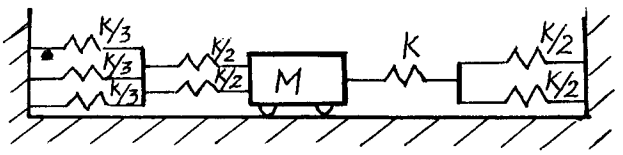


Fig. 2

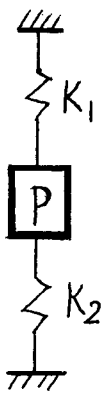


Fig. 3

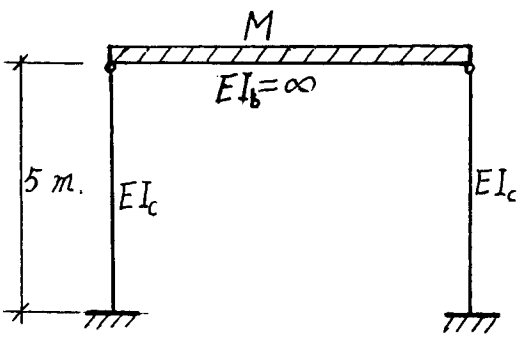


Fig. 4

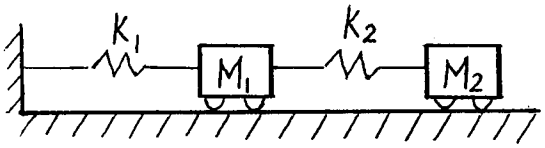


Fig. 5

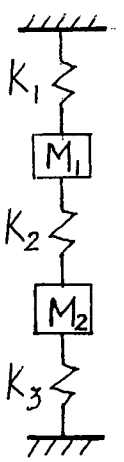
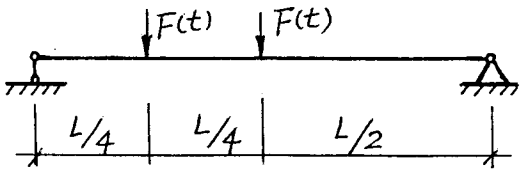


Fig. 6



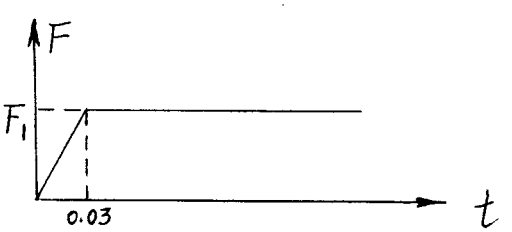


Fig. 7

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Final Exam

COURSE: CE 535 **TIME: 4 Hours**
Structural Steel Design

PART ONE

ANSWER ALL QUESTIONS

1. A 3.5 m long 254 x 254 UC 107 of grade 43 steel is subjected to a compressive load of 450 kN which acts at effective eccentricities of 100 mm about both axis from the column face so as to produce single curvature bending about both the xx – axis and yy-axis, taking as Lex = L and Ley =L

   (a) Check the local capacity of the column section chosen
   (b) Check whether overall buckling of the column is satisfactory using the simplified approach.
   (c) Check whether overall buckling of the column is satisfactory using the more exact approach.

2. The plate girder shown in figure 2.0 is chosen on a trial basis to carry maximum coincident values of moment and shear of 600 kNM and 3635.5 kN. The steel grade is 43 and the beam is to be fully braced against lateral instability. The design strength of steel is 265N/mm^2.

   (a) Check whether the chosen section is capable of carrying the applied moment and shear force.

   (b) design a pair of suitable vertical stiffeners for the girder without utilizing tension field action and taking a/d=1 and the thickness of stiffeners as 15 mm.

3. (a) Design the rafter (top chord) and bottom chord of the truss shown in figure 3.0 for the following:

   (a) Dimensions
   Span of truss 11.444 m

Height of truss	1.8 m
Roof slope	17.5^0
Truss spacing	3.0 m centre to centre
Rafter length	6.0 m

(b) Loading

Dead load	1.2 kN/m^2
Self weight	4.79 kN.
Live load	0.75/kN/m^2

It is assumed that the purlins are located at the node points and there are connections at quarter points in the top and bottom chords. The steel grade is 43. Assume an initial size of angles of 2 - 75 x 50 x 8 unequal angles spaced 8 mm apart to allow for gusset plates. The bottom chord is to be connected to gusset plates by one 20 mm diameter bolt at each end.

(c) Check the adequacy of the 2-75 x 50 x 8 mm angles in the rafter assuming the purlins are not located at node points for the same truss above.

PART TWO

ANSWER TWO QUESTIONS ONLY

4. The simply supported beam shown in figure 4.0 is loaded at C and D by secondary beams which transmit loads of 45 kN dead and 50 kN live respectively on it at these points. Check the suitability of a 610 x 305 x 149 UB, grade 43, to carry this load ignoring its self-weight.

(a) assuming it is restrained laterally along its length
(b) assuming it is restrained only at A, B, C and D

5. (a) Check whether the girder shown in figure 5.0 (a) and 5.0 (b) can carry a load of 3600 kN which act through a cleat of 15 mm thickness and if inadequate design a load bearing stiffener. Assume initial Pc=200N/mm^2 for determining the area required of stiffener and take the width of stiffener as 20 mm^2.

The grade of steel is 43 and Py = 265N/mm

5. (b) Check whether a 125 x 75 x 10 unequal angle of grade 43 steel is suitable for use as a side rail given the following:

(a) Dimensions

Span of rails	5.0 m $^c/_c$ simply Supported
Spacing	1.5 m Centres

(b) Loading

Dead load (cladding)	0.22 kN/m^2
Self weight	0.15 kN/m
Wind load (Pressure)	1. KN/m^2

Refer to figure 5.0 (c)

6. Steel purlins of grade 43 are required for a steel truss for the following Specifications:

(a) Dimensions

Spacing of purlins	1.5 m
Span of purlins	5 m simply supported
Rafter slope	20

(b) Loading

Dead load (Cladding)	0.22 kN/m^2
Imposed load	0.75 kN/m^2 (on plan)
Wind load	0.6 kN/m^2 (Suction)

Check whether an initial size of 150 x 75 x 12 mm

Unequal angle selected would carry the loading above.

7.(a) Check the ability of the Web Cleats form of beam to column connection shown in Figure 7.0 (a) and 7.0 (b) to transfer a beam end reaction of 160 kN into the column by

(i) Checking the capacity of the bolt group in the beam Web

(ii) Checking the capacity of the bolt group in the column/flange

(iii) Checking the capacity of the angle cleat in shear.

(iv) Checking the capacity of the angle cleat in bending.

Both the cleats and beam are grade 43 steel and the angle cleats are 90 x 90 x 8 mm. The bolts are M20 grade 4.6 black bolts.

7.(b) Design the truss connection shown in Figure7.0 (c). The grade of steel is 43 and the gusset plate is 8 mm thick. The bolts are M20 grade 4.6 black bolts.

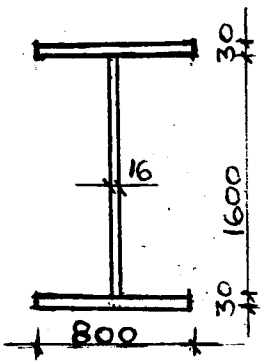


FIGURE 2.0

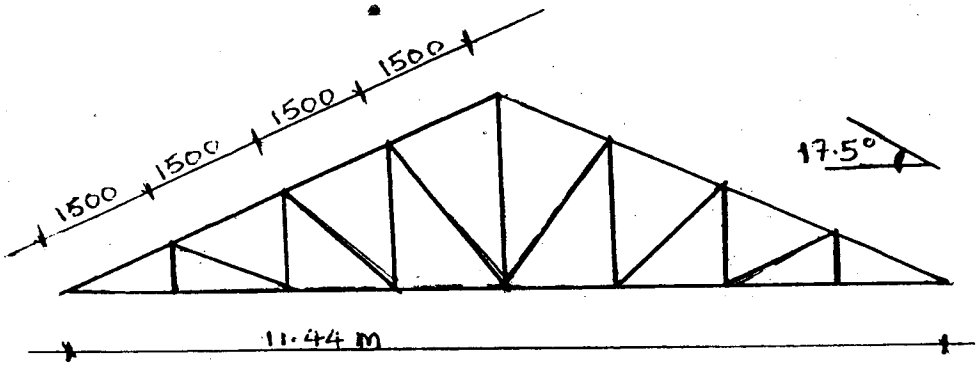


FIG 3.0

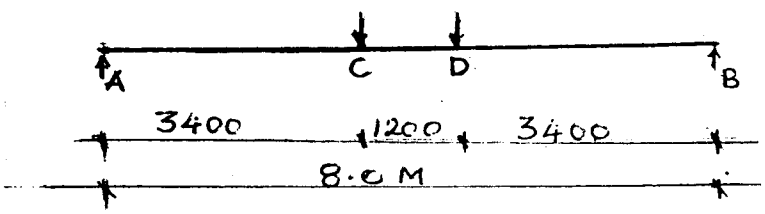


FIG 4

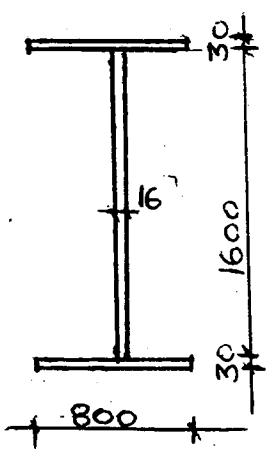


FIG 5.a

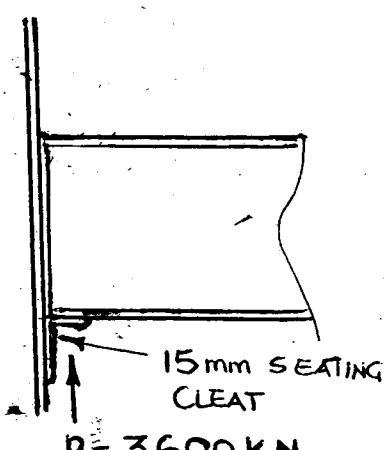


FIG 5.b

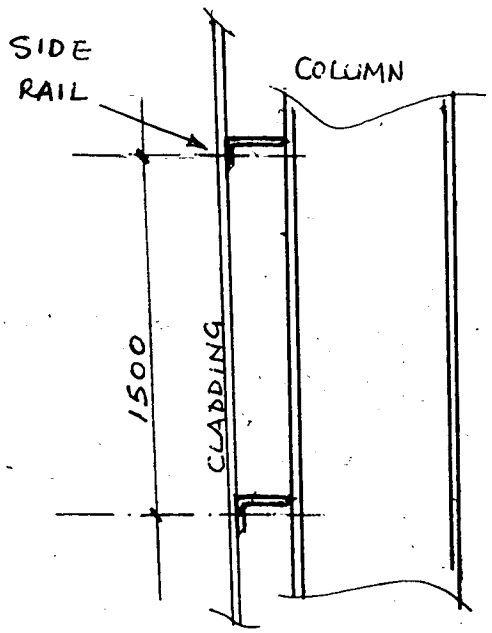


FIG 5-C

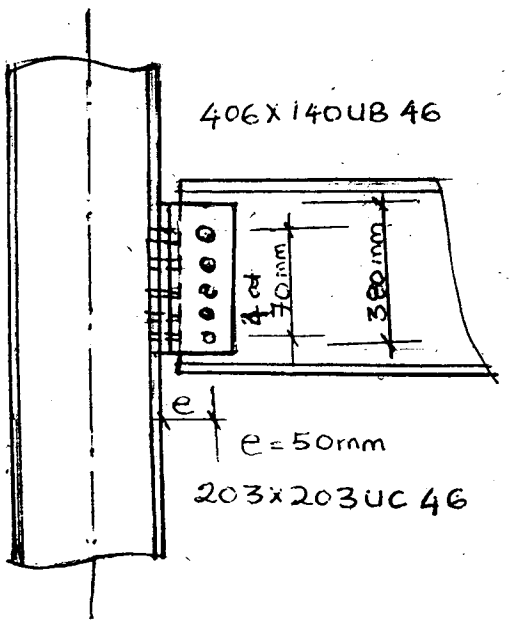


FIG 7.0a

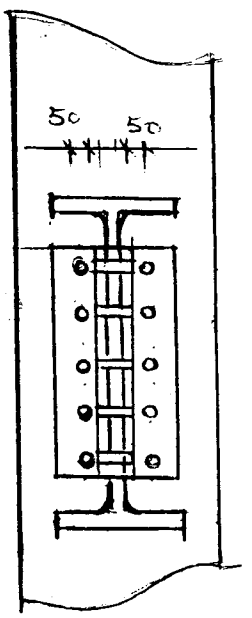


FIG 7.0b

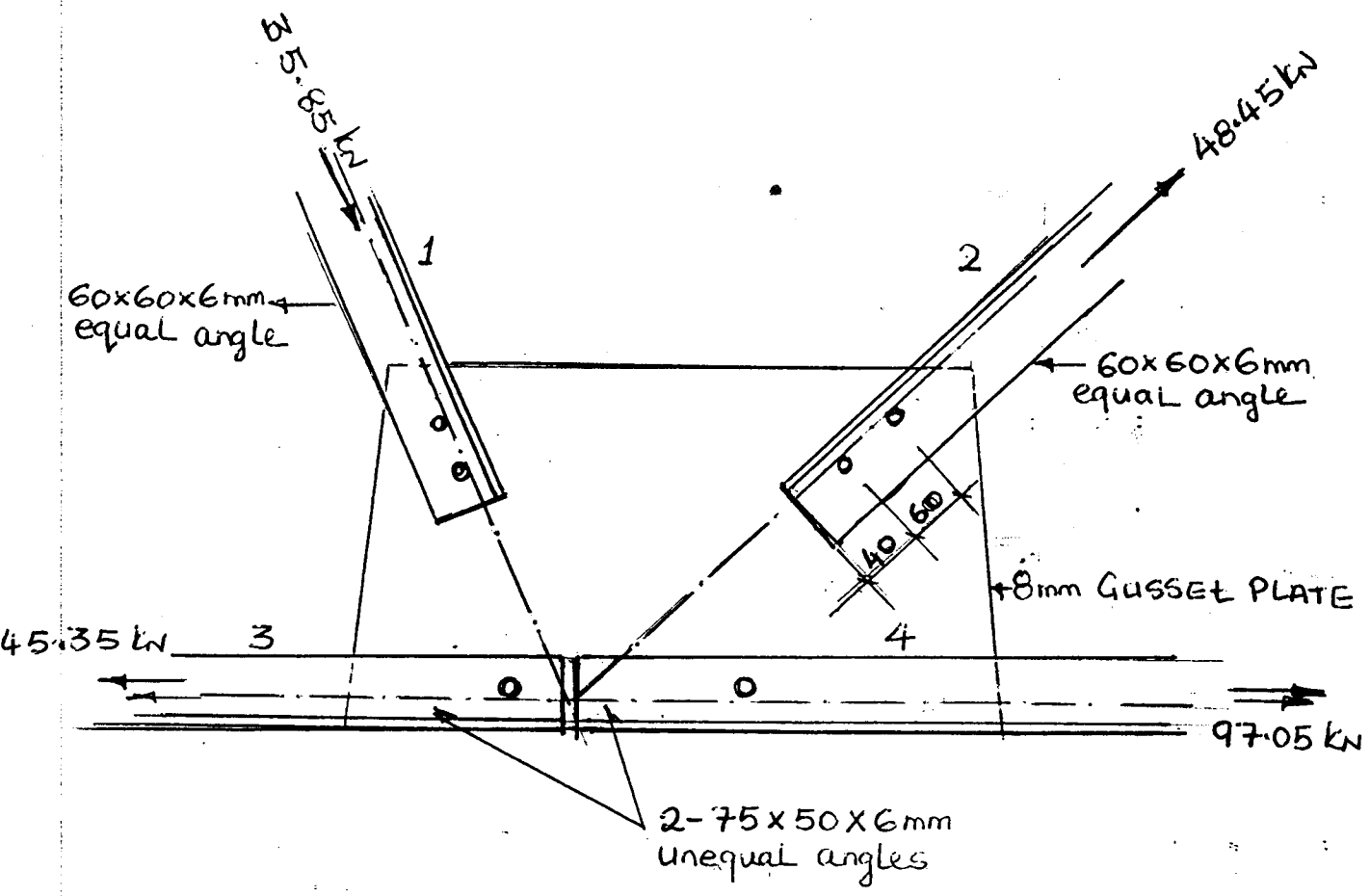

57.85 kN
48.45 kN
1
2
60×60×6mm
equal angle
60×60×6mm
equal angle
60
40
8mm GUSSET PLATE
45.35 kN
3
4
97.05 kN
2-75×50×6mm
Unequal angles

FIG 7.0 C

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF AGRICULTURAL ENGINEERING

EA 402 **FINAL EXAMINATION** **JULY, 2001**

INSTRUCTIONS: ANSWER ANY FIVE QUESTIONS.

TIME: THREE (3) hours

QUESTION 1

(a) What are the main advantages and disadvantages of renewable energy over conventional sources of energy? (**5 points**)
(b) Define solar constant. **(2 points)**
(c) What are the reasons for the variations in solar radiation reaching the earth to that received at the outside of the atmosphere? **(3 points)**
(d) Calculate the angle made by beam radiation with the normal to a flat plate collector on December 1, at 9:00 A.M., solar time for a location at 28° 35' N, in the eastern hemisphere. The collector is tilted at an angle of latitude plus 10°, with the horizontal and is pointing due south **(10 points)**

QUESTION 2

a What is the hydro power potential in Zambia and where are these found? **(6 points)**
b Kariba North Bank Power Station is equipped with 4 units of vertical shaft Pelton turbines to be coupled with 7000 kVA, 3 phase, 50 hertz generators. The generators are provided with 10 pairs of poles. The gross design head is 400 m and the transmission efficiency of head race tunnel and penstocks together is to be 94%.

The four units together will provide for a power of 600 MW at a guaranteed efficiency of 91%. The nozzle efficiency is 98%.

Find: i the design discharge for the turbine, **(4 points)**
ii jet diameter and number of jets, **(6 points)**
iii the pitch diameter of the wheel, **(4 points)**

QUESTION 3

(a) What are the advantages and disadvantages of biological conversion of solar energy? **(6 points)**
(b) What factors should be taken into account in order to arrive at an optimum size of a biogas plant? **(2 points)**
(c) Calculate : (i) the volume of a biogas plant suitable for the output of 5 cows, and (ii) the power available from the digester. Retention time is 20 days, biogas 30° C, dry matter 2 kg/day, biogas yield 0.24 m^3 per kg. Burner efficiency is 60%, methane proportion is 0.8. H_m the heat of

combustion of methane may be assumed to be 28 MJ/m^3 at STP. **(12 points)**

QUESTION 4

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

(b) Wind at standard atmospheric pressure and 21°C has velocity of 15 m/s calculate:

- (i) the power density in the wind stream, **(2 points)**
- (ii) the maximum obtainable power density, **(2 points)**
- (iii) a reasonably obtainable power density, **(2 points)**
- (iv) obtainable power, and **(2 points)**
- (v) the torque and axial thrust. **(4 points)**

Given: turbine diameter = 120 m, and turbine operating speed = 40 r.p.m. at maximum efficiency. Propeller type wind turbine is considered.

QUESTION 5

A family of six (6) people has 100 cattle and would like to build a biogas plant. It will be used for cooking, lighting four rooms and running a small engine. You are a design engineer and the family has come to you for advice. What advice would you give the family on the usage of the biogas in accordance with gas produced from the animals and their requirement. **(20 points)**

The following information is known;

1. Quantity of dung available is 10 kg/day/cattle,
2. Gas produced from 1kg of gobar in summer is 55 litres
3. Gas produced from 1kg of gobar in winter is 42 litres
4. For cooking purposes 0.227 m^3 of gas is required per day per person.
5. For lighting the mantle lamp of 100 Candle Power (C.P) will need 0.126 m^3 of gas per hour.
6. Retention time is 30 days
7. Density of slurry is 1090 kg/m^3
8. Calorific value of the biogas/m^3 is 4713kcal (with a burning efficiency of 60%).

QUESTION 6

a A Propeller turbine has a shape number $\xi = 4$ and produces 100kW (mechanical) at a working head of 6m. Its efficiency is about 70%. Calculate

- i. the flow rate, **(5 points)**
- ii. the angular speed of the shaft. **(5 points)**

b With the help of a well labeled diagram describe the working of a hydraulic ram pump. **(10 points)**

QUESTION 7

(a) What are the main components of a flat plate collector, explain the function of each. **(8 points)**

(b) Data for a flat-plate collector used for heating are given below

Factor	Specification
Location and latitude	Coimbatore 11° N
Day and time	March 22, 14:30 -15:30 (IST)
Average intensity of solar radiation	560 W/m^2
Collector tilt	26°
No. of glass covers	2
Heat removal factor for collector	0.82
Transmittance of glass	0.88
Absorptance of the plate	0.93
Top loss coefficient	7.95 W/m^{2}C
Collector fluid temperature	75°C
Ambient temperature	25°C

Calculate:

(i) Solar attitude angle, **(4 points)**

(ii) Incident angle, and **(4 points)**

(iii) Collector efficiency. **(4 points)**

END OF EXAMINATION NJK/2001 GOOD LUCK

SUPPLEMENTARY EQUATIONS

$$\cos\theta = \sin\phi(\sin\delta\cos S + \cos\delta\cos\gamma\cos\omega\sin S) + \cos\phi(\cos\delta\cos\omega\cos S - \sin\delta\cos\gamma\sin S) + \cos\delta\sin\gamma\sin\omega\sin S$$

$$\cos\theta_z = \cos\phi\cos\omega\cos\delta + \sin\phi\sin\delta$$

$$\cos\gamma_s = \sec\alpha(\cos\phi\sin\delta - \cos\delta\sin\phi\cos\omega)$$

$$\sin\gamma_s = \sec\alpha\cos\delta\sin\omega$$

$$H_o = \frac{24}{\pi} I_{sc}\left[\left\{1 + 0.033\cos\left(\frac{360n}{365}\right)\right\}\left(\cos\phi\cos\delta\sin\omega_s + \frac{2\pi\omega_s}{360}\sin\phi\sin\delta\right)\right]$$

$$P_{max} = \frac{8}{27}\rho A V^3$$

$$\Im = \frac{P_m^{1/2} w}{\rho^{1/2}(g H_a)^{5/4}}$$

R= 0.287 kJ/kgK

1 atm. = 1.01325 x 10^5 Pa

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
DEFERRED UNIVERSITY EXAMINATIONS SEPTEMBER 2001
SEMESTER II

EE 209 PRINCIPLES OF ELECTRICITY I

Time: **Three hours.**
Answer All Questions

---

1. (a) Calculate the steady state current **i(t)** response of the network in Figure 3(a) for the excitation **v(t) = 1 sin 1t** .(15marks)
   (b) How much capacitance is required to resonate a coil of 0.001 mH at a frequency of 2 MHz? (15 marks)
   (c) Find the Thevenin and Norton equivalent circuits that would represent the circuit in Figure 3(c), from the point of view of terminals **a,b** . (20 marks)
2. (a) For the normal operation of a transistor (8 marks)
   (i) Forward bias both the base emitter and collector base diode [T or F]
   (ii) The collector part acts as a current controlled current source[T or F]
   (iii) Draw the ideal equivalent circuit an npn bipolar transistor
   (iv) The DC Beta of a Transistor is I_C/I_B [T or F]
   (b) Coupling capacitors look like short circuits in DC Equivalent circuits and open circuits in AC Equivalent circuits. (2 marks) [T or F]
3. Given V_M as the maximum peak phase voltage on the secondary of a transformer in a bridge rectifier and on one-half winding of a center-tap rectifier. The Peak Inverse Voltage for non-conducting diodes in each half-cycle of rectification for: (10 marks)
   (i) Bridge rectifier PIV is $2V_M$ [T or F]
   (ii) Center-Tap Rectifier PIV is $2V_M$ [T or F]
   (iii) VDC is $2V_M/\Pi$ [T or F]
   (iv) f_{out} is $3f_{in}$ [T or F]
3. Use the principle of superposition to find $\mathbf{V_X}$ in Figure 4. (10 marks)
4. For the circuit in Figure 5, find $\mathbf{i_L(t)}$ and $\mathbf{v_L(t)}$ for $t > 0$. Initially switch has been in position **1** for a long time until $t = (0^-)$. At $t=(0^+)$ the switch is moved to position **2**. (10 marks)
5. In the circuit of Figure 6, what value should **V** be so that a charge of 600 C is delivered to the 100 V source in 1 minute? (10 marks)
6. What must be the resistance of **R** in the circuit of Figure 7? (10 marks)

END OF EE209 EXAMINATION

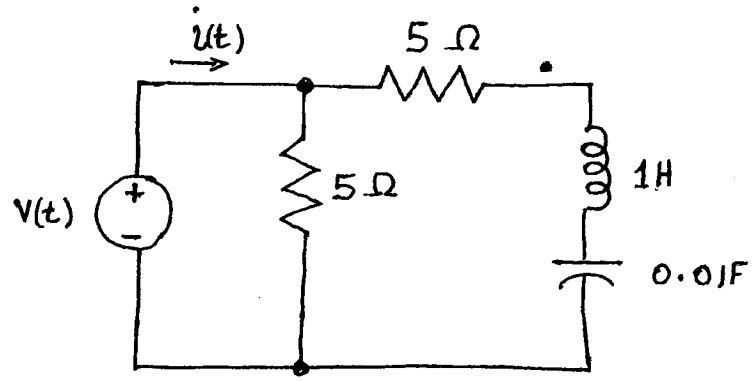


FIG. 3(a)

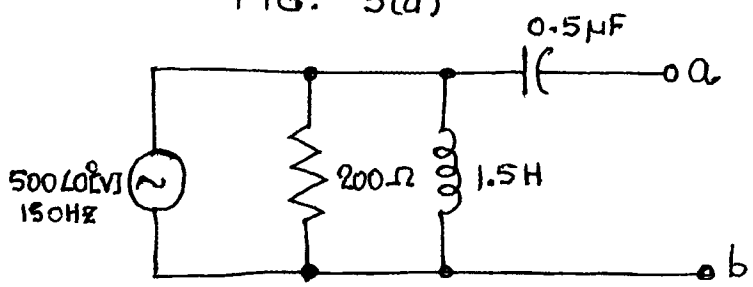


FIG. 3(c)

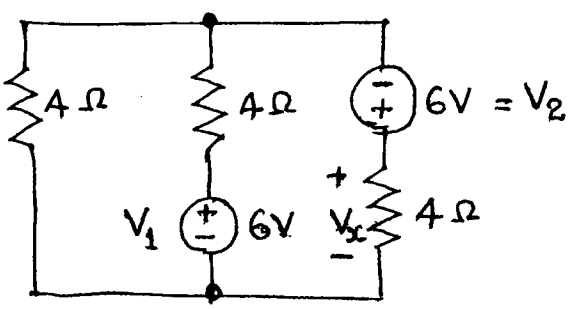


FIG. 4

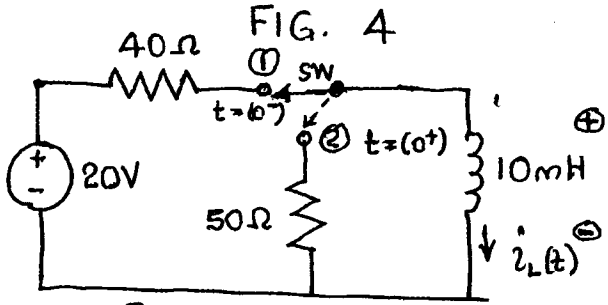


FIG 5.

