THE UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAM PAPER 2001/2002
SCHOOL OF ENGINEERING

1. CE 369	-	Fluid mechanics 1
2. CE 452	-	Environmental Engineering I
3. CE 532	-	Structural Steel Design
4. EA 242	-	Soil and Water Conservation Engineering
5. EA 332	-	Agricultural Engineering
6. EA 452	-	Post harvest Technology
7. EA 512	-	Agricultural Engineering Design
8. EE 342	-	Electrical Engineering I
9. EE 392	-	Electrical Engineering Practice
10. EE 442	-	Electrical and Electronic Engineering
11. EE 452	-	Electrical Power System
12. EE 462	-	Electrical Instrumentation
13. EE 532	-	Power Electronics
14. EE 552	-	Electrical Power Systems II
15. EE 562	-	Systems and Control Engineering II
16. EE 572	-	Telecommunications Systems
17. EG 269	-	Information Technology
18. EG 475	-	Engineering Management and Society I
19. EG 575	-	Engineering, MGT. And Society II
20. EM 212	-	Engineering Mathematics II
21. ME 202/ME 302	-	Engineering Drawing II
22. ME 209	-	Engineering Drawing I
23. ME 232	-	Properties of Engineering Materials
24. ME 375	-	Dynamics
25. ME 415	-	Production Technology I
26. ME 442	-	Thermodynamics II and Heat Engines
27. ME 461	-	Fluid Mechanics II
28. ME 545	-	Alternative Energy Sources
29. ME 585	-	Automobile Engineering
30. ME 595	-	Maintenance Engineering
31. SE 212	-	Surveying
32. SE 215	-	Introduction to Computing for Geomatics
33. SE 332	-	Photogrammetry I
34. SE 412	-	Numerical Methods and programming for Surveyors
35. SE 562	-	Land Resources Planning

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

SECOND SEMESTER FINAL EXAMINATION
OCTOBER/NOVEMBER 2002

AE 512 – AGRICULTURAL ENGINEERING DESIGN

TIME ALLOWED: THREE (3) HOURS

OPEN BOOK:

INSTRUCTIONS

1. ***Attempt ALL the three (3) questions.***
2. ***Indicate your computer number on ALL your answer sheets.***
3. ***Question 1 has 50 Marks, Questions 2 and 3 have 25 marks each.***
4. ***Marks will be awarded for correct engineering solution, correct methodology, accuracy, neatness and good outline.***

Q1. You are the **Design and Production Engineer** for a new Company to be involved in the production of agricultural lime for small-scale farmers. The production facility is to be portable (total weight of about 50kg) and to be used in limestone-deposit areas scattered around Mkushi district. Most of these areas are not served with Hydro-Electric Power. It is therefore decided to design and produce the facility on the concept of hammermills (without need for pulleys and belts), driven by a 12Hp petrol engine (weighing 15kg). The proposed output is 50kg per hour of agricultural lime. The average particle size of agricultural lime should be 1.0 mm, while the input particle size should be 20 mm. The lime is to be sold at K5,000 for 25 kg.

a) Give specifications of the machine and outline in details how you would carryout the design using the process of methodical design. For each of the components give reason for choice of material. **[20]**

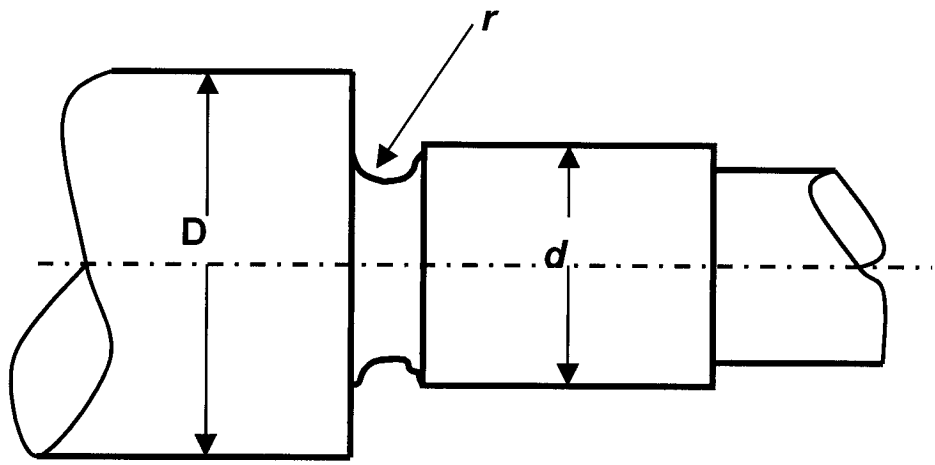
b) Sketch a **NEATLY** labelled cross-section assembly of final design. **[15]**

c) Outline the fixed and variable costs you would consider to arrive at the selling cost of K5,000 per 25 kg of lime. **[15]**

Q2. The section of shaft shown in the figure is to be designed to approximate relative size of $d = 0.75D$ and $r = D/20$, with the diameter d conforming to that of standard metric rolling-bearing bore size. It is to be made of an SAE 2340 steel, heat-treated to obtain minimum tensile strengths in the shoulder are $S_u = 1226\ MPa$ and $S_y = 1130\ MPa$ with a Brinell hardness not less than 368. At the shoulder, the shaft is subjected to a completely reversed bending moment of 70 N.m accompanied by a steady torsion of 45 N.m.

a) Use a design factor of 2.5 and size the shaft for an infinite life. The result should be based on the maximum-shear-stress theory and modified Goodman line for fatigue. **[15]**

b) Using the SKF catalog, select the appropriate rolling-bearing for diameter ***d***. **[10].**



Q3. A single-threaded 25-mm power screw is 25mm in diameter with a pitch of 5mm. A vertical load on the screw reaches a maximum of 6 kN. The coefficient of friction are 0.05 for the collar and 0.08 for the threads. The frictional diameter of the collar is 40mm.

Determine:

a) The overall efficiency of the power screw. **[10]**

b) The torque to 'raise' the load. **[8]**

c) The torque to 'lower' the load. **[7]**

END OF EXAM

The University of Zambia
Department of Civil and Environmental Engineering
CE 369-Fluid Mechanics I

Semester 2 - Academic Year 2001/2002
FINAL EXAM

CLOSED BOOK Examination
TIME: THREE HOURS

Instructions to candidates:
1. Candidates must ensure that their computer numbers are clearly written on each answer sheet used.
2. Answer ANY FIVE questions. All questions carry equal mark (20 %).

General Information

1. Specific gravities

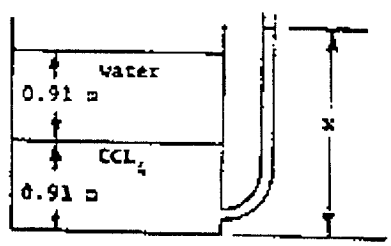
Liquid	Specific Gravity
Water	1.00
Carbon Tetrachloride	1.59
Mercury	13.55

2. Conjugate depths in a hydraulic jump

$$y_2 = -\frac{y_1}{2} + \sqrt{\left(\frac{y_1}{2}\right)^2 + \frac{2v_1^2 y_1}{g}}$$

Question 1

(a) For situation shown on the sketch, how high will the carbon tetrachloride rise in the piezometer (ie find x)?

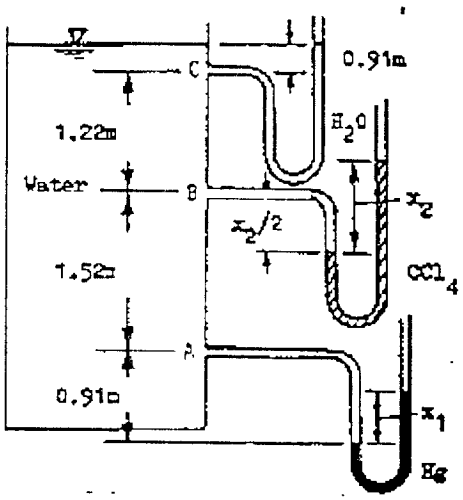


(b) Manometers are attached at different levels to the side of a tank containing water as shown below. With different fluids in these manometers the readings shown on the sketch were obtained.

(1) Indicate for taps A, B, and C the magnitudes of

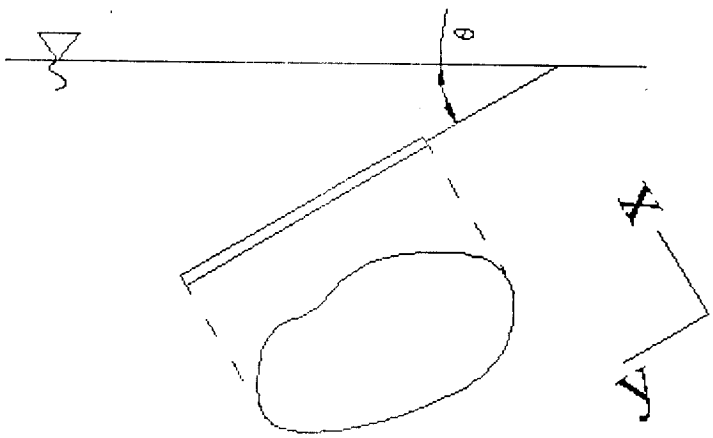
(i) The Elevation head
(ii) The Pressure head
(iii) The Piezometric head

(2) Determine the values of x1 and x2.

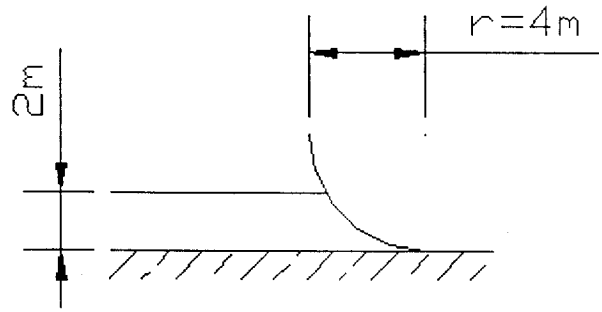


Question 2

(a) Obtain the expression for the centre of pressure of an irregular plane surface wholly submerged in a fluid.



(b) A gate which is a quarter of a circle of radius 4.0m holds back 2.0m of water as shown in the figure. Calculate the magnitude of the resultant hydrostatic force on a unit length of the gate.

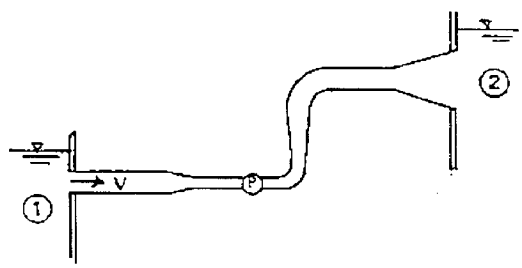


Question 3

For the flow systems shown below, produce neat sketches of the Energy Grade Line and the Hydraulic Grade Line.

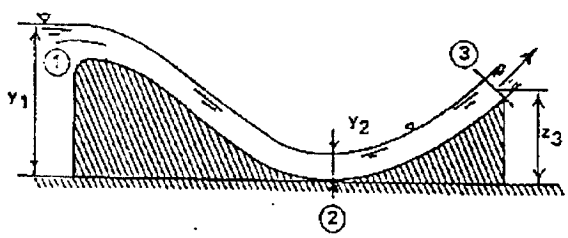
(a)

Real Fluid



(b)

Ideal Fluid
Open Channel



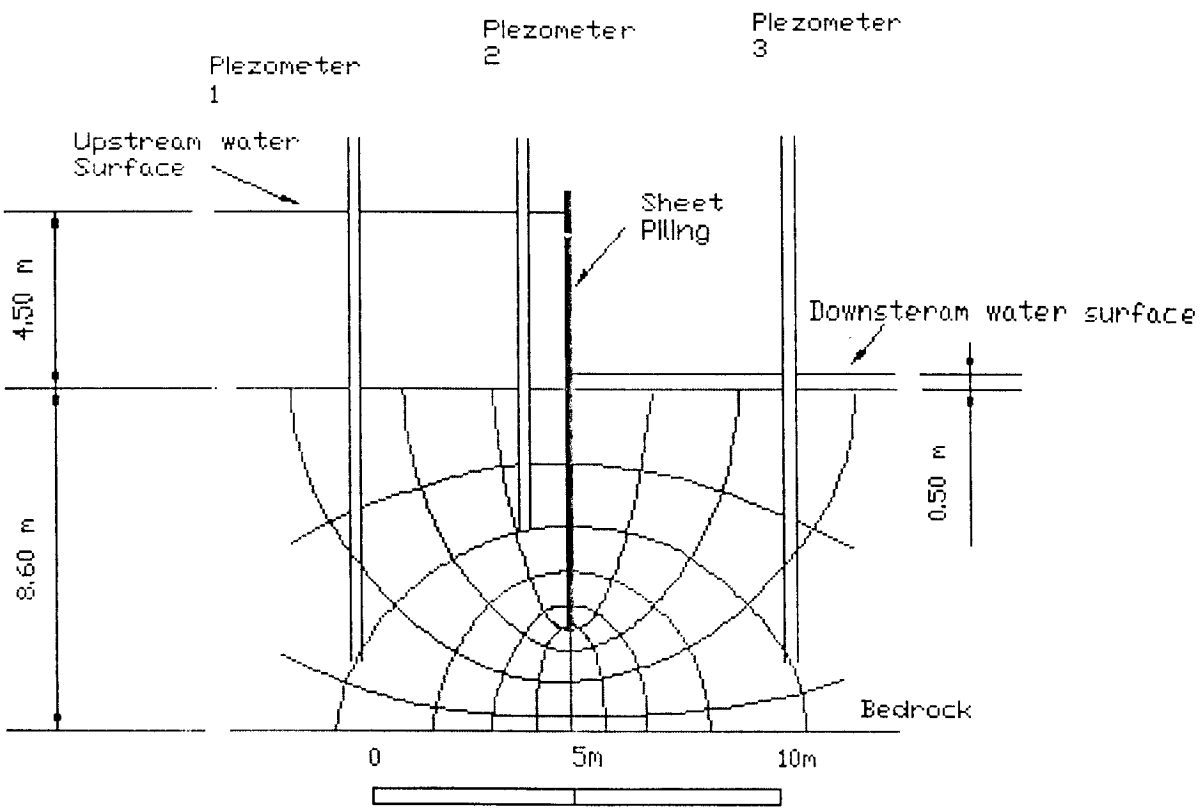
Question 4

Given the following equations which describe two-dimensional flows, determine (1) whether the flow is steady or unsteady (2) whether the flow is rotational or irrotational.

(a) u = 3x - 2y, v = 5x - 3y
(b) u = 2x + 3y + t/2, v = 3x - 24 + t/2
(c) u = 2xt + 3y, v = 3x - 2yt
(d) u = 2x + 3yt, v = 3xt - 2y
(e) u = 3xt + 2y, v = (2x - 3y)t

Question 5

The scaled drawing below shows a line of sheet piling driven 6.00m into a stratum of soil 8.60m thick, underlain by an impermeable stratum. On one side of the piling the depth of water (reduced by pumping) is 0.50m. A flow net has been drawn in.

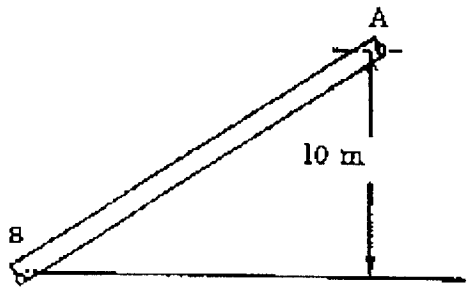


(a) Using graph paper, plot the net pressure distribution along the depth of the piling (Pressure at the front minus pressure at the back).
(b) Given three piezometers (1), (2), and (3), calculate the piezometric head of water in each of the piezometers.

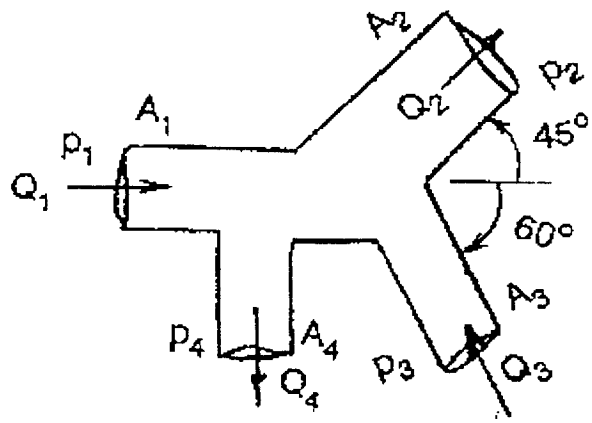
Question 6

(a) A pipe AB is of uniform diameter and section A is 10m above section B. The pressure at A is 140 kPa and at B is 210 kPa.

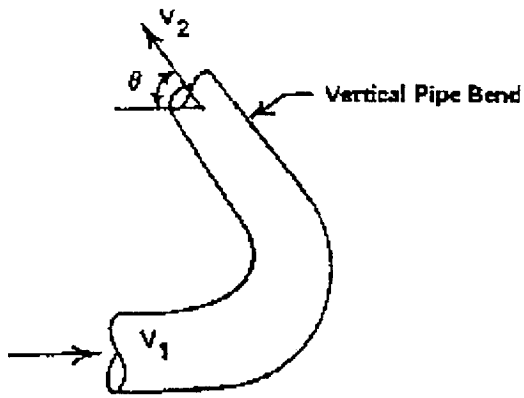
(i) In which direction is the flow?
(ii) What is the friction loss per unit weight of the fluid if the liquid has a specific gravity of
1. 0.45
2. 2.00?



(b) Draw the control volume for the pipe junction shown below, showing on it the pressure forces and unit flux vectors. Pipes 1 and 3 flow into the junction and pipes 2 and 4 flow out from the junction.



(c) Find the resultant force on a vertical pipe bend if the water flowing through this bend has the following:
V_1=30m/s, A_1=0.8m^2, V_2=40m/s, and the weight of the water within the bend being considered is 70N.

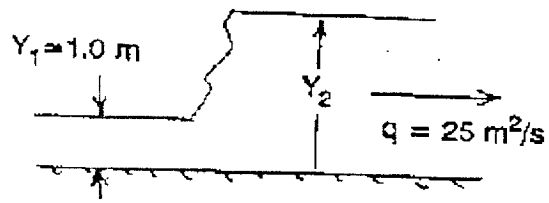


Question 7

(a) Determine the area, wetted perimeter, hydraulic radius, and top width for channels as follows:

(i) Trapezoidal, b=3.05m, z=1, y=1.83m
(ii) Rectangular, b=3.05m, y=1.83m
(iii) Traingular, z=1.5, y=1.52m
(iv) Circular, D=3.05m, $\theta = 3\pi/2$ radian

(b) A flow rate per unit width of $q=25 m^2/s$ is at a depth of $y_1=1.0$ m upstream from a hydraulic jump (See figure below).
(i) What is the depth after the jump?
(ii) How much energy is dissipated in the hydraulic jump per unit width of the channel?
(iii) What power does this represent?



END OF EXAM

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATION
OCTOBER, 2002
CE 452 - ENVIRONMENTAL ENGINEERING I

INFORMATION AND INSTRUCTIONS:

1. Duration: Three (3) hours
2. The paper contains two sections
3. Section A is compulsory and contains two questions
4. Section B contains 4 questions. You are required to attempt any three
5. You can answer the questions in any order
6. Remember to clearly number your solutions
7. Marks will be lost for untidy and unorganised presentation
8. The examination is strictly closed book

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SECTION A - COMPULSORY - ATTEMPT *BOTH* QUESTIONS

1. a) State and very briefly explain the general components of a water supply system.

   b) Distinguish between gravity and pumped distribution systems.

   c) Explain the significance of alkalinity in the process of coagulation/flocculation in water treatment.

   d) Kafue town has a population of 1200 inhabitants. Of this population, 30% resides in high cost areas while the rest are in medium cost areas. The per capita water consumption is 250 and 150 liters per day for the high cost and ~~low~~ medium cost areas respectively. For both areas, population grows linearly at 3% per annum.

   A water treatment plant has been proposed. The design period is to be 20 years. The leakages and losses in the system are expected to be 20%.

   i) Determine the design capacity of the water treatment plant.

   ii) Determine the dimensions of a rectangular sedimentation tank assuming the plant design capacity is $99m^3/h$ and given that the maximum permissible surface loading rate is 0.3m/h. Take the depth of the tank as 3.6m and the length to breadth ratio as not less than 4.

[4+3+3+10]

2. (a) What is (are) the function(s) of each of the following units in a wastewater treatment plant utilising waste stabilisation ponds?

(i) Anaerobic ponds;

(ii) Facultative ponds;

(iii) Maturation ponds.

(b) A wastewater treatment plant is designed to handle $100m^3/h$ of domestic wastewater. The BOD concentration in the influent is 500mg/l. Given that the lowest average ambient temperature for the coldest month is 15^oC and the information in Table 1and also given that the retention time should never be less than 2 days.

Minimum monthly ambient temperature (^0C)	Volumetric organic loading rate λ_v (in g $BOD_5/m^3.d$)	BOD_5 removal (%)
< 10	100	40
10 - 20	20T - 100	2T + 20
> 20	300	60

Table 1: Design volumetric organic loading rates for anaerobic ponds as a function of the monthly average ambient temperature.

(i) Design ~~a facultative~~ an anaerobic pond for this wastewater. Take depth as 3m and the length to breadth ratio as 2.5.

(ii) What would the BOD concentration in the effluent be?

(iii) Given that the per capita sewage production rate is 200 liters per day and that the sludge accumulation rate is $0.04m^3$/PE.year and if sludge volume provided is 40% of the pond volume, what would the desludging rate, in years, be?

(c) For the same treatment plant, three maturation ponds are to be provided each with a retention time of 5 days. If the faecal coliform concentration in the influent is 268 300/100ml, what will the faecal coliform concentration in the effluent be?

[6+10+4]

SECTION B - ATTEMPT ANY *THREE* QUESTIONS FROM THIS SECTION

3. a) What is precipitation and when is it applied in water treatment.

b) Draw a clear distinction between Carbonate and Non-Carbonate Hardness of water.

c) Explain the principle behind the removal of Iron and Manganese from groundwater by aeration.

d) The Intercontinental Hotel uses a resin bed contained in a cylindrical filter unit for the treatment of water that goes to the boilers. The diameter of the filter is 175mm. The height of the resin bed in the filter is 1200mm. This unit is able to treat $5m^3$ before regeneration is required.

i) Express the treatment effectiveness of the resin in bed volumes.

ii) If the hardness in the influent and effluent is 305mg $CaCO_3$/l and 5mg $CaCO_3$/l respectively, how much hardness is the resin able to remove in mg $CaCO_3$?

[4+4+4+8]

4. a) Give one advantage and one disadvantage of using chloramines in water disinfection instead of chlorine.

b) Explain why effectiveness of disinfection process with chlorine decreases with increasing pH values.

c) Describe the relationship between Residual Chlorine, Chlorine Demand and Chlorine Dose.

d) When the Chipata Water treatment plant was just commissioned, disinfection was by dosing of chlorine gas. The gas was fed at a rate of 0.05kg/h. The capacity of the plant is $1,200m^3$/day. Due to failures in feeding equipment, management has decided to resort to dosing of Calcium Hypochlorite (HTH) which contains 70% of free chlorine by weight. How much HTH will be required per day at the plant to attain the same quality of treated water as when disinfecting was with gaseous chlorine?

[4+4+4+8]

5. (a) Discuss the importance of removing or reducing the concentration of each of the following parameters from wastewater before the wastewater is discharged into the surface water bodies.

i) Organic matter – ... depletion of dissolved oxygen

ii) Suspended solids – Silting, Aesthetic Nuisance

iii) Nutrients – toxic

b) Explain the difference between off-site and on-site sanitation systems.

c) Briefly discuss the function(s) of the following units in a conventional wastewater treatment plant:

i) Primary sedimentation tanks,

ii) Secondary sedimentation tanks.

d) Settled sewage flowing at a rate of $100m^3/h$ and with an organic concentration of 140mg/l is to be treated using trickling filters. The effluent quality required should never exceed a BOD concentration of 42mg/l.

(i) What should the minimum removal efficiency of the filter be?

(ii) If the filter for the treatment of this wastewater has an effective height of 3m and diameter 30m, calculate the volumetric organic loading rate.

[6+2+4+8]

6. (a) Briefly explain how both the particulate matter and the liquid component of the wastewater is treated and disposed of in a wastewater treatment system employing septic tanks.

(b) In a conventional pit latrine, the two major problems are that of odour and fly breeding. Explain how these problems have been addressed in VIP latrines.

(c) Explain how small bore sewers differ from the other two types of wastewater collection systems.

(d) Design a septic tank for a small community of 200 inhabitants whose per capita sewage production is estimated at 100 liters per day. Take the effective depth as 1.5m, length to width ratio as 4 and free board as 0.5m. State your assumptions clearly (if any!!!).

[4+4+4+8]

END OF EXAMINATION

GOOD LUCK!

JMT/CE452/EXAM/2002

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATION

OCTOBER, 2002

STRUCTURAL STEEL DESIGN (CE 532)

Time allowed: 4 hours
OPEN BOOK

PART A

ANSWER ALL QUESTIONS

QUESTION ONE

Check the ability of a 3.5 m long 254x254xUC 107 of grade 43 steel to carry a compressive load of 400 kN assuming that it acts at effective eccentricities of 100 mm from the column face such as to produce single curvature bending about the Y-Y axis and double curvature bending about the X-X axis.

The column is effectively held in position and partially restrained in direction at both ends about the X-X axis and effectively held in position at both ends but not restrained in direction at either end about the Y-Y axis.

Use the more exact approach for overall buckling. **(20 marks).**

QUESTION TWO

Design the rafter (top chord) of the truss shown in figure 2.0 given the following:

(a) Dimensions
- (i) span of truss = 16.0 m
- (ii) rise of truss = 3.2 m
- (iii)roof slope = 21.8 degrees
- (iv)truss spacing = 4.0 m
- (v) rafter length = 8.62 m.

(b) Loading
- (i) cladding and insulation = 0.1 kN/sq.m
- (ii) roof truss self weight (estimated) = 8.0 kN
- (iii)purlin load = 0.1 kN/m
- (iv)imposed load = 0.25 kN/sq.m (on plan)
- (v) wind pressure = 0.5 kN/sq.m
- (vi)external pressure coefficient = 0.7
- (vii) internal pressure coefficient = -0.3.