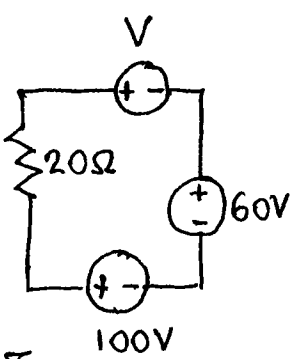


FIG 6.

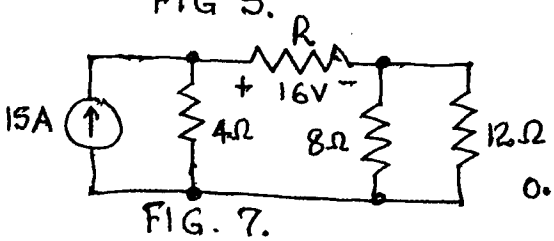


FIG. 7.

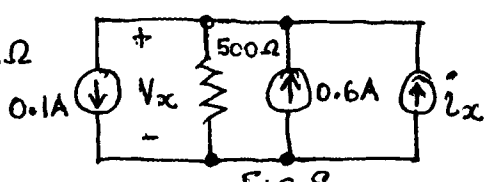


FIG.8.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
DEFERRED UNIVERSITY EXAMINATIONS SEPTEMBER 2001
SEMESTER II

EE 209 PRINCIPLES OF ELECTRICITY I

Time: **Three hours.**
Answer All Questions

---

1. (a) Calculate the steady state current **i(t)** response of the network in Figure 3(a) for the excitation **v(t) = 1 sin 1t** .(15marks)
   (b) How much capacitance is required to resonate a coil of 0.001 mH at a frequency of 2 MHz? (15 marks)
   (c) Find the Thevenin and Norton equivalent circuits that would represent the circuit in Figure 3(c), from the point of view of terminals **a,b** . (20 marks)
2. (a) For the normal operation of a transistor (8 marks)
   (i) Forward bias both the base emitter and collector base diode [T or F]
   (ii) The collector part acts as a current controlled current source[T or F]
   (iii) Draw the ideal equivalent circuit an npn bipolar transistor
   (iv) The DC Beta of a Transistor is I_C/I_B [T or F]
   (b) Coupling capacitors look like short circuits in DC Equivalent circuits and open circuits in AC Equivalent circuits. (2 marks) [T or F]
3. Given V_M as the maximum peak phase voltage on the secondary of a transformer in a bridge rectifier and on one-half winding of a center-tap rectifier. The Peak Inverse Voltage for non-conducting diodes in each half-cycle of rectification for: (10 marks)
   (i) Bridge rectifier PIV is $2V_M$ [T or F]
   (ii) Center-Tap Rectifier PIV is $2V_M$ [T or F]
   (iii) VDC is $2V_M/\Pi$ [T or F]
   (iv) f_{out} is $3f_{in}$ [T or F]
3. Use the principle of superposition to find $\mathbf{V_X}$ in Figure 4. (10 marks)
4. For the circuit in Figure 5, find $\mathbf{i_L(t)}$ and $\mathbf{v_L(t)}$ for $t > 0$. Initially switch has been in position **1** for a long time until $t = (0^-)$. At $t=(0^+)$ the switch is moved to position **2**. (10 marks)
5. In the circuit of Figure 6, what value should **V** be so that a charge of 600 C is delivered to the 100 V source in 1 minute? (10 marks)
6. What must be the resistance of **R** in the circuit of Figure 7? (10 marks)

END OF EE209 EXAMINATION

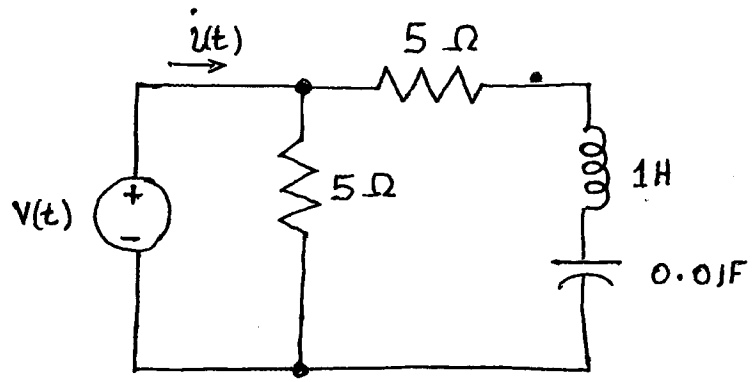


FIG. 3(a)

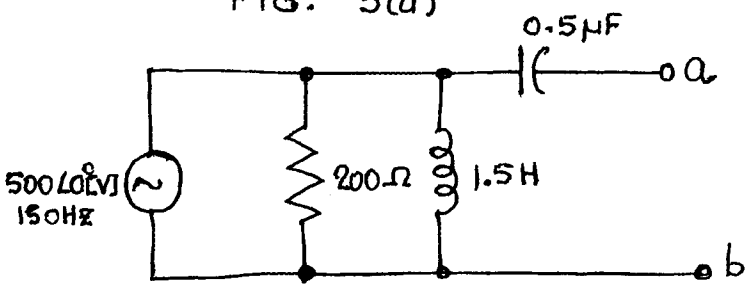


FIG. 3(c)

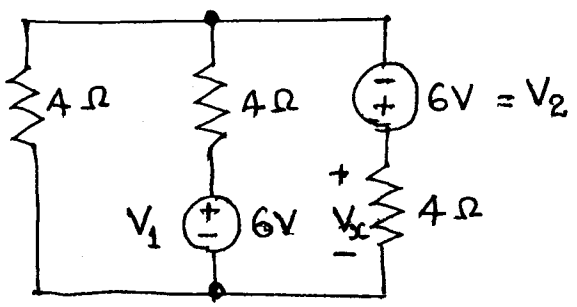


FIG. 4

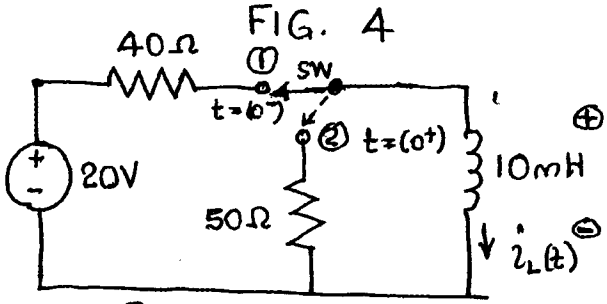


FIG 5.

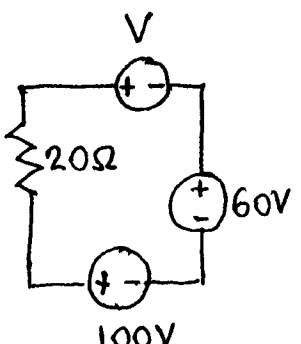


FIG 6.

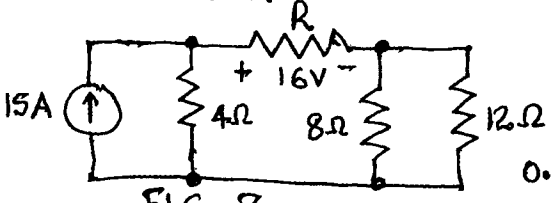


FIG. 7.

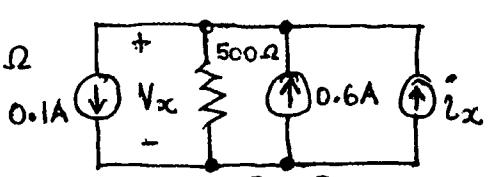


FIG.8.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

FINAL EXAMINATIONS –30th JULY, 2001

EE 342 – ELECTRONIC ENGINEERING I

TIME: THREE HOURS
ANSWER: FIVE QUESTIONS

Boltzman's constant: 1.38×10^{-23} J/k
Electric charge: $q = 1.602 \times 10^{-19}$ C
Ambient temperature: T= 300K

Q1 a) Explain, with the aid of Ebers-Moll Model circuit diagramme, transportation of charge carriers across the emitter-base and base-collector junctions of the pnp bipolar junction transistor.

b) Discuss and explain the following terms as they relate to semiconductor physics:
i) avalanche multiplication
ii) Potential barrier in conjunction with minority charge carriers.
iii) Zener breakdown.

c) Explain in detail how the p-n junction is formed.

Q2 a) Derive Ebers – Moll equations for a pnp bipolar junction transistor and use the derived equations to solve explicitly for the emitter-base and base-collector junction voltages.

b) Express, using Ebers –Moll equations, an emitter terminal current as a function of emitter-base junction voltage for a bipolar junction transistor operating in the cut-off region.

c) Using a circuit diagramme for npn bipolar junction transistor, derive the mathematical expression for the base-collector saturation voltage in terms of parameters appearing in Ebers-Moll equations for the bipolar junction transistor which is operating in the saturation region.

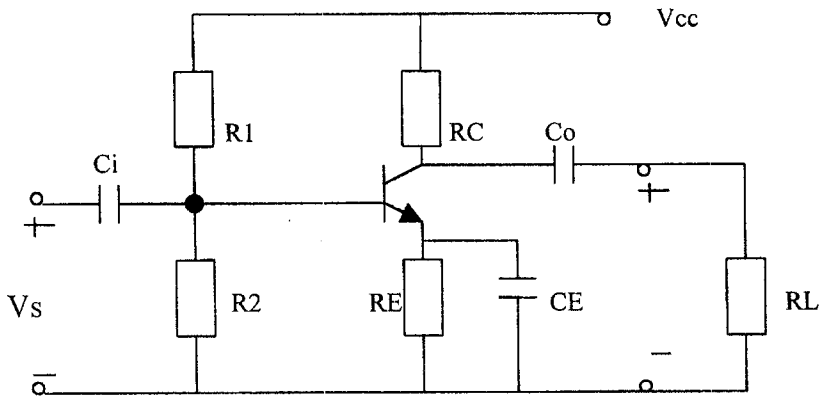
Q3. a) Draw a common collector high frequency hybrid-π mode transistor equivalent circuit and explain in detail the meanings of all the parameters of the circuit.

b) Write, in terms of h parameters, and draw an equivalent circuit which shows the relationship between emitter – base voltage and collector current as dependent variables, emitter current and collector-base voltage as independent variables.

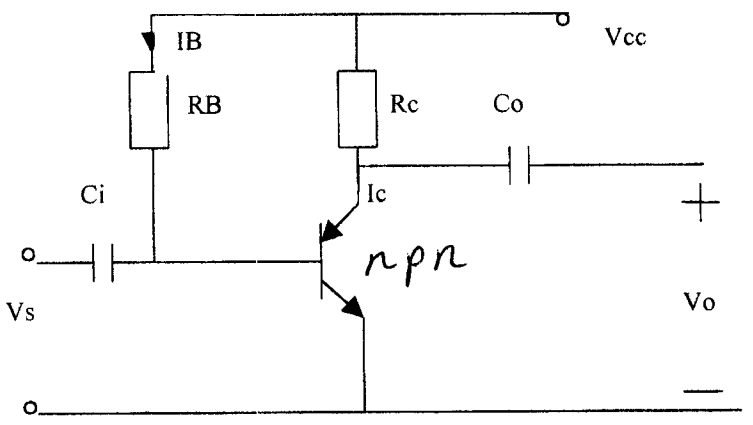
c) Using the low frequency hybrid-π circuit together with two current sources, derive the expression for the base-emitter junction voltage in

terms of low frequency hybrid-π parameters, base current, and collector-emitter voltage.

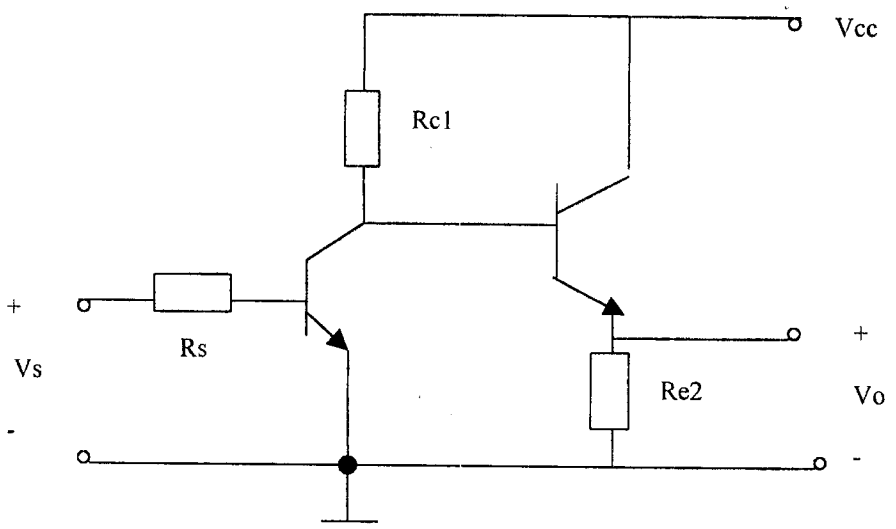
Q4. Derive, following rules by which incremental circuit is created, expressions for the input resistance, voltage gain, and current gain for the common emitter amplifier shown below.



Q5. Derive expressions for the input resistance, current gain and base current of the circuit shown below:

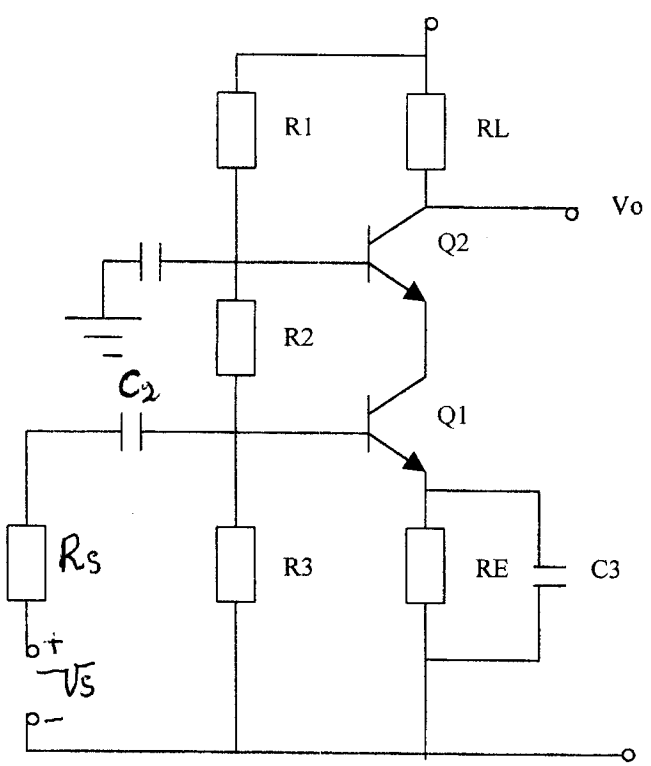


Q6. Find the input impedance, output impedance, voltage gain, and current gain of the circuit shown below.



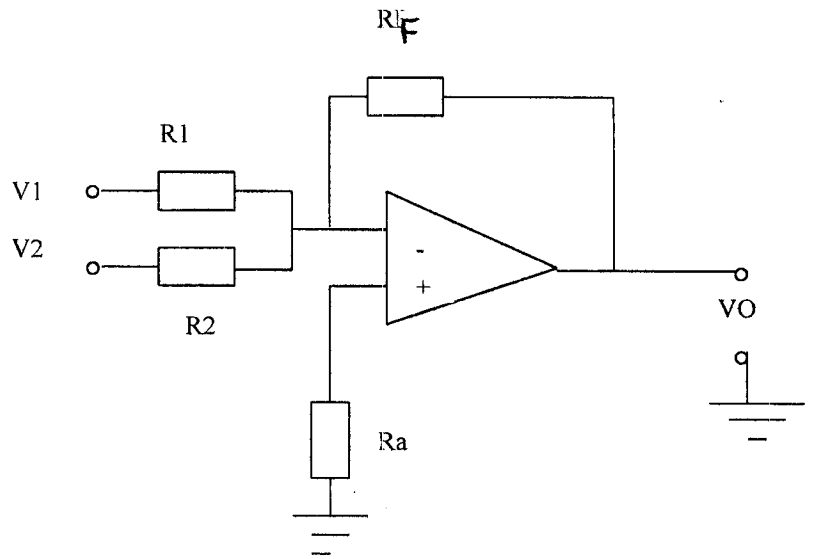
Rs=1kΩ;Rc1=5kΩ; Re_2=5kΩ;
hie=2kΩ;hfe =50;hre=10^{-4};
hoe=25μA/V; hic =2kΩ;
hfc=-51; hre = 1;
hoe =25μA/V

Q7. Explain what is meant by saying that two transistors are in cascode. Find the voltage gain and current gain of the cascode amplifier shown below.

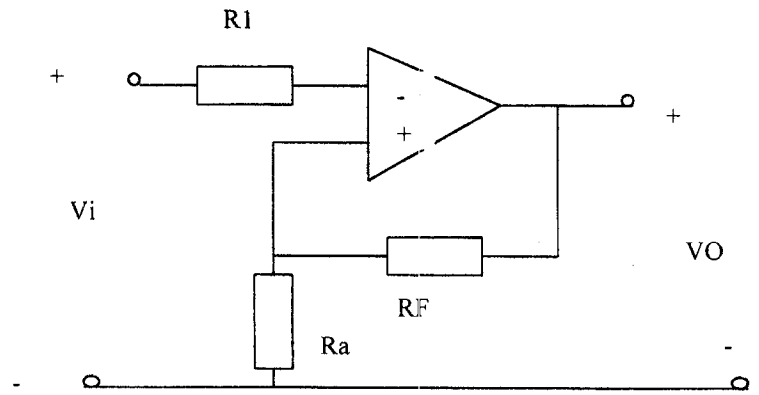


Rs=1kΩ; Rl=2kΩ; β=100; gm=40; ϒb= 0.1kΩ,ϒπ =2.5kΩ; RL = 2kΩ;ϒπ=2.5kϒΩ

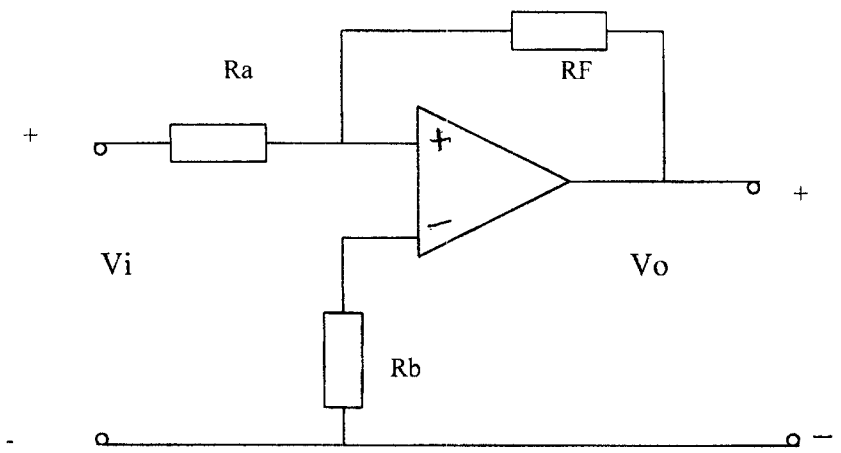
Q8. a) Find the expression for the output voltage of the following circuit.



b) Find the expression for voltage gain of the circuit shown below.



c) Find input resistance of an operational amplifier circuit shown below.



THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
END OF SEMESTER FINAL EXAM-JULY 2001
EE 442 ELECTRONIC ENGINEERING II

TIME: THREE HOURS. ANSWER FIVE QUESTIONS

Q1.

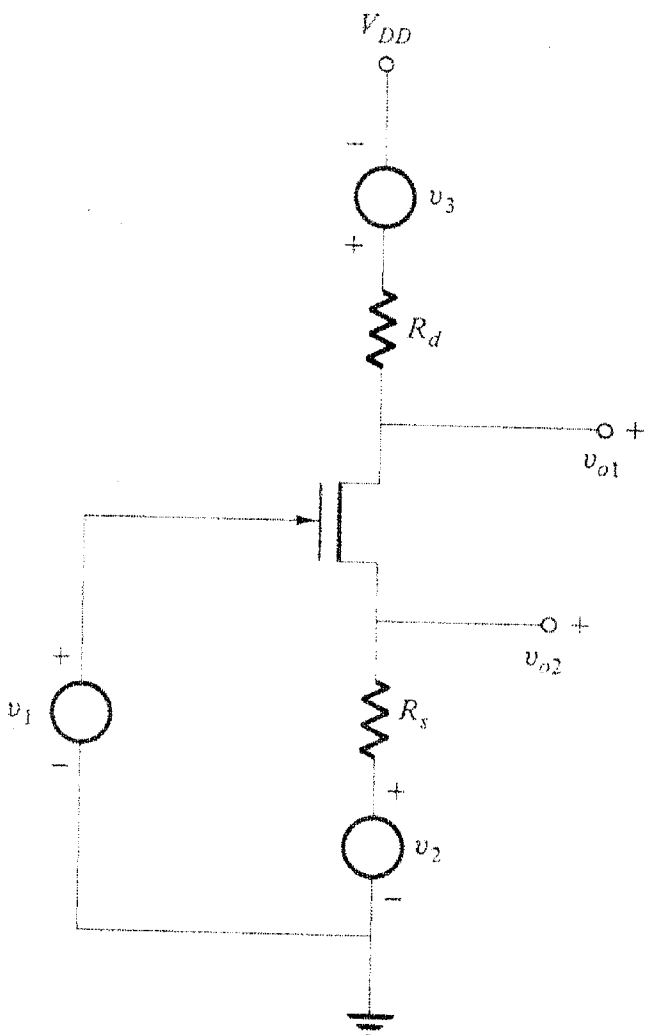


Figure 1. A FET amplifier with three independent sources (bias components omitted)

a) Determine the equivalent circuit of the FET amplifier in figure 1 using impedance reflection.

b) Using equivalent circuits looking into the drain and source, write the equation of these equivalent circuits.

c) What is υ_{01} and υ_{02} when $\upsilon_3 = \upsilon_2 = 0$.

Q2.

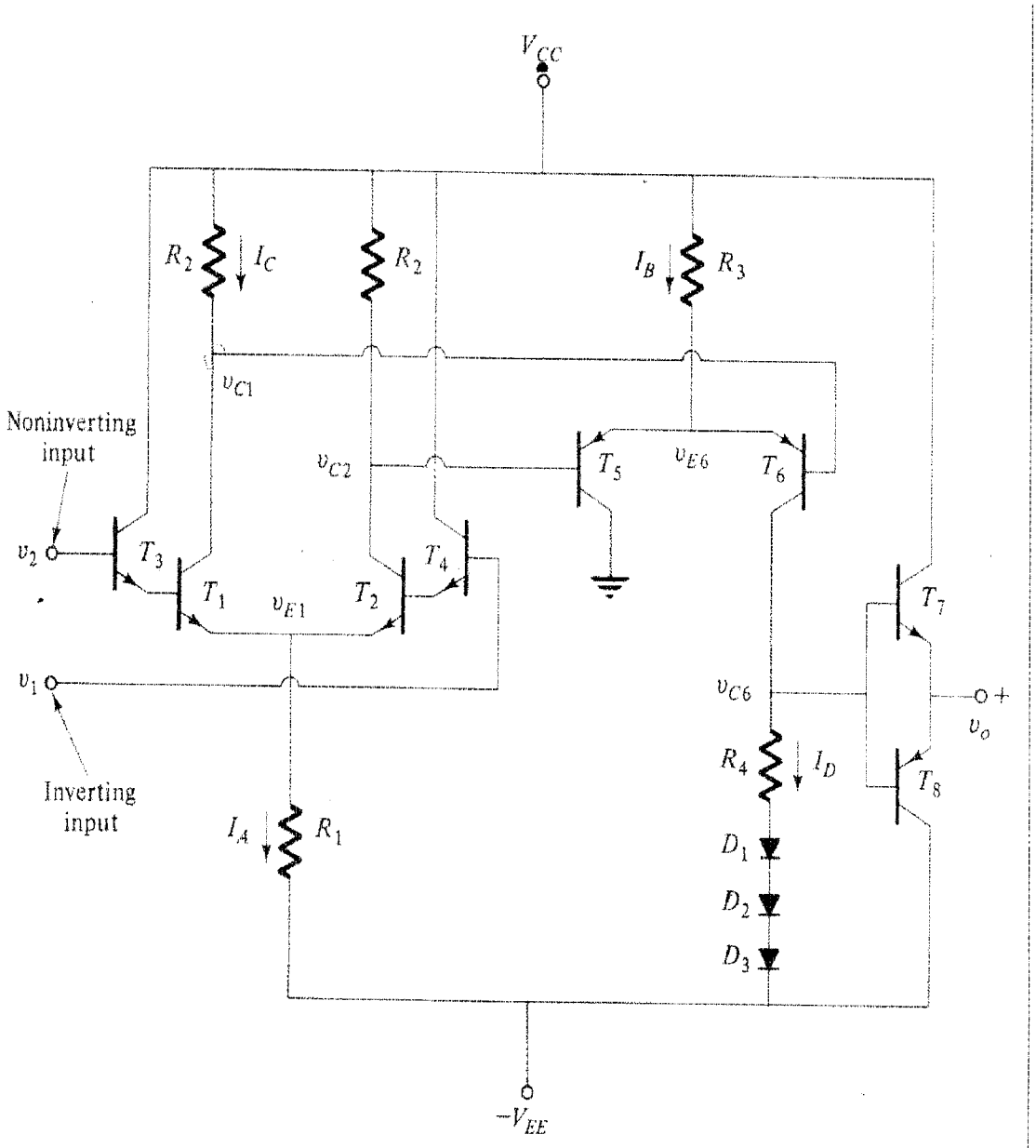


Figure 2. An IC op-amp

For a typical Operational amplifier given in figure 2 above, carry out a complete d.c. analysis of the circuit to determine R_1 to R_4 which will ensure that $\upsilon_0=0$ is independent of temperature and supply- voltage variations.

Q3.

Draw the output from the Op amp given in figure 3a for

a) i) $e_1 = 0.5$ Vpp sinewave, $e_2 = +2V_{dc}$

ii) $e_1 = 0.5$ Vpp sinewave, $e_2 = -4V_{dc}$

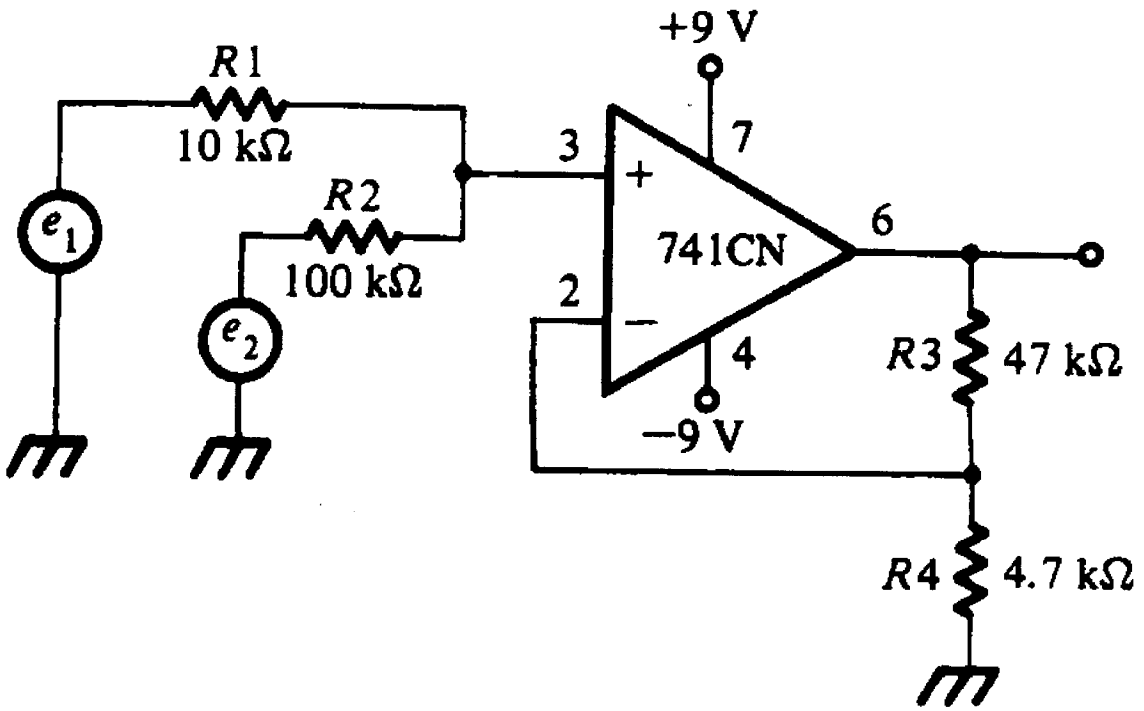


Figure 3a. Op-amp

b) For the circuit given in figure 3b below, determine voltage at point A and B if

i) $e_1 = 6V$, $e_2 = 6.2V$

ii) $e_1 = 5V$ $e_2 = 5.1V$

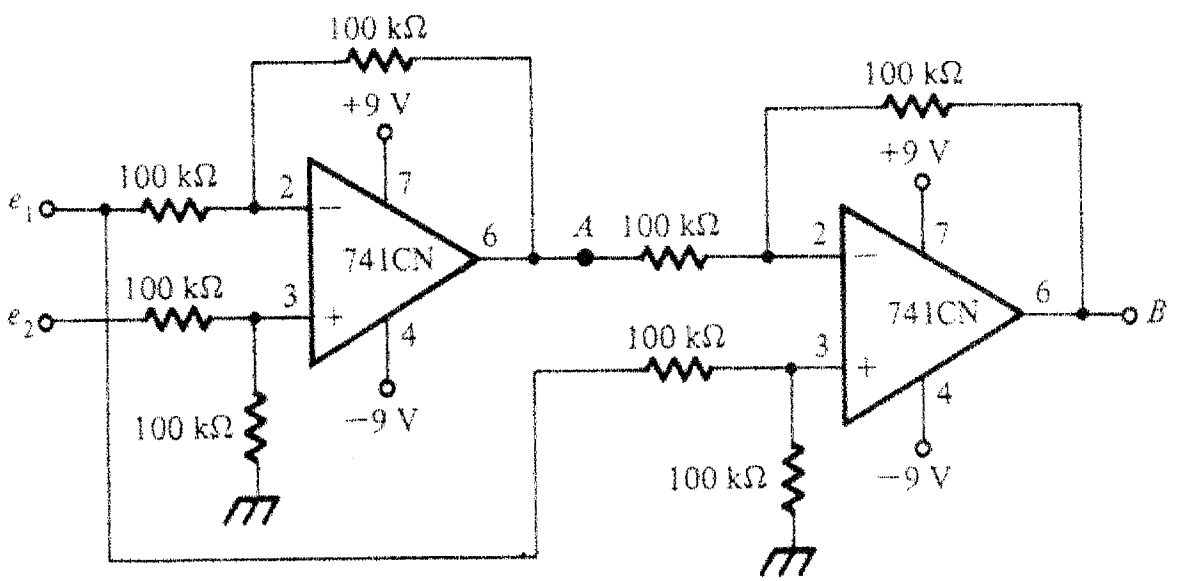


Figure 3b. Op-amp

Q4.

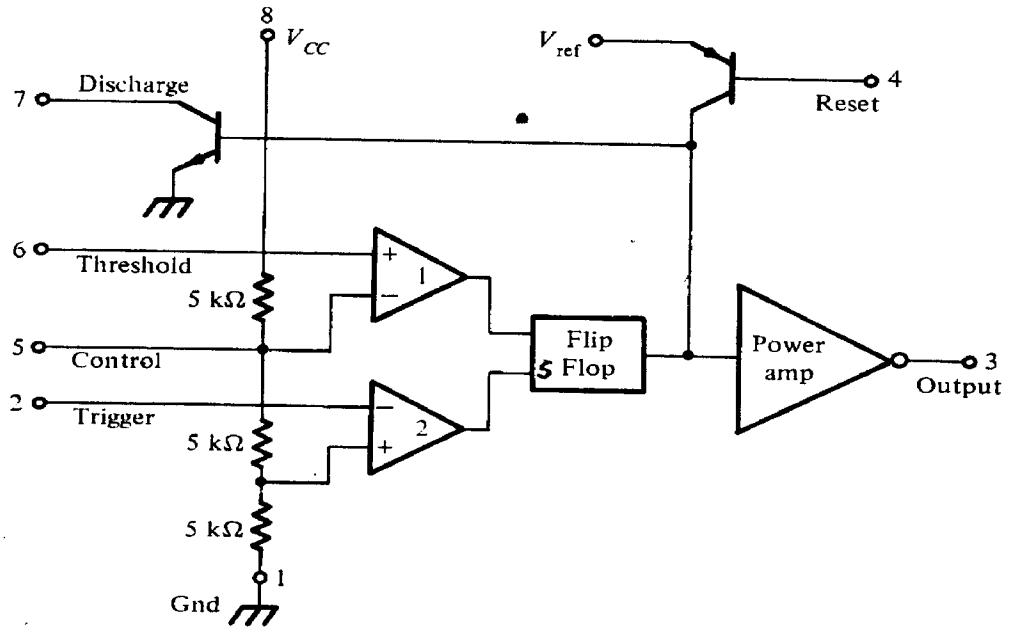
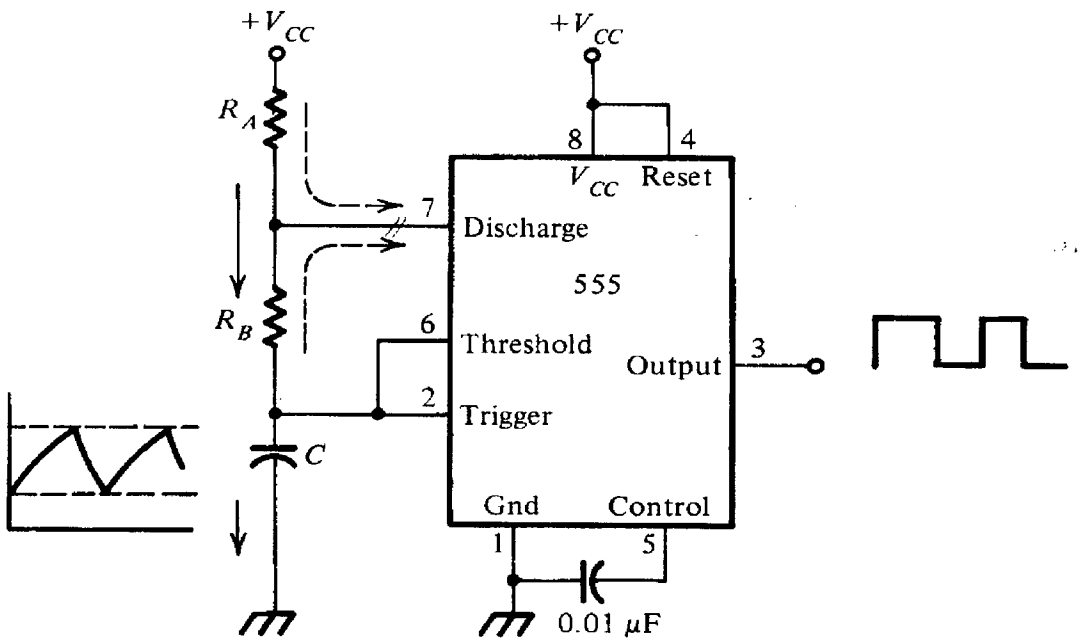


Figure 4. 555 Timer IC

a) The circuit given above is a block diagram of 555 Timer. Explain the circuit function.
b) The circuit given in figure 4b below is an astable multivibrator. Using mathematical analysis analyze it to determine the output square wave generated.



$1\ \text{k}\Omega \leqslant R_A + 2R_B \leqslant 10\ \text{M}\Omega$

$R_A \geqslant 100\ \Omega$

$0.001\ \mu\text{F} \leqslant C \leqslant 100\ \mu\text{F}$

Figure 4b. Basic square wave generator

Q5 (a) State the requirements for Sinusoidal Oscillations.

(b) Design Wien-bridge Oscillator, using an Op-amp to oscillate at 1KHz and to have an adjustable output amplitude.

Q6 The circuit given below is Pulse Width modulator application of IBM switch mode power supply SMPS.

a) Determine how this circuit implements the Pulse Width modulation function (PWM).

b) Explain the working of the Dead time comparator and draw the pulses.

c) What happens when the circuit commands is to shut the system down.

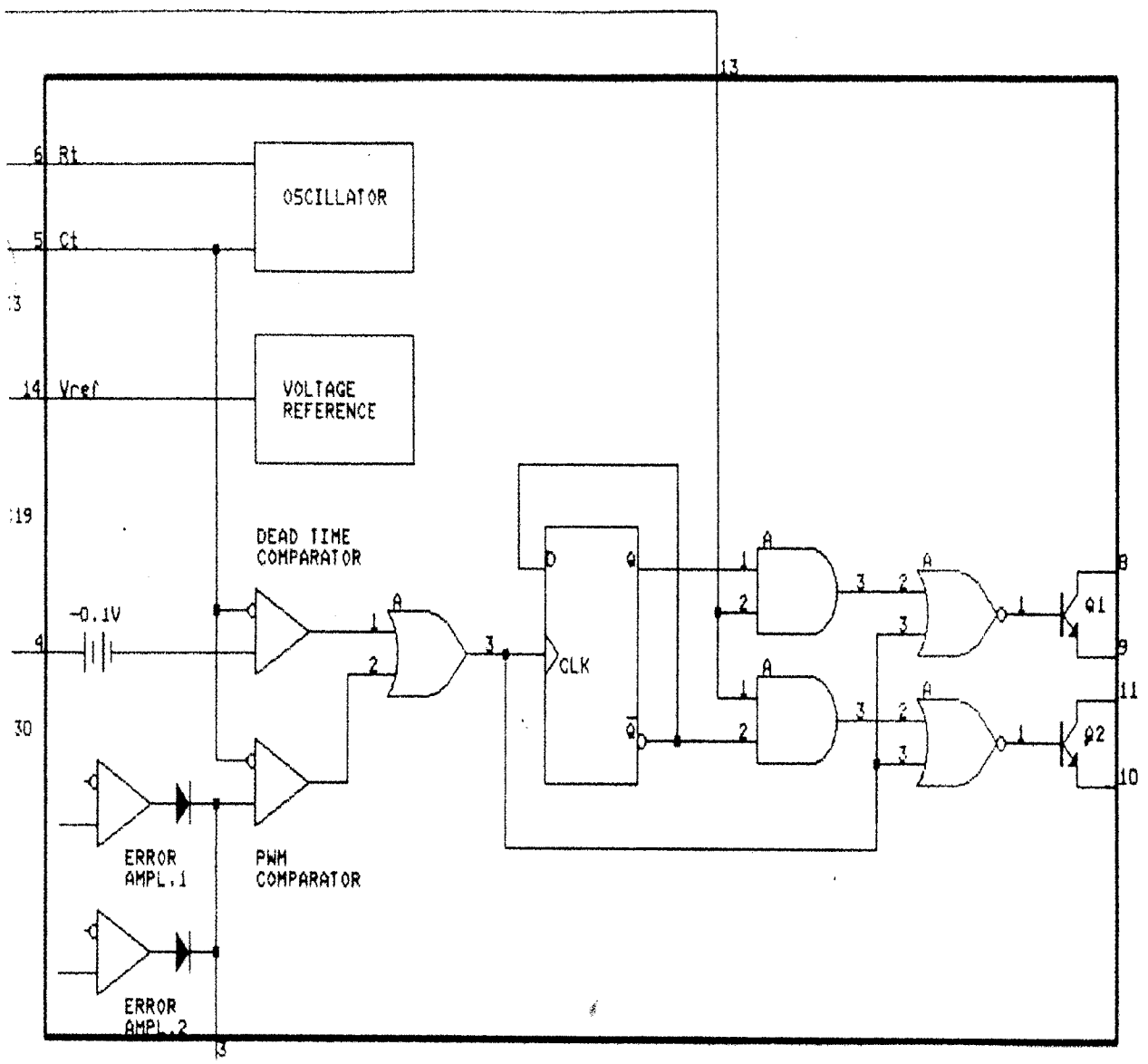
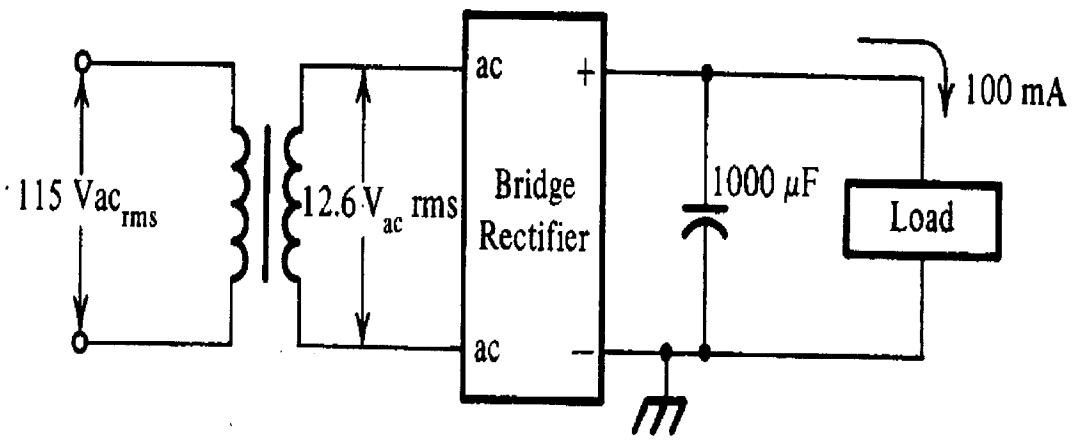


Figure 6. Pulse Width modulator

Q7. a) Draw a block diagram of a full wave capacitive filtered linear power Supply.

b) For the circuit of figure 7, determine

a) Vpk
b) Vmin
c) Vripple (p-p)
d) Vdc



Q8. Design a single-tuned amplifier to operate at a centre frequency of 455KHz with a bandwidth of 10KHz. The transistor has the parameters gm=0.045, hfe=100, Cb'e=1000pF and Cb'c=10pF. The bias network and the input resistance are adjusted so that $r_i = 5k\Omega$ and $R_L = 500\Omega$.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS JULY 2001

EE452
ELECTRIC POWER SYSTEMS

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

1.

(a) Using the expression for the capacitance of a three-phase transmission line explain how the effect of earth on the phase capacitance is accounted for.

[5 marks]

(b) Explain why the voltage distribution across units of an insulator string is not uniform and describe ways to improve it.

[5 marks]

(c) A 140-km, 50-Hz, regularly transposed 3-phase distribution line has one conductor of diameter 30 mm per phase. The conductor positions form an equilateral triangle of side 4 m. The effective resistivity of the conductor material is 0.025 μΩm. Find the ***ABCD*** constants of the line.

[15 marks]

2.

Derive, with a definition of terms, the general expressions for maximum tension in a conductor, length of conductor and maximum sag of conductor, in a span of overhead line supported at equal heights.

[15 marks]

A transmission line has a span of 350 m and phase conductors with a breaking capacity of 130 kN. Determine the maximum sag of the conductor for a safety factor of 2, given that the weight of the conductor is 16 N/m and that there is a wind with a force of 500 N/m^2 acting over the projected areas of the conductors. The overall diameter of the conductor is 3 cm.

[10 marks]

3.

Derive, with a definition of terms, the expression for the maximum power that can be transmitted in an inter-connector whose properties are expressed by the ***ABCD*** parameters.

[10 marks]

The sending-end and receiving-end voltages of a three-phase transmission system are 33 kV and 30 kV, respectively. The line has a resistance per phase of 10 Ω and reactance per phase of 20 Ω. Under these conditions, what is the maximum power that can be transmitted by the line? If the voltage at the receiving-end is kept at 33 kV, what will be the voltage at the sending-end if the load associated with maximum power transfer in the above case is reduced by 50%?

[15 marks]

4.

Describe, with the aid of sketched waveforms, how the reactance of a synchronous generator varies with time upon the occurrence of a short-circuit at its terminals and how it affects the short-circuit current. With suitable derivations, explain how a d.c. transient component can arise at the instant of short circuit.

[10 marks]

Four 11-kV generators designated A, B, C and D each have a subtransient reactance of 0.1 p.u. and a rating of 50 MVA. They are connected in parallel by means of three 100 MVA reactors which join A to B, B to C and C to D; these reactors have per unit reactances of 0.2, 0.4 and 0.2, respectively. A three phase short circuit occurs on the terminals of machine B. Calculate the fault current and fault voltamperes.

[15 marks]

5.

Describe the use of the plug setting multiplier and time multiplier setting in an IDMT over-current relay. Explain why adjacent protective schemes on the same system are time-graded, indicating how the discriminating time is chosen.

[10 marks]

A radial system has identical 5-A relays of the IDMT standard characteristic type at each of the three substations. The time multiplier setting varies between 0.1 and 1.0 while the plug setting multiplier increases in 25% steps from 50% to 200%. The system information is as follows.

Substation	**A**	**B**	**C**
CT ratio	600/5	300/5	200/5
Load Current	800 A	300 A	200 A
Fault Current	5 kA	5 kA	2.5 kA

Determine the plug settings and time multipliers for the three relays. Allow for a minimum safety margin of 15% when choosing plug settings and a discrimination time between faults at adjacent relays of not less than 0.4 seconds. Find the actual discrimination times and the safety margins.
The relay characteristic is given by

$$t = \frac{0.14}{PSM^{0.02} - 1}$$

[15 marks]

6.

(a) Explain why a high power factor is encouraged in tariff structures. Derive the condition for the optimum power factor to which a load with lagging power factor can be improved in order to obtain the lowest electricity tariff.

[10 marks]

(b) A factory takes an average load in a year of 4 MW at a load factor of 90%. The electricity company charges K110 per kilowatt-hour for energy, plus an annual K125,000/kVA of maximum demand. Calculate the lowest power factor at maximum load at which the factory could operate, so that the annual cost for the electricity does not exceed K4.5 billion.

[15 marks]

END OF EE452 EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

SECOND SEMESTER UNIVERSITY EXAMINATIONS - JULY 2001

EE541 ELECTRONIC ENGINEERING III

TIME ALLOWED: THREE (03) HOURS

ANSWER: ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS. USEFUL DATA IS GIVEN AT THE END OF THIS EXAM PAPER

Q1. For the given Operational amplifier circuit in Figure 01, carry out a small signals analysis to determine the output voltage υo in relation to the input voltages υ1 and υ2.
Assume the following component values: $R_1=R_3=5k\Omega$, $R_2=R_4=10k\Omega$, $V_{CC}=V_{EE}=12V$, $I_C\sim1mA$, $h_ib_1=h_ib_2=25\Omega$, Each transistor has $h_{fe}=99$.

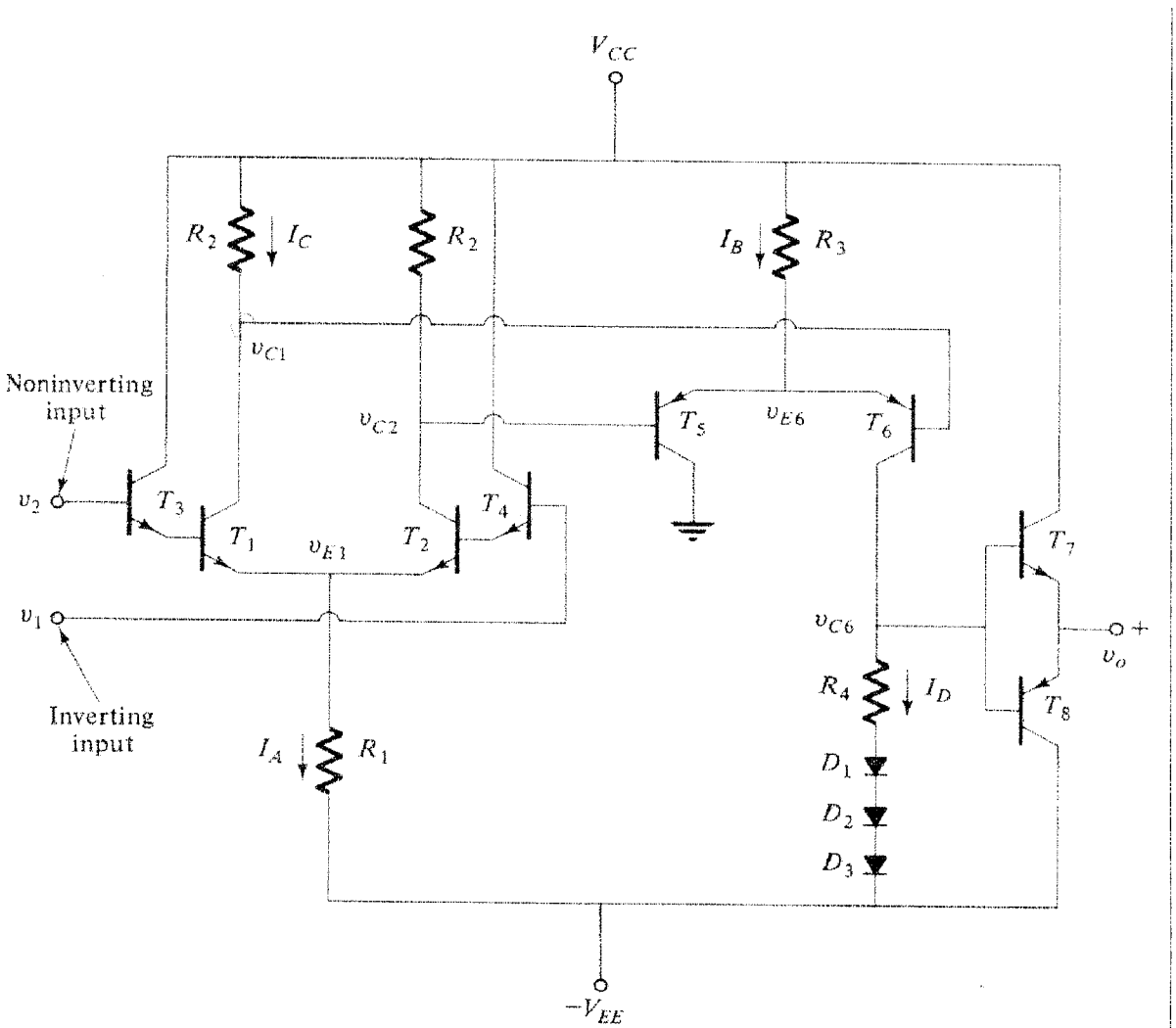


Figure 01: An IC Op-Amp

Q2. The circuit given at Figure 02 below is Pulse width modulator application of IBM switchmode power supply (SMPS).

a) Determine how this circuit implements the pulse width modulation function (PWM)

b) Explain the working of the Deadtime comparator

c) What happens when the circuit command is to shut the system down.