Assume for the rafter an initial size of 2-80x60x8 mm unequal angles, grade 43 steel with connections at third points space 8 mm apart to allow for gusset plates with spacing washers.
(20 marks).

QUESTION THREE

(a) Check whether a rolled 150x75x10 mm unequal purlin of grade 43 steel at a roof angle of 20 degrees as shown in figure 3.0 with a span of 4.0 m simply supported and at 1.5 m centres can carry the loads given below:

(i) dead load (cladding + insulation) = 0.22 kN/sq.m

(ii) imposed load = 0.25 kN/sq.m (on plan)

(15 marks)

(b) Check the deflection of the purlin designed in **QUESTION THREE (a)** above.

(5 marks).

PART B

ANSWER TWO QUESTIONS ONLY

QUESTION FOUR

Check whether stiffeners are necessary without using tension field action to carry a maximum shear load of 2160 kN. If stiffeners are necessary, design a pair of vertical stiffeners. The girder is made of two 600 x 20 mm flange plates and one 1200 x 12 mm web plate grade 43 steel. Assume stiffener plate thickness of 15 mm.

(20 marks)

QUESTION FIVE

Design a simply supported 8 m span beam for an industrial building in grade 43 steel which is loaded as shown in figure 5.0. Assume an initial size of beam as 533 x 210 x 101 UB.

(20 marks).

QUESTION SIX

Determine the compressive load that can be carried by a 406 x 178 x 60 UB in grade 43 steel over a height of 5.6 m assuming that it is braced against out of plane failure and that the maximum moment about its major axis is 72 kNm. Assume single curvature bending m = 1. (Equal moments at both ends).

(20 marks).

QUESTION SEVEN

(a) Design the side rail shown in figure 7.0 (a) for the following and check its deflection:

(i) Dimensions

- Side rails at 2.0 m centres
- Span of side rails = 5.0 m simply supported.

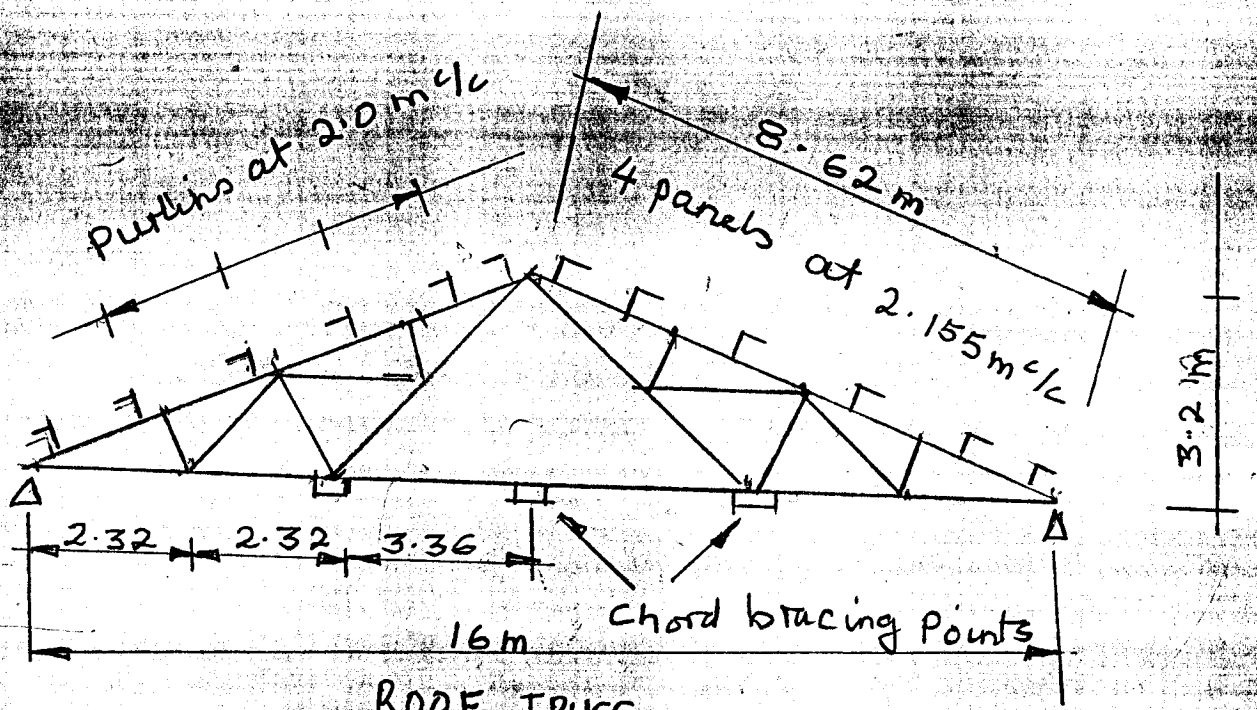
(ii) Loading

- Dead load = 0.12 kN/sq.m
- Wind load (pressure) = 0.75 kN/sq.m
- Assume an initial size of angle 125 x 75 x 12 unequal angle grade 43 steel

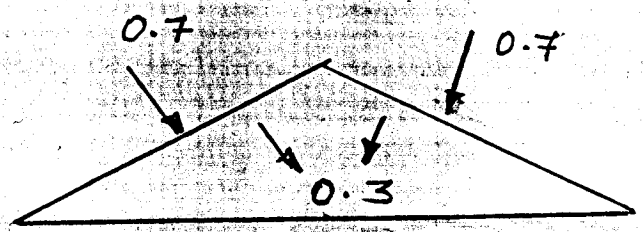
(10 marks)

(b) Check whether 2 - 80 x 60 x 8 mm grade 43 steel unequal angles, placed back to back and spaced 8 mm apart to allow for gusset plates, are capable of carrying a tensile force of 120 kN. Assume connection through the longer leg by one 20 mm diameter bolt.
(10 marks).

END OF EXAMINATION
GOOD LUCK!!

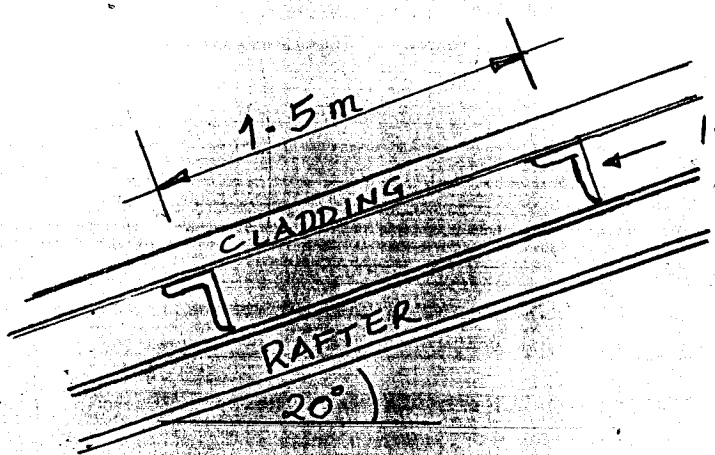


ROOF TRUSS



INTERNAL AND EXTERNAL PRESSURE CO-EFFICIENTS

FIGURE 2.0



150x75x10mm Unequal angle Purlin

FIGURE 3.0

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING
DEPARTMENT OF AGRICULTURAL ENGINEERING

POST HARVEST TECHNOLOGY
EA452

FINAL EXAMINATION **OCTOBER 2002**

TIME allowed: **3** hours **answer FIVE (5) questions**

It is desirable to show the method of calculation and the steps taken to achieve the results.

QUESTION 1

A) Give 2 advantages and 2 disadvantages of wet cleaning. [5 marks]

B) It is required to grind grain from a feed size of 50mm at a throughput of 500kg/h using a machine with a 15 kW motor, Ritttinger's constant of 0.02 and a reduction ratio of 95. Is the motor suitable.

Take :

1 hp = 746 W

E is expressed in horsepower hour ton^{-1}. [12 marks]

C) Comment on the effect of increasing the moisture content of the fed grain. [3 marks]

QUESTION 2

A) With the help of a labelled sketch, explain the application of regeneration in Pasteurisation using a plate heat exchanger. [8 marks]

B) A fruit juice is pasteurised using a plate heat exchanger. The juice enters at 6°C and is pasteurised at 65°C.The regeneration section has 60 effective plates representing a regeneration rate of 85 %. At what temperature does the juice enter the heating section if 20 more plates are added to the regenerator section. [12 marks]

QUESTION 3

A) The Decimal Reduction Time (D- value) of a micro-organism is given as 5 minutes. What does this mean. [5 mark

B) Given that Food Microbiologists have determined that a new canned food product is to be sterilized with a lethality $F_0 = 10$ minutes, explain with the aid of a plot and relevant equations how you would determine the process time required. [12 marks]

C) Why is it undesirable to have a process whose actual F_0 value is substantially above that of the required. [3 marks]

QUESTION 4

A) Differentiate Constant - Rate drying period and Falling-rate drying period - what determines the drying rates in these two periods. [5 marks]

B) Cassava is to be dried in a tray drier .The diced cassava pieces are loaded on perforated trays of dimensions 110 cm by 90 cm with a loading density of 12 kg/m^2. The drier can accommodate 36 trays. The fresh tubers have a moisture content of 92 % w.b. and are to be dried to a final moisture content of 0.22 kg/kg d.b. The inlet air is first dehumidified using cooling coils and in so doing is reduced to a temperature of 10°C. The air is reheated to a temperature of 50°C using a coal burner air heat exchanger before being brought into contact with the food material. The exhaust air temperature is 28°C.

i) How much cassava can be processed in a week if the drier is operated 24 hours a day with an allowance of 1 hour for loading and offloading in between batches. [12 marks]

ii) What is the coal consumption in Kg/h. [3 marks]

Given

- ambient conditions : 24°C dry bulb temperature and 60% Relative Humidity
- Fan capacity = 5000 m^3/ h
- Heat value of coal = 27.5 Mj / Kg
- All heat losses are neglected.

Note : Please draw the process on the provided Psychrometric Chart and hand it in with your Student Number clearly indicated.

QUESTION 5

A) Give 4 design factors that affect the efficiency of a fluid mixing system. [4 marks]

B) A mixing system is used to prepare recombined milk of density 1035 Kg/ m^3. The system operates with a fixed rotational speed of 20 revs per second and has an impeller blade of 25 cm in diameter taking $f(\mu) = 1$ and pumping system constant (k) = 0.7.

i) Determine the power consumption (taking average efficiency into account). [8 marks]

ii) If it is desired to double the pumping rate by using a similar type of blade of larger diameter, operating at the same speed, what is the required motor size. [6 marks]

iii) What is the pumping system constant for the higher rate system. [2 marks]

QUESTION 6

A) Explain using a labelled sketch how a simple feedback system may be used to ensure that the water flowing out of a jacketed vessel is kept at 70°C. (Assume steam is used in the jacket). [6 marks]

B) It is required to pump hot water out of a vacuum vessel under the following conditions:

- flowrate required = 10 000 litres per hour
- gauge pressure of vessel = -80 kPa
- Suction line is 80 mm i.d. and 3 m total length
- Total height of liquid above pump inlet is 1.5m
- Pressure drop due to friction is 66.6 Pa / m length.
- from steam tables, saturation vapour pressure = 7.38 kPa

(take density of water to be 1000 Kg / m^3 and atmospheric pressure as 101.35 kPa).

Calculate the net positive suction head available. If this were found to be inadequate, how might the situation be remedied? [14 marks]

QUESTION 7

A) State Fourier's Law and express as an equation. Derive the units of thermal conductivity. [5 marks]

B) Derive the following equation for the heat loss through a wall composed of two layers of thermal conductivity, k_a and k_b, and thickness, a and b:

$$Q = \frac{A\Delta T}{\frac{1}{h_i} + \frac{a}{k_a} + \frac{b}{k_b} + \frac{1}{h_e}}$$

where h_i and h_e are internal and external boundary layer convective heat transfer coefficients. [5 marks]

C) The internal and external heat transfer coefficients for a window under normal weather exposure can be taken as 7 W/m^{2}K and 20 W/m^{2}K respectively. The glass is of thermal conductivity 1.05 W/mK and thickness 6 mm. Calculate the heat loss per square meter for internal and external temperatures of 18 °C and 2 °C. [5 marks]

D) Examine the effect of increasing the thickness of glass in C). What do you conclude from this? [5 marks]

QUESTION 8

A) A 1-cm thick steel pipe with an internal diameter of 5 cm is used to convey steam for processing. The temperature of the inside surface of the pipe is 120 °C. The pipe is covered with 3 cm thick layer of insulation. Under steady-state conditions, the heat loss from the pipe (with insulation) is 35 W/m. Calculate the temperature of the outer surface of the insulation. The thermal conductivity of steel is 16.3 W/m°C and that of the insulation is 0.038 W/m°C. [8 marks]

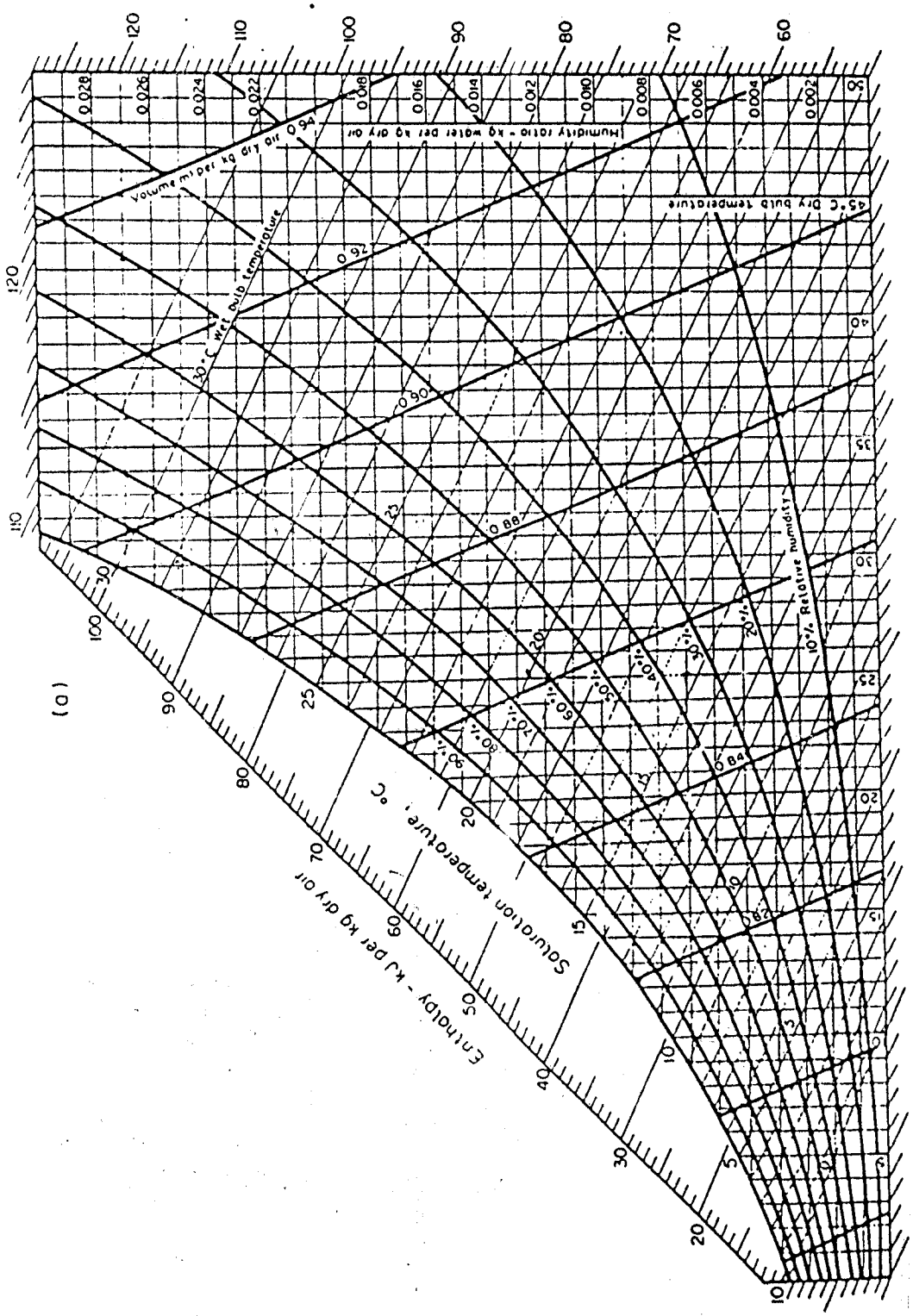
B) Find the refrigeration load expressed in tons of refrigeration which is caused by heat loss from the four side walls of a small cold room 3.4 m by 4.0 m by 3.4 m. The walls are made of 40 cm thick brick, 40 cm cork board and 2.5 cm cement. The inside and outside wall temperatures are –30 °C and 21 °C respectively. Take a safety factor of 2 for losses through joints etc. Thermal conductivities for brick, cork and cement plaster are 0.6 W/m °C, 0.04 W/m °C and 0.8 W/m °C respectively. [12 marks]

Note: 1 ton of refrigeration = 3489 W.

-------END------

PSYCHROMETRIC CHART

Normal temperatures 1013.25 millibars



THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

FINAL EXAMINATIONS - OCTOBER, 2002

EE 342 - ELECTRONIC ENGINEERING I

TIME : **THREE (3)** Hours

ANSWER: **FIVE(5)** Questions

Boltzman's constant: $k = 1.38 \times 10^{-23}$ J/K

Electronic charge: $q = 1.602 \times 10^{-19}$ C

Ambient Temperature: T = 300 K

Q1. (a) Describe and discuss with the aid of Ebers - Moll Model and its equations, transportation of charge carriers, from the emitter to the collector and from base to the circuits outside it.

(b) Explain the source of minority charge carriers in a p-n junction and discuss the concept of minority charge carriers in terms of energy band diagrams, and also explain minority charge carrier currents in terms of potential hill or barrier.

(c) Explain and describe with the aid of diagrams, formation of a pn junction in terms of donor and acceptor concepts.

Q2. (a) Derive Ebers - Moll equations for a pnp bipolar junction transistor.

(b) Discuss and explain the term avalanche multiplication as it relates to semiconductor physics.

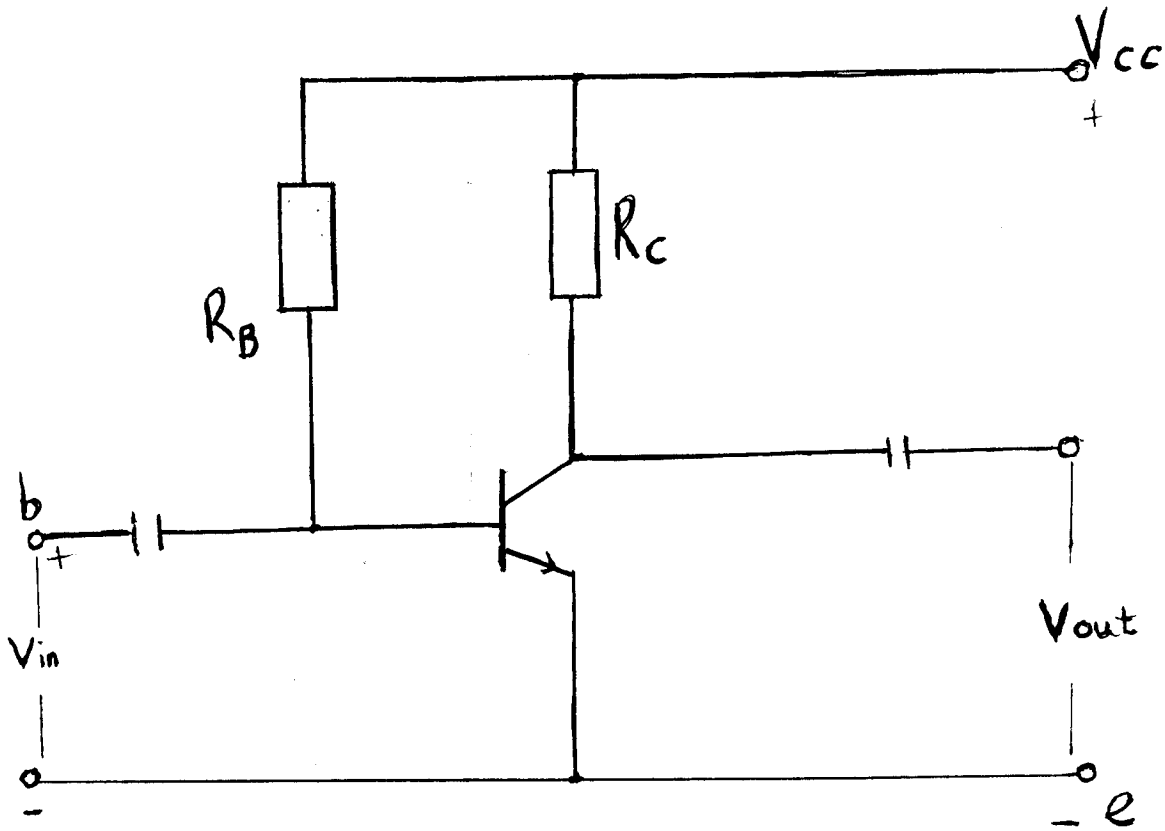
(c) Explain in details the term zener breakdown as it relates to semiconductor physics.

Q3. (a) Derive Ebers Moll equations for npn bipolar junction transistor and use them to

(b) Solve explicitly for base-emitter junction voltage and base-collector junction voltage.

(c) Solve explicitly for terminal collector current, Ic, in terms of base-emitter, V_BE, and base-collector, V_{BC}, junction voltages for npn bipolar junction transistor.

Q4. For the transistor amplifier circuit shown below, find the value of the collector-emitter voltage, V_{CE}. Also, find new value of R_B so that the maximum β of 300 brings V_{CE} down to 5 volts.

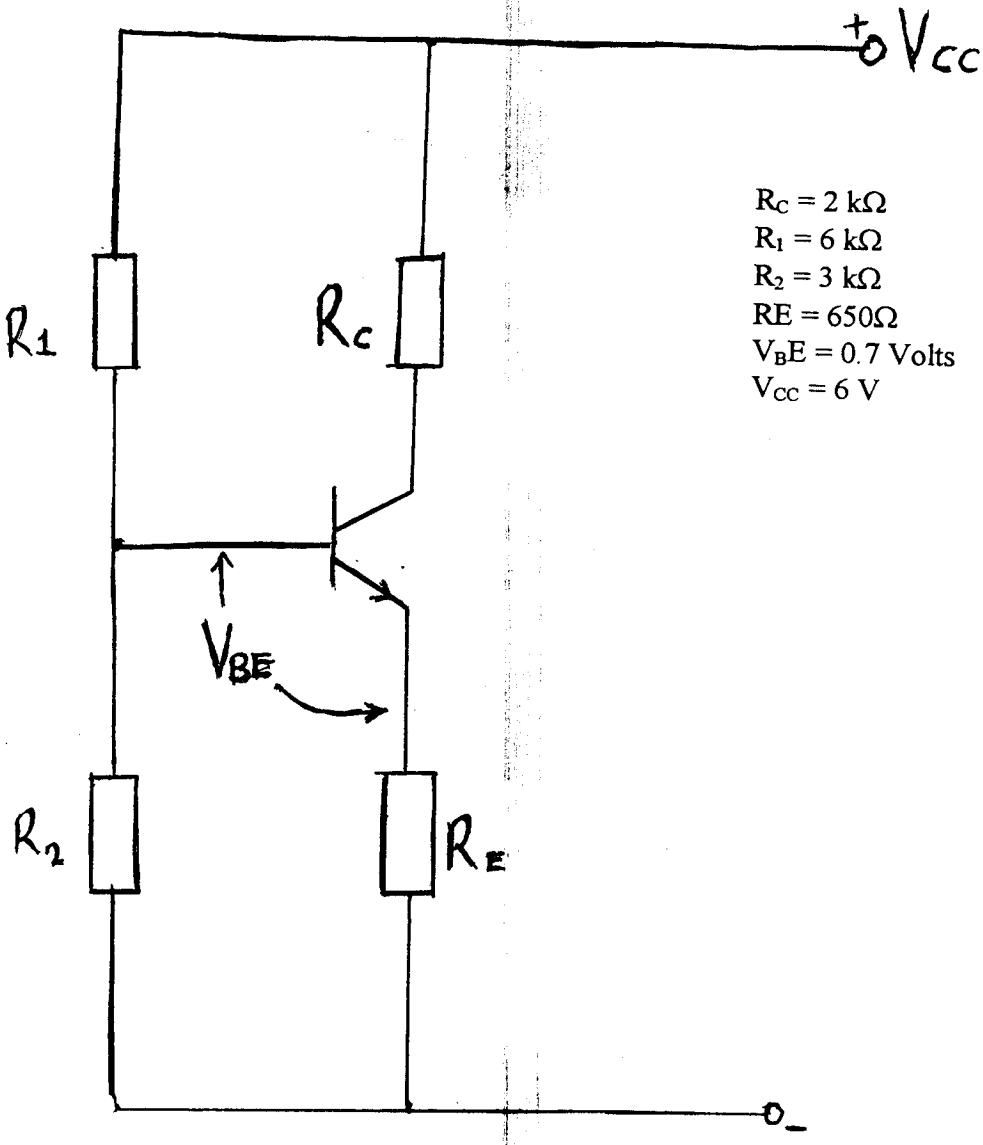


$V_{CC} = 18$ Volts

$R_C = 4.7\ k\Omega$

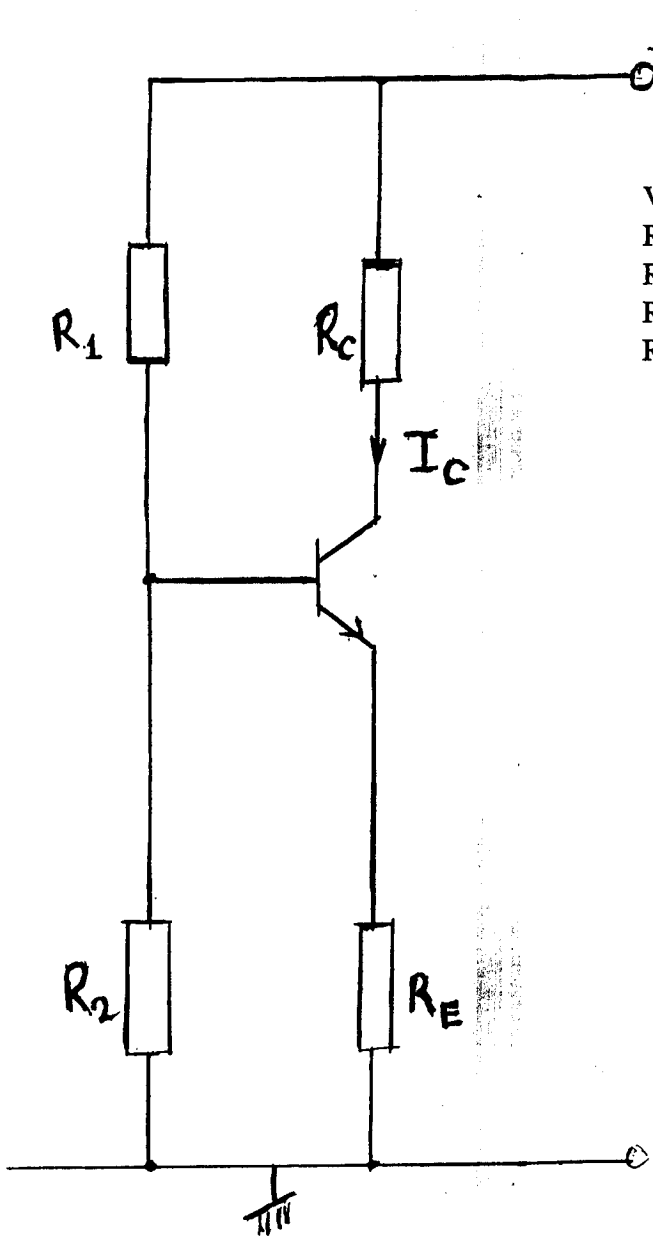
$\beta = 100$

(b) Calculate the emitter bias current for the transistor amplifier circuit shown below.



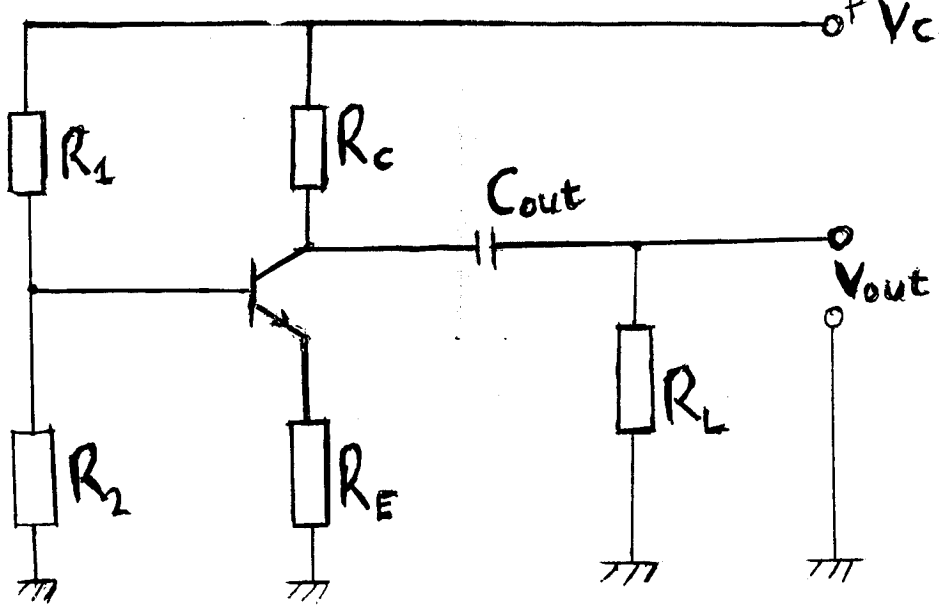
$R_C = 2\ k\Omega$
$R_1 = 6\ k\Omega$
$R_2 = 3\ k\Omega$
$RE = 650\Omega$
$V_BE = 0.7$ Volts
$V_{CC} = 6$ V

(c) For the circuit shown below draw, the dc load line and mark in the Q-point of the circuit.



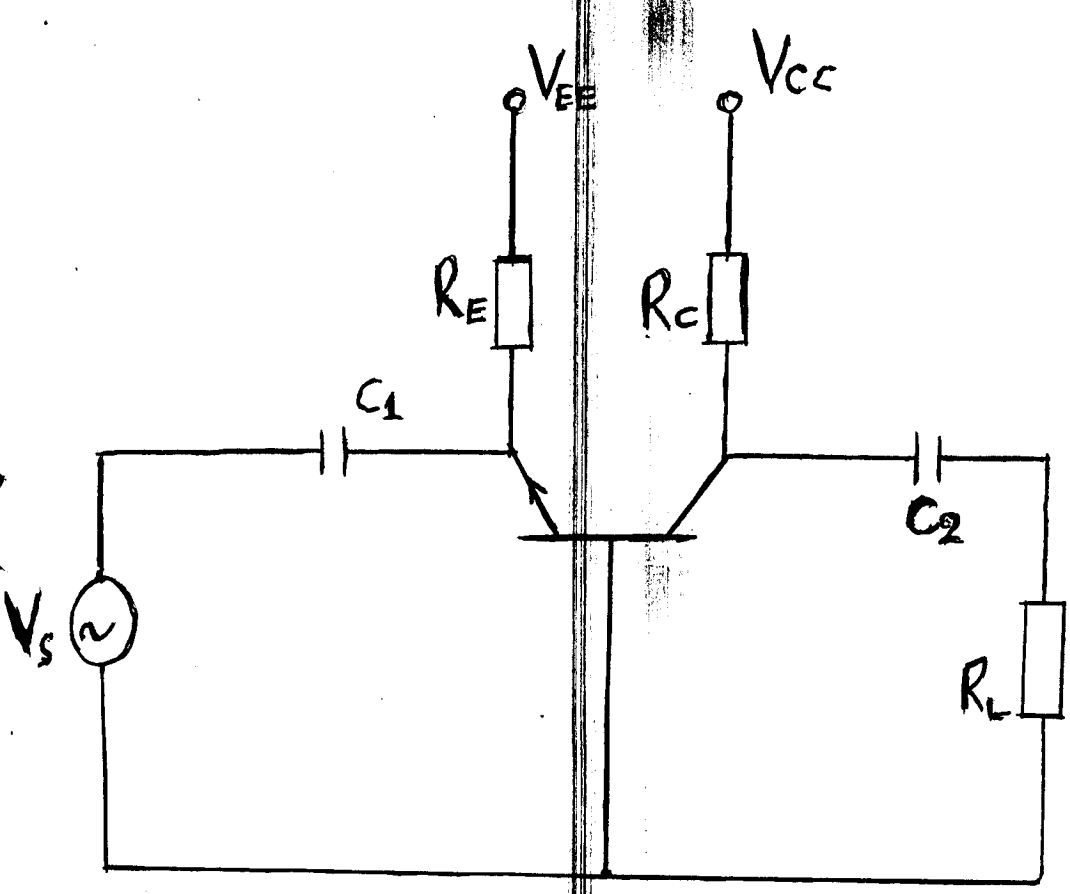
$V_{CC} = 20V$
$R_C = 2\ k\Omega$
$R_1 = 15\ k\Omega$
$R_2 = 5\ k\Omega$
$RE = 3\ k\Omega$

Q5. (a) Find the dc and ac load lines for the common emitter (CE) amplifier Circuit shown below.



$V_{CC} = 20$ V
$V_{BE} = 0.7$ V
$R_1 = 16$ kΩ
$R_C = 3$ kΩ
$R_2 = 4$ kΩ
$R_E = 2$ kΩ
$R_L = 6$ kΩ

(b) Draw the dc and ac load lines for the common base (CB) circuit shown below.

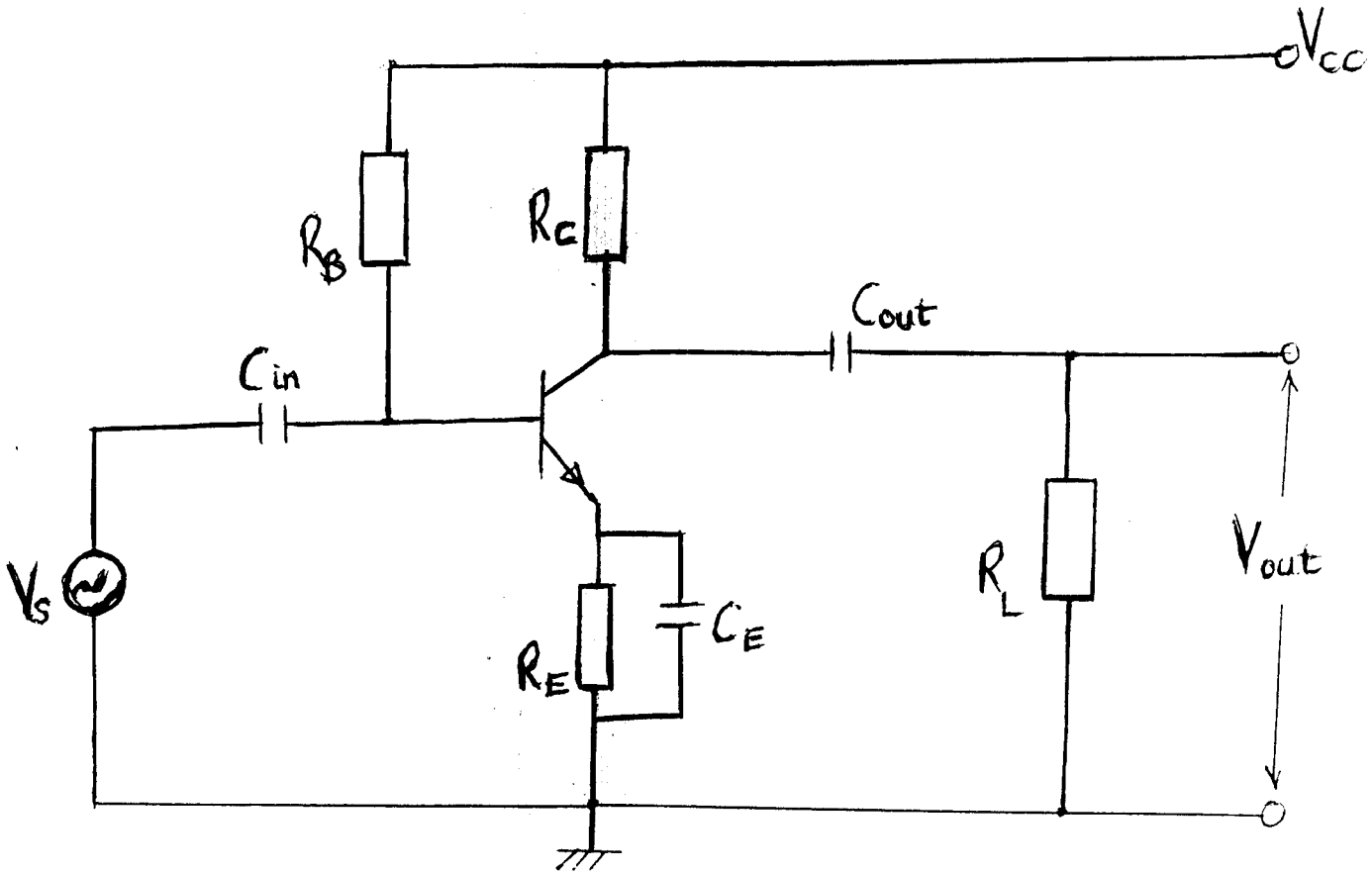


$V_{CC} = 30$ V
$V_{EE} = -20$V
$R_C = 30$ kΩ
$R_E = 40$ kΩ
$R_L = 30$ kΩ

(c) For the circuit shown in 5(b), find the approximate value of the source voltage Vs that will cause clipping. The voltage source has an internal resistance of 1 kΩ.

Q6. For the common emitter (CE) amplifier circuit shown below, find its:

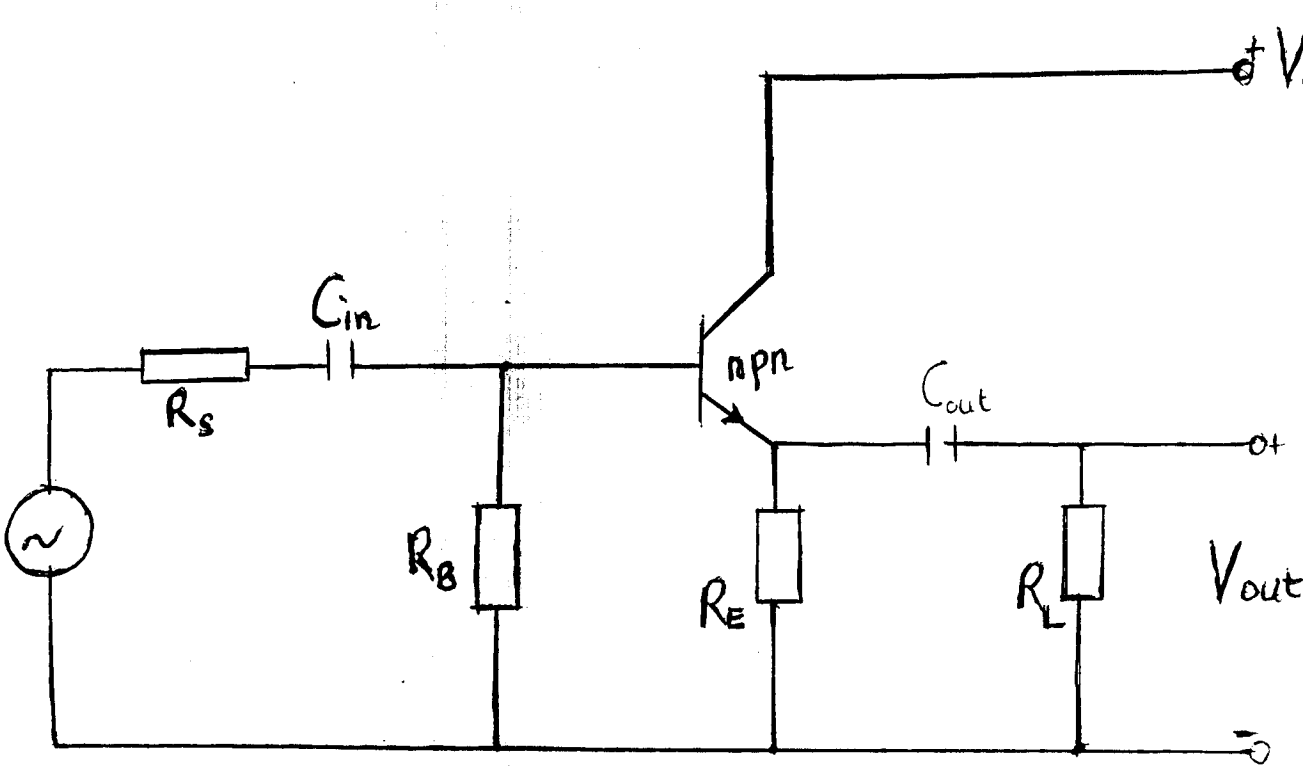
(i) Input resistance
(ii) Voltage gain
(iii) Current gand and
(iv) Output resistance



$V_{CC} = 30$ V
$V_{BE} = 0.7$V
$R_B = 2M\Omega$
$R_C = 10k\Omega$
$R_E = 10k\Omega$
$R_L = 20k\Omega$
$\beta = 50$
Cin = 1μF
C_{out} = 1μF
CE = 50μF

Q7. For the common collector - emitter follower circuit shown below, find expression for its:

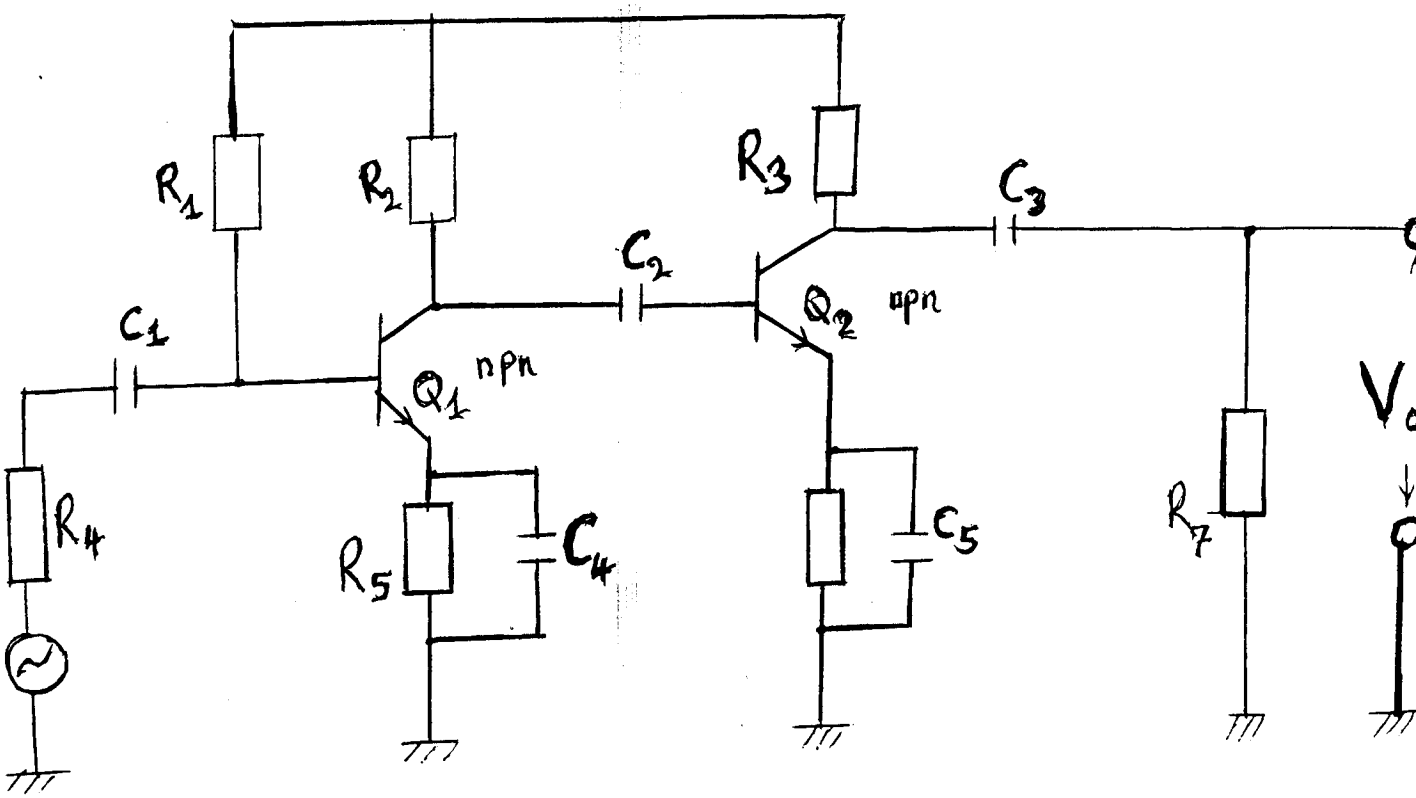
(i) Input resistance
(ii) Voltage gain
(iii) Current gain and
(iv) Output resistance



$V_{CC} = 20V$
$R_S = 1k\Omega$
$R_B = 400\ k\Omega$
$R_E = 20\ k\Omega$
$R_L = 5k\Omega$
$\beta = 500$

Q8. For the two - stage RC - coupled amplifier shown below, find

(i) Its input impedance
(ii) Its output impedance
(iii) Its voltage gain and
(iv) Its current gain.



V_{CC} = 25 V
R_1 = 1.5 MΩ
R_2 = 5 kΩ
R_3 = 5 kΩ
R_4 = 1 kΩ
R_5 = 10 kΩ
R_6 = 10 kΩ
R_7 = 10 kΩ

h_{ie} = 2 kΩ
h_{fe} = 50
h_{re} = 6.1 x 10^{-4}
h_{oe} = 25 μA/V

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

UNIVERSITY EXAMINATIONS OCTOBER 2002

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.

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

[10 marks]

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

[15 marks]

2.

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

[15 marks]

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

[10 marks]

3.

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

[15 marks]

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

[10 marks]

4.

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

[25 marks]

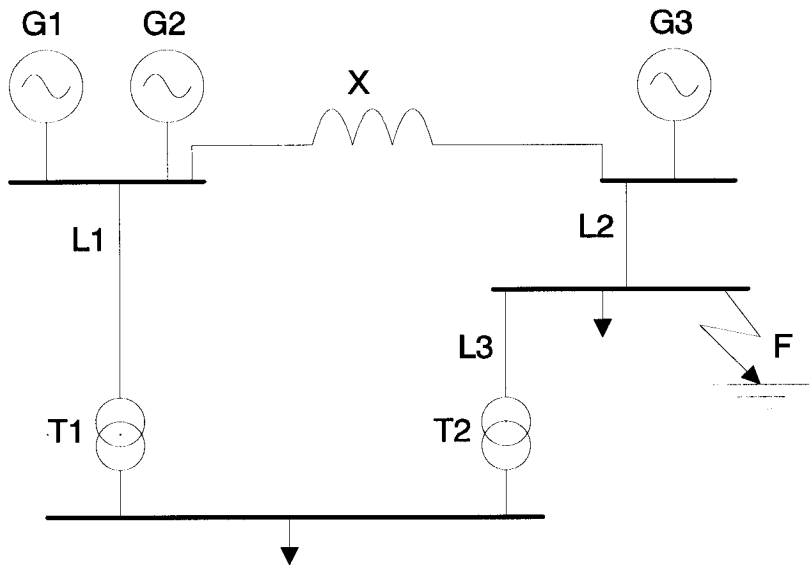


Fig 1

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

Table 1

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

Table 2

5.

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

[10 marks]

A 33-kV radial distribution feeder ***ABC*** (Fig. 2) which is fed at substation ***A*** has 3-phase fault levels of 300, 260 and 210 MVA at busbars ***A***, ***B*** and ***C***, respectively. There are current transformers with ratios 300/5, 400/5 and 300/5

at ***A***, ***B*** and ***C***, respectively. Calculate the settings to be applied to these relays which give a discrimination of 0.4 s between each relaying point and which achieve a plug setting multiplier close to, but less than 20.0, for 3-phase faults close to the relaying points.

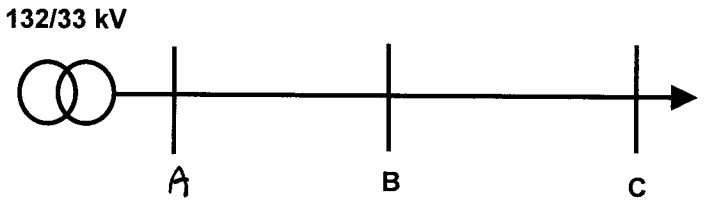


Fig. 2

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

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

[15 marks]

6.

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

[9 marks]

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

[7 marks]

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

[9 marks]

END OF EE452 EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL FO ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS - OCTOBER 2002
EE 572: TELECOMMUNICATION SYSTEMS

TIME: **THREE (3)** HOURS
ANSWER: ANY **FIVE (5)** QUESTIONS
TOTAL MARKS: 100
ALL QUESTIONS CARRY EQUAL MARKS

SPECIAL INSTRUCTIONS: USE TWO SEPARATE ANSWER BOOKS, ONE FOR QUESTIONS 1 AND 2 AND THE OTHER FOR QUESTIONS 3, 4, 5, 6, 7 AND 8.

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

Q1. (a) i) What are the disadvantages of a circular waveguide compared to a rectangular Waveguide? ***[2 Marks]***

ii) Define the function of the directional coupler. ***[2 Marks]***

iii) Define *guide wavelength,* and *group velocity* of a signal. ***[2 Marks]***

(b) A rectangular waveguide has internal dimensions of 3.76 cm x 1.88 cm.

i) Assuming a dominant mode, determine the lowest frequency that can be propagated in the waveguide. ***[2 Marks]***

ii) Assuming a frequency of 9 GHz, what is the highest mode that can be accommodated? ***[2 Marks]***

iii) Assuming f = 11GHz and m = 2, calculate cut-off wavelength (λ_0), guide wavelength (λ_g), group velocity (v_g), phase velocity (v_p), and characteristic wave impedance (Z_0). ***[10 Marks]***

Q2. (a) State the major distinction between the low frequency vacuum tubes and the specialized Microwave tubes. ***[4 Marks]***

(b) In terms of the interaction of the electron beam and the RF, explain the difference of the *Klystron, travelling wave tube (TWT)* and *the magnetron.* ***[4 Marks]***

(c) Define the terms *pushed* and *pulled* for microwave oscillators. ***[2 Marks]***

(d) What is the significance of the sequence in which the voltages are applied to a klysron? ***[2 Marks]***

(e) With the help of a diagram, explain the operation of a Travelling Wave Tube (TWT). State, also, some applications of a Travelling Wave Tube. ***[8 Marks]***

Q3. (a) Consider a small diffuse light source and an adjacent step index optical fiber, whose core diameter is greater than the diameter of the source. Deduce an expression for the power collected from such a source by the fiber. Write down the ratio of the total power emitted and the power collected. Show the relation between the power ratio and the numerical aperture. The fiber has got an outer cladding having refractive index n_2. The core has a refractive index n_1, which is greater than n_2.

The numerical aperture of a step-index fiber is 0.160. Find the fraction of the optical power from a diffuse source that the fiber will propagate.

(b) Calculate the multipath time dispersion of a cladded glass fiber whose core has a refractive index n_1 = 1.6. The refractive index of the outer glass cladding is n_2 = 1.2. Deduce the formula used.

(c) Show the trajectories of the two groups of meridional rays in a parabolic index fiber with the necessary mathematical analysis. The rays in a group are non-dispersive.

(d) What is material dispersion? Derive a formula for the complex refractive index of the bulk material. Show the expressions for its real and imaginary parts. *[6 + 5 + 5 + 4]*

Q4. (a) In what way does the effect of the ground on a nearby ungrounded antenna differ from that on a grounded one? What is a basic Marconi antenna? Show its voltage and current distribution, as well as its radiation pattern.

(b) Explain the working of a rhombic antenna by means of a suitable diagram. Show its radiation pattern.

(c) Describe the Yagi-Uda antenna. Show its radiation pattern.

(d) Draw the circuit of a typical antenna Coupler.

(e) To produce a power density of $1 mW/m^2$ in a given direction, at a distance of 2 km, an antenna radiates a total of 180 W. An isotropic antenna would have to radiate 2400 W to produce the same power density at that distance. What, in decibels, is the directive gain of the practical antenna? *[6 + 4 + 4 + 3 +3]*

Q5. (a) Describe fully the Cassegrain method of feeding a paraboloid reflector, including a sketch of the geometry of this feeding arrangement. Discuss in detail some shortcomings and difficulties connected with the Cassegrain feed of parabolic reflectors. How can they be overcome?