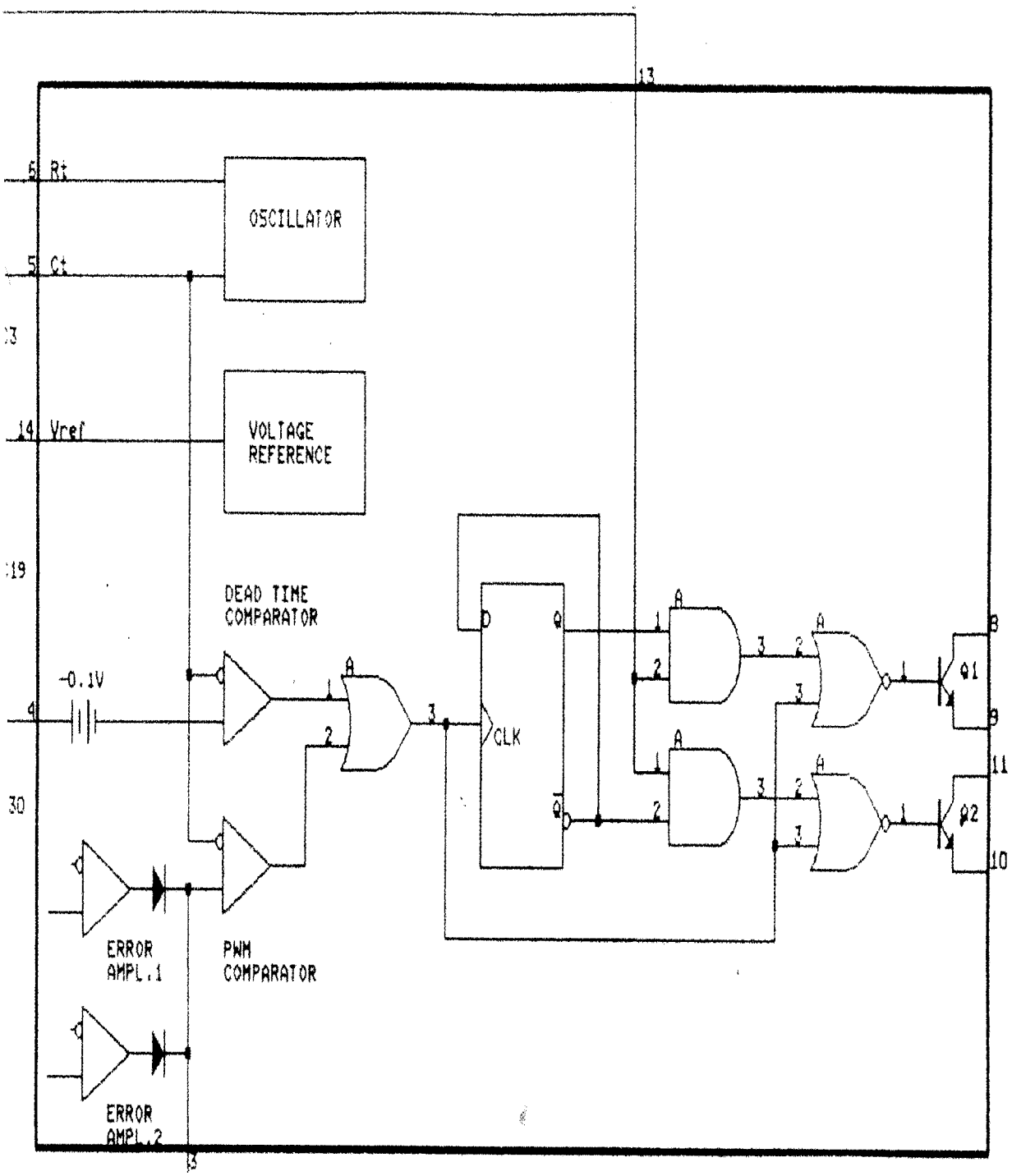


Figure 02. Pulsewidth Modulator Application

Q3.

a) For J-K flip flop and S-C flip flop, make the next state table and derive the next state equation in each case.

b) By means of a timing diagram indicating signal levels at relevant points, show that the circuit given in Figure 03 functions as a J-K flip flop.

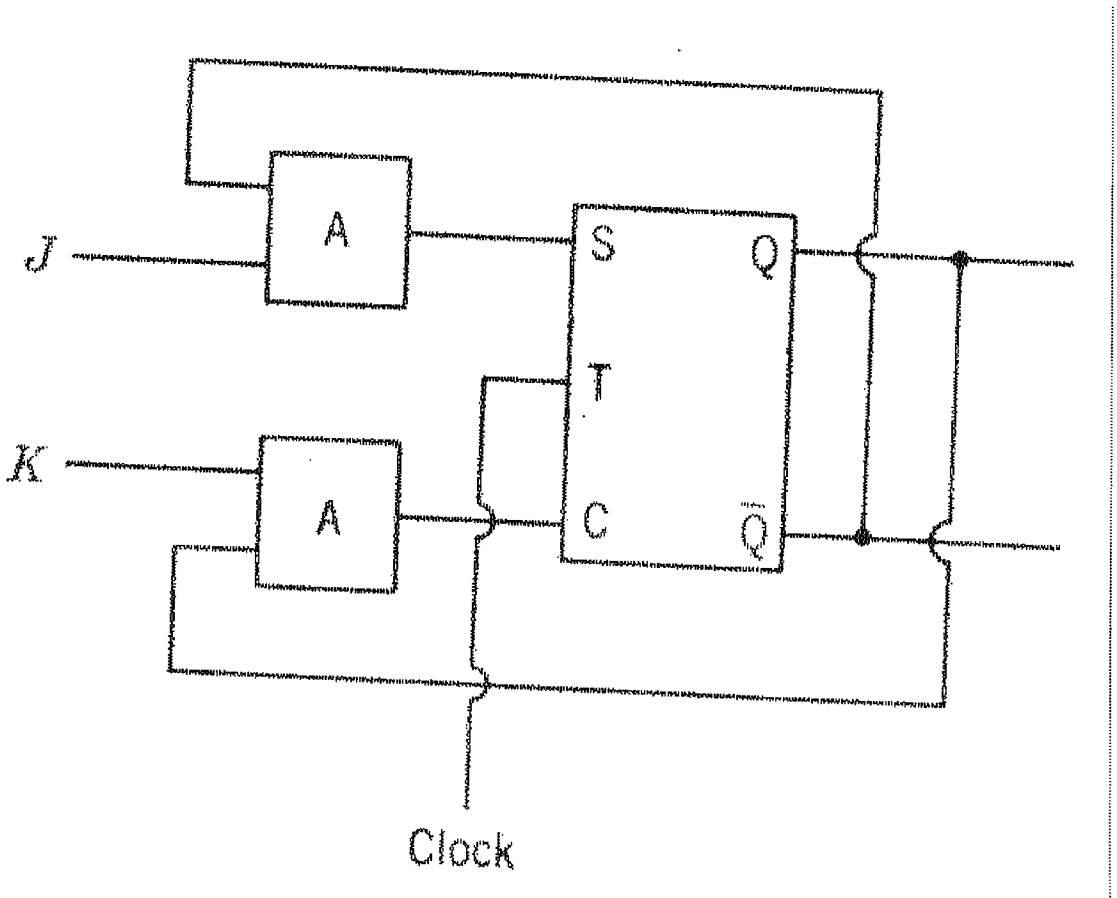


Figure 03. J-K Flip Flop

Q4. Design a 3 bit (Modulo-8) up-down counter. The output is to appear as a binary number on three output lines, z_2, z_1 and z_0. The most significant bit is z_2. The counter will change with each clock pulse. If the input x=1, the count will increase. If x = 0, the count will decrease. Modulo-8 implies that increasing the count from 7 results in a count of 0, and increasing it from 0 given a count of 7.

Hint: This is a finite output memory machine of memory length 1.

Q5. a) Find the output of the network of Figure 05 if the input in a single pulse of amplitude A at t=o and if $y(-\Delta t)=0$.

b) The difference equation of this filter is given as $y(n\Delta t) = Ky[(n-1)\Delta t] + x(n\Delta t)$, where $x(n\Delta t)$ is the amplitude of the input signal at the sample time $n\Delta t$. Find the response (steady state) of this filter to input $x(t) = X_m \text{Cos}\omega t$

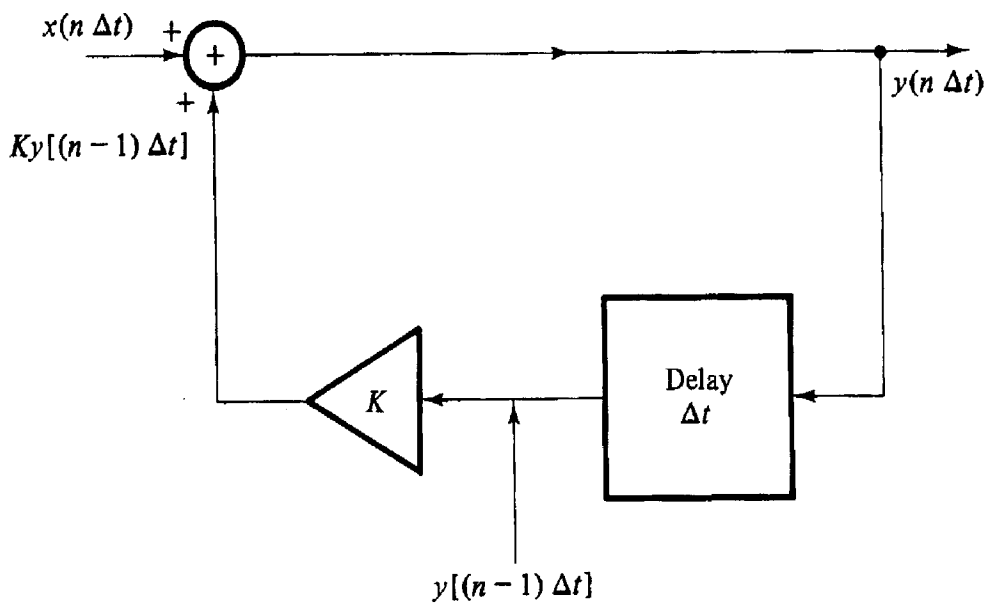


Figure 05. Digital Filter

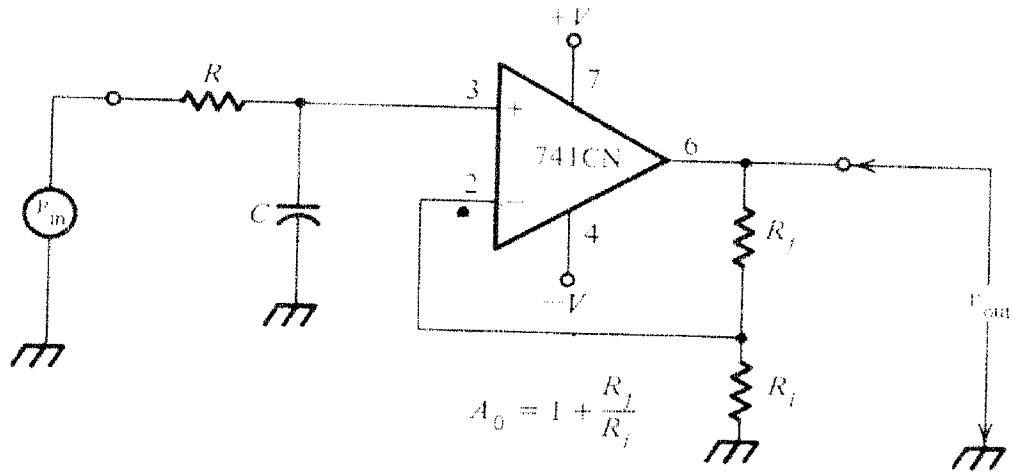
Q6. a) Figure 6a shows a first order low pass active filter. Determine the gain and phase frequency responses.

b) Figure 6b shows a second order low pass active filter. Determine,

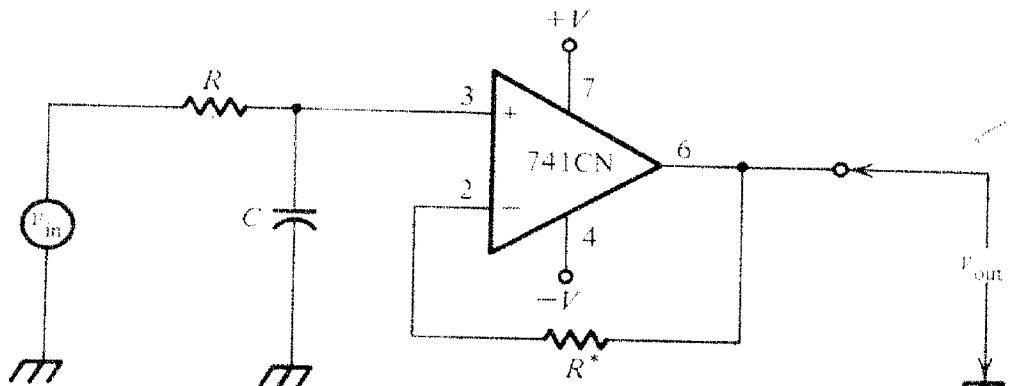
i) Gain and phase frequency responses

ii) Critical frequency ω_o

iii) Damping coefficient α



(a) Gain > 1



(b) Gain = 1 (0 dB)

Figure 6a. First Order Low Pass Active Filter

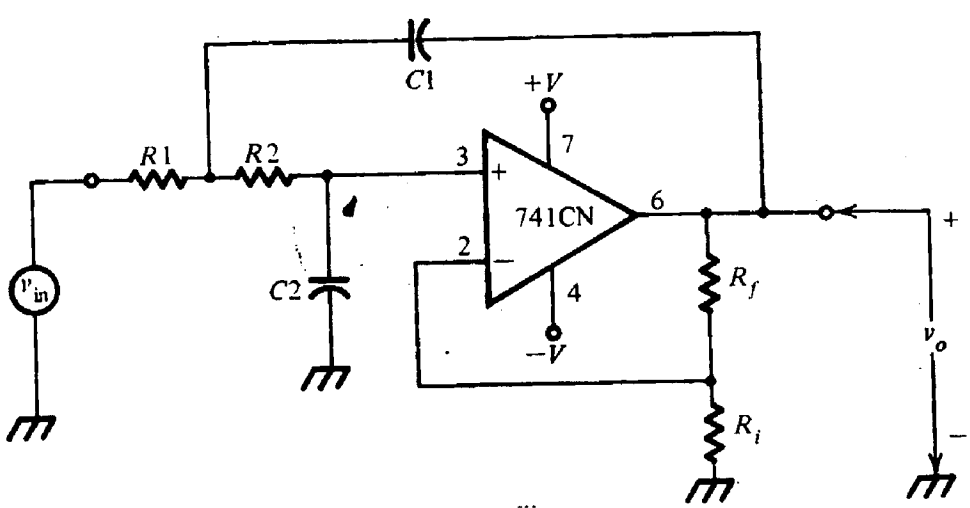


Figure 6b. Second Order Low Pass Active Filter

Q7.

a. What is the basis of operation for photonic devices? Distinguish two classes of devices on the basis discussed. For each class list three practical devices.

b. According to your knowledge of the electromagnetic spectrum, sketch a suitable graph showing the spectrum range visible to the human eye as a function of corresponding photon energy and wavelength (estimated). For which colour and wavelength on the spectrum does the human eye have maximum response?

c. Using appropriate reasoning distinguish between a direct and indirect energy band gap semiconductor. Clearly explain mechanisms of the de-excitation process in each case.

d. Define the terms recombination time and threshold wavelength for a direct band gap semiconductor.

e. Determine the threshold wavelength of a cadmium sulphide LED.

Q8.

a. Detail the construction of a basic p-n junction photodiode and describe its operation. How does a p-n photodiode differ from a p-i-n photodiode?

b. Detail the construction and operation of an optocoupler. Why is an optocoupler sometimes referred to as an optoisolator?

c. In optical fibre communications, electromagnetic waves in the optical frequency region are used as a carrier.

(i). Detail any four advantages of optical fibre communication in comparison to traditional ones.

(ii) Explain any three potential areas of application of optical fibre communications.

(iii) Draw a block diagram of an optical fibre communication system clearly labeling its main components.

(iii) Distinguish between a LED and an injection laser. Name any two compound semiconductors used in commercial LEDs giving the colour of light emitted.

(iv) Briefly discuss reasons that would influence your choice to use either a LED or injection laser in an optical fibre communication system.

LIST OF SOME USEFUL DATA

1.	Boltzmann constant	$= 1.38 \times 10^{-23} \text{JK}^{-1}$
2.	Electronic charge	$e = 1.602 \times 10^{-19} \text{C}$
3.	1 electron volt	$eV = 1.602 \times 10^{-19} \text{J}$
4.	Cadmium sulphide energy gap	$= 2.53$ eV
5.	Planck constant	$h = 6.63 \text{x} 10^{-34} \text{Js}$
6.	Speed of light	$c = 3.0 \times 10^{8} \text{m/s}$

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS JULY 2001
SEMESTER II

EE 552 ELECTRICAL POWER SYSTEMS II

TIME: **THREE HOURS**
ANSWER: **FOUR QUESTIONS. EACH QUESTION CARRIES 25 MARKS**

---

1. (i) To what extent can renewable energy sources help in increasing accessibility to electricity for households in peri-urban and rural areas of Zambia? Suggest ways of how this programme would be funded on a sustainable basis, given that the present ZESCO rural electrification programme has not been very successful for the past 30 years. What social and economic benefits would such an electrification programme bring to the nation as a whole? (10 Marks)

   (ii) Write a brief summary of one renewable energy source from the following: Mini-hydro, wind, solar-thermal, solar photovoltaic, ocean energy, geothermal, bio-energy and biogas electricity. (15 Marks)

2. (i) If you observe that the frequency is constant and the voltage magnitude is constant in a power system, what does this signify? What are the four bus variables in a loadflow problem? On generator buses, why can't we apriori specify all the four variables? (6 Marks)

   (ii) Define insulation co-ordination with the aid of the peak voltage strength as a fuction of time. Define basic insulation level. Is this related to the insulation resistance measured using a Megger in MΩ? What does the latter represent? (4 Marks)

   (iii) What are the three major sources of voltage transients? What is an isokeraunic map? What is the difference between a voltage spike and a swell? What is a Bewley lattice diagram? For a lossless line of length l define: $\Gamma_R(s)$, Z_C ,v (wave velocity), and τ (the transient time). (15 Marks)

3. (i) Develop a per unit transformer model having "Off-nominal turns ratio", represented as two transformers in series. Draw the corresponding ideal transformer per unit impedance equivalent circuit with C: 1 turns ratio. What is the value of C on nominal tap for a power transformer, voltage regulator and a phase shifter? (6) Marks)

   (ii) Draw the star-equivalent per unit sequence networks of a three-phase three winding transformer. Express the star-equivalent impedances in terms of the pair-wise short-circuit test leakage impedances. (4 Marks)

   (iii) Given three parallel transformers fed from a common 161 kV bus.
   T1:.X=10%, 50MVA, 161 (gnd Y) - 69(Δ) kV
   T2:.X=10%, 40MVA, 161 (gnd Y) - 66(Δ) kV
   T3:.X=10%, 40MVA, 154 (gnd Y) - 69(Δ) kV
   Compute : the HV/LV rated voltage transformation ratios and percentage deviation from T1 nominal ratio; the per unit impedances on 100MVA base; and the HV/LV per unit off-nominal turns ratios if the voltage on the 161 kV bus is 1.0 per unit. (15 Marks)

4. (i) Define symmetrical components for a three phase AC system in accordance with the method developed by C.L. Fortescue in 1918 ? (5 Marks)

(ii) Derive the interconnected sequence relations from the phase domain conditions of a double line to ground fault, through Z_G to ground and fault impedance Z_F in each phase. Then determine the configuration of the interconnected positive, negative and zero sequence networks. (10 Marks)

(iii) Given a power system consisting of the series connection of : a generator G1(25MVA, X=0.125 pu; 10 kV,Y-grounded); Bus A 10kV; transformer TA (30MVA, X=0.105 pu; Delta 10kV; Y-grounded, 20 kV) ; Bus B, 20 kV; transmission line L1 ($Z = 2 = j\,4\ \Omega$, 20 kV); Bus C 20kV; transformer TB (20 MVA, X=0.05 pu; Delta 20kV, Y-ungrounded, 5 kV), Bus D, 5kV ($V_D = 1.0$ pu); and a load P= 10 MW , Q=5MVAR equivalent to ($Z_L = 1.6 + j0.8$ pu on 20MVA base , $I_L = 0.5 - j0.25$ pu.

(a) Draw the one line diagram. (2 Marks)

(b) Consider a double LG fault on phase b and c at Bus C through $Z_F = 4\Omega$ in each phase and through $Zg = 8\Omega$ to ground. Find V_F at Bus C and determine the corresponding Z1, Z2, Z0 sequence network. (8 Marks)

5. (i) Define Area Control Error (ACE). Why is isochronous control important in automatic load frequency control of a control area? (8 Marks)

(ii) Draw an integrated generation control scheme involving load prediction, economic dispatch, automatic generation control. (7 Marks)

(iii) What happens when all turbine-generating units on joint control have the same per unit regulation constant R based on their own ratings ? Compute the area frequency response characteristic for three generators on 1000 MVA system base. Given: G1: 600 MVA, R = 0.02 pu; G2: 1000 MVA, R = 0.05 pu; G3: 800 MVA, R = 0.08 pu. (10 Marks)

6. (i) Draw the operating states transition diagram of a power system as a function of the equality and inequality constraints. Give four examples of energy management functions which are carried out in a National Control Centre to maintain the power system in its normal state. (10 Marks)

(ii) Define the incremental power balance equation of a control area. Then explain how the net power surplus in an area is absorbed in the system. (5 Marks)

(iii) Briefly state uses of: power-flow, short-circuit, stability and transient over-voltage computer programs in power system analysis and design. (10 Marks)

END OF EE 552 EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Department of Electrical and Electronic Engineering
UNIVERSITY EXAMINATIONS - JULY 2001
EE572: TELECOMMUNICATION SYSTEMS

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

$\mu_o = 4\pi \times 10^{-7}$ henry per metre is the permeablity of vacuum or free space, $\epsilon_o = 8.854 \times 10^{-12} \simeq \frac{1}{36\pi} \times 10^{-9}$ farad per metre is the dielectric permittivity of vacuum or free space,

$c = 3 \times 10^8$ metres/sec is the velocity of light in vacuum or free space.

Q1. (a) Define a complex Poynting vector. Derive the equation for the complex Poynting theorem. State the theorem.

(b) What is an electromagnetic plane wave ? What are uniform and non-uniform plane waves ? State their properties.

(c) Derive the electric wave equation

$$\nabla^2 E = \gamma^2 E$$

Where E is the electric field intensity and γ is the intrinsic propagation constant of a medium.

(d) Consider the reflection of a uniform plane wave when it is normally incident on a plane boundary between two media. Show the schematic diagram and write down the field equations. Write the condition for the continuity of the wave impedance at the boundary. Write down the expressions for the reflection and transmission coefficients, standing wave ratio and power densities. Make any necessary assumptions.

(e) Consider a uniform plane wave propagating in a lossless dielectric. Calculate the phase constant β, the intrinsic impedance of the medium η and the phase velocity v_p . The impressed frequency is100 MHz and the relative permittivity of the medium is 1.21.

[5+3+3+6+3]

Q2. (a) Write down the Helmholtz's equation for the TM_{mn} mode in a rectangular waveguide. Derive the field equations for this mode in the partial differential equation form showing the different steps. Discuss the solution of these equations to derive TM_{mn} field equations in rectangular waveguides. Consider a lossless dielectric.

(b) Derive the expressions for the average power transmitted through a rectangular waveguide for both TE_{mn} and TM_{mn} modes.

(c) An air-filled rectangular waveguide of inside dimensions 1.5x3 cm operates at 10 GHz. Find the cutoff frequencies for TE_{01} , TE_{10} ,TM_{11} and TE_{11} modes.

[10+6+4]

Q3. (a) Show by means of a suitable diagram the propagation of light rays in a step index optical fiber. Define the numerical aperture. What is the significance of numerical aperture ? Derive an expression for the multipath time dispersion of the fiber.

(b) What is a graded index fiber ? Show the ray trajectories in such a fiber. Explain how the multipath time dispersion may be avoided in a graded index fiber. Write also the necessary analytical expressions. Show the trajectories of the meridional rays in your proposed fiber.

(c) Calculate the multipath time dispersion for an unclad glass fiber of refractive index 1.45. Calculate also the multipath time dispersion when the fiber is cladded with glass having the refractive index 1.42. Calculate the light gathering powers of these two fibers, one unclad and the other cladded as mentioned earlier. Compare these two fibers.

[8+7+5]

(CONTINUED IN PAGE 2)

Q4. (a) Distinguish between (I) Directive gain and directivity (ii) Radiation resistance and loss resistance (iii) Bandwidth and beamwidth.

(b) If the radiation resistance is 3 times the total loss resistance then calculate the antenna effeciency . Assume the antenna to be a resonant one.

(c) Discuss briefly the effects of ground on antennas. Compare grounded and ungrounded antennas.

(d) Explain the Cassegrain feed for the paraboloid reflector of a microwave antenna. Calculate the beamwidth between the nulls of a 3m paraboloid reflector used at 10 GHz. Find the effective radiated power of the antenna if the actual power fed to the primary antenna is 1.2 watts.

[6+2+5+7]

Q5. (a) Draw the detailed block diagram of a pulsed radar set and explain the diagram.

(b) Calculate the maximum range of a radar system which operates at 2cm (wavelength) with a peak pulse power of 500kW, if its minimum receivable power is 10^{-13}W, the capture area of its antenna is $5m^2$, and the radar cross-sectional area of the target is $20m^2$.

(c) What is a parasitic element in an antenna ? Describe the Yagi-Uda antenna.

(d) Calculate the input impedance of a half- wave folded dipole with equal diameter arms. The input impedance of a straight half-wave dipole is 72 ohms. The same power is applied to both the dipoles.

[7+5+6+2]

Q6. (a) Explain Manchester encoding and differential Manchester encoding. Show them in a diagram for the bit stream 0001110101. Assume the line is initially in the low state. Mention the advantages and the disadvantages of each encoding.

(b) Show the IEEE standard 802.3 frame format and explain the 802.3 MAC sublayer protocol.

(c) What is the baud rate of the standard 10-Mbps 802.3 LAN ?

(d) Explain the binary exponential back off algorithm in an 802.3 LAN.

[6+6+4+4]

Q7. (a) Explain the IEEE standard 802.4 token bus MAC sublayer protocol. Show the frame format.

(b) Compare IEEE 802.3,802.4 and 802.5 standards in brief. What are the factors other than the performance that are important when making a choice between 802.3 and 802.4 ?

(c) Explain the token ring MAC sublayer protocol. Show the token format and the data frame format.

(d) A 4-Mbps token ring has a token-holding timer value of 10msec. What is the largest frame that can be sent on this ring ?

[6+5+6+3]

Q8. Write short notes on any four:

(a) DQDB (b) Superheterodyne receiver (c) TCP/IP (d) Satellite communication and its applications (e) Microwave tubes (f) Binary countdown protocol (g) Transmission line and its parameters (h) The basic bit-map protocol.

[20]

END OF QUESTION PAPER

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
SEMESTER II FINAL EXAMINATIONS - JULY 2001

EG 212 WORKSHOP TECHNOLOGY

TIME: THREE HOURS.