(b) Show the detailed block diagram of a typical highpower pulsed radar set. Explain its operation. Discuss briefly the different units in the system.

(c) What do you mean by the maximum range of a radar set? Derive the radar range equation. Show the different steps.

(d) Calculate the maximum range of a radar system which operates at 2.5 cm (wavelength) with a peak pulse power of 600 kW, if its minimum receivable power is 10^{-14} W, the capture area of its antenna is 5 m^2, and the radar cross-sectional area of the target is 20 m^2. *[6 + 7 + 4 + 3]*

Q6. (a) Explain the token bus MAC sublayer protocol giving the IEEE standard 802.4 frame format. Show the frame format of the IEEE 802.3 and compare these two standards.

(b) Show the names and meanings of the token bus Control frames in a tabular form. Describe the logical ring maintenance in a token bus LAN.

(c) In a token bus LAN there are 100 stations. The parameters of the network running at 10 Mbps have been adjusted to give priority 6 traffic half of the bandwidth. Calculate the guaranteed 'kbps' each station has for priority 6 traffic.

(d) What is erlang?
During a 2-hour busy period, 2400 calls arrive at an exchange. Average holding time per call is two minutes. What is the traffic load in (i) erlangs and (ii) in CCS?
[8 + 6 + 3 + 3]

Q7. (a) Write down the binary exponential back off algorithm. Discuss the algorithm.

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

(c) Calculate the signal propagation speed in a 1-Mbps ring whose circumference is 3000 metres. The ring can contain only 15 bits on it at once.

(d) What is the full form of DQDB? Explain the working of a DQDB network as defined by IEEE 802.6 standard by means of a suitable diagram.

There are five stations A, B, C, D and E situated in this order from left to right in a DQDB network. At first E has data to send and then B has. Show by means of suitable

diagrams how this problem of data transmission can be solved by using 802.6 protocol.
[5 + 5 + 4 + 6]

Q8. (a) Distinguish between the radiation resistance and the loss resistance of an antenna.

If the radiation resistance is 3 times the total loss resistance then calculate the antenna efficiency. Assume the antenna to be a resonant one.

(b) Write a short explanatory note on the superheterodyne receiver.

(c) Explain the simplex protocol for a noisy channel which is often called PAR or ARQ. Discuss the protocol in detail giving the different scenarios it can handle. Give an example of a pathological scenario, which this protocol cannot handle and hence it fails. Compare this protocol with the simplex stop-and-wait protocol for an ideal error free channel.

(d) Compare briefly the TCP/IP and the ISO/OSI architectures. *[4 + 5 + 7 + 4]*

END OF QUESTION PAPER

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION - OCTOBER 2002
EE442 - ELECTRONIC ENGINEERING FINAL EXAMINIATION

TIME: 3 HOURS
ANSWER: ANY FIVE QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS

1. (a) Consider the common-emitter amplifier with unbypassed emitter resistance shown in figure 1. Using impedance reflection in the transistor analyse the circuit and obtain the current gain Ai

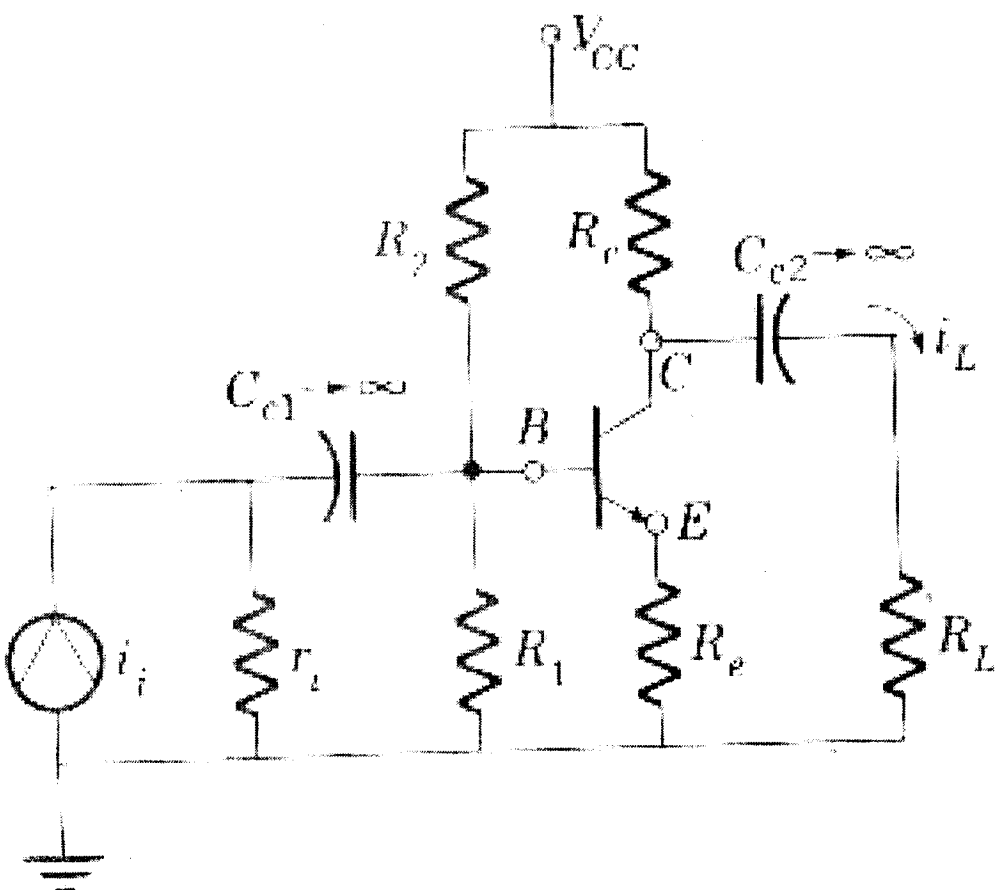
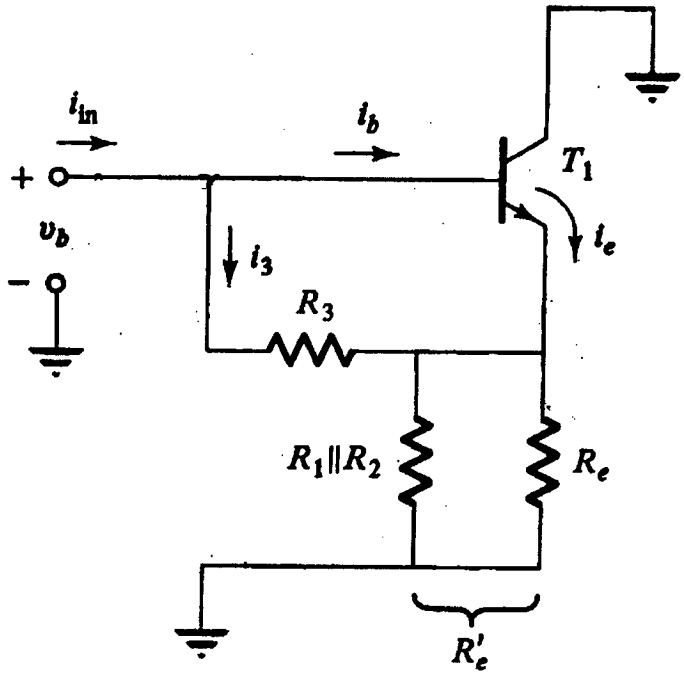


Fig. 1



(b) Find Z_{in} for the circuit given in fig. 2.

Q2. For the given basic diference amplifier in Fig 3 carry out the small signal Analysis and find expression for v_{01} and v_{02} and $v_{01} - v_{02}$. Obtain expressions for common mode gain Aa, difference mode gain Ad and common mode rejection ratio.

CMMR

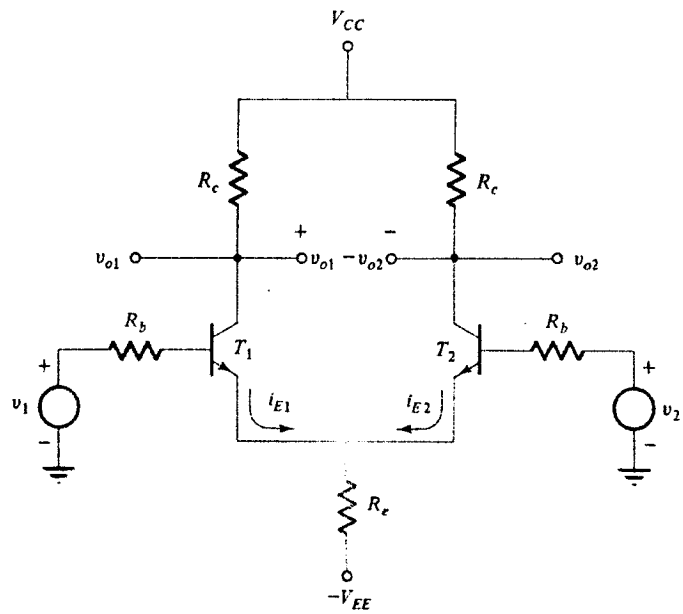


Fig 3.

Q3. The circuit given below is that of a motorola MC1530 operational amplifier. Carry out a DC analysis on the circuit to find out all the dc currents and voltages.

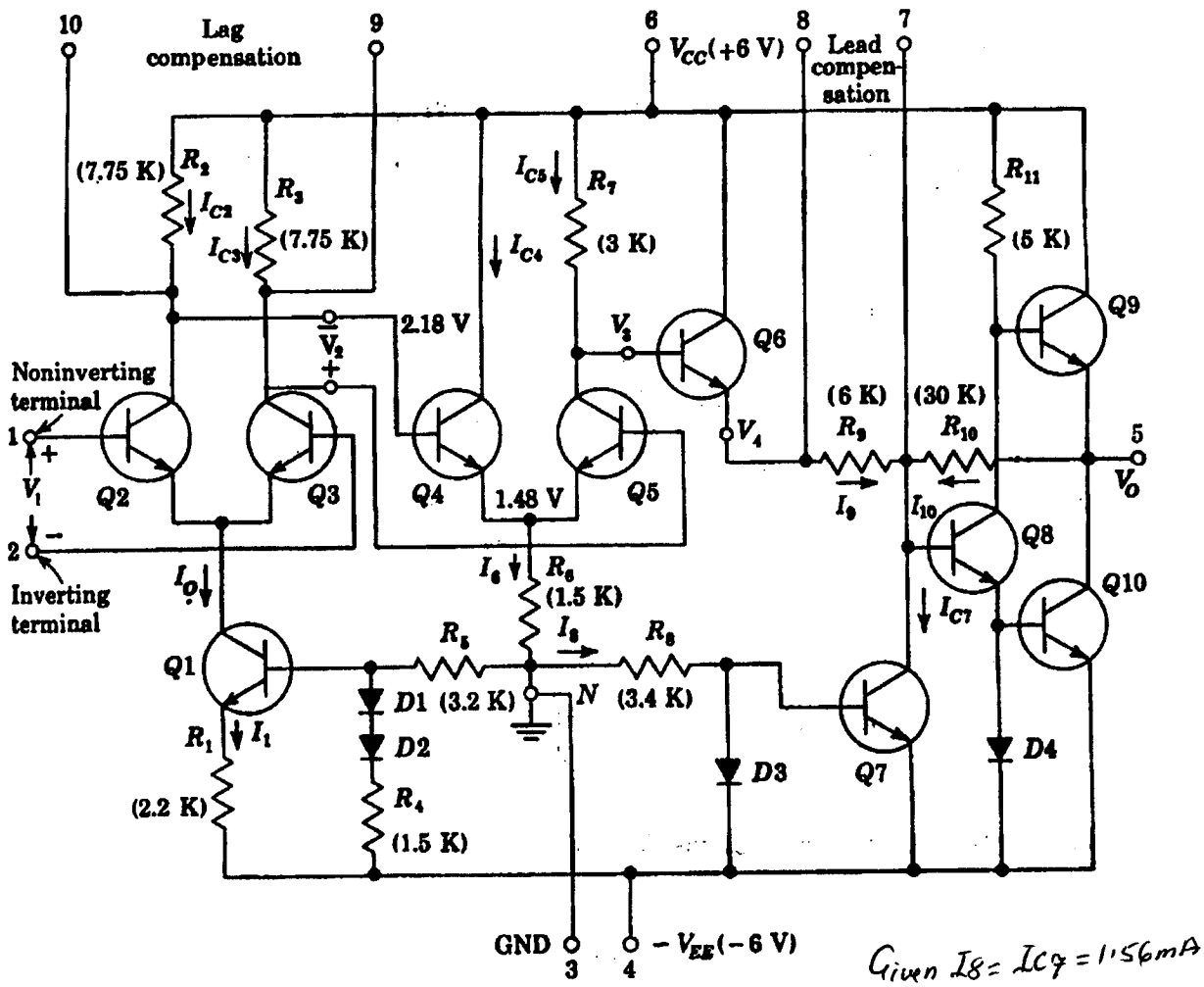


Fig 4.

Q4. Analyse this circuit to show that it is a differencing amplifier.

(a)

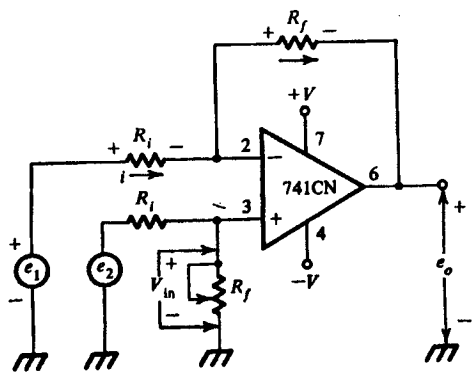


Fig. 5

(b) What is the voltage at point A and point B for the circuit of Fig. 6 if e_1 = 6v and
(c) e_2 = 6.2v

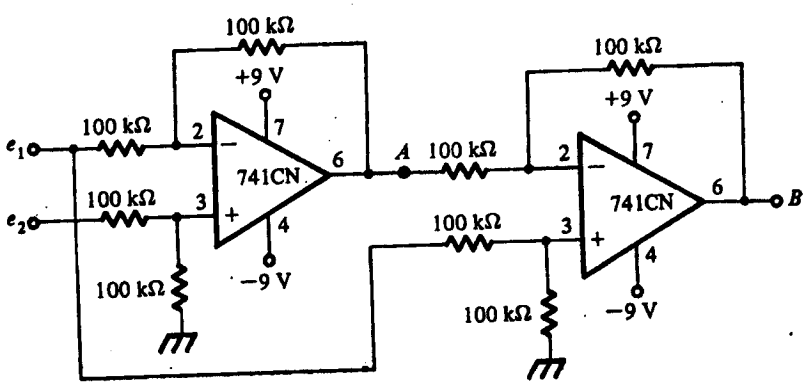


Fig. 6

Q5.

(a) The sketch given in figure 7 is that of a DC power supply

Draw sketches and state equation for

(i) the peak value of the secondary circuit
(ii) the ac to dc conversion (without filter)
(iii) the filtered output

Therefore state Vpk, Vripple, Vmin, and Vdc.

Design an adjustable voltage regulator (3v to 28v) with a short circuit current limit of 60mA, (Fig 8)

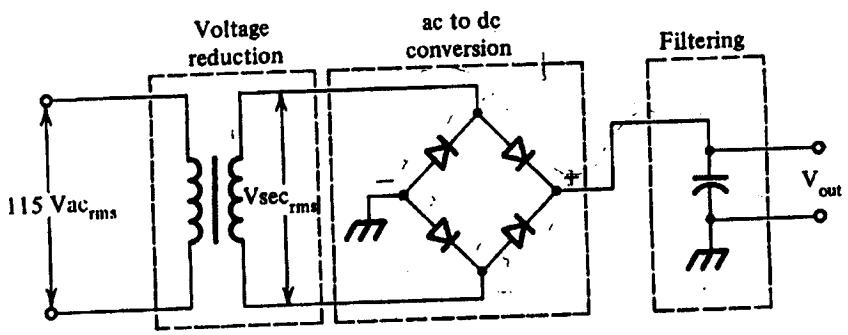


Fig. 7

(b) Design an adjustable voltage regulator (3v to 28v) with a short circuit current limit of 60mA, shown in fig. 8

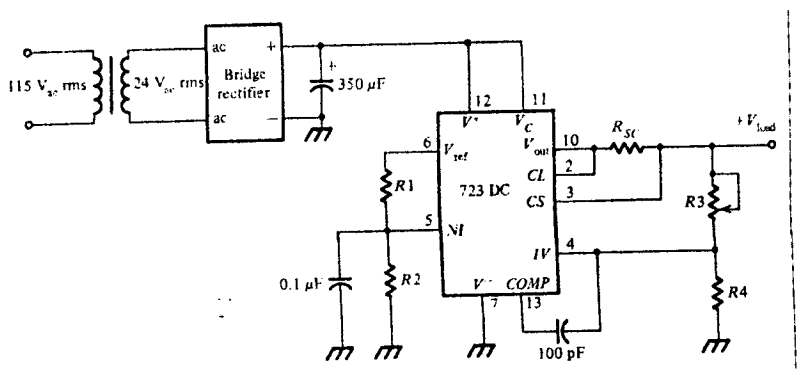


Fig. 8

Q6. (a) State the requirements for sinusoidal oscillations
(b) Analyze the circuit in fig. 9 to find expressions for μo,β, fɔ.
(c) Design a wien-bridge oscillator, using an op amp to oscillate At 1KH with an adjustable output amplitude.

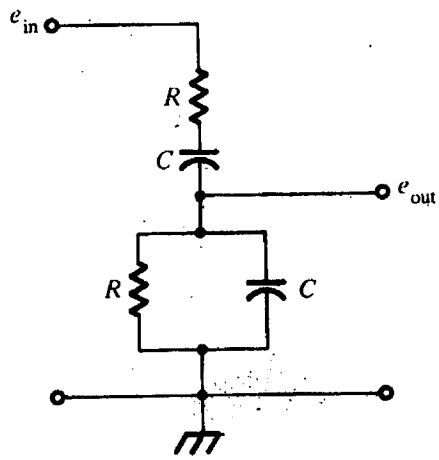


FIG. 9

7. The given circuit Fig 10. is that of the common emitter amplifier.

Carry out high frequency analysis on the circuit to obtain expressions for Millen Capacitor CM, input admittance Yin, current gain Ai, mid frequency F_b.

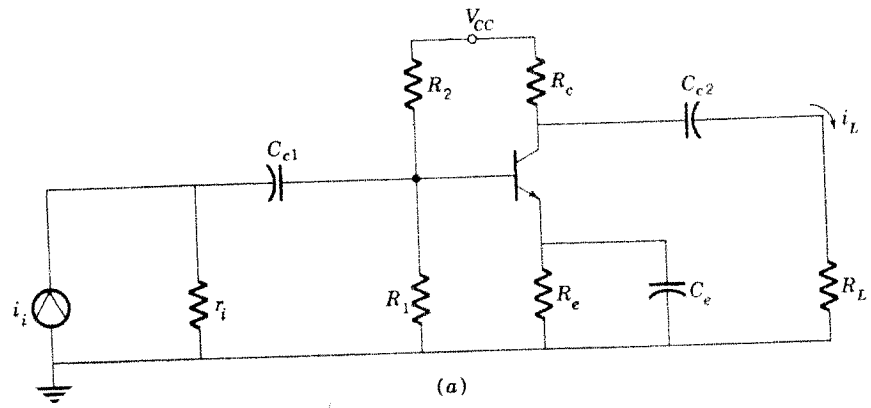


Fig. 10

8. An alarm system shown in Fig 11 will work as follows. When door is opened (switch s connected) the system is triggered and will sound for two minute producing a tone of 2 KHZ. Calculate the parameters that will implement this.

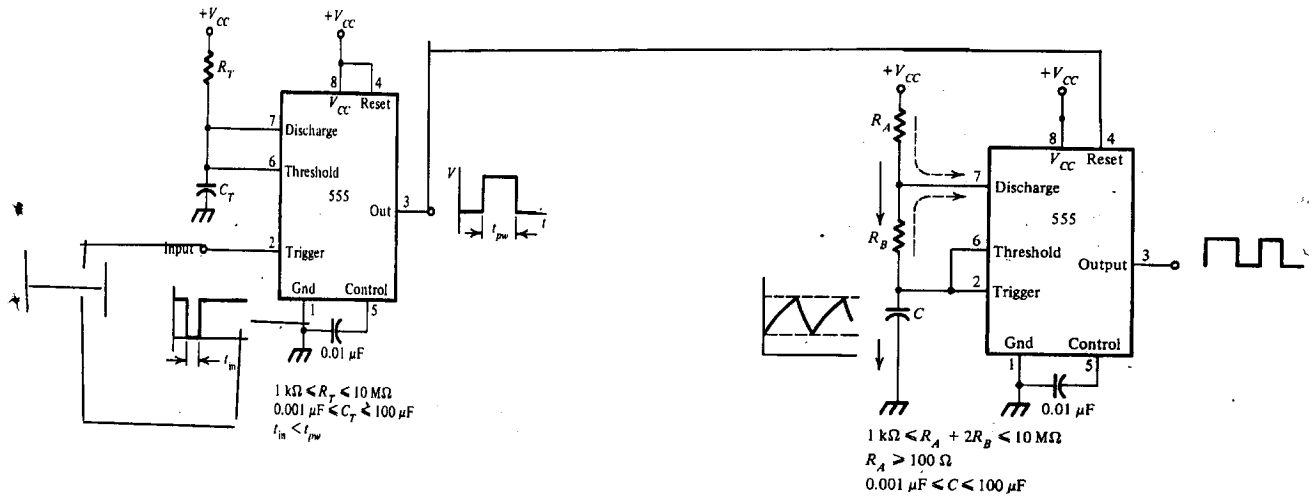


Fig. 11

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

UNIVERSITY EXAMINATION – OCT 2002

EE 462 ELECTRICAL INSTRUMENTATION

DURATION :3 HOURS

Answer five questions out of 8
Each question carries 20 points

Q1.

a) Discuss how a variable slope ADC can be used as a voltage-frequency converter (***10 marks***)

b) A tripple slope ADC operates in three phases for each conversion corresponding to three slopes. Explain the significance of the last phase (***10 marks***)

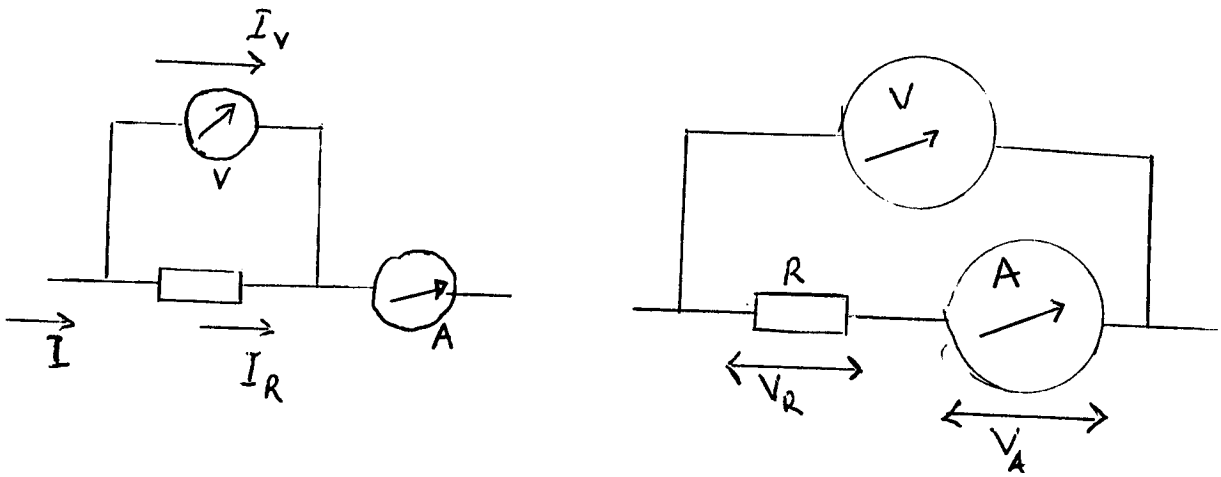
Q2 An ADC is required to convert analog inputs in the range 0 to 5V to an accuracy of at least 10mV. Determine the resolution in bits, for this converter (***20 points***).

Q3 Define the following technical specifications:

a) Linearity (***5 points***)
b) Offset and drift (***5 points***)
c) Rejection factor (***5 points***)
d) Monotonicity (***5 points***)

Q4 Consider two ways of measuring an unknown resistance R:

Circuit A **Circuit B**



Given that: $R_{voltmeter} = R_V = 20k\Omega$

$R_{ampmeter} = R_A = 1k\Omega$

$R_{measured} = R_M = V/I$ (for both circuits)

$R_{exact} = R_e = V/I_R$ (circuit A)

$R_{exact} = R_e = V_R/I$ (circuit B)

And the **Error** = $E = \dfrac{|R_M - R_e|}{R_e} \times 100\%$

a) Which circuit gives the best accuracy for high values of **R**? (***4 points***)

b) Derive two graphs of accuracy as a function of R/R_V, and R/R_A (***8 points***)

c) Find the optimum value of **R** (optimum value for which the accuracies using circuit A or circuit B are the same) (***8 points***)

Q5 For some strain gauge, a wire of length **L = 10 cm** with cross-sectional area **0.1mm^2** is used.
A force has stretched this wire to a length of **10.1cm**. The resistivity of this material is $\rho = 10^{-6}$ **Vm/A.**

a) Calculate the initial resistance before stretching the wire (***10 points***)

b) Calculate $\Delta R/\Delta L$ (***10 points***)

Q6 a) Define oversampling in data acquisition systems, focussing on the relationship between oversampling factor **N** and the number of bits gained **R**. (***5 points***)

b) What is meant by the Nqvist creterion? (***5 points***)

c) Name three component features of the automated electronic measurement structure

(***5 points***)

d) What is meant by the term dynamic range? (***5 points***)

Q7 Define and also derive the equations(where they exist), for each of the following terms:

a) Forced oscillations (***5 points***)
b) Damped oscillations (***5 points***)
c) Logarithmic decrement (***5 points***)
d) Damping factor (***5 points***)

Q8 a) Design an instrumentation amplifier driven by a fixed DC bias voltage for which a small change in differential output voltage is the net result. (***10 points***)

b) Give one example of the use of such an amplifier and describe its characteristics.(***10 points***)

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS OCTOBER 2002
SEMESTER II

EE 552 ELECTRICAL POWER SYSTEMS II

TIME: THREE HOURS
ANSWER: QUESTION 1 AND FOUR OTHERS.
EACH QUESTION CARRIES 20 MARKS

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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 aided by the Ministry of Education and Ministry of Health rural solar power programs 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 rural communities if rural telecommunications and ICT centres are created at schools and hospitals throughout Zambia? (10 Marks)

   (ii) State six of the important aspects of the overall power system which are considered when planning a new transmission addition. Also state nine out of fourteen important factors that the design of the transmission addition in an EHV network must take into account. (10 Marks)

2. (i) What is the load-flow problem? If you observe that the frequency is decreasing and the voltage magnitude is decreasing in a power system, what does this signify? What is the optimal number of voltage swing buses which are required in wheeling power from Congo DR to South Africa via Zambia in order to satisfy the load-frequency control objectives? State the two basic LFC objectives for an interconnected power system? Under what conditions is the area control error zero under LFC operating conditions? (10 Marks)

   (ii) Define insulation co-ordination with the aid of the peak voltage strength as a function of time. Define basic insulation level. State the transient threat and solution for : a stand-alone PC with peripherals in different outlets; ICT systems in separate buildings; ICT power-line and dataline interface.(10 Marks)

3. (i) What are the three major sources of voltage transients? What is an isokeraunic map? What type of equipment is affected by sags and swells? What equipment can provide effective protection against sags and swells? What are the three basic requirements that should be specified on a surge suppressor rating plate? (10 marks)

(ii) What is a Bewley lattice diagram? For a lossless line of : length l = 300 km, wavelength =5000 km, ,ν (wave velocity =3 x 10^8 m/s, V_S=V_R = 765 kV, Z_G = 0, Z_R = Z_C = 266.1 ohms . Define and calculate: $\Gamma_S(s)$, $\Gamma_R(s)$, Z_C ,ν, τ (the transient time), SIL (surge impedance loading) and P_{max} the theoretical steady state stability limit for the line. (10 Marks)

4. (i) 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. (5 Marks)

(ii) Given a 20-kV three-phase generator feeding a 20-Y/0.400-D kV transformer which feeds the load via a three-phase circuit breaker. The combined generator and referred transformer impedance per phase is X = 8 Ohms, and R = 0.8 Ohm . Draw the per phase equivalent circuit with the circuit breaker included. Given that a bolted 3 phase short circuit occurs in the 400 V Busbars with maximum dc-offset, and the circuit breaker opens 3 cycles after fault inception. Determine the rms fault current, the rms momentary current at τ = 0.5 cycle which passes trough the circuit breaker and find the rms asymmetrical fault current the breaker interrupts. (15 Marks)

5. (i) Derive the interconnected sequence relations from the phase domain conditions of one 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)

(ii) Given a power system consisting of the series connection of : a generator G1(Z_1= Z_2 = j 0.1pu, Z_0 = j0.05 pu, E_G= 18kV,Y-grounded); 18 kV transmission line L1 (Z_1= Z_2 = j 0.4 pu, Z_0 = j0.8 pu); transformer T1(Z_1= Z_2 = j 0.05 pu, Z_0 = j0.05 pu 18kV Y-grounded, 330 kV Delta) . Draw the one line diagram. Consider a single LG fault on phase-A at the centre of the transmission . Find V_F for each phase at point of fault and determine the corresponding Z_1, Z_2, Z_0 sequence network. (10 Marks)

6. (i) By way of a power angle diagram define the Equal Area Stability Criterion for a synchronous generator. Assume a round rotor generator delivering power in steady state to an infinite bus through a transmission line with reactance X_L = 0.4 pu , E_G = 1.8 pu, V_∞ = 1 pu, H = 5 s , X_d = X_q = 1 pu and P_M = 0.5 pu. Find the critical clearing angle and the corresponding fault critical clearing time. (10 Marks)

(ii) Draw the operating states transition diagram of a power system as a function of the equality and inequality constraints including the disaster , rebuild and recovery states. How can a power system have a high inherent system reliability if it is designed based on the transition diagram? is the significance of this 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)

END OF EE 552 EXAMINATION

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
UNIVERSITY EXAMINATIONS OCTOBER 2002
SEMESTER II

EE 552 ELECTRICAL POWER SYSTEMS II

TIME: THREE HOURS
ANSWER: QUESTION 1 AND FOUR OTHERS.
EACH QUESTION CARRIES 20 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 aided by the Ministry of Education and Ministry of Health rural solar power programs 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 rural communities if rural telecommunications and ICT centres are created at schools and hospitals throughout Zambia? (10 Marks)

   (ii) State six of the important aspects of the overall power system which are considered when planning a new transmission addition. Also state nine out of fourteen important factors that the design of the transmission addition in an EHV network must take into account. (10 Marks)

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   (ii) Define insulation co-ordination with the aid of the peak voltage strength as a function of time. Define basic insulation level. State the transient threat and solution for : a stand-alone PC with peripherals in different outlets; ICT systems in separate buildings; ICT power-line and dataline interface.(10 Marks)

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6. (i) By way of a power angle diagram define the Equal Area Stability Criterion for a synchronous generator. Assume a round rotor generator delivering power in steady state to an infinite bus through a transmission line with reactance X_L = 0.4 pu , E_G = 1.8 pu, V_∞ = 1 pu, H = 5 s , X_d = X_q = 1 pu and P_M = 0.5 pu. Find the critical clearing angle and the corresponding fault critical clearing time. (10 Marks)

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END OF EE 552 EXAMINATION

The University of Zambia
School of Engineering

Semester II Final Examinations – 29 th October, 2002.

EG 269: Information Technology

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

Please! Answer Section A and Section B on separate answer booklets! DO NOT tie the two sections together.

SECTION A

Answer THREE (3) ONLY questions ONLY from this section

QUESTION 1

The Information technology age has seen the merging of computer technology with communications technology and brought about the revolution of information Systems.

a) Explain how Information technology has revolutionarised information Systems using internet as an example. (10 Marks)

b) b) Identify the computer technology and communications technology involved in internet service provision to a small company. (10 Marks)

(Total 20 Marks)

QUESTION 2

Softech is a new software company formed to assemble software components that can be used by several programmers as library functions

a) Discuss whether the prospect of a software factory is a practical proposition. (10 Marks)

b) Discuss the merits of such a library being written in
- i) an assembly language
- ii) high level language (10 Marks)

(Total 20 Marks)

QUESTION 3

Use C++ to answer the following questions

a) What kind of data types would you use to declare the following data elements
   i) 12045
   ii) 'S'
   iii) 4.28915
   iv) Chibichesu
   v) 1, 2, 6, -9 (5 Marks)

b) If a, b and c are integers, what is the value of the following expressions given a=3, b=11 and c=9
   i) b%3
   ii) b/3
   iii) (a>b) || (c!=a)
   iv) b-4* c%(a+1) (8 Marks)

c) What will the following program print out?

```
# include<iostream.h>
void main()
{
  int sum, n;
  sum=0;
  for (n = 2; n <= 12; n = n+2)
  { cout << n;
    sum = sum + n;
  }
  cout << sum;
}
```

(7 Marks)

(Total 20 Marks)

QUESTION 4

(a) Explain briefly each of the following programming concepts
i) Pointer
ii) Data structure
iii) Function
iv) Class (12 Marks)

(b) Write a C++ to compute the roots of a quadratic equation (8 Marks)

(Total 20 Marks)

Section B: Answer question five (5) and any other one question from this section

Question 5: (25)

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

> *.....All the students studying in the school of Engineering should be recorded. This information will include: Student names, ID numbers, date of birth, the department ID to which the student belong, year of study, hostel number, and home address. Since the school is broken down in departments, we'll also need the following information documented: Department names, department identification number, head of department by Man number or names, and the floor on which the department is located. The course names, course numbers, credit hours, the department in charge and the lecturers of all the courses offered by the school must be documented. Records on all the members of staff should include: Staff name(s), Man number, Department ID and residential address. For academic staff, the Qualifications (i.e. MSc, PhD, Prof...) and courses(by course numbers) involved in must be given. And the records for Technical staff should also include the position and the Man number of the immediate supervisor. Being industrial oriented, all the projects coordinated by the School must be identified with Project name, site location, project leader(by man number) and the ID of the coordinating department. 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. Underline the possible key attribute(s) for each entity.
b) Identify the relationships existing between the entities.
c) For each entity type, group the attributes into atomic, composite and multi-valued.

Question 6: (10+5)

a) Categorize the two main classes of database users and explain the functions of each category. Give two applicable examples of each category.
b) What differentiates a GIS database from other database systems?

Question 7: (10+5)

c) Explain how you would apply GIS in the expansion of the Great East Road (currently going on). Indicate in your explanation what would be the possible outputs from GIS to assist in the expansion works.
d) What type of data model would be suitable for the creation of a digital map of the University of Zambia? Explain your reasoning.

********** **GOOD LUCK** **********

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
UNIVERSITY SEMESTER II EXAMINATIONS 2001/2002
(OCTOBER 2002)

EG 475 - ENGINEERING MANAGEMENT AND SOCIETY I

INSTRUCTIONS

1. There are separate instructions for the two sections.
2. All questions carry equal marks (20 %). Marks for sub-questions are indicated at the end of each sub-question
3. Make sure the computer number is clearly indicated on all the booklets together with the questions attempted

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

SECTION A: ATTEMPT QUESTION 1 AND ANY OTHER THREE QUESTIONS.

Question 1

The following is an extract from a recent article in one of the local dailies:

> ***Italians to set up drugs Company***
> *An Italian firm intends to set up a pharmaceutical company in Zambia to manufacture cheap HIV/AIDS anti-retroviral drugs, Vice-president Enoch Kavindele has said.*
> *Mr Kavindele said this yesterday at Lusaka international airport on arrival from Switzerland where he attended a one day New Economic Partnership for African Development (NEPAD) summit.*
> *"We had bilateral talks with the Italian officials who are keen to set up a pharmaceutical company in Zambia that would manufacture anti-retroviral drugs (ARV) for our people infected with HIV/AIDS".*
> *He said apart from Italy, he had talks with several other countries with interest to promote business here.*

a) You have been appointed by the Government of the Republic of Zambia to be part of a team that would, among other things, recommend investors for setting up of a drug company in Zambia.

   i) Why is the Italian firm interested in setting up a plant in Zambia? (5 Marks)

   ii) As a local expert, why do you think the Zambian government should consider the Italian proposal? (5 Marks)

   iii) As part of your risk analysis, what issues do you think the government should be concerned with? (5 Marks)

b) Give 5 conditions that favour the transfer of technology. (5 Marks)

Question 2

a) List and briefly describe the major channels of International Technology Transfer. (10 marks)

b) What is Appropriate Technology? (3 marks)

c) What factors would you consider when determining the appropriateness of a particular technology? (7 marks)

Question 3

a) What is Technological change? (4marks)

b) Briefly discuss the major sources of technological change. (4 marks)

c) What role should the Government play in promoting Technological advancement? (7 marks)

d) Why should Government be involved in the shaping and advancement of Technology? (5 marks)

Question 4

(a) Give a detailed explanation of the following phenomena:

i) Global warming. (5 marks)

ii) Ozone layer depletion. (5 Marks)

(b) Outline the major strategies that one would adopt to protect the biosphere from threats that have arisen due to industrialisation. (4 marks)

(c) Explain the concept of Cleaner production. (6 marks)

Question 5

a) Explain, with the use of examples, the following terms: (6 marks)

i) Comparative advantage.

ii) Resource effect.

iii) Scale effect.

b) Outline the major characteristics of an engineering problem. (7 marks)

c) Rewrite the following sentences in active voice: (3 marks)

i) Control of the bearing-oil supply is provided by the shutoff valves.

ii) Leaking of the seals is prevented by the use of O-rings.

iii) Fuel-cost savings were realised through the installation of thermal insulation.

d) Rewrite the following sentences to remove redundancies: (4 marks)

i) This story is based on Mr Zulu's actual experience.

ii) The truck delivered two cubic meters in volume of water.

iii) Gaseous chlorine containers are normally Cylindrical in shape.

iv) The filter material must be uniformly homogeneous.

Question 6

In the period after Independence, the government embarked on a programme of industrialisation based on policy of import substitution. In promoting self-reliance, domestic industries were encouraged to produce manufactured goods. This support operated through putting tariff barriers on imports, keeping close government control over foreign exchange and restricting access to many multinational enterprises. The government of President Kenneth Kaunda created a large number of state-owned conglomerates called parastatals. These organisations ensured that the agricultural, mining and manufacturing output was controlled by the government. Output and pricing decision were in line with objectives of self-sufficiency and the reduction of poverty.

In the 1990s, the newly elected government of President Frederick Chiluba adopted an alternative strategy for industrialisation.

a) Why did this strategy fail to achieve industrial development and economic growth? (7 marks)

b) What alternative strategies did the Government implement? (7 marks)

c) What is Export oriented industrialisation (EOI)? (2 marks)

d) What are the draw backs of EOI? (2 marks)

e) Give the advantages of EOI over import substitution industrialisation. (2 marks)

SECTION B: ATTEMPT ANY ONE QUESTION

Question 7

You wish to set up in business as a manufacturer, to produce engineering spares and parts. Your target market is both local and export market. Before you embark on this venture, you seek the assistance of a Consultant in formulating the business plan and in particular the caption called "The Market".

a) Itemise what you expect the Consultant to cover under this caption. (12 Marks)

b) Explain what a business plan is. (4 Marks)

c) What is the purpose of the business plan? (4 Marks)

Question 8

One feature of the current trading environment has been that a number of Organisations which although profitable according to their financial statements have collapsed because of lack of cash.

Comment with reference to the cash flow forecast below the financial position of XYZ for the six months to December 2002 and what interim action would you take. (20 Marks)

XYZ Company Limited

Cash flow forecast for the six months to December 2002

Months	July	August	September	October	November	December	Total
Inflows							
Debtors	30,000	40,000	56,000	64,000	72,000	80,000	342,000
Cash sales	3,600	3,800	3,900	3,800	3,600	3,800	22,500
	33,600	**43,800**	**59,900**	**67,800**	**75,600**	**83,800**	**364,500**
Outflows							
Creditors	24,000	28,000	32,000	40,000	48,000	52,000	224,000
Salaries	18,000	18,000	18,500	18,500	18,500	18,500	110,000
Purchase of van	4,000	0	0	0	0	0	4,000
Company tax	0	0	3,000	0	0	0	3,000
	46,000	**46,000**	**53,500**	**58,500**	**66,500**	**70,500**	**341,000**
Net cash flow	**(12,400)**	**(2,200)**	**6,400**	**9,300**	**9,100**	**13,300**	**23,500**
Opening balance	**4,000**	**(8,400)**	**(10,600)**	**(4,200)**	**5,100**	**14,200**	**4,000**
Closing balance	**(8,400)**	**(10,600)**	**(4,200)**	**5,100**	**14,200**	**27,500**	**27,500**

Question 9

The summarised final accounts of ABC for the year ended 31 March 2002 were as follows:

ABC Trading Limited

Trading and Profit and Loss Account for the year ended 31 March 2002

	K
Sales	52,000
Less Costs of Sales	38,000
Gross Profit	14,000
Less Overhead Expenses	8,300
Net Profit	5,700

Balance Sheet as at 31 March 2002

		K
Fixed Assets		27,000
Current Assets		
Stock	4,300	
Debtors	1,200	
Bank	1,500	7,000
Current Liabilities		4,000
Long Term Loan		5,000
		25,000
Capital		18,000
Retained Profits		7,000
		25,000

N.B. Stock on 1 April 2001 was K5,000.

The average figures of performance for that type of and size of business in that area (as obtained from the trade association sources) were:

Gross profit/Turnover	31.2%
Net profit/Turnover	12.4%
Net profit/Net capital employed	14.2%
Stock turnover	11.8 times
Current ratio	1.6:1

Required:

a) Calculate the above ratios for the above business (5 Marks)

b) Suggest possible reasons for the difference revealed between the ratios in (a) and the "average" ratios (10 Marks)

c) State briefly what you understand to be the meaning of the terms "profitability" and 'financial stability" (2 Marks)

d) Name three ratios that can be used for measuring the profitability and three ratios for measuring financial stability. (3 Marks)

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
EG 575-ENGINEERING, MANAGEMENT AND SOCIETY 2001-2002
SEMESTER II FINAL EXAMINATION, OCTOBER 2002

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

Instructions

Answer five (5) questions, two (2) questions from section A, all questions in section B and one (1) question from section C. Use separate answer scripts for each section.
All questions carry equal marks (20 marks).

Question 1.

1.1 You have been tasked, as a junior engineer, to carry out an appraisal. Define to the appraisee what an appraisal is and discuss briefly what it often involves from the employers point of view.

1.2 The company you work for has just recommended, for Mr. Mwanza as a new employee coaching, and mentoring as training processes. Other than that Mr. Mwanza has to carry out a work study. Discuss in detail these stages in Mr. Mwanza's employment development.

Question 2

Your company has organised an in house seminar and as one of the presenters you are required to discuss in details public corporations, local governments, use of resources and market systems.

Question 3

Discuss in detail conduct, capability, redundancy, legal prohibition and any other substantial reason as forms of employment dismissal.

Section B

Question 4 (5+10+5)

(a) What are organizational objectives
(b) Discuss all the steps of the strategy management process, highlighting the main components of each step.
(c) Contrast between strategic planning and tactical planning

Question 5 (5+5+5+5)

(a) What is meant by managerial effectiveness and efficiency?
(b) What are the purposes of planning?
(c) What is meant by break-even point? Illustrate with a figure defining all the terms.
(d) What do you understand by apportionment to cost centers. Give an example.

Section C

Question 6

Distinguish an offer from an invitation to a treat. Your answer should be supported by authorities.

Question 7

Discuss in detail the legal principles established in the case of Doughue vs. Stevenson (1932) ALL ER 562.

End of EG 575 – Engineering, Management and Society II Examination.
Good Lucky

THE UNIVERSITY OF ZAMBIA
UNIVERSITY SECOND SEMESTER EXAMINATIONS
OCTOBER/NOVEMBER - 2002

EM212 - ENGINEERING MATHEMATICS II

INSTRUCTIONS: There are seven(7) questions in this examination paper. Candidates must answer ANY five(5) questions of their choice. All questions carry equal marks. Show all your working to earn full credit.

TIME ALLOWED: Three (3) hours.

---

1. (a) Given the matrix $A = \begin{pmatrix} 1 & -1 & 4 \\ 3 & 2 & -1 \\ 2 & 1 & -1 \end{pmatrix}$,

(i) find its characteristic equation and the corresponding eigen values and eigen vectors.

(ii) find the matrix C so that

$$C^{-1}AC = \text{diagonal matrix.}$$

(b) Estimate the value of ρ upto 4-places of decimals given that
$(\rho - 1.97)(\rho + 1.97) = (4.02)^2$

---

2. (a) Determine whether or not the vectors $v_1 = (1, -3, 0)$; $v_2 = (3,0,4)$ and $v_3 = (11, -6, 12)$ are linearly dependent.

(b) Solve the following system of equations:

$$2x_1 + 4x_2 + 6x_3 = 18$$
$$4x_1 + 5x_2 + 6x_3 = 24$$
$$3x_1 + x_2 - 2x_3 = 4$$

(i) by "Gauss ellimination" method.

(ii) using the augumented matrix method.

3. (a) A round robin tennis tournament can be organised in the following way. Each of the n players plays all the others, and the results are recorded in an n x n matrix $\mathfrak{R}$ as follows:-

$$R_{ij} = \begin{cases} 1 & \text{if the } i^{th} \text{ player beats the } j^{th} \text{ player.} \\ 0 & \text{if the } i^{th} \text{ player loses to the } j^{th} \text{ player.} \\ 0 & \text{if } i = j \end{cases}$$

The i^{th} player is then assigned the score

$$S_i = \sum_{j=1}^{n} R_{ij} + \frac{1}{2}\sum_{j=1}^{n} (R^2)_{ij}$$

(i) In a tournament between four-players

$$R = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 \end{pmatrix}$$

Rank the players according to their scores.

(ii) Interpret the meaning of the score.

(b) A cylindrical tin has an inside radius of 5cm and a height of 2cm. The thickness of the tin is 0.2cm. Estimate the amount of tin needed to construct the can (including its ends).

(c) Determine whether the vectors $\begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$, $\begin{pmatrix} 2 \\ -2 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \\ 7 \end{pmatrix}$ are linearly dependent or linearly independent.

4. (a) A state Fish and Game Department supplies three types of food to a lake that supports three species of fish. Each fish of species 1 consumes, each week, an average of one unit of food 1, one unit of food 2 and two units of food 3. Each fish of species 2 consumes, each week, an average of three units of food 1, four units of food 2, and five units of food 3. Each week 25,000 units of food 1, 20,000 units of food 2 and 55,000 units of food 3 are supplied to the lake. If we assume that all food is eaten, how many Fish of each species can coexist in the lake? Suppose we have 6,000 fish of species 3, calculate the number of fish of species 1 and species 2.

(b) Find the general solution to the following differential equation

$$y'' - y = x^2$$

---

5. (a) Solve the equation

$$y'' + y = xe^{2x}$$

(b) Let C denote the oxygen consumption of a fur bearing animal, let T denote its internal body temperature, let t denote the outside temperature of its fur, and let w denote its weight. Experimentally, it has been found that if T is considerably larger than t, then a reasonable model for the oxygen consumption of the animal is given by

$$C = \frac{5(T-t)}{2\left(\sqrt[3]{w}\right)^2}$$

Find (i) C_T (ii) C_t (iii) C_w

(c) The functions 1, x and x^2 are solutions to the equation $y'''(x) = 0$. Determine whether these are linearly independent or dependent.

---

6. (a) Solve:-

$$y'' - 3y' + 2y = e^x \sin x$$

(b) (i) Let V be the set of points lying on the line $y = 2x + 1$. That is, $V = \{(x,y): y = 2x + 1;\ x \in \Re\}$. Show that V is <u>not</u> a vector space.

(ii) Let $H = \{(x,y,z): x = at,\ y = bt$ and $z = at;\ a,b,c$ are real.$\}$

i.e. H consists of vectors in $\Re^3$ lying on a straight line passing through the origin. Show that H is a subspace of $\Re^3$.

---

7. What is meant by the following:-

A set of vectors $\{v_1, v_2, ..., v_n\}$ forms a <u>basis</u> for the vector space V.

Find a basis for the set of vectors lying on the plane

$$\Pi = \left\{ \begin{pmatrix} x \\ y \\ z \end{pmatrix} : 2x - y + 3z = 0 \right\}$$

Hence or otherwise, find a basis for the solution space S of the system

$$\begin{aligned} 2x - y + 3z &= 0 \\ 4x - 2y + 6z &= 0 \\ -6x + 3y - 9z &= 0 \end{aligned}$$

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

ME202/ME 302 – ENGINEERING DRAWING II
UNIVERSITY EXAMINATIONS
October 2002

Time: 4 hours. OPEN BOOK.
ANSWER ALL QUESTIONS!

The next page shows an assembly of an elastic coupling. The two coupling halves are identical. They have to be assembled at a distance of a few millimetres. Each coupling has eight (8) equally spaced large and small holes on a pitch circle of 132 mm. A small hole is situated between every two large holes. Eight (8) special bolts (non-standard bolts) and rubber bushes form the connection between the two coupling halves. A nut and a split pin lock every bolt. The two coupling halves are locked on the shafts (not drawn) by slotted set screws. Note that in the shown assembly only one coupling half shows the set screw because the section did not pass through the location of the set screw on the opposite half.

Q1 Prepare detail drawings of all non-standard parts. Tolerance every dimension and angle and indicate surface roughness.

Hints on Tolerancing:

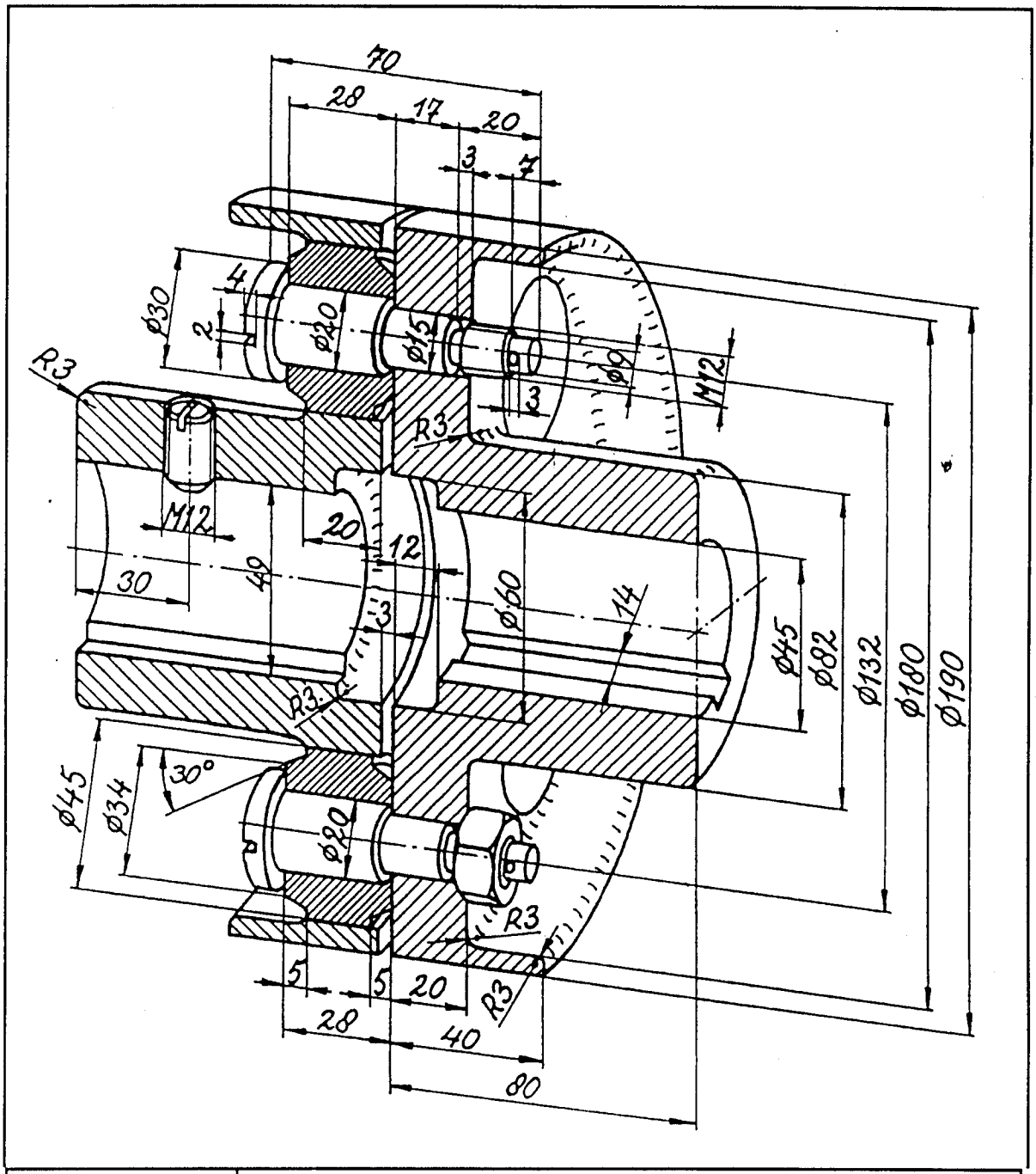
(i) Use the ISO code for small tolerances.
(ii) Use unilateral and/or bilateral tolerances for larger permissible deviations.
(iii) Use general tolerancing for cast and/or machined parts.