CLOSED BOOK

ANSWER: PARTS **A, B, C, D** AND **E** QUESTIONS AS STATED
NOTE: ***EACH PART*** SHOULD ***BE ANSWERED IN A SEPARATE ANSWER BOOKLET*** CLEARLY MARKED AS PART A, B, C, D, or E

PART A: ELECTRICAL WORKSHOP TECHNOLOGY
(ANSWER QUESTION Q1 OR Q2)

Q1. (i) State the three definitions of logistics from a military, and the industrial and commercial sectors point of view. **(5 marks)**

(ii) What is maintenance? Maintenance may be categorized as corrective maintenance and preventive maintenance. Briefly describe the differences and implementation procedures for the two categories. **(10 marks)**

Q2. (i) Explain to your parents the safety advantages of having their metal cased cookers earthed using a TN-S system instead of an IT system. Demonstrate your answer with skethes of the cooker electrical connections in a TN-S and IT earthing configurations. **(10 marks)**

(ii) What is the difference between soldering, fusion-welding and non-fusion electric welding? Why is electricity used in soldering and welding? **(5 marks)**

PART B: **SURVEYING WORKSHOP TECHNOLOGY**
(ANSWER QUESTION Q3 OR Q4)

Q3. A survey of a farm was done in 1993. The farmer has the diagram showing the corners of this property and wants the boundaries of his farm retraced. The coordinates of the corner points are:

A	2462.14mE	4798.82mN
B	3313.05	mE 4329.05mN
C	2998.35mE	4157.35mN
D	1985.56mE	4468.78mN

Calculate the distances and bearings of lines AB, BC, CD and DA. The reference direction for the bearings is the North. The farmer wants the bearings in both the sexigismal (degrees, minutes, seconds) and centismal systems. **(15 marks)**

Q4. The following is a page from a levelling field book. Complete the booking form provided using the Rise and Fall method and apply the necessary checks. Furthermore, compute the misclosure. **(15 marks)**

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
1	1.576			49.6				1262.813	BM1
2	2.010		0.894	46.8	49.1				CP
3	1.097		1.131	38.3	47.4				CP
4	1.045		1.786	30.1	38.2				CP
5		2.168							
6		1.087							
7		1.140							
8		2.239							
9	0.962		1.179	65.6	39.5				CP
1			1.712		56.1				BM1

PART C: AGRICULTURAL ENGINEERING
(ANSWER QUESTION Q5 OR Q6)

Q5. A six cylinder two stroke I.C (internal combustion) diesel engine has been designed to be used for running a power generator to power a small farming community.

(a) With the aid of sketches, describe the events that occur in this engine. **(10 marks)**

(b) Give a sketch of a piston and illustrate how the oil and compression rings are positioned on the piston. **(5 marks)**

Q6. (a) In a workshop, you are given a task of wiring of the ignition and electrical system a newly rebuilt engine. Describe how you would determine the firing order of the engine keeping in mind that the cylinder closest to the radiator is cylinder 1. **(11 marks)**

(b) The following should be matched **(4 marks)**

Idle circuit	**Problem**
Idle circuit	Engine cold, will not start
Low speed circuit	Bad "Flat spot'
High speed circuit	Fuel level too high
High speed full power circuit	No power at full speed
Choke circuit	Accelerator up (accelerator pedal not stepped on)- Engine will not start
Float circuit	Engine very rough at speed just above idle.
Accelerating circuits	Engine rough at cruising speeds.

PART D: **MECHANICAL ENGINEERING**
(ANSWER QUESTION Q7, THEN ANSWER Q8 OR Q9)

Q7. An aluminium cylinder of length 170 mm, external diameter 90 mm and a wall thickness of 15 mm is to be produced by casting. With the help of clearly labelled diagrams, describe the process of manufacture of the cylinder. **(20 marks)**

Q8. (a) Why are factories dangerous to work in? **(5 marks)**

(b) Discuss the specific roles performed by each of the following in order to promote safe and healthy working environments in factories:

(i) Government **(5 marks)**
(ii) Management **(5 marks)**
(iii) Employees. **(5 marks)**

Q9. (a) Discuss important mechanical properties associated with engineering materials used in metalworking workshops. **(10 marks)**

(b) Give an outline of the main steels available in mechanical workshops and suggest their uses. **(10 marks)**

PART E: CIVIL WORKSHOP TECHNOLOGY
(ANSWER QUESTION Q10 OR Q11)

Q10. (a) Discuss any three essential factors in a permanently satisfactory concrete job.
(4 marks)

(b) Explain why reinforcement is used in concrete beams.
(4 marks)

(c) In which part of the beam is the reinforcement placed?
(2 marks)

(d) Suppose that you are working for a civil engineering consultancy firm and you are designing a building. Discuss how you would protect the door and window frames from being crushed by the wall above them.
(5 marks)

Q11. (a) What is the dual function of ceiling joists? **(4 marks)**

(b) Explain (briefly) the need to have an eave in a roof? **(3 marks)**

(c) On which corrugation you would fix the roofing sheet (using bolts or screws) to the purlin? **(2 marks)**

(d) If a client is concerned with the health risk attached to use of asbestos cement sheets, how would you respond based on the current arguments. **(4 marks)**

(e) How would you help the client does not want the asbestos cement sheets?
(2 marks)

END OF EXAMINATION

The University of Zambia
School of Engineering

2nd Semester Final Examinations - July 2001

EG 269: Information Technology

Instructions:
Time: Three Hours
Answer Five (5) question in total. Three questions from Section A and Two questions from Section B.

PLEASE, ANSWER SECTION A AND SECTION B ON SEPARATE ANSWER BOOKLETS!!!

SECTION A: Answer all questions in this section.

1. With examples, distinguish between Batch processing and Real time processing (5 Marks)

2. Most of the software nowadays come on CD-ROMs as opposed to floppy disks.
   a) Give two reasons why CD-ROMs have replaced floppy disks as a storage media for software. (4 Marks)
   b) Give two ways in which floppy disks are still commonly used (2 Marks)
   c) Give two disadvantages for using magnetic tapes as a storage media (4 Marks)

4. Security in computer systems is very critical.
a) Mention at least two reasons why security is very important in computer systems (2 Marks)
b) How can a computer be protected from
   i) Hackers
   ii) Power failure
   iii) Viruses

(6 Marks)

c) What do you understand by the term software piracy? (2 Marks)

5. Describe at least five reasons why every computer system need systems software. (10 Marks)

(Total 35 Marks)

6. Use C++ programming language to answer the following questions

a) Debug the following C++ program

```
void Main()
{ int a=0, b;
  cout<<A;
  cout<<b;
}
```

(4 Marks)

b) Write down the output from the following programs

i)
```
include <iostream.h>
void main()
{ int a=10,b,c;
 cout<<"\n a="<<a; b=--a+5
 cout<<"\n b="<<b; c=7+a--;
 cout<<"\n c="<<c;
 cout<<"\n a="<<a;
 cout<<"\n b="<<b++/3;
}
```

(5 Marks)

ii)
```
include <iostream.h>
void main()
{ int a=b=0;
 do {++a;
     b+=a;
    }while(b<10
 cout<<"\n b="<<b;
}
```

(5 Marks)

c) Use the for loop statement to display the numbers 2, 4, 6, 8 and 10 (5 Marks)

d) Distinguish between

i) an array and a structure(or record)

ii) formal argument and actual arguments

iii) automatic and global variables

(6 Marks)

(Total 25 Marks)

End of Section A

Section B

Answer question one (1) and one other question from this section.

Question One (25)

The School of Mines has decided to create a database for its operations. Part of the document obtained from the dean's office, on the database needs, reads as follows:

.....Details about all the students in the School of Mines should be recorded. This information will include: Student's full names, ID number, date of birth, the department ID to which the student belongs, year of study, hostel number, sponsor and home address. Since the school is broken down in departments, we'll also need the following information documented: Department names, departmental identification number, Head of Department by Man number, and the floor on which the department is located. The course names, course numbers, credit hours, the department in charge(by Departmental ID) and the lecturers (by Man numbers) of all the courses offered by the school must be documented. It will be assumed that only one lecturer is in charge of a particular course, and a lecturer can be in charge of more than one course. Records on the members of staff must include: Staff full names, Man number, DepartmentID, Qualifications (e.g. MSc, PhD, Prof...) and the courses (by course numbers) they are in charge of, and residential address. Room facilities must also be identified by room number. The classrooms must include type, capacity and other facilities found in the room like whiteboards, blackboard, laboratory tables, air conditioning etc. Data on offices will also identify the occupant(s) with their Man numbers and office phone number. .....

Being an *"expert"* in Information Technology, here is your task.

a) Create the database schema from the above given data. NO NEED to specify any constraint rules for this database.
   Hint: Use meaningful acronyms like Dept_ID for Departmental Identification number, ManNo. for Man number, etc.
b) Identify the relationships existing between the entities and state the connector attribute(s) for each relationship. Connector attributes are those that contain information which can provide a link between to tables. They need not necessarily be key attributes.
c) For each entity type, identify the composite and multi-valued attributes.

Question Two (7+8)

(a) What is a "database interface"? Briefly describe 3 different kinds of user-friendly interfaces.
(b) Explain the different techniques you can use to acquire GIS data sets.

Question Three (10+5)

(a) What procedure would you follow if you have to introduce a GIS unit in an organization?
(b) What is the importance of having data that is topologically correct?

End of Examination
Good luck.

THE UNIVERISITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ENGINEERING, MANAGEMENT AND SOCIETY 1

EG 475 FINAL EXAMINATION, JULY 2001

DURATION: 3 HOURS

SECTION A: ANSWER BOTH QUESTIONS

Q1. Your company has just received an order for a specially designed electric motor from a good customer. Nonetheless, the contract states that starting on the 13th Day from now, your firm will experience a penalty of $100 per day if the job is not completed. Indirect costs amount to $200 per day. The data on direct costs and activity precedence relationships are shown in the table below.

Activity	Normal Time (days)	Normal Cost $	Crash time (days)	Crash Cost $	Immediate Predecessors
A	4	1000	3	1300	None
B	7	1400	4	2000	None
C	5	2000	4	2700	None
D	6	1200	5	1400	A
E	3	900	2	1100	B
F	11	2500	6	3750	C
G	4	800	3	1450	D,E
H	3	300	1	500	F,G

(a) In your study of project management you have observed that Project work have inherent characteristics which make them different from normal routine work. Contrast these characteristics between Project and normal routine work. (5 marks)

(b) Draw the Project network Diagram. (5 marks)

(c) What completion date would you recommend? (10 marks)

Q.2. (a) Explain four major uses of a budget (4 marks)

(b) What components make up the Master Budget? (4 marks)

(c) When preparing a sales budget what FOUR key factors should you take into consideration? (4 marks)

(d) Define (i) Cross Elasticity of demand

(ii) Income elasticity of demand (4 marks)

(e) An increase in disposable personal income in Rhodes Island from $1.0 m to $1.10m is association with an increase in boat sales in Gwanju from 5000 to 6000 units.

Determine the income elasticity of demand over this range. (4 marks)

SECTION B: ANSWER ANY THREE

Q.3. (a) Outline the uses of Variance Analysis Reports by management (5 marks)

(b) What limitations do practicing business executives face as they employ Variance Analysis in running businesses? What approach would you recommend to practicing business executives which would ensure that they attain superior corporate Performance? (5 marks)

(c) Capital budgeting techniques have a number of important applications in managerial finance. Give FOUR examples of these applications. (5 marks)

(d) Define the following: (i) Salvage value

(ii) Loan Amortisation (5 marks)

Q.4. (a) The Dean of School of Engineering has asked you to carry out a research to establish the professional challenges facing young graduate engineers in industry two years after leaving UNZA. The Research work is expected to commence on 20/08/01. Prepare a checklist of key information that would aid you in compiling the report of your Research. (5 marks)

(b) What would be the disadvantages of providing too much information in your Report? (5 marks)

(c) What are the essential qualities of good information? (5 marks)

(d) What factors hinder effective communication? (5 marks)

Q.5. Paul Munga, a financial analyst for Monze Butcheries has prepared the following sales and cash disbursement estimates for the period February to June 2001.

Month	Sales $	Cash Disbursements $
February	500	400
March	600	300
April	400	600
May	200	500
June	200	200

Mr. Munga notes that historically, 30 per cent of sales have been for cash ,of credit sales, 70% are collected one month after the sale, and the remaining 30% are collected two months after sale. The firm wishes to maintain a minimum ending balance in its account of $25. Balances above this amount would be invested in short term government securities, whereas any deficit would be financed through short term bank borrowing. The beginning cash balance at April 2001 is $115.

(a) Prepare a cash budget for April, May and June (10 marks)

(b) How much financing, if any, at maximum would Monze butcheries need to meet its obligations during this three months period?

(2 marks)

(c) How much interest would the company pay if the cost of short-term loan is 15%?

(2 marks)

(d) Due to the falling economy, Mr. Munga has projected that 5% of the Accounts Receivable after June would not be collected. What interest would be earned in August if the company invested all the money it collected at an interest of 16% assuming that Munga's debtors pay at the end of each month?

(6 marks)

Q.6. Parry Sound Diskettes (PSD) manufacturers and sells a line of diskettes for microcomputers. Three models are produced; Economy, Standard, and Premium. Unit cost and revenue data, as well as fixed costs for PSD are as follows:

Description	Economy	Standard	Premium
Selling price	$10	$15	$25
Variable costs:			
Direct materials	2	3	5
Direct labour	2	4	6
Overhead	1	2	3
Selling commission	2--- 7	2 11	2 16
	---	--- ----	-----
Contribution margin	$3	$4	$9
	===	= ==	===
Product % of total sales	10%	50%	40%
Fixed manufacturing costs		$200,000	
Advertising		$100,000	
Fixed Administrative costs		$100,000	
Total expected sales (all products)		80 000 units	
Capacity (total all products		100,000 units	

(a) What is the projected profit given the initial data?

Management is considering increasing the advertising budget by $100,000 to increase total unit sales from 80,000 to 100,000. The mix of product would remain the same. Is the advertising campaign desirable?

(5 marks)

(b) Management is considering altering the manufacturing budget so that more effort will be placed on selling the Premium model. The advertising budget could be increased by $150,000. While this would not increase the total unit sales, this campaign would result in the Mix of Economy Standard, and Premium Model being 5%, 30% and 65%.

Is the change desirable? (5 marks)

(c) Management is considering increasing the selling commission paid to the sales force. The marketing manager believes that if the selling

commission of each product is increased by 2%, the total level of sales will rise to 90,000 units. Is the change desirable?

(5 marks)

(d) Management is considering altering the production process by installing new manufacturing equipment, the direct materials, direct labour and variable overhead costs can be reduced to 75% of their current levels for all products. Fixed manufacturing costs would rise by $200,00 reflecting depreciation on new equipment. What is the minimum level of total sales for which change would be desirable?

(5 marks)

Q.7. After having spent and written off against expenses of past periods an estimated $95,000 of Research and Development funds on a new drug, a Pharmaceutical Company is faced with a decision to invest a total $1000,000 in a large scale advertising campaign to bring the new product to market.

Campaign is to last 9 months and all costs will be capitalized and armotized over 5 years. The effect of the campaign is an estimated average incremental profit of $300,000 per annum for at least the next 5 years, before taxes but excluding the armotization of the initial promotional cost.

Likely pattern of these incremental profits estimated to be:

t	$	PVIF at 10%
1	100,000	0.909
2	200,000	0.826
3	300,000	0.751
4	400,000	0.683
5	500,000	0.621

Assume the company presently experiences break-even profits position, income taxes at 40% and minimum required return 10% after tax.

Compute the NPV and decide whether the promotion should be launched.

(20 marks)

THE END

The University of Zambia
School of Engineering
EG 575- Engineering Management and Society
Semester II Final Examination 1999-2001, July 2001

Time: Three (3) Hours **Closed Book**

Instructions

Answer One (1) Question from Section A, Two (2) Questions from Section B and also Two (2) Questions from Section C.

In case of Question Two (2), Section A, for every wrong answer half a mark will be deducted. Shade the respective correct box for each question in the answer sheet provided at the end of Question Two (2). Note that T=True and F= False.

All questions carry equal marks

Section A

Question 1

The personnel section, in your company, has just short listed a number of persons who are likely to meet requirements for a job and are worthy further investigations. Your team has to conduct an interview, test, ask for references and make recommendation for job offer. Discuss the purposes of these selection processes.

Question 2

(i) Managers must have powers to successfully

(a) Command the respect of the workers and fellow managers
(b) Influence, to some extent, employees to respond to orders
(c) Have authority over company resources
(d) Measure deviation from established company objectives
(e) All the above

(ii) The ergonomics is science of characterising the way humans exchange information with machines.

T	F

(iii) An appraisal is an objective assessment of the employee performance against objectives and often involves the following:

(a) A review of performance for a specified period, and a discussion of improvement in performance if necessary
(b) A statement of the present skills and abilities of the appraisee
(c) A statement of the objectives and goals for the next period including the criteria for performance measuring
(d) Identification of the best way(s) to develop existing skills and experience to the one(s) likely to prove more critical to the company bearing in mind established company objectives
(e) All the above

(iv) Engineering managers that have a rationalistic approach, to work, have difficulties in applying motivation theories in practice.

T	F

(v) Which one of the following is not one of the basic methods in training and personnel development:

(a) On-the-job- experience
(b) Role playing, Simulation and Case Studies
(c) Appraisal
(d) Study, Workshops
(e) Coaching

(vi) Successful training requires one to have a strong desire to lesson as opposed to intellectual capability.

T	F

(vii) Under contract of employment the following have to be satisfied for the contract to be legally binding:

(a) The employer and employee must have legal capacity to contract
(b) The employer and employee must intend the contract of employment to be legally binding
(c) There must be a clear offer that has been accepted by both employer and employee
(d) There must be an element of consideration
(e) All the above

(viii) Concurrent control is applying corrective measures while the process is going on.

T	F

(ix) Organisation using formal application forms for recruitment purposes, normally want to know some basic information, about the potential employee, such as:

(a) The type of job the potential employee is applying for and how he find out about the job
(b) Name and contact address of the potential employee
(c) Qualifications and experience of the potential employee
(d) Age, interests out side work, Health and disabilities.
(e) All the above

(x) A job description should give a broad indication of the responsibilities of the job and how the job-holder is rewarded monetary wise.

T	F

Answer sheet for Question Two (2).

.....Cut Here.....

1. A, B, C, D, E
2. T, F
3. A, B, C, D, E
5. A, B, C, D, E
4. T, F
6. ~~A, B, C, D, E~~ T, F
7. A, B, C, D, E
8. T, F
9. A, B, C, D, E
10. ~~A, B, C, D, E~~ T, F

Section B

Question 3

Mr. Musonda has been accused of negligence. Discuss in detail the elements that constitute negligence.

Question 4

What do you understand by the term Alternative Dispute Resolution (ADR). Write brief notes on three types of ADR.

Question 5

Discuss the procedure of registering a patent in Zambia.

Question 6

Discuss the various circumstances that can vitiate a contract.

Section C

Question 7

(a) Discuss the duties of a planner
(b) What are the four qualifications of a planner
(c) Define the term primacy of planning

Question 8

Strategic planning is very important for any organization. Discuss the strategy management process, highlighting all the important aspects.

Question 9

(a) Define the following terms:
(i) Milestones
(ii) Resource allocation and levelling
(iii) Float
(iv) Earliest start date
(v) Latest finish date

(b) Analyse the following network, indicating the critical path:

Activity	*Predecessor activities*	*Duration*
A	-	22
B	-	20
C	-	10
D	A	14
E	B,C	8
F	B,C	14
G	B,C	4
H	C	12
I	G,H	16
J	D,E	8

End of EG 575 Engineering, Management and Society, July 2001

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS
JULY/AUGUST - 2001

MATHEMATICS EM212 - ENGINEERING MATHEMATICS II

INSTRUCTIONS: Attempt any five (5) questions. You are required to show all your working for full credit. Calculators are not allowed.

TIME ALLOWED: Three (3) Hours.

---

1. a) Find the domain and range of the function $f(x,y) = \cos^{-1}(xy)$ and describe the domain graphically.

   b) Given $f(x,y) = x\ln(y\cos x)$, find

   $$\frac{\partial f}{\partial x} \text{ and } \frac{\partial^2 f}{\partial x \partial y} \text{ at the point } (\pi/3,1).$$

   c) Solve the differential equation $\frac{dy}{dx} + ky = a\sin mx$ where k,a and m are non zero constants.

2. a) An unevenly heated plate has temperature T(x,y) in °C at the point (x,y). If $T(2,1) = 135$, $T_x(2,1) = 16$ and $T_y(2,1) = -15$, estimate the temperature at the point (2.04,097).

   b) Verify that the function

   $$u(x,t) = \frac{1}{2\sqrt{\pi t}} e^{\frac{-x^2}{4t}} \text{ satisfies the heat equation } u_t = u_{xx} \text{ for all } t > 0$$

   and all real x.

   c) The Zambeef company has experienced that the equality Q(in kilograms) of beef that the consumer community buys during a week is a function $Q = f(b,c)$, where b is the per kilo price of beef and c is the per kilo price of chicken during the week. State with reasoning, what should be signs of $\frac{\partial Q}{\partial b}$ and $\frac{\partial Q}{\partial c}$.

3. a) When it rains on the surface $z = \frac{1}{x} + \frac{1}{y} + xy$, a puddle will form at the lowest point of the surface. Determine the point at which the puddle will form.

b) If $z = f(x,y)$ where $x = e^u \cos v$ and $y = e^u \sin v$, show that

$$y\frac{\partial z}{\partial u} + x\frac{\partial z}{\partial v} = e^{2u}\frac{\partial z}{\partial y}$$

c) The pressure (P), volume (V) and temperature (T) of a gas are related by the law $PV = kT$, where k is a constant. At the instant when $P = 20$, $V = 80$ and $T = 300$, the pressure and volume are changing at the rates

$$\frac{dP}{dt} = 2, \frac{dV}{dt} = -3,$$ where t is time.

Determine the rate of change of temperature at that instant.

4. a) Find the solution of the initial value problem

$xy' + (1+x)y = e^{-x}$, $y(1) = 0$

b) The growth rate of a bacteria population is proportional to its size. Initially the population is 10,000. After 10 days its size is 25,000. Find the population size after 30 days.

c) Find the solution of the differential equation $(3x^2 \ln x + x^2 - y)dx - xdy = 0$ with initial condition $y(1) = 5$.

5 a) Verify that $y(x) = \sin x^2$ is a solution of the differential equation $xy'' - y' + 4x^3 y = 0$

b) Show that the solutions $y_1(x) = \sin x$ and $y_2(x) = 4\sin x - 2\cos x$ of differential equation $y'' + y = 0$ are linearly independent.

c) Find a general solution of the differential equation
$I'' + I' + 3I = 5\cos t$

6. a) Let A and B be any two matrices such that AB exists and AB = 0. Comment on matrices A and B.

b) Given the linear system of equations

$$\begin{aligned} 2x + 6y &= -11 \\ 6x + 20y - 6z &= -3 \\ 6y - 18z &= -1 \end{aligned}$$

Find the rank of the coefficients matrix and the augmented matrix. Hence show that the above liner system does not have a solution.

c) Find the eigen values and eigen vectors of the matrix

$$\begin{pmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{pmatrix}$$

Note: If there is an eigen value having algebraic multiplicity greater than one, then you are required to find linearly independent eigen vectors corresponding to such an eigen value.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

UNIVERSITY EXAMINATIONS SECOND SEMESTER JULY/AUGUST 2000/2001

MATHEMATICS EM312 - ENGINEERING MATHEMATICS IV

INSTRUCTIONS: Attempt any four (4) questions from Section A and any one(1) question from section B. Show necessary working. All questions carry equal marks. Calculators can be used.

TIME ALLOWED: Three(3) hours.

SECTION A

1. (a) Determine the new integration limits in the RHS:

$$\int_0^4 \int_{\frac{z}{2}}^{\sqrt{z}} \int_0^{y+z} f(x,y,z)dxdydz = \iiint f(x,y,z)dxdzdy$$

(b) Evaluate $I = \int_0^2 \int_0^{z^3} \int_{\sqrt{y/z}}^{z} \frac{e^{y/x^2}}{x^2 z} dxdydz$

(c) 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).

2. (a) Find the directional derivative of $f(x,y) = e^2 \tan y + 2x^2 y$ at the point $\left(0, \frac{\pi}{4}\right)$ in the direction of $\vec{i} - \vec{j}$.

(b) Show that if g(x,y,z) is a scalar valued function and $\vec{F}(x,y,z)$ is a vector field, then $\text{div}(g\vec{F}) = (\text{grad}g).\vec{F} + g\text{div}\vec{F}$

(c) Verify Stoke's theorem for

$\vec{A} = 2y\vec{i} + 3x\vec{j} - z^2\vec{k}$, where s, the surface, is the upper half surface of the sphere $x^2+y^2+z^2 = 9$ and c its boundary.

3. (a) Identify the quadric surface given by

$$4x - x^2 + y^2 + z^2 = 0$$ and sketch it.

(b) Find the curl of the vector

$$\vec{v} = x\vec{i} + 5xy\vec{j}$$

(c) Verify the divergence theorem for

$\vec{A} = (2xy + z)\vec{i} + y^2\vec{j} - (x + 3y)\vec{k}$
taken over the region bounded by

$2x + 2y + z = 6$, $x = 0$, $y = 0$ and $z = 0$.

4. (a) Determine the nature of the critical points of the function $f(x,y) = (4 - x - y)xy$.

(b) Write the equation $x^2 + y^2 + z^2 = 25$ in cylindrical and spherical coordinates.

(c) A manufacturing company has three plants I, II and III, which produce x,y and z units, respectively, of a certain product. The annual revenue from this production is given by

$$R(x,y,z) = 6xyz^2 - 400,000x - 400,000y - 400,000z.$$

If the company is to produce 1000 units annually, how should it allocate production so as to maximise profits?

5. (a) Evaluate $\int_{(1,1)}^{(4,2)}[(x+y)dx+(y-x)dy]$

along straight lines from (1,1) to (1,2) and then to (4,2).

(b) Show that $\int_0^2\int_{y/2}^3 \frac{1}{x}e^{y/x}dxdy = 3(e^2-1)$.

(c) Show that the volume of the solid bounded above by the surface $z = 3 + r$ and below by the region enclosed by the cardiod $r = 1 + \sin\theta$ is given by $v = \frac{37\pi}{6}$.

SECTION B

6. (a) State the four axioms of probability.

(b) Four students are to be randomly selected to fill certain senate posts, from a group of three undergraduate and five graduate students. Find the probability that exactly two undergraduates will be among the four chosen.

(c) A batch of 500 containers for frozen orange juice contains 5 containers that are defective. Two are selected at random, without replacement from the batch.

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

(ii) What is the probability that both are defective?

(iii) What is the probability that both are acceptable?

(iv) What is the probability that one is defective and another one is effective.