(40 (drawings) + **30** (dimensions) + **18** (surface) **Marks)**

Q2 Give a title block with title UNIVERSITY EXAMINATIONS and SCALE 1:1. Indicate the correct course code, that is, either ME 202 or ME 302.

(12 Marks)

END OF EXAMINATION



Course	Engineering Drawing II
Assessment	University Examinations – October 2002
Component	ELASTIC COUPLING
Institution	School of Engineering - UNZA
Class(es)	ME 202 and ME 302 Students

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY SEMESTER II EXAMINATIONS 2001-2002

ME 209 – ENGINEERING DRAWING I

TIME ALLOWED: FOUR (4) HOURS
CLOSED BOOK EXAM: TEXT BOOKS AND MARKED TUTORIAL SHEETS ARE NOT ALLOWED

INSTRUCTIONS

1. Answer a total of FOUR (4) questions in the following order:

SECTION A	One question (Compulsory)
SECTION B	Any two (2) questions
SECTION C	Any one (1) Question

2. Indicate your computer number just above the title block & Clearly Label each answered question.

3. Construction lines should not be erased and should be clearly visible.

4. Do not dimension unless otherwise stated.

5. Marks will be awarded for: Correct Solution, Accuracy, Neatness, Layout and Good Line Work

6. All dimensions are in millimeters.

SECTION A (Compulsory)

Q1. **Fig Q1** shows an exploded isometric drawing of a Bracket and pin. Omitting hidden details, draw in first angle projection and scale 1-1 the following:

(i) An assembled Front Elevation looking in the direction of Arrow A
(ii) An assembled Sectional End Elevation on C-C
(iii) Give a parts list and six important dimensions

[40 Marks]

SECTION B (Answer any TWO (2) questions from this section)

Q2. **Fig Q2** shows "Uncle Deez's" proposal for a beer jar to store his favorite "brown and white stuff". You have been approached to produce a drawing of scale 1-1 of the jar to be presented to a manufacturer. The handle assumes a parabolic profile with its focal point being at distance 20mm along the axis from the directrix. Use fillet radius equal to 3mm for joining the handle to the jar.

[15 Marks]

Q3. **Fig Q3 (a)** shows a photograph of a lorry-mounted crane. A line drawing of the crane in its position while the lorry is traveling is shown in **Fig. Q3 (b)**

- In use, the arm AB swings clockwise in a vertical arc about A through a maximum of 90^{o};
- The arm BC swings clockwise in a vertical arc about B through an angle of 120^{o};
- The end C extends from C to C_1 (being maximum position of C as arm BC opens). In it's closed position, BC = BC_1.

Assuming that each movement is at a uniform velocity and takes place at the same time, draw the locus of C from the given position to the maximum extension of each part of the crane.

[15 Marks]

Q4. **Fig. Q4** shows the plan and elevation of a tin-plate dish.

i) Draw the given views and construct a development of the dish showing its corners interconnected and the seam being at 1-1. Attach the base to one of the sides of the development.

ii) Calculate the area of the plate require to produce a single dish.

[15 Marks]

SECTION C (Answer any ONE (1) question from this section)

Q5. The diagram Fig. Q1C shows part of a circuit used to control a sliding door, PS1(NO) is a Pressure Mat, PS2 (NO) is a Push Button switch. The relay coil C operates a set of four pole change over contacts. The power supply is 6 VDC. The other components not shown are:-

i) A permanent magnet dc motor M which operates the mechanism for opening and closing a sliding door.

ii) MS1 (NC) - a limit switch which is activated when the door is fully closed.

iii) MS2 (NC) - a limit switch which is activated when the door s fully open.

Using standard symbols and dimensions given in class draw the Fig. Q1C on A2 paper.

a) Show the relay latch circuit

b) Add the motor control circuit such that when the relay coil is de-energised the motor closing operation is initiated. Include MS1 and MS2 switches.

[15 Marks]

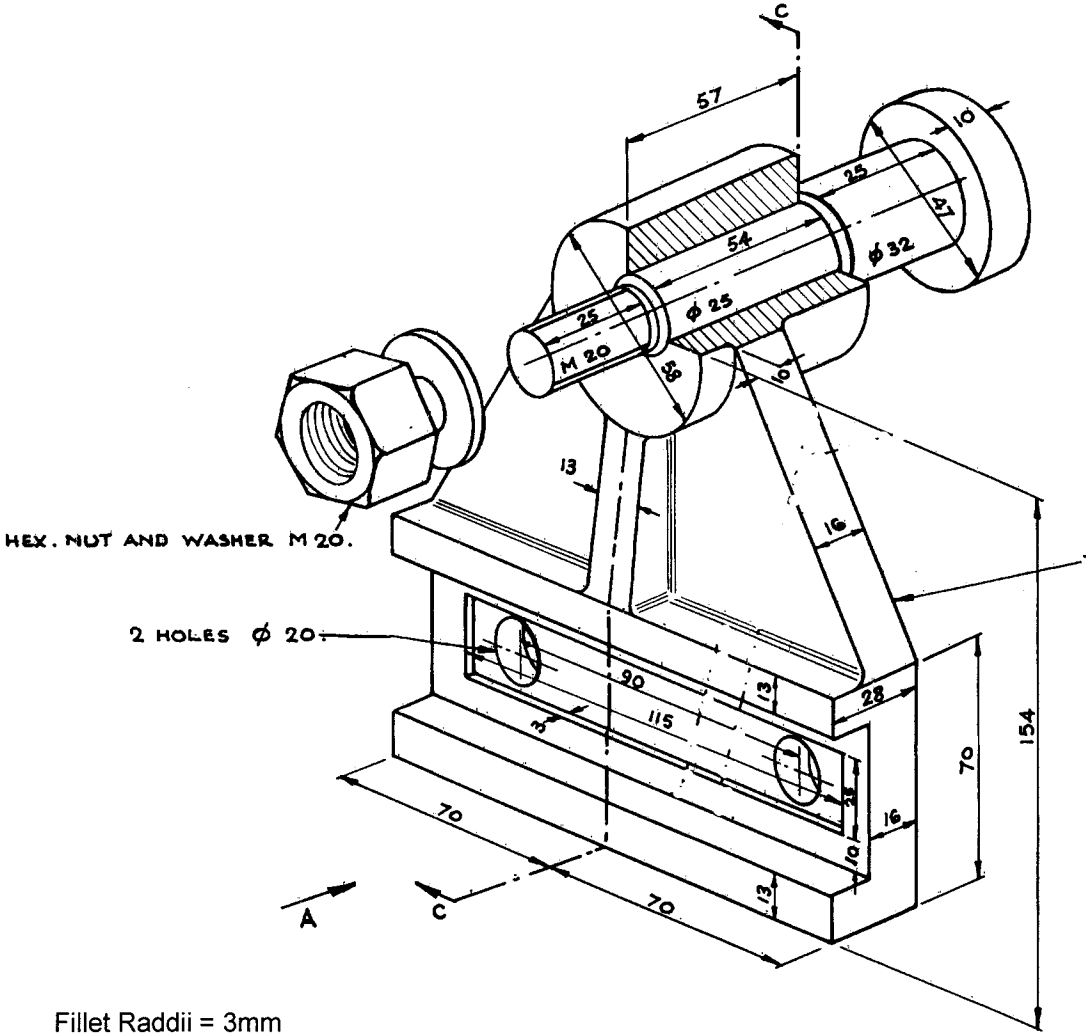
Q6. Fig Q2C is a circuit which utilizes Transistor Q (NPN) as a switch. Draw this circuit on part of A2 size paper and the associated Truth Table. Using the above circuit as a building block design and draw a NAND LOGIC GATE and the associated Truth Table on the rest of the drawing paper.

[15 Marks]

END OF ME 209 SEMESTER II FINAL EXAMINATION, 2002

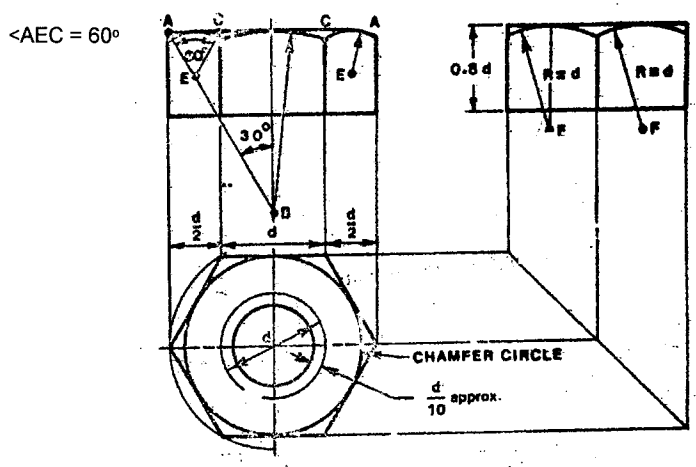
Prepared by: Mr. C.G. Chizyuka, Mr. A.P. Malichi & Mr. S.S. Virdy.

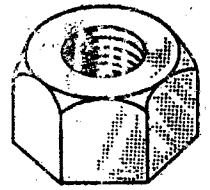
FIG. Q1 : BRACKET & PIN



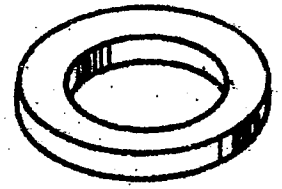
Fillet Raddii = 3mm

DETAILS FOR DRAWING THE NUT





DETAILS FOR DRAWING THE WASHER



INT DIA = d + 1 mm

EXT DIA = 2 d

THICKNESS = 0.2 d

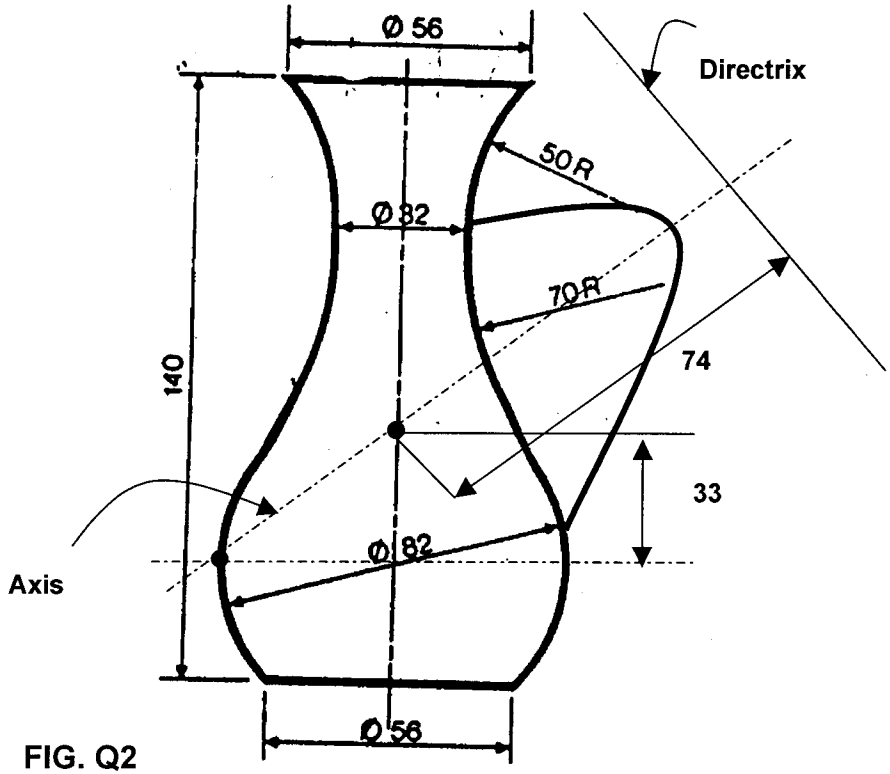


FIG. Q2

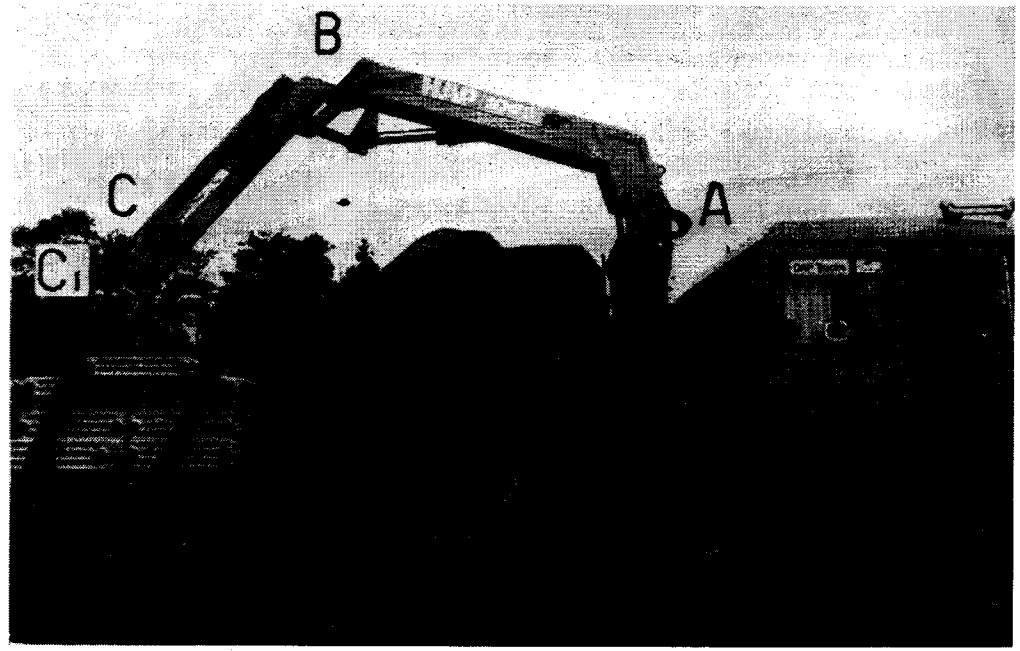
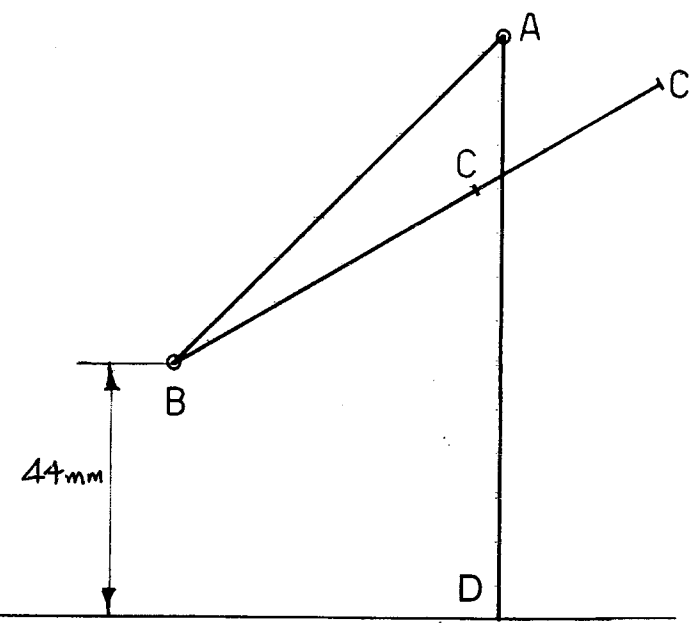


FIG. Q3 (a)

FIG. Q3 (b)

AB = 80mm
BC = 60mm
CC_1 = 32mm
AD = 100mm
<ABC = 15°



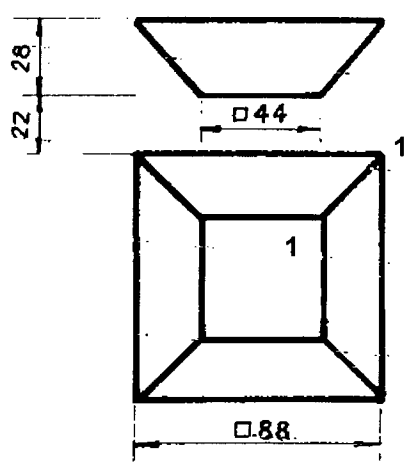


FIG. Q4

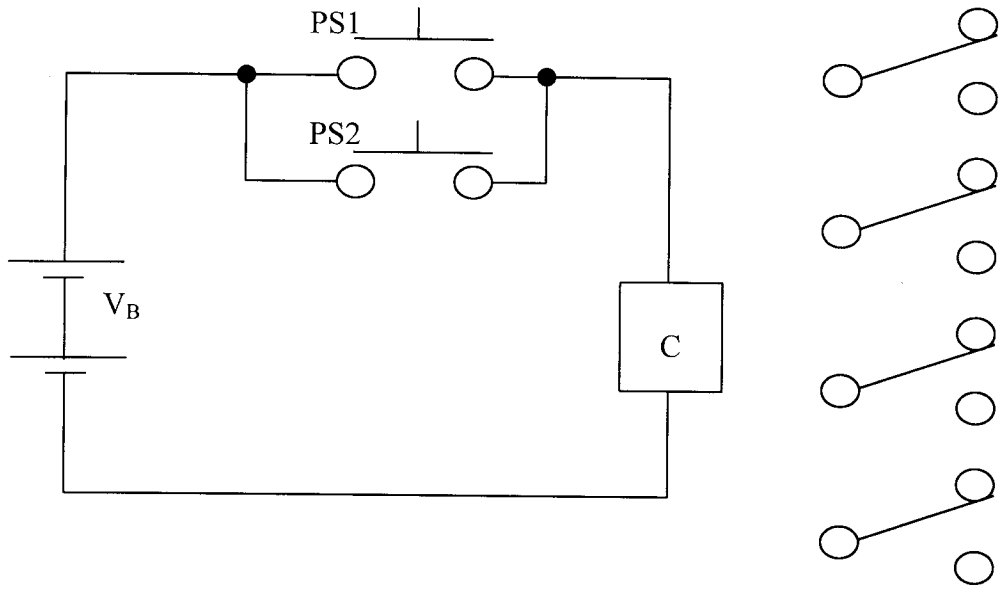


Fig Q 1 C

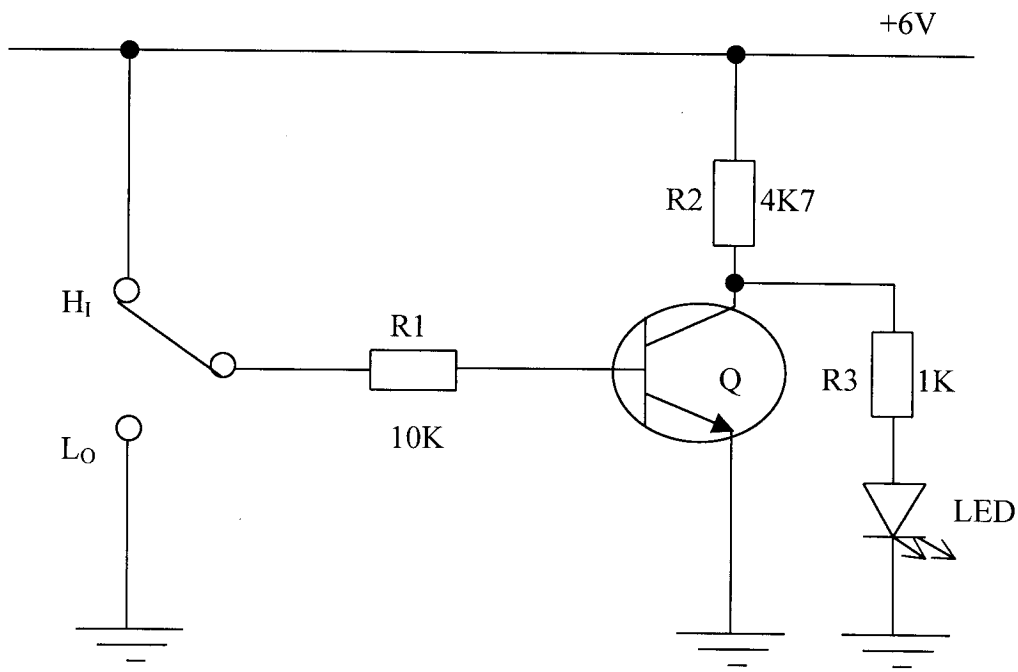


Fig Q 2 C

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL EXAMINATION SEMESTER II 2001/2002
OCTOBER/NOVEMBER 2002

ME 232 - PROPERTIES OF ENGINEERING MATERIALS I

Time Allowed: THREE Hours — CLOSED BOOK

ANSWER: Five Questions With At Least Two Questions from Each Section

HAND IN: Sections A and B in Separate Answer Books

All Questions Carry Equal Marks

SECTION A - Answer at least two questions from this Section.

Q1.

(a) Assuming that metal crystals can be considered as hard spheres in contact, determine the co-ordination numbers and packing fractions for the following crystal structures:
(i) Body-centred cubic [4 marks]
(ii) Face-centred cubic [5 marks]
(iii) Hexagonal close-packed. [5 marks]
[**Hint:** Packing fraction = (volume of atoms in unit cell)/(volume of unit cell)]

(b) Draw sketches showing the near neighbours of the atoms in these crystal structures.
(i) Body-centred cubic [2 marks]
(ii) Face-centred cubic [2 marks]
(iii) Hexagonal close-packed. [2 marks]

Q2.

(a) Draw a fully labelled Fe-C phase diagram up to 6.7% Carbon. [12 marks]

(b) With reference to your Fe-C phase diagram, for two plain carbon steels of 0.4% and 1.0% Carbon:
(i) Calculate the amount of austenite present in each of these steels at 723°C, assuming the transformation is complete. [2 marks]
(ii) Calculate the amount of pearlite present in each of these steels at 25°C, assuming slow cooling. [2 marks]
(iii) Suggest a typical application for each steel in its fully hardened and tempered conditions, and justify your choice. [4 marks]

Q3.

(a) What is electrochemical corrosion? [4 marks]

(b) Explain concisely each of the following forms of metallic corrosion
(i) Pitting [6 marks]
(ii) Corrosion fatigue [3 marks]
(iii) Stress corrosion [3 marks]
(iv) Fretting corrosion [4 marks]

SECTION B: - Answer <u>at least two questions</u> from this Section.

Q4.

Refer to the plot below (Figure Q4) of the engineering stress-engineering strain curve for stainless steel. E=200GPa. S_0 = 750 MPa, Poisson's ratio = 0.3, Sample Diameter = 50 mm and Sample Length = 100 mm.

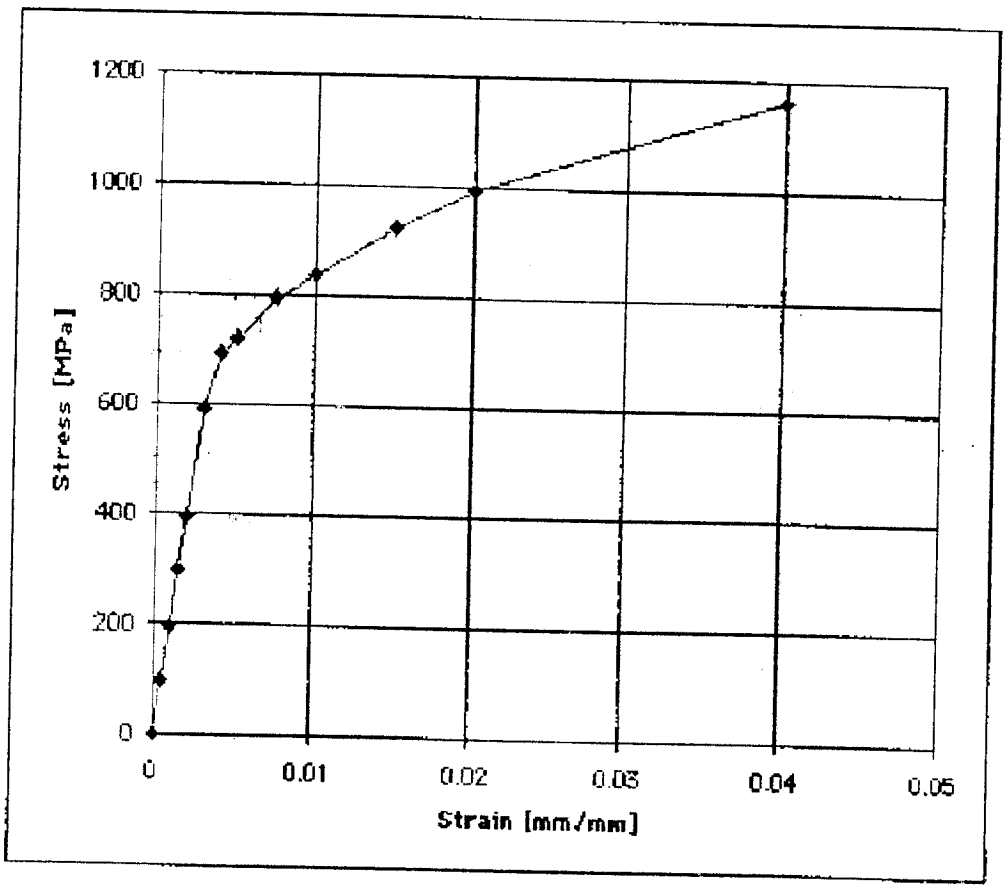


Figure Q4: Stress-Strain Plot

Assume the plot is made for testing the sample in **COMPRESSION**, and that it only undergoes uniform deformation.

(a) How much larger in diameter will the sample get when compressed with a load of P= 800,000 N? [5 marks]

(b) The stainless steel sample is loaded in compression with a load of **P = 1,964,000 N**, and then unloaded to **P = 0 N.** How much larger in diameter will the sample be? [5 marks]

(c) The stainless steel sample is loaded in compression with a load of P = ~~1,964,000 N~~ 1.5MN, and then unloaded to P = 0 N. How much larger in diameter will the sample be? [5 marks]

(d) What is the modulus of resilience for the stainless steel? [3 marks]

(e) Sketch the strain as a function of time for a sample with significant ANELASTICITY that is loaded and unloaded within the elastic region. [2 marks]

Q5.

(a) What are the three basic categories of polymer [2 marks]

(b) Briefly describe the two main types of polymerisation process [4 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 pore size, and explain your answer in words. [6 marks]

(d) How can the glass transition temperature of polymers influence the properties of the end products in service? [3 marks]

(e) A polystyrene component must not fail when a tensile stress of 1.25 MPa is applied. Determine the maximum allowable surface crack length if the surface energy of polystyrene is 0.50 J/m^2. Assume a modulus of elasticity of 3.0 GPa. [5 marks]

Q6.

(a) What are the principle reasons for the heat treatment of metals? [2 m arks]

(b) Name three important stages in annealing process. Describe briefly the change of strength and ductility in each stage. [6 marks]

(c) Using the isothermal transformation diagram (Figure Q6 on Page 4) for eutectoid composition shown below, specify the nature of the final microstructure of a specimen that has been subjected to the following time-temperature treatments. In each case assume that the specimen begins at 760^0 C and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure.

(i) rapidly cool to 250^0 C, hold for 1000 sec and rapidly cool to room temperature: [3 marks]

(ii) rapidly cool to 400^0 C, hold for 1000 sec and rapidly cool to room temperature: [3 marks]

(iii) rapidly cool to 600^0 C, hold for 3 sec, rapidly cool to 400^0 C, hold for 30 sec, and rapidly cool to room temperature: [3 marks]

(iv) rapidly cool to 300^0 C, hold for 30 sec, and rapidly cool to room temperature. [3 marks]

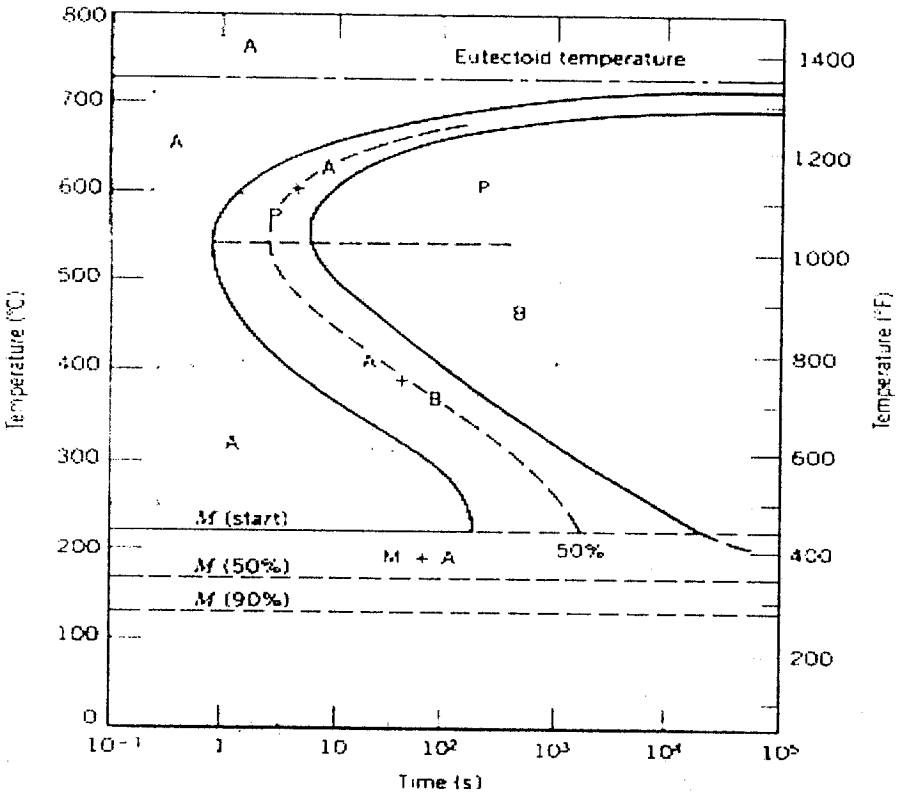


Figure Q6: Isothermal transformation diagram for eutectoid composition

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END OF EXAMINATION
Mr G M Munakaampe / Dr J Phiri

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

2001-2002 UNIVERSITY SEMESTER II EXAMINATIONS – OCTOBER 2002.

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.**

ANSWER THIS ONE

Q1. A slender, uniform rod of weight W is pivoted at the bottom end and is held in equilibrium by two springs, as shown in Figure Q1.

(a) Show that for small vibrations and $I_o = ml^2$, the natural frequency is given by

$$f_n = \frac{1}{2\pi}\sqrt{\frac{6gK}{W} - \frac{3g}{2l}}$$

[12 marks]

(b) At time t = 0 s, the angle θ (between the rod and the vertical) is 0.035 rad to the right of the vertical; while at the same time the angular velocity is 2 rad/s in a counterclockwise direction. If the stiffness of the spring is 2 kN/m, the length of the rod is 1500 mm and its weight is 49.05 N, determine:

(i) the angular displacement of the rod as a function of time and [6 marks]

(ii) the amplitude of the motion. [6 marks]

OR THIS ONE

Q1. – ALT.

.A boy starts from the centre O of a merry go-round and walks along the radial line OM fixed to the rotating platform (see Figure Q1. – ALT.). When he is 2.8 m from the centre O of the platform at point P, his velocity relative to the platform in the direction of M is 0.8 m/s and decreasing at a rate of 0.2 m/s^2. The merry go-round rotates in the direction shown at a constant rate of one revolution each 5 seconds. If θ = 30° when the boy reaches P, determine ;

(a) his absolute velocity in terms of X and Y components of the ground fixed axes (use unit vectors I and J) [12 marks]

(b) his absolute acceleration in terms of rotating x and y components. [12 marks]

Q2 An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hour. The rotary engine and the propeller of the plane weigh 400 N with a radius of gyration of 30 cm. The engine runs at 2,400 rpm, clockwise, when viewed from the rear. Find;

(i) the gyroscopic couple on the aircraft and state its effect on it. [14 marks]

(ii) What will be the effect, if the aeroplane turns to its right instead of to the left? [5 marks]

Q3. A shaft rotating at 120 rev/min is supported in bearings A and B, 1.8 metres apart, A being at the left-hand end. Two unbalanced rotating masses of 7.5 kg and 10 kg at radii of 75 mm and 50 mm respectively are situated between A and B at distances of 0.6 m and 0.9 m respectively from A. The angle between the radii is 60° when viewed along the shaft.
Find the magnitudes,

(i) The magnitude, directions and senses of the forces of the shaft on the bearings due to the combined action of the dynamical forces and gravity when the 7.5 kg mass is vertical and above the shaft and the 10 kg mass is on the right of the 7.5 kg mass when viewed from B to A. [12 mark]

(ii) Show the results in an end view looking from B to A. [7 marks]

Q4. Neglect the weight of the cable in Figure Q4, and find the speed of the 450 N block A after it has moved 1.7 m along the incline from a position of rest. The static coefficient of friction along the incline is 0.32, and the dynamic coefficient of friction is 0.30. Consider the pulley B to be a uniform cylinder of diameter 0.30 m and weight 90 N, $I = Mr^2$.

[19 marks]

Q5. Given the figure shown in Figure Q5. Slider A moves in a vertical direction, slider B in a horizontal direction. Friction is assumed to be negligible. The system is released from rest with x=y. Sliders A and B have equal mass.

(i) Show that the relationship between the horizontal velocity v_x of B and the vertical velocity v_y of A is given by:

$$V_y = -v_x \cos\theta / \sin\theta$$

Where θ is the angle between the connecting rod of A and B and the horizontal. [9 marks]

(ii) Determine the velocity of slider A, when $x = 2y$. [10 marks]

Q6. Given the pile driver as shown in Figure Q6. It is desired that the ram lose all of its kinetic energy at each blow. The mass of each pile to be driven is 300 kg , and experience has shown that a coefficient of restitution of 0.3 can be expected .
Calculate:

(i) the mass m of the ram; [7 marks]

(ii) the velocity v of the pile immediately after impact, if the ram is dropped from a height of 4 metres onto the pile; [6 marks]

(iii) the energy loss due to impact at each blow. [6marks]

Q7. In the mechanism shown in Figure Q7, the slider C is moving to the right with a velocity of 1 m/s and an acceleration of 2.5 m/s^2. The dimensions of various links are AB = 3 m inclined at 45° with the vertical and BC = 1.5 m inclined at 45° with the horizontal.
Determine:

(a) the magnitude of the vertical and horizontal components of the acceleration of the point B. [10 marks]

(b) the angular accelerations of the links AB and BC. [9 marks]

END OF ME 375 EXAMINATION
Dr. A N Ng'andu & Mr. C. Siakachoma

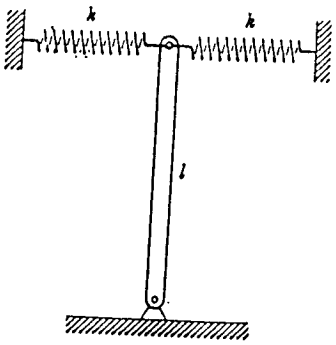


FIGURE Q1

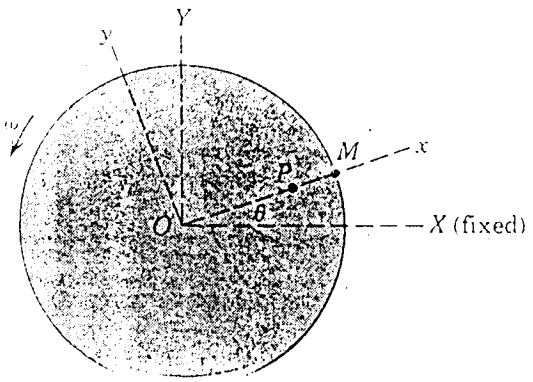


FIGURE Q1 - ALT.

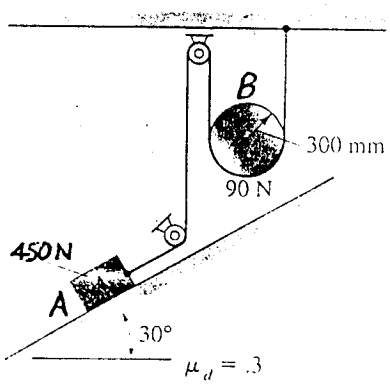


FIGURE Q4

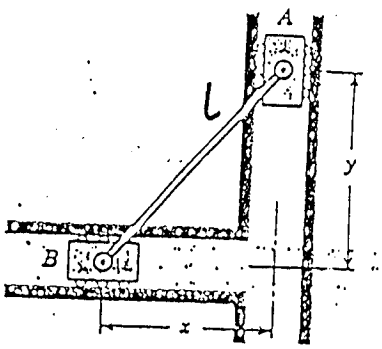


FIGURE Q5

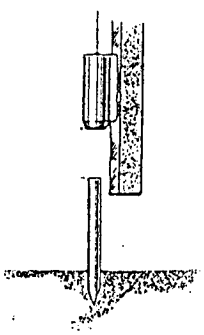


FIGURE Q6

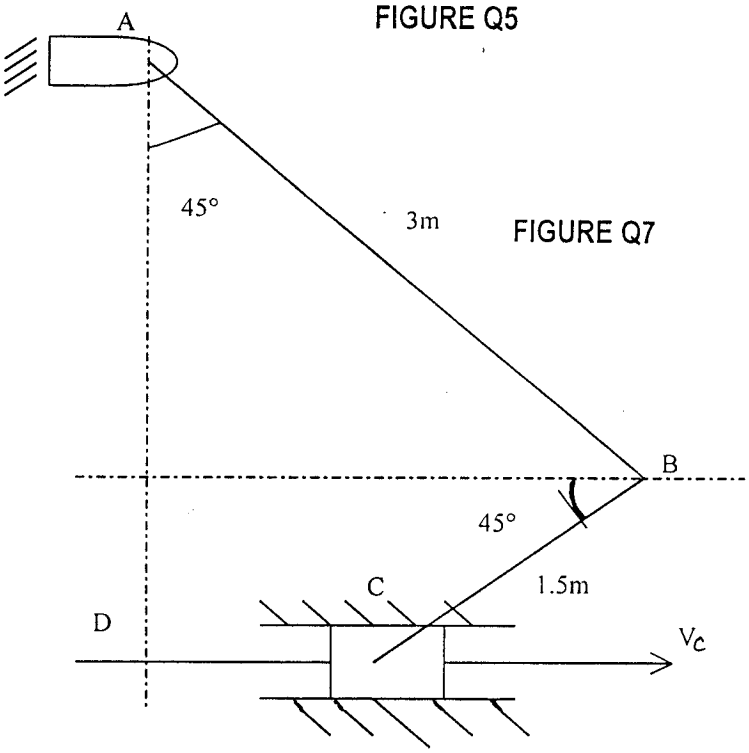


FIGURE Q7

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

SEMESTER II EXAMINATIONS 2001- 2002
OCTOBER 2002

ME 415 PRODUCTION TECHNOLOGY I

CLOSED BOOK

ANSWER: QUESTION **Q3, Q8,** AND ANY OTHER 3 QUESTIONS (WITH A MINIMUM OF TWO QUESTIONS FROM EACH SECTION)

NOTE: **EACH SECTION** SHOULD **BE ANSWERED IN TWO SEPARATE ANSWER BOOKLETS** CLEARLY MARKED AS **SECTION A or B.**

SECTION A

Q1) a) State the 4 main assumptions of Merchant's theory of cutting. (2 marks)

b) From Merchant's circle, derive expressions in terms F_ϕ and $F_{\phi n}$, for:

(i) Cutting force. (3 marks)
(ii) Feed force. (3 marks)

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

Cutting velocity	V	=	300 m/min
Cutting force	F_v	=	1400 N
Tool rake angle	γ	=	+8°
Cut thickness	h	=	0.32 mm
Width of cut	b	=	4.25 mm
Apparent coefficient of friction	μ	=	0.65

(i) Shear velocity (3 marks)
(ii) Shear stress on shear plane (3 marks)
(iii) Feed force (3 marks)
(iv) Normal stress on the shear plane (3 marks)

Q2 a) As the Production Manager in a Lusaka based factory, you have a contract to machine a batch of widgets. The machining conditions are as follows:

Total cost of machine operation is K30,000/hr
Total cost of a tool change is K26,500
The cutting velocity for a tool life of 65 minutes is 75.5 m/min
The Taylor tool life equation exponent is 0.15
Depth of cut is 9 mm
Feed is 0.2 mm/rev

Based on the minimum cost criterion find:

(i) Economic tool life. (3 Marks)

(ii) Economic cutting speed. (4 Marks)

(iii) For a total Cost of K109,000 how many cubic centimeters can be removed. (4 Marks)

b) Describe with diagrams the 3 forms of gear hobbing (9 Marks)

Q3. A 100mm diameter milling cutter, with 16 teeth, cuts a slot of 25mm deep by 25mm wide. The table feed is 75mm/min, and cutting speed is 15m/min

Based on up-cut milling, Find:

(i) The maximum number of teeth in engagement (3 Marks)

(ii) Chip length. (3 Marks)

(iii) The percentage reduction in sliding between cutter edges and the material cut, if the milling is switched from up to down cut milling (4 Marks)

If the specific cutting pressure for the operation is K_{cmean} = 4070N/mm^2 and the maximum available power to the cutter is 4 kW. Determine:

(iv) Maximum table feed (5 Marks)

(v) Maximum chip thickness. (5 Marks)

Q4 a) Derive an expression for the force per grit in external cylindrical grinding. (10 Marks)

b) What is Trueing and dressing in relation to grinding. (5 Marks)

c) Determine the depth of cut for a surface grinding operation carried out with a 35-grit wheel under the following conditions: (5 Marks)

V = 2100 m/min	v = 14m/min	C = 3.15
r = 15	t = 0.00321 mm	D = 150 mm

Q5 a) Describe the concept of "Chatter", and then relate its manifestation and reduction to a vertical milling machine. (8 Marks)

b) Briefly describe with diagrams the basic types of slide ways used in machine tools. (8 Marks)

c) Determine the efficiency of a 6mm pitch acme screw, thread angle 31.5°, 39mm effective diameter when the coefficient of friction is 0.03 (4 Marks)

SECTION B

Q6. .a) Explain the principle of Superposition of Errors. (8 Marks)

b) Discuss the types of errors in mechanical measurements and there possible remedy. (12 Marks)

Q7. a) Fig. Q7 shows a design of an aluminium vessel with a wall thickness of 6mm. With the help of clearly labelled sketches, describe the Gravity Die casting process of the above-mentioned vessel. (10 Marks)

b) Describe with the help of clearly labeled sketches the method you would employ for the casting of a long aluminium bar of 100mm in diameter and 6m long. (10 Marks)

Q8. Fig. Q8 shows views a spherical ball valve with internal channels serving the purpose of redirecting hydraulic fluid.

i) Give a graphical representation of the locator and holding force system to facilitate the mass drilling of the 10mm holes for the smooth flow of the fluid. (6 Marks)

ii) Based on the selected graphical locator and holding force system, produce a sketch of an appropriate jig that would be used to drill the above-mentioned holes. Clearly illustrate how the hole depth can be controlled. (14 Marks)

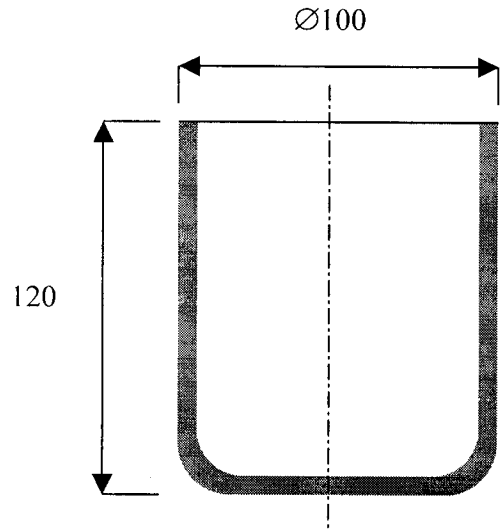


Fig. Q7

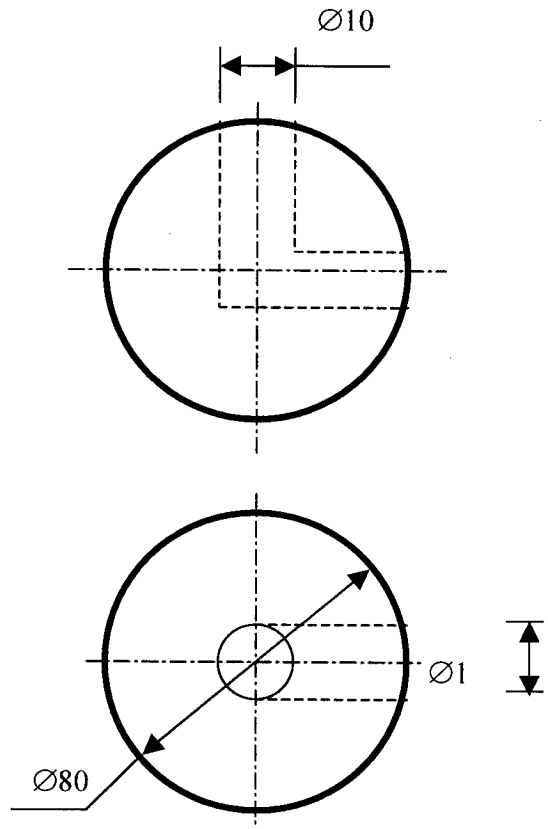


Fig. Q8

END OF EXAMINATION

Examiners: M.O. Goma, C.G. Chizyuka

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
ME – 442 THERMODYNAMICS II AND HEAT ENGINES 2001 - 2002
DEFERRED EXAMINATION, NOVEMBER 2002

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

Instructions

Answer All Questions

Draw sketches and graphs and state all the assumptions where necessary. All questions carry equal marks

SECTION A

Question 1

Drive the expression for thermal efficiency of the dual cycle and briefly discuss the derived expression in the light of Otto and Diesel Cycle thermal efficiencies.

Question 2

Discuss in detail the following qualities of fuel used in internal combustion engines:

I. Crank case distillation
II. Sulphur content
III. Starting and warm up as a quality for spark ignition engines
IV. Corrosion and wear
V. Smoking and odour

SECTION B

Question 3

A six cylinder, four-stroke, direct injection oil engine is to deliver 120 kW at 1600 rpm. The fuel to be used has a calorific value of 43 MJ/kg and its percentage composition by mass is; carbon 86 %, hydrogen 13 %, and non combustibles 1 %. The absolute volumetric efficiency of the engine is assumed to be 80 %, the indicated thermal efficiency 40 % and the mechanical efficiency 80 %. The air consumption is 110 %, that is in excess of the air required for theoretically correct combustion.

I. Estimate the volumetric composition of the dry exhaust gas
II. Determine the bore and stroke of the engine, taking a stroke to bore ratio as 1.5

Assume the volume occupied by 1 kg of air to be 0.77 m^3 and that oxygen in air is 23 % by mass and 21 % by volume.

Question 4

A gasoline engine has a stroke volume of 0.0015 m^3 and a compression ratio of 6. At the end of the compression stroke, the pressure is 8 bar and the temperature is 350 °C. Ignition is set so that the pressure rises along a straight line during combustion and attains its highest value of 25 bar after the piston has travelled 1/30 of the stroke. The charge consists of a gasoline-air mixture in proposition by mass 1:16. Calculate the heat lost per Kg of the charge during combustion.

Take R = 287 J/kgK, the calorific value of fuel 42 MJ/kg and Cp = 1 kJ/Kg K.

Question 5

A Zambia Air Force helicopter if fitted with two ram-jet engines, each equipped with a subsonic diffuser and a converging exhaust nozzle. The helicopter is designed to operate at speed equivalent to a Mach of 0.8 at sea level conditions (Pressure = 1.013 bar and Temperature = 288K). Neglecting the effects of fuel mass added determine:

I. The specific air impulse (Total thrust/air mass flow rate)
II. The overall efficiency (Thrust power/rate of fuel energy supplied)

The following data relate to the ram-jet engine:

Ram efficiency	0.9
Propelling Nozzle efficiency	0.95
Pressure drop across the combustion system	6 % of stagnation pressure at burner entry
Combustion system efficiency	0.85
Nozzle entry Temperature	1500 K

Assume the following:
For air Cp = 1 kJ/Kg K, γ = 1.40
For products of combustion Cp = 1. 11 kJ/Kg K, γ = 1.35

End of ME 442- Thermodynamics II and Heat Engines Deferred Examinations, November, 2002.
Prepared by Dr. P. C. Chisale ©Dept. of Mech. Engineering, Unza.

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

SEMESTER II FINAL EXAMINATION, October, 2002

ME 545 – ALTERNATIVE ENERGY SOURCES

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

INSTRUCTIONS

1. Answer a total of FIVE (5) questions. Any TWO (2) questions from SECTION A and Any THREE (3) questions from SECTION B

2. Draw sketches and graphs where necessary and State clearly any assumptions made. Necessary charts, graphs and tables are provided.

SECTION A (Answer any TWO (2) questions from this section)

Q1. (a) Describe in detail the principles of operation of the following types of wind rotors, stating in each case the advantages and disadvantages that each type may have.

(i) horizontal axis rotors

(ii) vertical axis rotors

(b) What is the magnus effect? Discuss briefly.

[20 marks]

Q2 a) Explain how energy is related to the environment.
b) List three broad local, and two specific regional impacts of energy activities. Explain what an EIA is as a response to such impacts?
c) What is global warming, and how does it relate to energy?
d) Calculate the CO_2 emissions per year for an 800 kW diesel-electric generation engine operating for 200 days per annum. Assume the CO_2 emission factor to be 800×10^{-6} tCO_2/kWh.

[20 marks]

Q3 Discuss methodological steps required in instigating an energy management system in an industrial set up.

[20 marks]

SECTION B (Answer any THREE (3) questions from this section)

Q4 You are required to design a power supply system for a cold room for small business activities in a rural area. The size of the cold room is $62.5m^3$ with one light of 11Watts for lighting purposes. The size of the compressor is 1.493kW.Calculate the following:

(i) Total system and energy demand. The number of hours for lighting and cooling are 6 hours and 16 hours respectively.
(ii) Number of batteries assuming autonomy of 3 days, a 40% depth of discharge, and batteries operate at 24Volts.
(iii) Size of the regulator.

[20 marks]

Q5 The government of Zambia has embarked on a "Food Security Programme" to ensure sufficient amount of maize for the coming year. You have been appointed to give a suitable size of a one tonne forced convection solar dryer for drying maize in three days in various remote areas, having average ambient temperature, relative humidity, sunshine period and solar intensity of 22°C and 60%, 8 hrs per day and $600W/m^2$ respectively. Determine the following parameters:

(i) Average pickup rate
(ii) Necessary air flow rate
(iii) Blower power
(iv) Collector area

The following additional information is given:

Initial moisture contents for maize	=	35% (wet basis)
Final recommended moisture content for maize	=	15% (wet basis)
Bulk density for maize	=	$700kg/m^3$
Maximum temperature	=	60°C
Relative humidity of air leaving the bin	=	80%
Air velocity in the drying bin	=	0.5m/s
Air resistance for maize (m^{-1})	=	33000
Collector efficiency	=	53%
Motor / Blower efficiency	=	33%

[20 marks]

Q6 Discuss with the help of diagrams how biomass, an important energy resource in Zambia, can be used in various technologies to generate electricity. Calculate the amount of biomass with a calorific value of 18MJ/Kg required to power an electric generator of 1MW capacity. First calculate the overall efficiency of the system if the combustion, boiler, turbine and generator efficiencies are given as 85%, 60%, 80% and 85% respectively. The generator runs for a period of 8760 hours per annum.

Q7 An NPS two-branch steam main, (50mm diameter, 20m long), is not insulated. Steam temperature is 125°C and ambient temperature is 25°C. As part of an

energy management system you are setting, you decide to save energy of the main distribution system by insulating the pipe with 63mm thick cellular glass insulation. The steam system operates 2,880 hours per year. Would you decide to go ahead with a required investment of US $ 450 if the following data is available?