7. (a) The percentages of change in crude oil production from 1976 to 1977 for 30 countries in North America, South America, Europe, and the Middle East are as follows

-1.4	-13.6	8.1	-2.2	-0.2
9.4	-0.4	-2.7	-10.6	-4.5
0.3	-4.1	-7.5	-6.5	-7.0
0.0	-5.0	-4.1	-40.3	-20.7
8.0	-2.1	-2.0	205.2	-7.6
12.7	19.6	4.5	1.8	6.3

(i) Calculate the mean $\bar{x}$ and the standard deviation, S, for the given data.

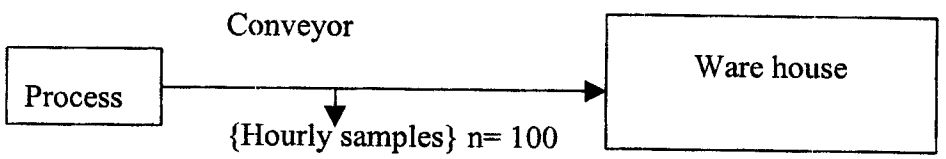
(ii) Calculate the intervals $\bar{x} \pm ks$ for $k = 1,2,3$.

Count the number of measurements falling within each interval and compare this result with the empirical rule.

(iii) The extremely large value of 205.2 is for the United Kingdom and was due to a major oil strike in the North Sea. Eliminate this value and repeat parts (i) and (ii) using the remaining 29 observations. Comment on the effect of a single large observation in the data.

(b) Define a Bernoulli process

(c) A production process represented schematically below produces thousands of parts per day.



On the average does not vary with time. Every hour, a random sample of 100 parts is selected from a conveyor and several characteristics are observed and measured on each part; however, the inspector classifies the part as either good, or defective. If we consider the sampling as $n = 100$ Bernoulli trials with $p = 0.01$, the total number of defectives in the sample, X, would have a binomial distribution

$$P(X = x) = \left(\frac{100}{x}\right) p^x (1-p)^{100-x}, \quad x = 0,1,2,...,100$$
$$= 0 \quad , \text{ otherwise.}$$

Suppose the inspector has instruction to stop the process if the sample has more than two defectives. Calculate the probability of the inspector stopping the process. i.e $P(X > 2)$.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

SEMESTER II EXAMINATIONS 1999/2001
JULY / AUGUST 2001

ME 252 – PROPERTIES OF ENGINEERING MATERIALS I

TIME ALLOWED: THREE HOURS **CLOSED BOOK**

ANSWER: Five Questions With At Least Two From Each Section

All Questions Carry Equal Marks **Please Hand In Sections A And B Separately**

SECTION A

Question 1:

(a) Distinguish between interstitial and a substitutional solid solutions. [6 marks]

(b) Figure Q1 shows the phase diagram of the solubility of pure element B and into pure element A. Describe the phase transformation in the slow cooling of an alloy containing 95% A and 5% B by weight. [10 marks]

(c) What are the percentages by weight of A and B in the solid and liquid phases of the alloy at 320 °C? [4 marks]

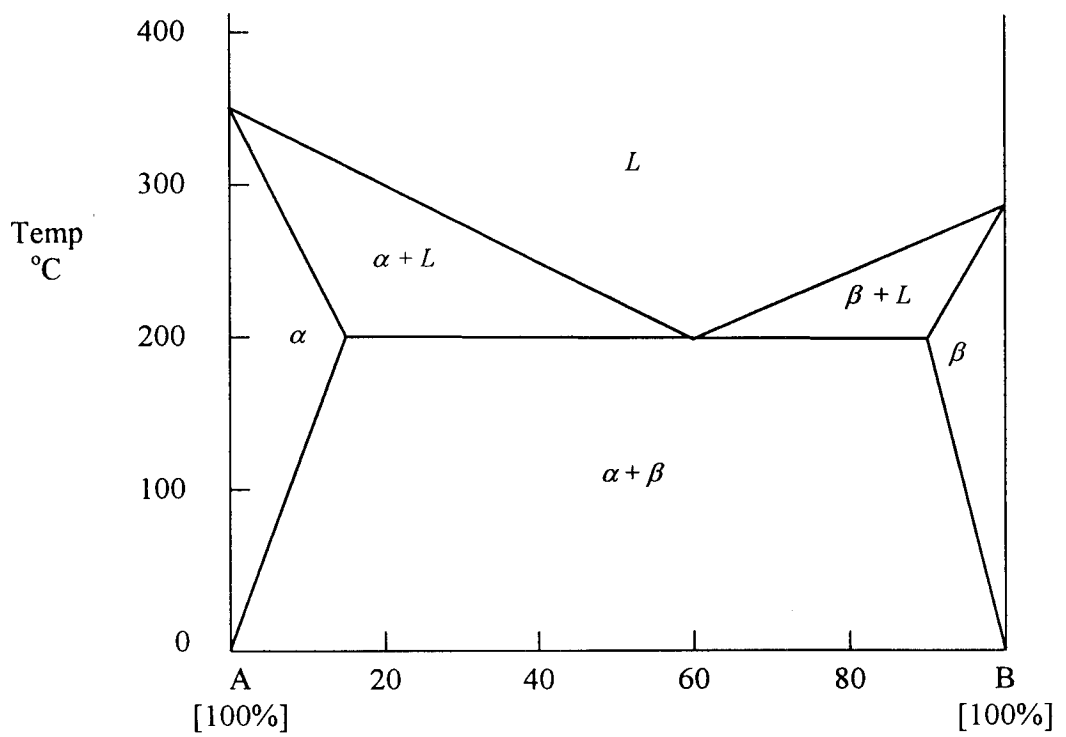


Figure Q1

Question 2:

(a) Tantalum, Ta, has the bcc structure. Its lattice parameter is $a = 0.33026$ nm at room temperature.
  (i) Sketch the unit cell, and show the lattice parameter. [2 marks]
  (ii) Determine the atomic radius, R, and the atomic diameter, d, in nm. [3 marks]
  (iii) Determine the atomic volume, V, in nm^3. [3 marks]
  (iv) Sketch another bcc unit cell and draw solid lines between the body-centred atom and its nearest neighbours. What is the nearest-neighbour co-ordination number? [4 marks]
  (v) Sketch another bcc unit cell and draw solid lines between the body-centred atom and all of its near neighbours. (You have to draw atoms that are outside of the unit cell.) What is the near-neighbour co-ordination number? [4 marks]

(b) Explain why silica, SiO_2, should melt at a much higher temperature (1710 °C) than silicon fluoride, SiF_4 (-77 °C). [4 marks]

Question 3:

(a) What does the term 'doping' mean and what is its significance in semiconductor theory? [5 marks]

(b) Explain what would happen if the temperature of a piece of doped semiconductor material in an electric circuit is increased. [3 marks]

(c) Briefly distinguish between *n*-type and *p*-type semiconductors. [12 marks]

Question 4:

(a) What is the role of oxygen in the corrosion of steel. [4 marks]

(b) Describe in outline one method and the principle involved by which each of the following may be protected against corrosion:
  (i) an exposed steel structure
  (ii) a steel boiler
  (iii) a ship's hull
  (iv) a buried steel pipeline. [16 marks]

SECTION B

Question 5:

(a) What are the three basic categories of polymer [4 marks]

(b) Briefly describe the two main types of polymerisation process [10 marks]

(c) Ceramic materials are generally limited in their tensile mechanical properties due to brittle failure caused by small porosity and surface cracks. Using Griffith's criteria for brittle solids, determine the functional dependence of the failure strength on the pore size, and EXPLAIN your answer in words. [6 marks]

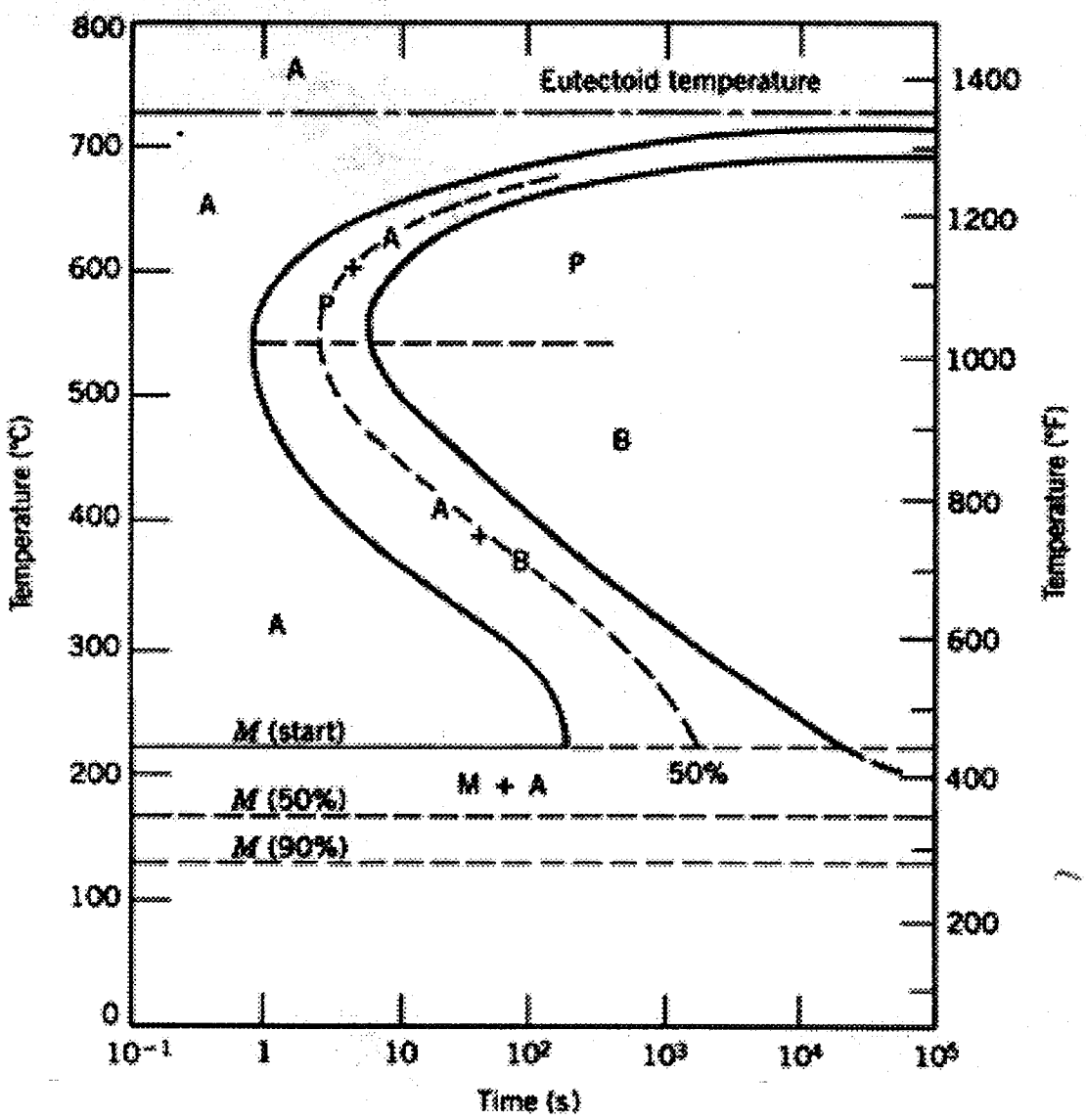
Question 6:

(a) With the aid of well labelled diagrams define the terms:
  (i) hysteresis [8 marks]
  (ii) relative permeability [8 marks]

(b) Define the Matthiessen rule [4 marks]

Question 7:
Heat treatment of ferrous and non-ferrous metals enhances their behaviour in a number of ways.

(a) List the principle reasons for the heat treatment of metals [3 marks]
(b) Describe briefly the four main heat treatment processes [5 marks]
(c) Using the IT curve shown below for steel, describe and sketch the heat treatment you would use to obtain a material with the following microstructure and properties. (Neglect the starting condition of your steel).
  (i) Maximum strength steel without regard to ductility [3 marks]
  (ii) Easily machinable, low strength, high ductility steel [3 marks]
  (iii) 50% fine bainite, 50% martensite [3 marks]
  (iv) 1/3 fine pearlite, 1/3 martensite, 1/3 coarse bainite [3 marks]



Question 8:

(a) A cylindrical rod of steel (E = 207 GPa) having a yield strength of 310 MPa, is subjected to a load of 11,100 N. Given that the length of the rod is 500 mm, what must the diameter be to allow a reversible elongation of 0.38 mm? [10 marks]

(b) Write the best answer to the following questions

(i) Elastic strain is present in a tensile test: [3 marks]

- only during elastic loading
- at all stresses
- only up to the uniform strain limit
- only after the load is removed.

(ii) The minor preload in a Rockwell Hardness test is: [3 marks]

- 10 kg
- 100 kg
- 1 kg
- depends on the indenter.

(iii) The 0.2% offset yield strength is defined as: [4 marks]

END OF EXAMINATION
G M Munakaampe / J Phiri

UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

ME 332 - Strength of Materials

Semester II – Final Examination 1999 - 2001, July 2001

Time: Three (3) Hours **Closed Book**

Instructions:

(i) *Comment as much as possible to ensure clarity and give sketches where you think it is necessary.*
(ii) ***Answer ANY FIVE (5) Questions, at least Two from each Section.***
(iii) ***Answer Sections A and Section B in separate answer books.***

SECTION A

Question1

A horizontal bar of uniform section and length **L** is simply supported at its end. In addition to the uniform load ***w*** per unit length due to its own weight, the bar is subjected to longitudinal thrusts **P** acting at an eccentricity **e** below the centre line.

(a) Show that the resultant maximum bending moment in the beam will have its least possible value if

$$e = \frac{w(\sec mL/2 - 1)}{Pm^2(\sec mL/2 + 1)}, \qquad \text{where } m^2 = \frac{P}{EI}$$

[15 marks]

(b) If the bar is of steel, 2.5 m long, of rectangular cross section 80 mm wide and 25 mm deep and weights 150 N / m, and if the end thrust is 13.3 kN, find the eccentricity **e** as already defined and also the corresponding maximum deflection. **E** = 200 000 N / mm^2. **[5 marks]**

Question 2

2.1 Mr Mungonyinga bought a second hand tractor for his Mungo Farms. His intentions were to be connecting the output shaft of the tractor to a water pump for irrigation. The water pump requires 500 H.P to run at 600 r.p.m. Unfortunately the shaft was missing, but he had some hollow shaft in his workshop which could stand a maximum shear stress of 792.7 kg / cm^2 and minimum shear stress of 581.6 kg / cm^2. He further discovered that he had a solid shaft of similar material in the same workshop which could stand a maximum shear stress of 529.4 kg / cm^2. If the length of the compound shaft required is to be 1.5 m long, advise Mr Mungonyinga on

(i) The internal and external diameter of the hollow shaft
(ii) The diameter of the solid shaft **[12 marks]**

2.2 A rigid bar weighting 500 kg and carrying a load of 2000 kg is supported by three springs having spring constants S_1 = 30 kg / m, S_2 = 18 kg / m and S_3 = 12 kg / m as shown in figure Q2. If the springs are all of the same length, find the distance x such that AC will be horizontal. **[8 marks]**

Question 3

A platform for loading small containers onto a lorry is constructed in the form of a cantilever whose horizontal axis is **h** m above the ground level. The platform is of length **L** and constant moment of inertia I. The containers are normally placed flash with the free end and extend backwards half way the platform length and are always of same weight ***w*** tonnes / m.

(a) Find

(i) The minimum height of the lorry bed from the ground to prevent the platform from deflecting beyond its design conditions for the above containers type.

(ii) The angle developed at the end to allow the containers slide easily at a slight push. **[15 marks]**

(b) Calculate the values of (i) and (ii) if **L** = 3 m, **h** = 1.5 m ***w*** = 2 tonnes / m, I = 54 000 cm^4 and **E** = 2100 tonnes / cm^2. **[5 marks]**

Question 4

A beam of uniform section and length **L** is simply supported at its ends and carries a distributed load which varies uniformly from zero at each end to a maximum intensity of ***w*** per unit run at a section **L**/3 from the right hand end.

(a) Show that the maximum deflection occurs at a distance approximately 1 percent of the span of the beam from the mid span and **[16 marks]**

(b) Find the maximum deflection in terms of ***w***, **L**, **E** and I. **[4 marks]**

SECTION B

Question 5

5.1 For a given material, Young's modulus is 2×10^6 kg / cm^2 and modulus of rigidity is 8×10^5 kg / cm^2. Find the bulk modulus and Poisson's ratio for the material. **[10 marks]**

5.2 At a certain point in an elastic material there are normal tensile stresses of magnitude 1200 kg / cm^2, and 600 kg / cm^2 acting orthogonally to each other. In addition there is a shearing stress of 800 kg / cm^2 acting normal to the directions of the normal stresses.Determine:

(a) the magnitude and direction of the principal stresses,
(b) the magnitude and direction of the maximum shearing stress,
(c) the normal and shearing stress on a plane inclined at 30° to the direction of 1200 kg/cm^2 stress. **[10 marks]**

Question 6

6.1 Provide an adequate explanation of what a SHEAR CENTER is. Apply your explanation to an angle section. **[10 marks]**

6.2 A cantilever beam specimen for a testing machine has a circular cross section throughout its length, but in a length of 8 cm the diameter decreases from 1 cm at the fixed end to 0.5 cm at the free end.

Calculate the maximum stress due to bending when a static load of 50 kg is applied at the free end in a direction perpendicular to the length of the specimen. **[10 marks]**

Question 7

7.1 For the beam shown in figure.Q7 simply supported at the ends and loaded as shown, write equations for the shearing force and bending moment at any point along the length of the beam. Also, draw the shearing force and bending moment diagrams. **[10 marks]**

7.2 A boiler drum consists of a cylindrical portion 2 m long, 1 m diameter, and 25 mm thick, closed by hemispherical ends. In a hydraulic test to 10 N/mm^2 how much additional water will be pumped in, after initial filling at atmospheric pressure? Assume the circumferential strain at the junction of cylinder and hemisphere is the same for both. For the drum material, E=207,000N/mm^2; Poisson's ratio ν=0.3. For water bulk modulus k=2100N/mm^2. **[10 marks]**

End of ME 332 Strength of Materials Final Examination July 2001.
Prepared by Mr. E. Luwaya and Mr. C. Siakachoma © Dept. of Mech. Engineering, Unza.

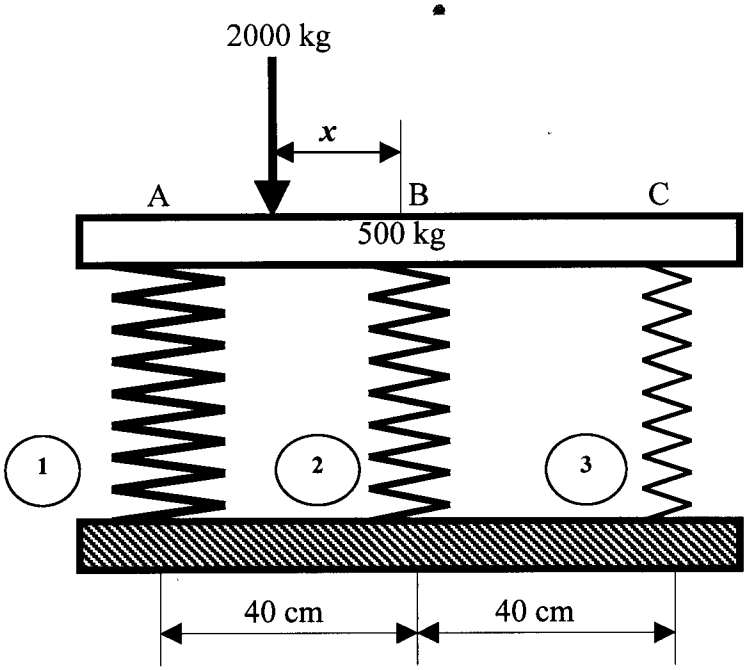


Figure Q2

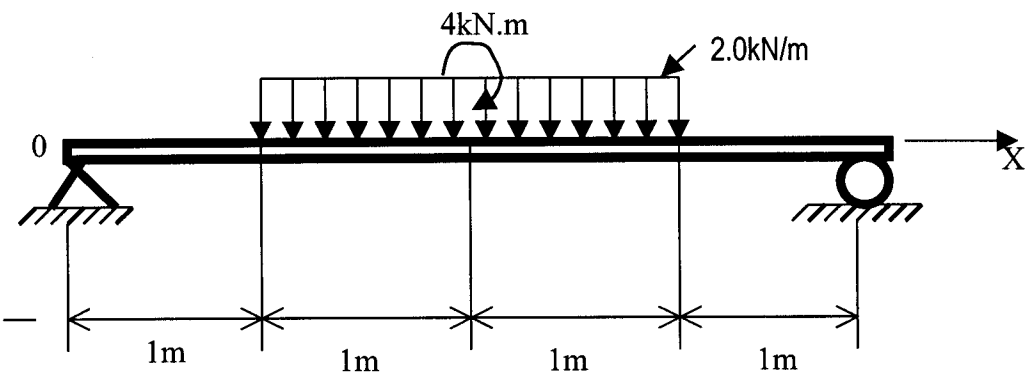


Figure Q7

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

1999/2001 UNIVERSITY SEMESTER II EXAMINATIONS - JULY 2001

ME 375 - DYNAMICS

Time: THREE (3) HOURS — **CLOSED BOOK**

Instructions: **Answer Question 1 AND any FOUR (4) others** (i.e. Five (5) Questions in total)
QUESTION 1 CARRIES 24 MARKS. ALL OTHER QUESTIONS CARRY EQUAL MARKS

Q1. A rotating cylinder mechanism is shown in Figure Q1. OA = 5 cm and AB = 12.5 cm. Determine, for the configuration shown, the acceleration of the piston inside the cylinder if the cylinder rotates at 300 rpm in a clockwise sense. [24 marks]

Q2. To pass inspection, steel balls for ball bearings must clear the fixed bar *A* at the top of their rebound when dropped from rest through the vertical distance *H = 900* mm onto the heavy inclined steel plate (Figure Q2). If balls that have a coefficient of restitution of less than 0.7 with the rebound plate are to be rejected, determine the position of the bar by specifying *h* and *s*. Neglect any friction during impact. [19 marks]

Q3. The vertical motion of the 20-kg block is controlled by the two forces *P* applied to the ends A and B of the linkage where A and B are constrained to move in the horizontal guide (as shown in Figure Q3). If forces P = 1100 N are applied with the linkage initially at rest with $\theta = 60^\circ$, determine the upward velocity *v* of the block as θ approaches 180°. Neglect friction and the mass of the links and note that P is greater than its equilibrium value of $(5W/2)\ cotan\ 30^\circ = 850\ N$. [19 marks]

Q4. A stepped cylinder having a radius of gyration k = 0.40 m and a mass of 200 kg is shown in Figure Q4. The cylinder supports a weight W of mass 100 kg with an inextensible cord and is restrained by a linear spring whose constant K is 2 N/mm. What is the angular acceleration of the stepped cylinder when it has rotated 10° after it is released from a state of rest? The spring is initially unstretched. What are the supporting forces at this time? [19 marks]

Q5. Each of the two cars A and B in Figure Q5 is travelling with a constant speed of 72 km/h. Determine the velocity and acceleration of car A as seen by an observer moving and rotating with car B when the cars are in the positions shown. The x-y axes are attached to car B. [19 marks]

Q6. A circular cylinder of mass *m* and radius *r* is connected by a spring of modulus k as shown in Figure Q6. If it is free to roll on the rough horizontal surface without slipping, find its frequency. J_o is the mass moment of inertia of the cylinder about its centre (i.e. $J_o = \frac{1}{2}mr^2$). [19 marks]

Q7. The turbine rotor of a ship weighs 2000 kg, rotates at 2000 rpm and has a radius of gyration of 30 cm. If the rotation of the rotor is clockwise looking from the aft (rear), determine the gyroscopic couple set by the rotor and state its effect when:

a) The ship rolls at an angular velocity of 0.1 rad/sec; [7 marks]
b) The ship takes a left hand turn at a radius of 300 m at a speed of 30 km/h; and [7 marks]
c) The ship pitches with the bow (front-end) rising at an angular velocity of 1 rad/sec. [6 marks]

Q8. Attached to a uniformly rotating shaft are four discs, A, B, C and D, spaced at equal intervals along the shaft, of mass 7.5 kg, 12.5 kg, 7 kg and 6 kg respectively. The centres of mass of the discs are at 4mm, 3mm, 5mm and 8 mm respectively from the axis of rotation. An additional mass M may be attached to D at an effective radius of 60 mm from the axis of rotation. Find the minimum value of the mass M, and the relative angular positions of the centres of mass of all the masses to ensure complete dynamic balance for the rotating shaft. [19 marks]