- Thermal conductivity of cellular glass = 0.05W/m°C
- Surface resistance temperature = 2.18m^2 °C/W
- Heat loss from uninsulated surface = 300W/m
- Cost of steam is US $ 0.008 per MJ

[20 marks]

END OF ME 545 – Alternative Energy Sources Semester II Examination,
Prepared by
Prof F.D. Yamba, Dr. C.K. Wamukwamba, Mr. E. Matsika and Mr. S.S. Virdy

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

ME 585 - AUTOMOBILE ENGINEERING

SEMESTER II FINAL EXAMINATION OCTOBER 2002

INSTRUCTIONS:

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

The paper contains three sections:

Section A - Compulsory
Section B - Answer Two Questions
Section C - Answer Two Questions

SECTION A

COMPULSORY

Q1. (a) Calculate and draw the dynamic certificate of a motor vehicle propelled by a four-stroke carburettor engine developing a maximum effective power of 72kW with a crankshaft angular velocity of $\omega_{e\,max}$ = 472rad/s. The minimum power occurs at $\omega_{e\,min}$ = 104rad/s. [23 marks]

Note:

- Do not include the skidding control graph
- Do not include gear 3 in your analysis
- Use five equidistant points ($\omega_{e\,min}$ and $\omega_{e\,max}$ inclusive) to plot the dynamic factor, D_a, Vs vehicle velocity, V, for each gear
- Use the provided blank tables to fill in the relevant calculated parameters. A sample calculation should be shown for each gear for each data set.
- Draw the Dynamic Certificate on the provided graph papers.
- Show some sample calculations
- Use the following scales:

Horizontal axis:
Velocity, 2cm : 5m/s
Load, 1cm : 10%

Vertical axis:
D_a, 4cm : 0.1
D_o, to be calculated

The relationship between a given power and maximum effective power at a given corresponding angular velocity is given by the following empirical formula describing the speed characteristics as follows:

$$N_e = N_{e\,max}\left[\left(\frac{\omega_e}{\omega_N}\right)+\left(\frac{\omega_e}{\omega_N}\right)^2-\left(\frac{\omega_e}{\omega_N}\right)^3\right]$$

where, N_e = power at a given angular velocity ω_e
$N_{e\,max}$ =maximum effective power at angular velocity ω_N

The motor vehicle with its own weight of 14, 900N, and that of the driver is 750N. It moves on an asphalt horizontal road in uniform motion and carrying an external load of 3, 000N. The weight taken by the driving wheels without load is given as 7, 000N.

Given below is additional information:

Transmission efficiency	= 90%
Radius of the driving wheels	= 0.33m
Streamlining Factor	=0.50 Ns^2/m^2

Gear ratios:

1st gear	= 3.51
2nd gear	= 2.26
3rd gear	= 1.45
4th gear	= 1.0
Differential gear	= 4.1

(b) Using the obtained Dynamic Certificate,

(i) Determine the road resistance coefficient if the motor vehicle moves with 50% load at a speed of 25m/s in top gear. [2 marks]

(ii) Determine the maximum possible speed if the load and road resistance coefficient are given as 100% and 0.20, respectively. [2 marks]

(iii) Find the maximum load in a certain gear with road resistance and speed given as 0.40 and 7.5m/s, respectively. In which gear(s) is this possible. [3 marks]

Clearly show these points on the Dynamic certificate.

[Total: 30 marks]

SECTION B

ANSWER TWO QUESTIONS ONLY

Q2. As the Transport Engineer for **Semi Transport Ltd ("Semitra")**, you are contemplating purchasing SI engine propelled minibuses at K30 million each with a seating capacity of 15 passengers, for the Zambian market. Determine the cost, to the next K1000, per passenger if the minibus operates from Lusaka to Kitwe, a distance of 400km. The minibus makes a round trip per day 5 times a week in a year. Some of the existing costs include:

Fuel	Gasoline	K3, 210 per litre
	Gas oil	K 2, 750 per litre
Lubricants		K 6,000 per litre
Labour costs		K 15, 000 per man-hour
Tyres/tubes		K 300, 000 per set
Depreciation		25% per year
Insurance		5% of original cost per year
Profit Margin		30%
Salaries of driver and conductor		K 160, 000 and K 100, 000 respectively

Do you think that **Semitra** would compete in the market when other transporters are charging K 20, 000 per passenger?

The other information available includes:

Life of tyres	50 000km
Number of wheels on the minibus (which also has one spare wheel)	4
Number of man-hours per service	6 hours
Number of man-hours per repair	1.5 hours per 1000km
Cost of vehicle spares	10% of initial investment per annum
Engine oil sump size	5 litres

[Total: 20 marks]

Fuel Consumption 10 l/100 km
Service interval 5000 km.

Q3. A motor vehicle is travelling along Great East Road, approaching UNZA. The grip coefficient of the road is 0.8. At the horizontal stretch of the road, the driver suddenly sees an UNZA student crossing the road ahead. The student is 0.9m away from the line of motion of the vehicle and 110m ahead. The following data is available:

Maximum deceleration	= $5m/s^2$
Reaction time of the driver	= 0.53 sec
Time for the brake system to operate	= 0.35 sec
Net mass of the motor vehicle	= 1730kg
Mass of driver	= 70kg

If during the increment of deceleration from zero to the maximum value the speed drops from 30 to 27.5 m/s, determine:

(a) The stopping time and distance of the motor vehicle for the given conditions at maximum deceleration. [4.5 marks]
(b) The speed of the vehicle at the moment preceding the braking if the skidding trace is ascertained to be 75.5m and the driver brakes at the maximum deceleration of $5m/s^2$. [6 marks]
(c) The optimum brake force distribution and the reaction change coefficients, given that the wheel base is 2.93m, the distance from the C.G. to the rear axle is 1.41m and the height of the C. G. is 0.6m.

As the "Honorary Judge", what would be your verdict over the driver's timely reaction if the pedestrian's average walking speed is 1.5 m/s. Use the condition of time. [9.5 marks]

[Total: 20 marks]

Q4. Your company, **Neti Works Ltd** has purchased a Land Cruiser with own mass of 1500kg. The vehicle is capable of taking an external load of 500kg. The following additional data is given:

Engine power	60 kW at 2500 rpm
Maximum torque	17.5kg.m at 2500rpm
Transmission efficiency	90%
Diameter of driving wheels	85cm
Maximum height of the land rover	180cm
Wheel track	140cm
Wheel base	280cm
Air resistance coefficient	$0.5Ns^2/m^4$

Gear ratios

1^{st} gear	3.68
2^{nd} gear	2.22
3^{rd} gear	1.50
4^{th} gear	1.0
Differential gear	4.02

(a) Determine the maximum running fuel consumption of the Land Cruiser moving uniformly in top gear on a flat road with a rolling resistance coefficient of 0.081. [4.5 marks]
(b) What would be the maximum running fuel consumption if the same vehicle moves at the same speed but up the same road with a gradient of 3.5^o? [4.5 marks]

The specific effective fuel consumption and density of the fuel are given as 350g/kWh and 0.76 kg/litre, respectively.

Discuss the difference in the results of the two situations in (a) and (b).

(c) The same vehicle is required to also operate on a gravel road with a grip coefficient of 0.7 and rolling resistance coefficient of 0.023. A braking performance analysis was carried. You are required to determine the maximum deceleration, total braking distance and time for the vehicle when the driver brakes on the road, at full load with initial velocities of:

(i) 15m/s
(ii) 20m/s

[10 marks]

Assume that the following:

Coefficient accounting for rotating parts during braking	= 1.0
Reaction time of driver	= 0.8 sec
Time for the braking system to operate	= 0.4 sec
Time during which deceleration increases from zero to its max. value	= 0.2 sec

Comment on the results from (i) and (ii). [1 mark]

[Total: 20 marks]

SECTION C

ANSWER TWO QUESTIONS ONLY

Q5. (a) Discuss the vehicle operational cost, S, stating clearly how it can be used to determine the transportation charge both in K/ tonne and K/passenger. [8 marks]

(b) Discuss durability as related a motor vehicle. Also state the factors that affect durability. [7 marks]

[15 marks]

Q6. Discuss the various factors that affect the fuel economy of a motor vehicle.

[15 marks]

Q7. (a) What is lateral stability and what are the factors which affect lateral stability? [4 marks]

(b) Discuss how lateral stability of a motor vehicle is assessed. [4 marks]

(c) Briefly discuss ride of a motor vehicle. Tests have shown that human beings are used to the walking bounce frequency of 1.17 – 1.66Hz. Do you think that a vehicle with the following design parameters K_{sp} = 16kN/m, K_t = 250kN/m and m_{sp} = 400kg would pass the ride test? Comment on your findings. [7 marks]

[15 marks]

END OF SEMESTER II ME 585 FINAL EXAMINATION

Mr. E. Matsika

Gear I

I_{tr} = _____

ω_e (rad/s)	N_e (kW)	V (m/s)	P_t (kN)	P_{air} (N)	D_a

Gear II

I_{tr} = _____

ω_e (rad/s)	N_e (kW)	V (m/s)	P_t (kN)	P_{air} (N)	D_a

Gear IV

I_{tr} = _____

ω_e (rad/s)	N_e (kW)	V (m/s)	P_t (kN)	P_{air} (N)	D_a

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL EXAMINATION SEMESTER II 2001/2002
OCTOBER/NOVEMBER 2002

ME 595 - MAINTENANCE ENGINEERING

Time Allowed: THREE Hours **CLOSED BOOK**

Sections A and B Must Be Handed In Separately **All Questions Carry Equal Marks**

SECTION A: Answer EITHER Question Q1 OR Q2 From This Section

Q1.
Compare and contrast Corrective Maintenance and Preventive Maintenance, stating in which instances each may be applied [20 marks]

Q2.
Suggest a maintenance strategy for the Machine Tool Workshop in the Department of Mechanical Engineering at the University of Zambia. In your presentation, clearly identify factors affecting the development of your strategy [20 marks]

SECTION B: Answer Question Q3 AND Any Other Three Questions From This Section

Q3.
A computer-interface circuit card assembly for airborne applications is made up of interconnected components in the quantities listed in the table Q3 below. If the assembly must operate in a 50°C environment, the component failure rates are given in column 3 of the table. Assume a non-redundant system.

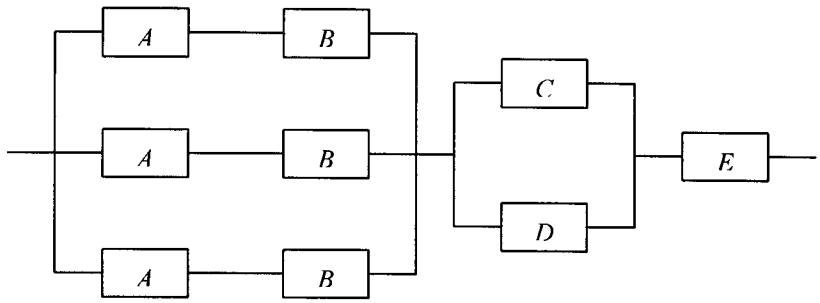
Table Q3: Computer-interface circuit card components, their quantities and failure rates

Component type	Quantity	Failure Rate / 10^6 hr
Capacitor tantalum	1	0.0027
Capacitor ceramic	19	0.0025
Resistor	5	0.0002
J-K, M-S flip flop	9	0.4467
Triple NAND gate	5	0.2456
Differential line receiver	3	0.2738
Differential line driver	1	0.3196
Dual NAND gate	2	0.2107
Quad NAND gate	7	0.2738
Hex inverter	5	0.3196
8-bit shift register	4	0.8847
Quad NAND buffer	1	0.2738
4-bit shift register	1	0.8035
AND-OR inverter	1	0.3196
PCB connector	1	4.3490
Printed wiring board	1	1.5870
Soldering connections	1	0.2328

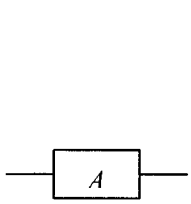
Calculate:
(a) The assembly failure rate. [10 marks]
(b) The reliability of a 12-hour mission [5 marks]
(c) The MTTF [5 marks]

Q4.

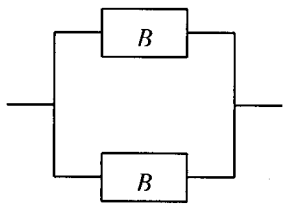
(a) Derive the reliability equation in terms of element reliabilities, P_a, P_b, P_c. P_d and P_e for the following redundant design. (Assume independent element operation with no short possibilities.) [10 marks]



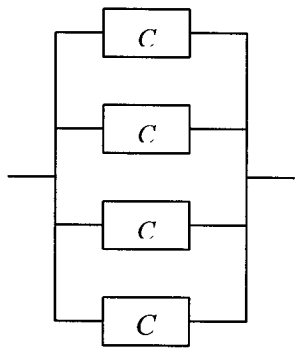
(b) Which of the following three competing systems would you select if reliability were the prime consideration? [6 marks]



$P_a = 0.90$



$P_b = 0.70$



$P_c = 0.60$

(c) If the three systems in (b) above are equally effective, which offers the highest reliability per Kwacha if the costs of the elements are: C_a = K4,600,000; C_b = K2,300,000 and C_c = K920,000. [4 marks]

Q5.

(a) What is the meaning and importance of condition monitoring in Maintenance Engineering? [5 marks]

(b) State the broad classifications of condition monitoring, giving at least two methods of monitoring each. [15 marks]

Q6.

(a) How do failure prediction and replacements relate to each other? [4 marks]

(b) The MTBF for punctures of truck tyres is 240,000 km. A truck with 10 tyres carries one spare tyre.

(i) What is the probability that the spare tyre will be used on a 16,000-km trip? [10 marks]

(ii) What is the probability that more than the single spare tyre will be required on a 16,000-km trip? [6 marks]

Q7.

(a) State and briefly explain five (5) types of failure [10 marks]

(b) Using a suitable diagram, show how gradual and sudden failures are analysed in failure analysis. [10 Marks]

END OF EXAMINATION

Dr H M Mwenda / Mr G M Munakaampe

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL EXAMINATION SEMESTER II 2001/2002
OCTOBER/NOVEMBER 2002

ME 595 - MAINTENANCE ENGINEERING

Time Allowed: THREE Hours **CLOSED BOOK**

Sections A and B Must Be Handed In Separately **All Questions Carry Equal Marks**

SECTION A: Answer EITHER Question Q1 OR Q2 From This Section

Q1.
Compare and contrast Corrective Maintenance and Preventive Maintenance, stating in which instances each may be applied [20 marks]

Q2.
Suggest a maintenance strategy for the Machine Tool Workshop in the Department of Mechanical Engineering at the University of Zambia. In your presentation, clearly identify factors affecting the development of your strategy [20 marks]

SECTION B: Answer Question Q3 AND Any Other Three Questions From This Section

Q3.
A computer-interface circuit card assembly for airborne applications is made up of interconnected components in the quantities listed in the table Q3 below. If the assembly must operate in a 50°C environment, the component failure rates are given in column 3 of the table. Assume a non-redundant system.

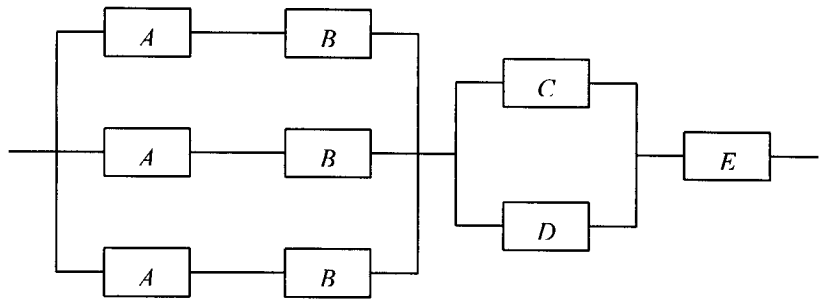
Table Q3: Computer-interface circuit card components, their quantities and failure rates

Component type	Quantity	Failure Rate / 10^6 hr
Capacitor tantalum	1	0.0027
Capacitor ceramic	19	0.0025
Resistor	5	0.0002
J-K, M-S flip flop	9	0.4467
Triple NAND gate	5	0.2456
Differential line receiver	3	0.2738
Differential line driver	1	0.3196
Dual NAND gate	2	0.2107
Quad NAND gate	7	0.2738
Hex inverter	5	0.3196
8-bit shift register	4	0.8847
Quad NAND buffer	1	0.2738
4-bit shift register	1	0.8035
AND-OR inverter	1	0.3196
PCB connector	1	4.3490
Printed wiring board	1	1.5870
Soldering connections	1	0.2328

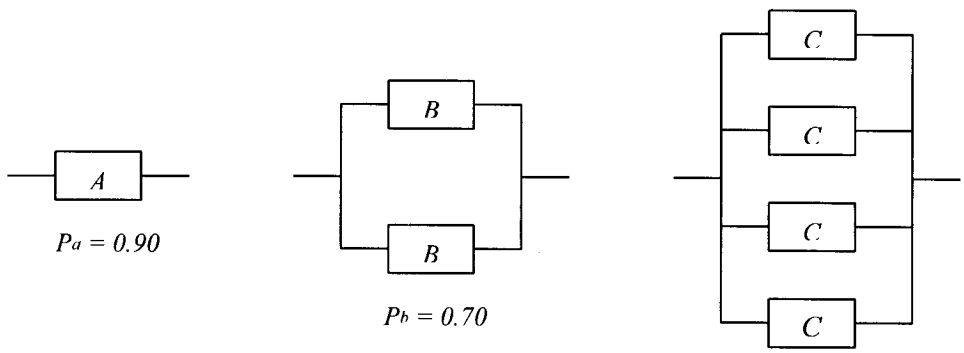
Calculate:
(a) The assembly failure rate. [10 marks]
(b) The reliability of a 12-hour mission [5 marks]
(c) The MTTF [5 marks]

Q4.

(a) Derive the reliability equation in terms of element reliabilities, P_a, P_b, P_c, P_d and P_e for the following redundant design. (Assume independent element operation with no short possibilities.) [10 marks]



(b) Which of the following three competing systems would you select if reliability were the prime consideration? [6 marks]



$P_a = 0.90$

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(c) If the three systems in (b) above are equally effective, which offers the highest reliability per Kwacha if the costs of the elements are: C_a = K4,600,000; C_b = K2,300,000 and C_c = K920,000. [4 marks]

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Dr H M Mwenda / Mr G M Munakaampe

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
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UNIVERSITY EXAMINATIONS

FINAL EXAMINATION SEMESTER II 2001/2002
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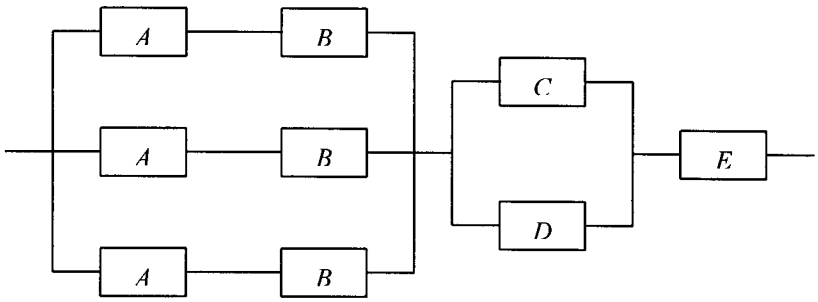

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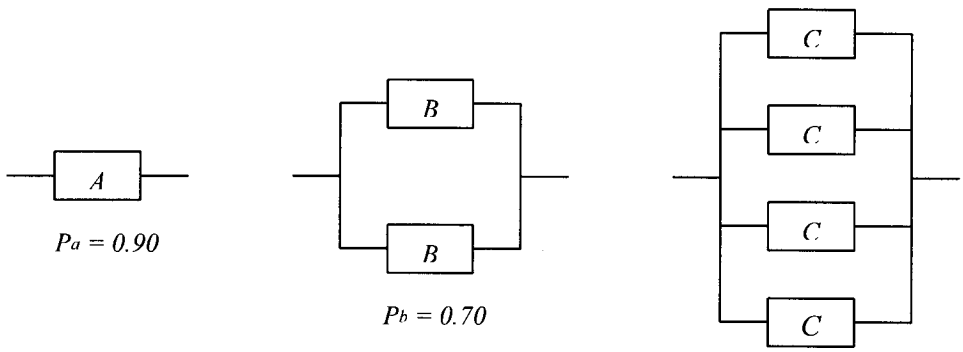

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END OF EXAMINATION

Dr H M Mwenda / Mr G M Munakaampe

The University of Zambia
School of Engineering
Department of Surveying

SE212 Final exam – 21st October 2002

Instructions: *This paper is divided into four sections. Answer one question from section A and all questions from subsequent sections. Remember to answer each section in a separate answer booklet.*

Time allowed: 3 hours

Section A: Introduction to Geomatics

Question 1

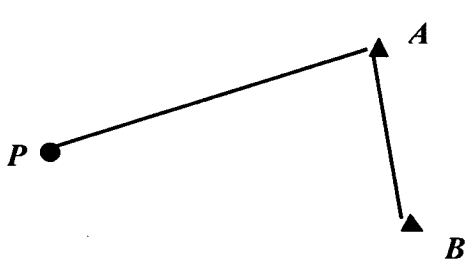
a) Explain the following terms using a maximum of 10 lines for each term. Where applicable make a sketch in aid of your explanation.

i. Geomatics
ii. Dumpy level
iii. Photogrammetry
iv. Topographic surveys
v. Levelling
vi. The L0 coordinate system (Zambia)

[13 Marks]

b) A minute theodolite is correctly mounted above point *A* in order to determine the plane coordinates of point *P*. The distance *AP* is measured twice along the slope with a tape as 100.130m and 100.132m. The known coordinates of A and B are:

A 3246.13mE 9843.22mN
B 5283.19mE 7577.11mN



The horizontal angles from point ***A*** are observed in two rounds and angle ***BAP*** (clockwise) was found to be 112.997 gons. The vertical angle ***AP*** was -5.778 gons.

What type of single point determination is this? Furthermore, calculate the co-ordinates of point ***P***.

[12 Marks]

Question 2

a) The following is a page from a levelling field book. Fill in the missing readings and calculate the reduced levels of all the points. All measurements in the table are in metres.

POINT	READINGS			DISTANCE		HEIGHT DIFF		REDUCED LEVEL	REMARKS
	BS	IS	FS	BS	FS	RISE	FALL		
BM1	1.253			49.6				1166.324	
1		0.651							
2	1.876		1.017	46.8	49.1				CP
3		1.412							
4	0.911		1.318	38.3	47.4				CP
5		0.549							
6	2.012		1.930	30.1	38.2				CP
7	0.172		0.769	45.1	30.7				CP
BM2			2.430		45.6				
Σ									

i. Compute the allowable and actual misclosures. State whether the latter is acceptable (assume σ = 25mm) if the published Reduced Level of BM2 is 1165.075m.

[10 Marks]

ii. Calculate the adjusted levels of all the points in this levelling loop.

[5 Marks]

b) A steel tape of nominal length 30m was used to measure a line ***EF***. The tape was laid on a smooth tarmac surface having a constant slope and the length of ***EF*** recorded on the tape was 28.266m. The mean temperature of the ends of the line was 10°C and a tension of 60 N was applied. The RLs of each end of the line were 1217.61m and 1218.42m above mean sea level (datum). The standardized length of the tape on the flat was 30.009m at 20°C and 44.5 N tension and the tape had a cross sectional area of $2mm^2$.

Young's modulus for the tape material was 200000 N/mm^2 and the coefficient of thermal expansion was 0.0000112/°C.

Calculate the horizontal length *EF*.

[10 Marks]

Section B - Photogrammetry

Question 3

a) Discuss the cost effectiveness of aerial photogrammetric mapping compared to field survey methods.

[8 Marks]

b) Distinguish metric from interpretative photogrammetry.

[6 Marks]

c) What ~~picture~~ photo quality is important for each of the two types of photogrammetry in (b)?

[2 Marks]

d) State the capabilities that are required of an aerial camera.

[4 Marks]

e) *"An aerial camera is the first component in a total photogrammetric system"* Briefly discuss the above statement.

[5 Marks]

Section C – Cartography

Question 4

a) Distinguish between an aerial photograph and a map.

[8 Marks]

b) All maps have the same basic objective regardless of their mode of compilation. What is this basic objective?

[5 Marks]

c) When was the first tourist map of Mosi-otunya published?

[2 Marks]

d) Under the objectives and tasks in Cartography what are the two main tasks for the Cartographer?

[10 Marks]

Section D - Remote Sensing

Question 5

a) Explain the importance of the Transmission windows in the electromagnetic spectrum.

[10 marks]

b) Explain how the electromagnetic energy is affected by the atmosphere and the earth surface on its way from the source to the sensor.

[15 Marks]

End of Exam

University of Zambia
School of Engineering
Department of Surveying

SE 562
LAND RESOURCES PLANNING EXAMINATION 2002

Answer all questions from sections A and B

Section A Planning and Land Tenure

Question 1 (20 MARKS)

Planning is defined as a process of decision-making that aims at bringing about optimum combination of activities, given the objectives and constraints on available resources

a. Outline the Cyclic Planning Process using a diagram *(7 marks)*
b. Define Landuse Planning *(6 marks)*
c. What are the overall goals of a planning process? *(7 marks)*

Question 2 (20 MARKS)

a. Mention the two main categories of Landuse Planning *(5 marks)*
b. List reasons why we conduct Landuse Planning *(5 marks)*
c. Mention the overall aim of Landuse Planning *(5 marks)*
d. List four areas on which Landuse Planning is focused on *(5 marks)*

Question 3 (20 MARKS)

a. Define Land Tenure *(6 marks)*
b. What factors affect land tenure systems? *(7 marks)*
c. Mention three common land tenure systems *(7 marks)*

Section B Environment and Natural Resources

Question 4 (20 MARKS)

a. Describe in detail three main categories of resources that exist in our environment? *(5 marks)*

b. What is the purpose of carrying out an Environmental Impact Assessment? *(5 marks)*

c. Define three main categories of Environmental Impacts? *(5 marks)*

d. Mention and briefly describe the receptors of Environmntal Impacts *(5 marks)*

Question 5 (20 Marks)

a. Outline the general procedure of conducting an Environmental Impact Assessment (EIA) *(10 marks)*

b. Mention and describe three methods of conducting an EIA *(10 marks)*

End OF Examination

Wishing you good Luck