END OF ME375 EXAMINATION
Dr A N Ng'andu

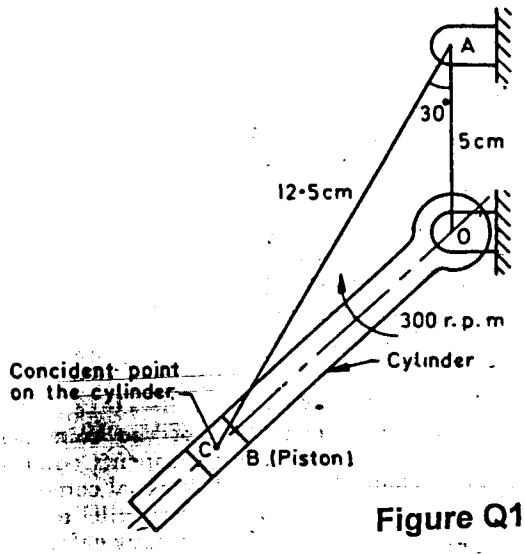


Figure Q1

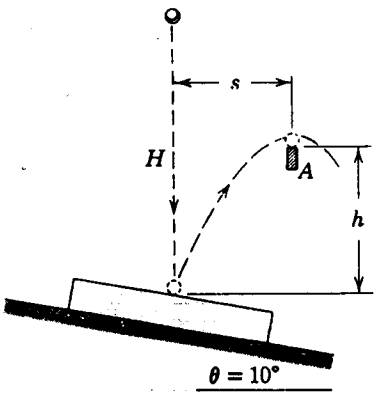


Figure Q2

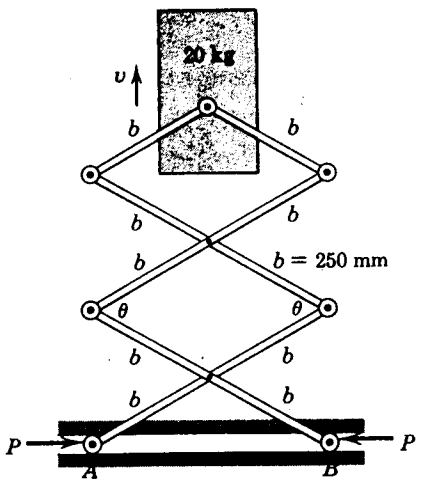


Figure Q3

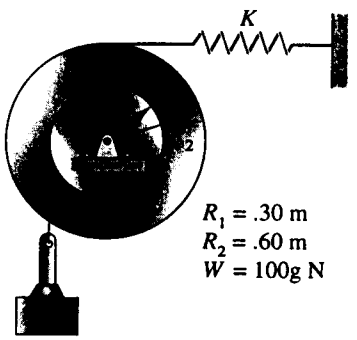


Figure Q4

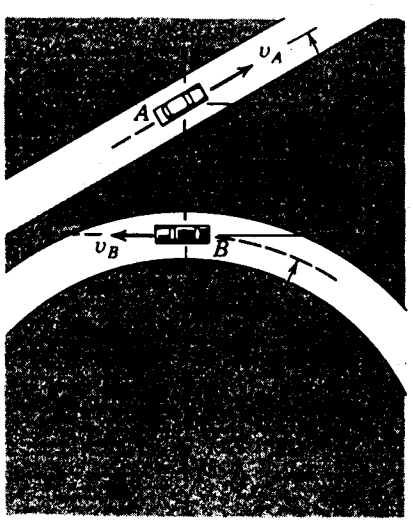


Figure Q5

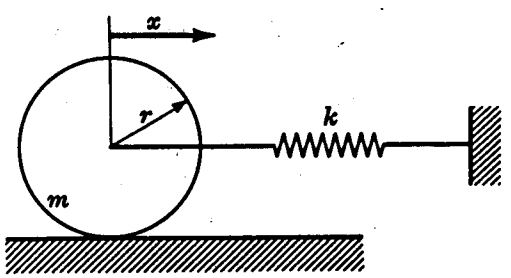


Figure Q6

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

1999/2001 UNIVERSITY SEMESTER II EXAMINATIONS - JULY 2001

ME 375 - DYNAMICS

Time: THREE (3) HOURS — **CLOSED BOOK**

Instructions: **Answer Question 1 AND any FOUR (4) others** (i.e. Five (5) Questions in total)
QUESTION 1 CARRIES 24 MARKS. ALL OTHER QUESTIONS CARRY EQUAL MARKS

Q1. A rotating cylinder mechanism is shown in Figure Q1. OA = 5 cm and AB = 12.5 cm. Determine, for the configuration shown, the acceleration of the piston inside the cylinder if the cylinder rotates at 300 rpm in a clockwise sense. [24 marks]

Q2. To pass inspection, steel balls for ball bearings must clear the fixed bar *A* at the top of their rebound when dropped from rest through the vertical distance *H = 900* mm onto the heavy inclined steel plate (Figure Q2). If balls that have a coefficient of restitution of less than 0.7 with the rebound plate are to be rejected, determine the position of the bar by specifying *h* and *s*. Neglect any friction during impact. [19 marks]

Q3. The vertical motion of the 20-kg block is controlled by the two forces *P* applied to the ends A and B of the linkage where A and B are constrained to move in the horizontal guide (as shown in Figure Q3). If forces P = 1100 N are applied with the linkage initially at rest with $\theta = 60^\circ$, determine the upward velocity *v* of the block as θ approaches 180°. Neglect friction and the mass of the links and note that P is greater than its equilibrium value of $(5W/2)\ cotan\ 30^\circ = 850\ N$. [19 marks]

Q4. A stepped cylinder having a radius of gyration k = 0.40 m and a mass of 200 kg is shown in Figure Q4. The cylinder supports a weight W of mass 100 kg with an inextensible cord and is restrained by a linear spring whose constant K is 2 N/mm. What is the angular acceleration of the stepped cylinder when it has rotated 10° after it is released from a state of rest? The spring is initially unstretched. What are the supporting forces at this time? [19 marks]

Q5. Each of the two cars A and B in Figure Q5 is travelling with a constant speed of 72 km/h. Determine the velocity and acceleration of car A as seen by an observer moving and rotating with car B when the cars are in the positions shown. The x-y axes are attached to car B. [19 marks]

Q6. A circular cylinder of mass *m* and radius *r* is connected by a spring of modulus k as shown in Figure Q6. If it is free to roll on the rough horizontal surface without slipping, find its frequency. J_o is the mass moment of inertia of the cylinder about its centre (i.e. $J_o = \frac{1}{2}mr^2$). [19 marks]

Q7. The turbine rotor of a ship weighs 2000 kg, rotates at 2000 rpm and has a radius of gyration of 30 cm. If the rotation of the rotor is clockwise looking from the aft (rear), determine the gyroscopic couple set by the rotor and state its effect when:

a) The ship rolls at an angular velocity of 0.1 rad/sec; [7 marks]
b) The ship takes a left hand turn at a radius of 300 m at a speed of 30 km/h; and [7 marks]
c) The ship pitches with the bow (front-end) rising at an angular velocity of 1 rad/sec. [6 marks]

Q8. Attached to a uniformly rotating shaft are four discs, A, B, C and D, spaced at equal intervals along the shaft, of mass 7.5 kg, 12.5 kg, 7 kg and 6 kg respectively. The centres of mass of the discs are at 4mm, 3mm, 5mm and 8 mm respectively from the axis of rotation. An additional mass M may be attached to D at an effective radius of 60 mm from the axis of rotation. Find the minimum value of the mass M, and the relative angular positions of the centres of mass of all the masses to ensure complete dynamic balance for the rotating shaft. [19 marks]

END OF ME375 EXAMINATION
Dr A N Ng'andu

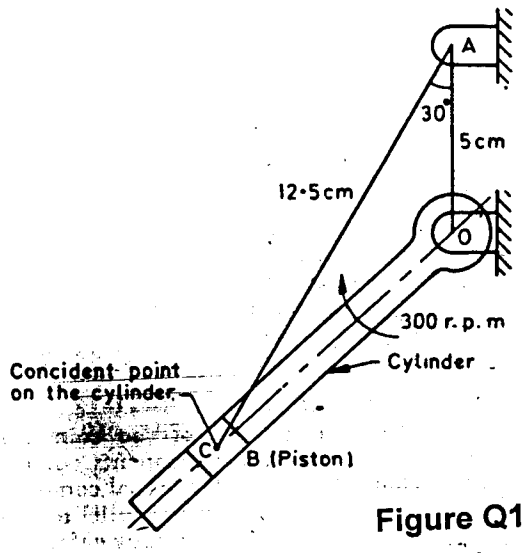


Figure Q1

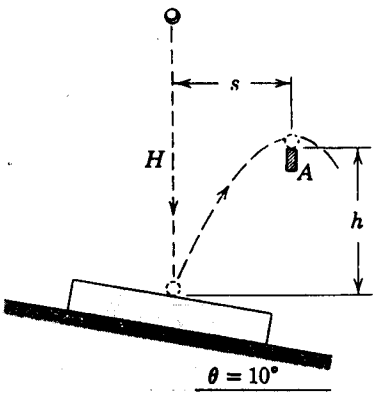


Figure Q2

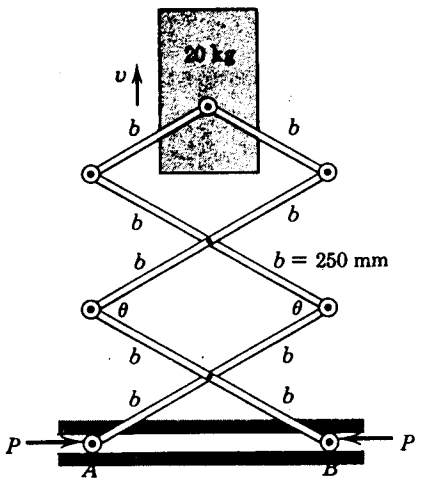


Figure Q3

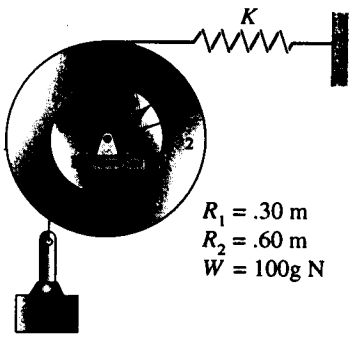


Figure Q4

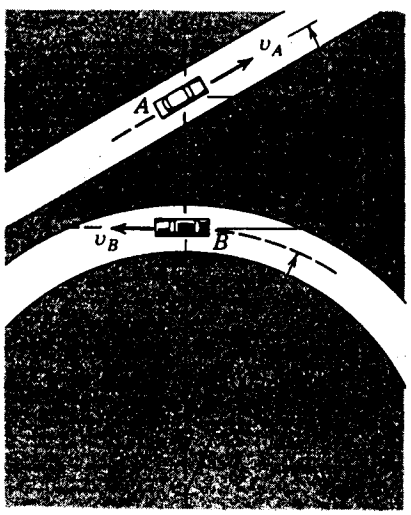


Figure Q5

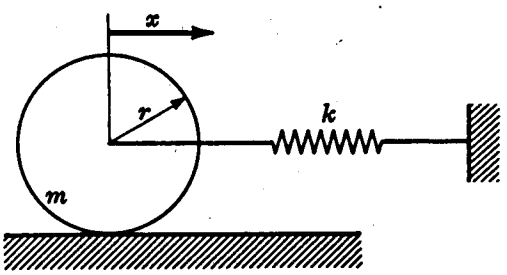


Figure Q6

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

ME – 442 Thermodynamics II and Heat Engines
Final Examination 1999 - 2001, July 2001

Time: Three (3) Hours **Closed Book**

Instructions

Answer Two (2) Questions fromSection A and Three (3) Questions from Section B
Draw sketches and graphs and state all the assumptions where necessary

SECTION A

Question1

1.1 List the three ranges of operation of an SI engine in terms of mixture required for the carburettor performance necessary to fulfil engine requirements and draw the graph for these ranges for a single cylinder engine.

1.2 With the help of a sketch explain the operation of a simple carburettor.

1.3 The fuel jet of a carburettor has an orifice diameter of 1.55 mm, and a coefficient of discharge of 0.94. The venturi has throat diameter of 31.8 mm, and a coefficient of 0.84. On a test at certain load, the venturi depression was observed to be 290 mm of water when a minimum depression of 8.9 mm of water had to be created in order to cause fuel flow.

(a) What is the probable air–fuel ratio delivered by the carburettor if the specific weight of air under the test conditions is known to be 1.1 kg / $m^3$and specific gravity of petrol is 0.72?

(b) If the engine is 4 - cylinder, 4 - stroke cycle with cylinder dimensions of 77.5 x 107.5 mm, with a fuel consumption of 10.9 kg / hr, what is the volumetric efficiency of the engine if the test speed was 3200 r.p.m? For the purpose of volumetric efficiency, assume that the cylinder contents consist of air only.

Question 2

2.2 What are the functional requirements of an injection system? And list the four types of classifications of solid injection system.

2.3 A nozzle is the part of an injector through which liquid fuel is sprayed into the combustion chamber, what are the functions of a nozzle? And list the various types of nozzles.

2.4 Before commencement of the effective stroke the fuel in the pump barrel of a diesel fuel injection pump is 6 cc. The diameter of the fuel line from pump to injector is 2.5 mm and is 600 mm long. The fuel in the injection valve is 2 cc.

(a) To deliver 0.10 cc of fuel at a pressure of 150 bar, how much displacement does the plunger undergoes? Assume a pump inlet pressure of 1 bar.

(b) What is the effective stroke of the plunger if its diameter is 7 mm?

Assume: The Coefficient of compressibility of oil as 75×10^6 per bar at atmospheric pressure.

Question 3

Answer any two (2) parts from each Section (i.e. 3.1 and 3.2): Total four (4) parts

3.1 (a) Discuss the factors affecting the choice of position and number of cylinders in an engine and give the order of proceeding in determination of the number of cylinders and explain why torque stability is important in this process.

(a) What are the requirements for good bearing materials? With the help of a sketch discuss the three engine lubrication regimes in engine bearings and discuss the design of Babbit metal bearings specifying materials so used

(b) Discuss in detail piston and piston ring design of an engine and specify materials used and explain piston allowance for thermal expansion and distortion.

AND

3.2 (a) Mention and explain the functions of the essential organs of a gas turbine unit and explain the difficulties inherent in using it in propulsion of automobiles and discuss its prospects for use in future commercial vehicles. Give examples of Engines using this system.

(b) What principles are applied in catalytic ignition to prevent fuel from coming into contact with the catalyst too early in the cycle? Also what are the prospects of the MCC engine? Give examples of dual chamber engines using this system.

(c) (i) Discuss the advantages and disadvantages of the Stirling engine. Give examples of Engines using this system.

(Question 3(C) Continue)

(ii) What are the merits and demerits of the Wankel engine and what solutions are applied to solve the problem?

SECTION B

Question 4

4.1 In the reciprocating steam engine, "the Carnot cycle has a practical difficulty" while "the toe of the Rankine cycle indicator diagram is cut off". Explain the two statements in full.

4.2 Explain with help of diagrams the two different methods of governing used in a steam engine.

4.3 A steam engine receives steam at 8 kg / cm^2 superheated to 200°C, and the pressure at release being 2.8 kg / cm^2 and at exhaust 1 kg / cm^2. Assuming adiabatic expansion and constant volume conditions between release and commencement of exhaust,

(d) Determine

(i) Work done in kg-m per kg of steam, and
(ii) Efficiency of the unit.

(e) Compare these values with those for Rankine cycle between the same pressure and temperature limits.

Question 5

5.1 What are the factors considered when evaluating the engine performance and what methods are used in determining these engine performance characteristics?

5.2 List and briefly explain the parameters by which performance of an engine is evaluated under

(a) Engine power

(b) Engine efficiencies

5.3 The Fourth year Heat Engines class in the School of Engineering carried out a laboratory test on a gasoline engine working on the Otto cycle in the Thermofluids Lab. The following results were recorded during a one-hour test run.

Cylinder diameter	24 cm
Stroke	48 cm
Torque	770 Nm
Average speed	220 r.p.m.
Average explosions per minute	77
Mean Effective Pressure	7.5 bar
Volume of gas used at 17°C and 770 mmHg	$12m^3$
Lower Calorific Value of gas at NTP	21 MJ / m^3

Inlet temperature of cooling water	25°C
Outlet temperature of cooling water	60°C
Cooling water used	600 kg

(f) Determine

(i) The mechanical efficiency.
(ii) The indicated Specific Gas Consumption in m^3 / kW h.
(iii) The indicated thermal efficiency.

(b) Draw up a heat balance for the engine on per minute basis, explaining why friction power has been included in or omitted from your heat balance.

Assume: The Normal Temperature Pressure conditions are 760 mmHg and 0°C.

(20 marks)

Question 6

A Zambia Flying Doctors aircraft has single jet engine, with a single compressor directly coupled to the turbine. It is mounted in the aircraft with a forward facing intake and rearward facing convergent propelling nozzle. Calculate the total thrust when the aircraft flies at a true airspeed of 274 m/sec at –9°C and 56539 N/m^2 ambient conditions.

Data for the Aircraft

Air mass Flow rate	35.38 Kg/Sec
Compressor Stagnation Compression Ratio	7.5:1
Turbine Inlet Stagnation Temperature	648.8 °C
Combustion Chamber Loss in Stagnation Compression	4%
Stagnation Compression Efficiency	82%
Turbine Inlet Stagnation Efficiency	85 %
Combustion Efficiency	100%
Ram Efficiency	90 %
Nozzle Efficiency	100%
Mechanical Efficiency	100%

Take that: For compression, Cp = 1.005 KJ/KgK and γ=1.4; and for combustion and expansion, Cp = 1.15 KJ/KgK and γ=1.33.

Also assume that the mass flow rate of fuel is smal compared to the mass flow rate of air and that the working fluid throughout has the properties of air at low temperature. Neglect extraneous pressure drops.

(20 marks)

Question 7

A Honda Accord passenger car is fitted with a six cylinder, four stoke engine with a bore of 120 mm and a stroke of 200 mm. During engine trials, the engine was supplied with gasoline of composition C= 82%, and H_2= 18 % by mass. The dry exhaust combustion by volume was CO_2 = 11.2 %, O_2 = 3.6 % and N_2= 85.2 %.

7.1 Determine the mass of air supplied per Kg of gasoline at 17°C and 1 bar that were conditions for the mixture entering the cylinder during the test.

7.2 Determine the volumetric efficiency of the engine based on the intake conditions when the mass of gasoline used is 30 Kg and the engine speed is 1400 rpm. Gasoline is completely evaporated before it enters the cylinder and the effects of its volume on volumetric efficiency should be included.

Assume: that the density of gasoline vapour is 3.4 times that air at the same temperature and pressure. Note that 1 kg or air at 0 °C and 1 bar occupies 0.783 m3 and that air contains 23 % oxygen by mass.

(20 marks)

End of ME 442- Thermodynamics II and Heat Engines Final Examinations, July, 2001.
Prepared by Mr. E. Luwaya and Dr. P. C. Chisale©Dept. of Mech. Engineering, Unza.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS - SEMESTER II: JULY 2001

ME 452 - PROPERTIES OF ENGINEERING MATERIALS II

ANSWER: FIVE QUESTIONS **TIME**: THREE HOURS

ALL QUESTIONS CARRY EQUAL MARKS

Q1. a) Briefly define the group of materials called glasses.

b) Describe in details the following:

i. Glass Formers
ii. Modifiers
iii. Intermediates

Q2. Discuss in detail the following hardening methods.

a) Martensite Strengthening
b) Dynamic Strain aging
c) Dispersion and precipitation hardening

Q3. a) Discuss the different stages of fatigue crack propagation

b) Explain:

i. S-N Curves
ii. Fatigue Limit
iii. Endurance Limit

Q4. Describe the process of material failure called creep, outlining all the various stages that may comprise this process

Q5. a) What is the equicohesive temperature (ECT)?

b) What are:

Persistent Slip Bands

c) What is grain bounding sliding.

Q6. Discuss:

a) The Phenomenon of cyclic softening and cyclic hardening in fatigued metallic materials.

b) Ordered and Disordered solid solutions

END OF EXAMINATION

Dr C K Wamukwamba **July 2001**

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS - SEMESTER II: JULY 2001

ME 452 - PROPERTIES OF ENGINEERING MATERIALS II

ANSWER: FIVE QUESTIONS **TIME**: THREE HOURS

ALL QUESTIONS CARRY EQUAL MARKS

Q1. a) Briefly define the group of materials called glasses.

b) Describe in details the following:

i. Glass Formers
ii. Modifiers
iii. Intermediates

Q2. Discuss in detail the following hardening methods.

a) Martensite Strengthening
b) Dynamic Strain aging
c) Dispersion and precipitation hardening

Q3. a) Discuss the different stages of fatigue crack propagation

b) Explain:

i. S-N Curves
ii. Fatigue Limit
iii. Endurance Limit

Q4. Describe the process of material failure called creep, outlining all the various stages that may comprise this process

Q5. a) What is the equicohesive temperature (ECT)?

b) What are:

Persistent Slip Bands

c) What is grain bounding sliding.

Q6. Discuss:

a) The Phenomenon of cyclic softening and cyclic hardening in fatigued metallic materials.

b) Ordered and Disordered solid solutions

END OF EXAMINATION

Dr C K Wamukwamba **July 2001**

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS
SEMESTER II FINAL EXAMINATIONS 1999/2001
JULY 2001

ME 512 - MANUFACTURING SYSTEMS MANAGEMENT

Time : THREE Hours **CLOSED BOOK**

ANSWER: QUESTION Q1, Q4, AND Q7 IN SECTION A, B, AND C RESPECTIVELY AS COMPULSORY QUESTIONS, AND FURTHER ANSWER ANY 2 QUESTIONS FROM ANY SECTION. ALL QUESTIONS CARRY EQUAL MARKS (20 Marks each).

PLEASE ANSWER QUESTIONS FROM SECTION A, B, AND C IN SEPERATE ANSWER BOOKLETS

SECTION A

Q1. A manufacturer observed the following monthly demand (in thousands of units) for a product during the past twenty-four months. Month 24 is the most recent month for which data are available.

Month	Demand	Month	Demand	Month	Demand	Month	Demand
1	13.8	7	12.3	13	10.9	19	10.5
2	13.5	8	11.8	14	9.2	20	10.1
3	12.7	9	10.8	15	11.6	21	10.3
4	11.8	10	12.7	16	11.2	22	9.1
5	12.5	11	11.5	17	10.7	23	8.5
6	13.6	12	11.3	18	11.4	24	9.2

The company has been forecasting demand a month ahead using a three-period weighted moving average. The weights used are as follows: 0.5, 0.3, 0.2. The first value given is the weight for the most recent data; in other words, older data is receiving less weight in generating the forecasts.

a). Develop the forecasts that the company generated for months 4 through 25. **(3 marks)**

What is the forecast for the 25th month? **(1 mark)**

b). Generate the forecasts that the company would have generated if they had used simple exponential smoothing with a= 0.20 and a month 1 forecast of 15. **(3 marks)**

What is the forecast for the 25th month? **(1 mark)**

c). Report the MAD for the period from month 13 through month 24 for the two forecasting approaches used in parts a and b.
What is the MAD for the forecasting method used in a and b? **(4 marks)**

d). Apply a forecasting method you believe best for this product **(8 marks)**

Q2. Zesco has a department that installs wiring and electrical fixtures in residential construction. The Director has been very concerned with the amount of time it takes to complete wiring jobs. Some of the workers are very unreliable. You are the new Chief Engineer, and have been put in charge of the project. The project has been allocated 16 weeks. A list of activities and their optimistic completion time, the pessimistic completion time, and the most likely completion time are given in the following table.

Activity	a	m	b	Immediate Predecessor(s)
A	1	2	3	*f*
B	2	3	4	*f*
C	1	2	3	A
D	2	4	6	B
E	1	4	7	C
F	1	2	9	C
G	3	4	1	D,E
H	1	2	3	F,G

a) Calculate the expected value and variance of the durations of the activities. **(4marks)**

b) Develop the project network. **(2marks)**

c) Compute the critical path using the expected times **(6marks)**

d) Calculate the expected value and variance of the project duration. **(5marks)**

e) Calculate the probability of project completion by the due date **(3marks)**

Q3. A manufacturing company has just received an order of 800 double reduction speed reducers. As a Production Engineer of the assembly section, you have been issued with design drawings and parts of this speed reducer to be assembled. The following tasks must be performed on the assembly of the speed reducer in the sequence and times specified.

Task	Task Time (seconds)	Tasks that must precede
A	25	*f*
B	20	*f*
C	10	a
D	22	a
E	10	b
F	13	c,d
G	5	e,f
H	18	g

a) Draw the schematic diagram **(3 marks)**

b) Calculate the cycle time **(3 marks)**

c) What is the theoretical minimum number of stations required to meet the production demand of 800 units per eight-hour shift? **(3 marks)**

d) Assign tasks in order of the largest number of following tasks and balance the line in the minimum number of stations to produce 800 units per shift. **(5 marks)**

e) Do the efficiency calculation and evaluate your solution. **(6 marks)**

SECTION B

Q4. You are the proprietor of a computer hardware store, operating in a leap year. The table below lists the stock of spare parts that you consume in your business.

ITEM	UNIT PURCHASE PRICE (K)	ANNUAL CONSUMPTION (UNITS)
Desktop Computers	4,500,000	60
Laser printers	850,000	78
scanners	400,000	23
RAM	80,000	1000
CD ROM drives	300,000	120
Printer Toner	400,000	350
Monitors	1,000,000	30
Notebook computers	8,000,000	25
Colour jet printers	450,000	120
Sound kits	250,000	150
Hard drives	500,000	90
Mouses	35,000	348
Floppy disks	20,000	2500
Playstation I consoles	700,000	200
Playstation II consoles	2,400,000	130

(a) Calculate the average daily turnover of your business. **(2 Marks)**

(b) Construct a cumulative ABC chart and suggest which items should be treated as Classes A, B, and C **(8 Marks)**

Focusing on the RAM, it has been shown that:

- The ordering cost = K100,000 / replenishment order
- The stock holding cost = K45,500 / item per year
- The average replenishment lead time = 21 days
- The standard deviation of replenishment lead time = 10 days
- The service level required = 70%
- Assume constant demand

Determine:

(c) The re-order quantity **(2 Marks)**

(d) The re-order level **(4 Marks)**

(e) The change in the annual stock holding cost if the service level is raised to 95% **(4 Marks)**

Q5. (a) List the main objectives of capacity planning. **(2 Marks)**

(b) Describe the strategic planning route for the implementation of Integrated Manufacture, further, mention at each stage, 3 factors influencing the output of that stage. **(8 Marks)**

(c) List the rules of Optimised production technology. **(6 Marks)**

(d) Diagrammatically show the inputs and outputs of a basic MRP system. **(2 Marks)**

(e) Define the principle of the pull method of control. **(2 Marks)**

Q6. You are the proprietor of a car body repair shop. The table below lists the jobs that you have been contracted to do.

Customer (In order of arrival)	**JOB DURATION (days)**	**DUE DATE (DAY)**
Mr. Banda	7	12
Mrs. Hatontola	3	5
Mr. Wright	12	14
Mr. Lukama	2	4
Mrs. Mukelabai	6	16
Mr. Chansa	8	17
Mrs. Patel	8	13
Mrs. Pietersie	6	12

Calculate the total flow time, mean flow time and the average job lateness applying the following priority rules:

(a) First come first serve. **(4 Marks)**

(b) Shortest operating time. **(4 Marks)**

(c) Earliest due date. **(4 Marks)**

Further, you split the jobs into two operations, firstly panel beating then spray painting as show in the table below.

Customer (In order of arrival)	PANEL BEATING (days)	SPRAY PAINTING (days)	DUE DATE (DAY)
Mr. Banda	5	2	12
Mrs. Hatontola	0	3	5
Mr. Wright	8	4	14
Mr. Lukama	2	0	4
Mrs. Mukelabai	2	4	16
Mr. Chansa	3	5	17
Mrs. Patel	5	3	13
Mrs. Pietersie	3	3	12

Applying Johnson's rule, determine:

(d) The total flow time, mean flow time, the average job lateness, utilisation % of the operations. **(6 Marks)**

(e) Compare results from (a) to (d) and list these rules from the best applied downwards in this situation. **(2 Marks)**

SECTION C

Q7. The design specification for a critical diameter of a product to be turned on a high lathe is given as Dia. 25 ± 0.40 mm. Statistical Process Control method is used to ensure the process produces the critical diameter to the desired quality standard.

The quality control method involves random sampling at intervals from the production line, with results of measured sample diameters as indicated in Table Q7(a).

Table Q7 (a).

SAMPLE NO. →	1	2	3	4	5	6
COMPONENT DIAMETERS PER SAMPLE. (mm)	25.01	25.10	25.10	24.94	25.59	25.60
	24.98	25.04	25.01	25.19	25.70	25.58
	24.99	24.98	24.99	25.03	25.75	25.97
	25.01	24.95	24.96	24.96	25.87	25.95
	24.97	25.09	24.91	24.98	25.97	25.99

Determine :

(a) Relative Precision Index (RPI); (8 marks)
(b) Control limits for means chart; (4 marks)
(c) Control limits for range chart; (2 marks)
(d) Plot means chart only and comment on results. (6 marks)

Table Q7(b) gives Statistical Process Control constants to be used.

Table Q7(b)

NUMBER IN SAMPLE n	MEANS Inner $A'_{0.025}$	MEANS Outer $A'_{0.001}$	RANGE Upper $D'_{0.999}$	RANGE Upper $D'_{0.975}$
2	1.229	1.937	4.12	2.81
3	0.668	1.054	2.99	2.17
4	0.476	0.750	2.58	1.99
5	0.377	0.594	2.36	1.81
6	0.316	0.498	2.22	1.72

Q8. (a) Give a definition of a single acceptance sampling plan as used in Statistical Quality Control. Show how a single sampling plan can be designed.

Define Average Outgoing Quality Limit and give a sketch to illustrate your definition.

(10 marks)

(b) A single sampling plan is operated from information as follows:

A sample size of 65 must be inspected to determine whether the incoming batch should be accepted or not. The batch should be accepted if the sample has 2 or less defective items and be rejected if the defectives amount to more than 2.

Give a sketch of the Operating Characteristic curve up to 8% defectives in the batch. Using the Poisson probability formula given below

$$P(m) = \bar{m}^{m} \; e^{-\bar{m}} / m !$$

Calculate the producer's risk of having batches containing 1% defectives rejected.

Calculate the consumer's risk of having batches containing 6% defectives accepted.

(10 marks)

Q9. Discuss the general framework of costs associated with engineering production. Clearly show how profitability may be factored into the framework of such costs.

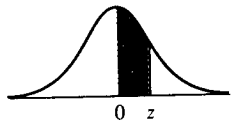
(20 marks)

END OF EXAMINATION

(ENSURE EACH SECTION IS ANSWERED IN SEPARATE ANSWER SHEETS)

Appendix

Areas of the Standard Normal Distribution



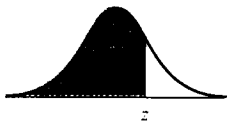
An entry in the table is the proportion under the entire curve which is between $z = 0$ and a positive value of z. Areas for negative values of z are obtained by symmetry.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990

Source: Paul G. Hoel, *Elementary Stastistics* (New York: John Wiley & Sons, 1960), p. 240.

Appendix

Areas of the Cumulative Standard Normal Distribution



An entry in the table is the proportion under the curve cumulated from the negative tail.

z	$G(z)$	z	$G(z)$	z	$G(z)$
−4.00	0.00003	−1.30	0.09680	1.40	0.91924
−3.95	0.00004	−1.25	0.10565	1.45	0.92647
−3.90	0.00005	−1.20	0.11507	1.50	0.93319
−3.85	0.00006	−1.15	0.12507	1.55	0.93943
−3.80	0.00007	−1.10	0.13567	1.60	0.94520
−3.75	0.00009	−1.05	0.14686	1.65	0.95053
−3.70	0.00011	−1.00	0.15866	1.70	0.95543
−3.65	0.00013	−0.95	0.17106	1.75	0.95994
−3.60	0.00016	−0.90	0.18406	1.80	0.96407
−3.55	0.00019	−0.85	0.19766	1.85	0.96784
−3.50	0.00023	−0.80	0.21186	1.90	0.97128
−3.45	0.00028	−0.75	0.22663	1.95	0.97441
−3.40	0.00034	−0.70	0.24196	2.00	0.97725
−3.35	0.00040	−0.65	0.25785	2.05	0.97982
−3.30	0.00048	−0.60	0.27425	2.10	0.98214
−3.25	0.00058	−0.55	0.29116	2.15	0.98422
−3.20	0.00069	−0.50	0.30854	2.20	0.98610
−3.15	0.00082	−0.45	0.32636	2.25	0.98778
−3.10	0.00097	−0.40	0.34458	2.30	0.98928
−3.05	0.00114	−0.35	0.36317	2.35	0.99061
−3.00	0.00135	−0.30	0.38209	2.40	0.99180
−2.95	0.00159	−0.25	0.40129	2.45	0.99286
−2.90	0.00187	−0.20	0.42074	2.50	0.99379
−2.85	0.00219	−0.15	0.44038	2.55	0.99461
−2.80	0.00256	−0.10	0.46017	2.60	0.99534
−2.75	0.00298	−0.05	0.48006	2.65	0.99598
−2.70	0.00347	0.00	0.50000	2.70	0.99653
−2.65	0.00402	0.05	0.51994	2.75	0.99702
−2.60	0.00466	0.10	0.53983	2.80	0.99744
−2.55	0.00539	0.15	0.55962	2.85	0.99781
−2.50	0.00621	0.20	0.57926	2.90	0.99813
−2.45	0.00714	0.25	0.59871	2.95	0.99841
−2.40	0.00820	0.30	0.61791	3.00	0.99865
−2.35	0.00939	0.35	0.63683	3.05	0.99886
−2.30	0.01072	0.40	0.65542	3.10	0.99903
−2.25	0.01222	0.45	0.67364	3.15	0.99918
−2.20	0.01390	0.50	0.69146	3.20	0.99931
−2.15	0.01578	0.55	0.70884	3.25	0.99942
−2.10	0.01786	0.60	0.72575	3.30	0.99952
−2.05	0.02018	0.65	0.74215	3.35	0.99960
−2.00	0.02275	0.70	0.75804	3.40	0.99966
−1.95	0.02559	0.75	0.77337	3.45	0.99972
−1.90	0.02872	0.80	0.78814	3.50	0.99977
−1.85	0.03216	0.85	0.80234	3.55	0.99981
−1.80	0.03593	0.90	0.81594	3.60	0.99984
−1.75	0.04006	0.95	0.82894	3.65	0.99987
−1.70	0.04457	1.00	0.84134	3.70	0.99989
−1.65	0.04947	1.05	0.85314	3.75	0.99991
−1.60	0.05480	1.10	0.86433	3.80	0.99993
−1.55	0.06057	1.15	0.87493	3.85	0.99994
−1.50	0.06681	1.20	0.88493	3.90	0.99995
−1.45	0.07353	1.25	0.89435	3.95	0.99996
−1.40	0.08076	1.30	0.90320	4.00	0.99997
−1.35	0.08851	1.35	0.91149		

Source: Bernard Ostle, *Statistics in Research*, 2d ed. (Ames: Iowa State University Press, 1967).

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

ME 585 - AUTOMOBILE ENGINEERING
SEMESTER II FINAL EXAMINATION - 25TH JULY 2001

INSTRUCTIONS:

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

The paper contains two sections:

Section A - Answer Three Questions only, including Question 1.
Section B - Answer Three Questions only

Draw Sketches, graphs, and state all assumptions where necessary

SECTION A
ANSWER THREE QUESTIONS ONLY

Q1. In an effort to diversify the income generating ventures, SEM INVESTMENTS LIMITED is contemplating purchasing five 20-ton trucks that operate using Compression Ignition at K 200 million each. The engine has a design life of 400, 000km with an average fuel consumption of 5km/litre. Some of the existing vehicle related costs in Zambia include:

Fuel:	Petrol	K 3, 210 per litre
	Diesel	K 3, 100 per litre
Engine oil		K 6, 000 per litre
Labour costs		K 30, 000 per hour
Cost of tyres		K 800, 000 per tyre
Insurance		5% of initial cost per year
Salaries of the driver and helper, respectively		K 200, 000 and K 120, 000

It is expected that each truck will be covering 100, 000 km per annum, with a vehicle service being done at intervals of 5000km. As the company's Assistant Technical Manager,

(a) State the factors that can affect the service life of the vehicles.
(b) Estimate the annual running cost of salaries, fuel, lubrication, repair and maintenance, tyres, depreciation and insurance (C_{sal}, C_f, C_{lub}, $C_{r\&m}$, C_{tyr}, C_d and C_{ins}, respectively) per truck.
(c) Hence estimate the annual transportation cost, S, and the annual operation cost per kilometre, S_{op}.
(d) Determine the annual operation cost per kilometre per tonne, $S_{op\text{-}ton}$, and hence deduce the cost (to the nearest K 1, 000) per tonne to transport 18 tonnes of fresh Kapenta from Siavonga to Lusaka, a distance of 200km, assuming a profit margin of 30%. Advise management if the company would compete favourably knowing that other transporters charge K 25, 0000 per tonne for the same route.
(e) What is the expected annual profit from this venture, assuming that there are no other extra costs since the operations of this business would be absorbed within the existing company structure.

The following assumptions can be made:

Life of tyres	50 000km
Number of wheels on the truck (which also has one spare wheel)	6
Number of man-hours per service	8 hours
Number of man-hours per repair	2 hours per 1000km
Cost of vehicle spares	10% of initial investment per annum
Engine oil sump size	8 litres

[23 marks]

Q2. A Mitsubishi Pajero belonging to the Ministry of Agriculture, Food and Fisheries weighs 1520kg has a track of 2.3m and a maximum height of 3.2m. The engine develops a maximum effective power of 80kW at a speed of 4000rpm. A driver of mass 80kg is driving to Siavonga on a fact-finding mission regarding the fisheries development of Lake Kariba.

At one moment, the vehicle is moving behind a South African haulage truck, travelling at the same speed as the truck. During this period, the Patrol develops an engine torque of 221.5Nm in direct drive at a partial speed of 3200rpm. The following additional information is available:

4th gear ratio	= direct
Differential gear ratio	= 4.1
Wheel diameter	= 0.66m
Transmission efficiency	= 90%
Streamlining factor	= $0.54Ns^2/m^2$
Gradient	= 3^o 20'
Rolling resistance coefficient at low speeds	= 0.02

(a) Determine the acceleration of the Pajero at maximum power assuming that the coefficient accounting for rotating masses is 1.05
(b) If the driver of the vehicle decides to overtake at maximum power speed, determine the time and distance for safe overtaking if there is no on-coming vehicle.
(c) If the Pajero were to carry a full load of 230kg and the engine develops maximum power whilst maintaining the same acceleration as obtained in part (a), determine the speed at which it would overtake the truck if the given engine speed is ignored. Comment on your answer
(d) Noting that there is a stationary broken down vehicle 300m away on the on coming vehicles lane, comment on the safely of overtaking taking into account the distance required for overtaking.

[21 marks]

Q3. Simbai Construction Company (SCC) owns 5 vehicles with overall dimensions given as: 1.8m track width and 2.3m height, for transporting crushed stones from a quarry 30km away from the construction site. The engine has a mechanical efficiency and indicated specific fuel consumption of 0.8 and 437.5g/kWh respectively. If the engine develops a maximum power of 160kW at 2400rpm and the fuel has a density of 0.75kg/m3, determine:

(a) Give the basic expression for the running fuel consumption of a vehicle. Explain each term.
(b) The running fuel consumption at maximum vehicle load at the maximum power speed in direct drive for each vehicle.
(c) The monthly (30day) fuel bill for the fleet if the loading, unloading and idling time is taken as 30 minutes per cycle. The vehicles have a 10hr work shift per day and the cost of diesel is K3, 180.00 per litre. Assume that the fuel consumption is constant throughout each cycle.
(d) How the monthly fuel bill is affected if it is assumed that the fuel consumption during the loading, unloading and idling periods of the cycle accounts for 30% of the total. Comment on your answer.
(e) How the monthly bill is affected if the loading and idling time is reduced by 10 minute and assuming a constant fuel consumption throughout each cycle. Is this reduction profitable to SCC in any way?

[21 marks]

Q4. LaMara Haulage Company is contemplating buying vehicles for hauling maize on asphalt roads which have an average grip coefficient of 0.8. As the firm's automotive expert, you are required to advise the purchasing office on what type of motor vehicle to buy from a short list of two. One of the roads on which the vehicles are to operate has a particularly dangerous corner with an arc radius of 60m. The following vehicle details are available:

	Vehicle 1	Vehicle 2
Wheel radius	0.5 m	0.55 m
Distance from C.G. to the front axle	2.3 m	2.5 m
Distance from C.G. to the rear axle	2.1 m	2.2 m
Height of C.G.	0.7 m	0.9 m
Coefficient of Rolling Resistance	0.03	0.03
Track width	1.6 m	1.8 m

a) State four factors which can influence the stability of the vehicles.
b) If your choice is solely dependent on the critical speeds for toppling, skidding and steerability, and the hill-side critical angle for toppling and skidding, and also bearing in mind that the maize-hauling exercise has to be completed within a limited period, which of the two vehicles would you recommend and why?
c) What is the maximum speed you would recommend for the drivers to use for the chosen vehicle as they go round the dangerous corner and why?
d) If one of the vehicles you have chosen is involved in an accident during operation, determine the speed at which the vehicle was travelling prior to the accident if it is ascertained that the time during which skidding occurred was 0.2 seconds and that in trying to avoid the accident, the driver sharply turned the steerable wheels (angular velocity = 0.2 rad/sec)

[21 marks]

SECTION B
ANSWER THREE QUESTIONS ONLY

Q5. (a) Discuss the tractive force according to conditions of the grip between the tyre and the road.
(b) Outline the factors affecting the grip coefficient and state the conditions for driving?
(c) Briefly describe how you would experimentally determine the grip coefficient of a given road.

[15 marks]

Q6. (a) What are the requirements for good handling of a motor vehicle?
(b) Give a brief description of each requirement in (a), but discuss stability in greater detail, carefully outlining the lateral stability characteristics.
(c) Briefly state the methods of measurement of lateral stability characteristics related to toppling.
(d) Describe the equations for determining the critical speed and hill-side angle under skidding.

[15 marks]

Q7. (a) What are the two basic functions of a motor vehicle suspension system?
(b) Differentiate between the sprung and unsprung masses.
(c) State the two main categories of suspension systems. Under each appropriate category, discuss the double wishbone, MacPherson strut and beam axle.

[15 marks]

Q8. (a) What is vehicle braking?
(b) Describe the three ways by which braking can be achieved.
(c) Differentiate between service (ordinary) and full (emergency) braking. Assume that no anti-lock braking system (ABS) is used. Also state why an ABS is necessary as observed in modern vehicles.
(d) State the main objectives of technical examination of traffic accidents. Also give the parameters required to satisfy the requirements.
(e) In a case where a pedestrian is knocked down, and the driver applied full braking, state the conditions related to time for timely and untimely braking.

[15 Marks]

END OF SEMESTER II FINAL EXAMINATION - ME 585

University of Zambia
University Examinations- July 2001
SE 332
Photogrammetry I

Time: Three (3) hours
Answer **ALL** questions from section A and only **ONE** from section B

.....

SECTION A

Question 1

a) Define the following photographic terms:
   - Scale of photograph
   - Photosensitivity
   - F-number
   - Dead area
   - Flying height

b) What are the main technical requirements for planning of aerial photographs?

c) Using a camera with 150 mm focal length and 230 square millimeters format and assuming that the average photobase is 69 mm, the distance between successive strips is 161 mm and photo scale 1: 30 000, calculate the following parameters;

   - End and side overlap of photographs
   - Size of overlapped area at photo scale and in terrain
   - Air base
   - Flying height

(10 + 5 + 10)

Question 2

a) Using a clearly labeled diagram, describe the functions of the main parts of an aerial camera.

b) Discuss the importance of camera calibration and indicate what information relating to the camera forms part of the calibration certificate.

c) What are the major steps involved in processing of black and white film?

(8 + 9 + 8)

Question 3

a) A shutter speed of 1/1000 is desired to obtain a sharp image at f/4.0, what f/number should be used to achieve the same result at a shutter speed of 1/500?

b) With the help of well-labeled diagrams, describe the five (5) major lens aberrations that affect image quality.

c) Explain the main differences between perspective and orthogonal projections.

(8 + 10 + 7)

SECTION B

Question 1

a) Explain the following terms;
- Stereoscopic depth perception
- Stereoscopic model
- Floating mark
- X- parallax

b) The length of line AB and the elevation of its endpoints, A and B, are to be determined from a stereopair containing images a and b. The camera used to take the photographs has a 154.4-mm lens. The flying height was 1200 m (average for two photos) and the air base was 600 m. The measured photographic coordinates of points A and B in the "flight line" coordinate system are x(a) = 54.61 mm, x(b) = 98.67 mm, y(a) = 50.80 mm, y(b) = -25.40 mm, x'(a) = -59.45 mm, and x'(b) = -27.39 mm. Find the length of line AB and the elevations of A and B.

(8 + 17)

Question 2

a) Name the seven basic characteristics of photographic images that are considered in photographic interpretation and give an example of how each may be used to identify a particular object.
b) Derive the parallax equation for determination of a point elevation from x-parallax measured on a pair of vertical photographs.
c) Show with figure and equation how an image point is displaced due to relief of terrain.
d) Compare the advantages and disadvantages of the pocket and mirror stereoscopes

(7 + 7 + 7 + 4)

School of Engineering
Department of Surveying

COURSE SE352: LAND LAW, CADASTRE AND SURVEY REGULATIONS

Time: 3.00hrs
Answer any four (4) with at least one (1) question from each section. Use a separate answer booklet for each section.

Section A

1. Compare and contrast a joint tenancy and a tenancy in common.
2. Discuss the purpose and use of the following
   i. Lands and Deeds Registry Act.
   ii. Lands and Acquisition Act.
   iii. Town and Country Planning Act.
   iv. Land Survey Act.
3. What two types of Land tenure exist in Zambia? Explain how the two concepts are similar or differ with respect to the concept of ownership.
4. Name three types of documents that are used in Land Conveyance. Discuss their nature and their use.

Section B

5. Discuss the Cadastre and its contents, and explain its roles in land dealings.

6. Discuss the following terms in cadastral surveying (bearing in mind the meaning, use, contents, occurrence, etc):

   (a) Site plan

   (b) Working plan

   (c) General plan

   (d) Indicatory beacon

   (e) Curvilinear boundary

   (f) Diagram

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF SURVEYING
SE412 NUMERICAL METHODS AND PROGRAMMING FOR SURVEYORS
FINAL UNIVERSITY EXAMINATIONS 2000/2001
SECOND SEMESTER, JULY 2001

Instructions: Answer Question 1 and any other three (3) questions
Total: 100 points
Duration: Three Hours

Question 1 (2+2+2+15+4)

a) A Mr. Hybrid Bwalya is a commercial farmer in the Mukushi farming block who contracted some men to dig some ditches around his farm. He wants to know the volume of the water the ditches will be able carry. He therefore decided to contact Mr. Analyst Musonda who wrote a computer program to compute the volume of the ditches using the trapezoidal rule for volumes. He used Turbo Pascal.

If the formula for the trapezoidal rule for the volumes is

$$V = L(\frac{A_1 + A_n}{2} + \sum_{i=2}^{n-1} A_i);$$

Assume that the sectional areas $A_1,...A_n$ are already computed.

(Assume that the type vector has already been declared).

```
type vector=array[1..10]of real;
```

Write down the program Mr. Analyst Musonda wrote. Ensure that the program should be able to:

i) ask for the total number of all cross sectional areas, n,
ii) ask for the total length, L between the first and the last sectional areas,
iii) ask for the values of the sectional areas $A_1..A_n$, and
iv) compute and write the volume to an output file "VOLUME.OUT"

Complete the solution

```
Program Volume_Computation;
{local variables declared here}
begin
{program body}
end.{end program}
```

b) Mention the four rules that govern the choice of identifiers in Turbo Pascal.

Question 2(3+12+2+2+6)

i) Define an orthogonal matrix
ii) State the main characteristics of an orthogonal matrix
iii) What are orthogonal matrices used for?
iv) What is the difference between a rotation and a reflection ?
v) Define the following terms; symmetric matrix, square matrix, singular matrix.

Question 3 (6+7+2+2+8)

a) Find the solution to 6 digits accuracy by Newton's method, starting from the given x_0: $\cot x = \sin x$, $x_0 = 1$. Carry out only three iterations.

b) State the properties of an inner product.

c) If A is a symmetric matrix, what is the relation between
   (i) $\|A\|_1$ *and* $\|A\|_\infty$
   (ii) the eigenvalues of **A** and $\|A\|_2$
   (iii) What is cond$_2$(**A**) if $A = \begin{bmatrix} 2 & 1 \\ 1 & 1 \end{bmatrix}$.

Question 4(8+4+13)

a) Define the following terms as used in numerical methods
   (i) relative error
   (ii) error bound
   (iii) loss of significance
   (iv) overflow

b) What is interpolation, and its classical application? Mention any two types of interpolation techniques.

c) Solve the system $Ax = b$, *where* $A = \begin{bmatrix} 7 & 3 \\ 3 & 5 \end{bmatrix}$ *and* $b = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

An approximate inverse of **A** is $A^{-1} = \begin{bmatrix} 0.19 & -0.12 \\ -0.12 & 0.27 \end{bmatrix}$ which gives the following approximate solution $\hat{x} = \hat{A}^{-1}b = (-0.05 \quad 0.42)^t$. Use an iterative improvement method (one iteration only) to calculate a better approximation to the solution.

Question 5(5+5+5+10)

a) What is the inverse of a lower triangular matrix? For definiteness sake take **L** to have dimension 3X3.

b) What is meant by the term "rank deficient" matrix?

c) What is the result of multiplying a matrix **A** with a diagonal matrix **D**,
(i) **DA** and (ii) **AD**?

d) Carry out the first step of QR factorisation with pivoting for the matrix **A** where;

$$A = \begin{bmatrix} 1 & 5 & 8 \\ 2 & 2 & 1 \\ -1 & 3 & 0 \\ 0 & -6 & 2 \end{bmatrix}$$

End of Examination Questions
Good Luck!

M. Phiri
F07

University of Zambia
School of Engineering
Department of Surveying
University Examinations
July/August 2001

SE531-Photogrammetry III

Instructions: Section A: **3** Compulsory Questions
Section B: Attempt **2** out of 3 questions
Duration: 3 hours

Section A

Question 1

a. Data acquired by photogrammetric means is an important input to the digital mapping process. Apart from cost reduction give and explain three reasons for mapping organisations to adopt digital mapping techniques. **14**

b. Another declared objective for adopting digital mapping systems is the reduction in the cost of map and plan production. Discuss the extent to which this objective has been realised. **6**

Question 2

a. 'Computer supported' stereo-plotters represent the most basic form of automation in photogrammetric instruments. Name three other components that can be added to an analogue stereo plotters as a result of this computer support. Briefly describe the function of each. **(3+ 6)**

b. What is the major difference between analogue and analytical plotters? Give three advantages of the analytical plotter over its analogue counterpart. **(3+6)**

c. Despite having a computer and other components found in digital systems, some people would like to refer to the **SD2000** as a semi-automated system. Why? **2**

Question 3

a. What is a Digital Photogrammetric System? **2**
b. Describe three main sources of data used as input to a DPS. **6**
c. What are the major components of a Digital Photogrammetric Workstation. **3**
d. Name the three basic types of software found in a DPW. Explain the use of each type of software giving examples. **6**
e. What types of output can be obtained from a DPS? Give examples of each. **3**

Section B: Only 2 questions to be attempted

Question 4

a. Explain the special features of x-ray photography and their implications on accuracy? **5**

b. Architectural photogrammetric recordings can be presented in three forms. Describe the three forms stating the applications to which each form is the suited. **9**

OR

Photogrammetric surveys of architectural structures can be grouped into three major categories. Name and describe the these categories.**9**

c. Explain one application of close range photogrammetry in the field of mechanical and manufacturing engineering. **6**

Question 5 (20marks)

a. List three engineering applications and three general mapping applications of large scale photogrammetry

b. What is the advantage of photogrammetric large scale maps (orthophotographs) as compared to conventional line maps?

c. Mention four features, data sets or information that are contained on large scale maps

Question 6[5+6+9]

a. Describe what map revision is and how it differs from original or new mapping.

b. List any three (3) factors that affect map revision and briefly explain their effect on map revision.

c. Among other methods of map revision is the orthophoto method.
   (i) Describe this method in detail.
   (ii) Which are the other three methods of map revision?

The University of Zambia

School of Engineering

2nd Semester Final Examinations – July 2001

SE 562: Land Resources Planning

Instructions:

Time: Three Hours

Answer Five (5) question in total. Two (2) questions from Section A and Three (3) questions from Section B.

PLEASE, ANSWER SECTION A AND SECTION B ON SEPARATE ANSWER BOOKLETS!!!

Section A: Answer question One (1) and ONE other question from this section

Question One (4+16)

a) Explain the "Planning theory"

b) Ideally, the planning process is said to be cyclic. Illustrate, figuratively, how the cycle goes.

Question Two (8+12)

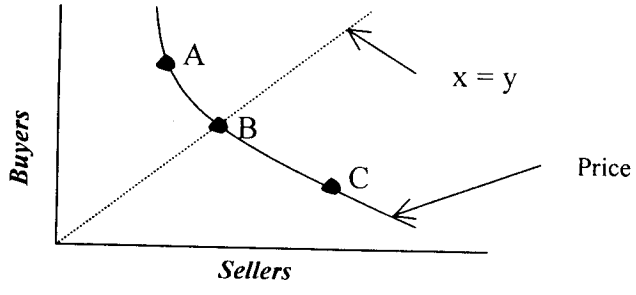
a) Torren's System is a land registration system of title to land introduced in South Australia in about 1858. How does this system differ from the English and the Zambian system?

b) Give an outline of a specified procedure for conveyancing state land.

Question Three (4+16)

a) Why should land be valued?

b) Define the value of an article in relation to the price and explain what happens to the value of a land parcel at point A, B and C in the figure below.



Section B: Answer all questions from this section

Question Four (20)

(a) Mention the overall aim of Landuse Planning
(b) Briefly outline three reasons why we conduct Landuse Planning

Question Five (20)

(a) Mention two conditions for successful Landuse Planning

(b) How is Town Planning different from other type of planning such as regional and economic planning?

(c) What is the main purpose of Zoning in Town Planning

Question Six (20)

(a) Mention and briefly describe each of the three main Environmental and Economic categories of resources

(b) What are the major Environmental Impact inducing agents?

(c) In relation to (b), mention describe in detail two major environmental impact receptors

End of Examination

Good luck and enjoy your vacation.