SCHOOL OF ENGINEERING

2010-2014 ACADEMIC YEAR.

FINAL EXAMINATIONS

TABLE OF CONTENT

UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

2010/2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS
MAY, 2011

AEG 6142 STATISTICS AND EXPERIMENTATION

TIME: THREE (3) HOURS

INSTRUCTIONS:
ANSWER: ALL QUESTIONS

INFORMATION:
1. THIS EXAMINATION CONTAINS FIVE (5) QUESTIONS
2. ALL QUESTIONS CARRY 20 MARKS

SECTION A

QUESTION 1

Batches of a given chemical are examined as to whether they are on-grade or not. Let the random variable X be the number of batches that are on-grade and that the probability that an examined batch is on-grade is constant from batch to batch and equal to 0.90.

a) Write the probability density function for X. **(5 marks)**
b) Calculate the probability of getting exactly one off-grade batch in 10 runs **(5 marks)**
c) Suppose these batches of chemicals are tested using three different methods and the number of on-grade and off grade batches for some period of time has been as follows:

	Method			
	A	B	C	Total
On-grade	300	100	200	600
Off-grade	40	20	40	100
Total	340	120	240	700

Is there enough evidence to say that the three methods gave different results? **(10 marks)**

QUESTION 2

In a hospital, an average of 3 patients per night arrive at the emergency unit. Due to the variation between nights in the number of patients arriving, the receiving emergency unit has to be able to take care of more than 3 patients. Arrangements have thus been made such that the unit has capacity to handle 5 patients. If the number is exceeded the patients will not get optimal treatment.

a) Let X be the number of patients arriving during a given night. For the purpose of this exercise we assume that X follows the Poisson distribution with expectation = 3. Discuss this assumption and list all possible arguments in favour or against it. **(10 marks)**
b) We consider a given night, what is the probability that the capacity will be exceeded **(10 marks)**.

QUESTION 3

A heat exchanger that had been performing poorly was taken out of service and cleaned thoroughly. To test the effectiveness of cleaning, measurements were taken before and after the cleaning so as to determine the heat transfer coefficient. The results were as follows:

Run	**Before**	**After**
1.	90.5	93.4
2.	87.6	90.4
3.	91.3	99.6
4.	93.2	93.7
5.	85.7	89.6
6.	89.3	88.1
7.	92.4	96.7
8.	95.3	94.2
9.	90.1	98.6
10.	83.2	91.1

a) Giving reasons, formulate an appropriate hypothesis that can be used to test whether the cleaning of the heat exchanger had an effect on the heat transfer coefficient. **(5 marks)**
b) Test the hypothesis in (a) above and make conclusions **(15 marks)**.

SECTION B

QUESTION 4

Fill in the missing values (A,B,C,D and E) in the table of ANOV A below. Give a full interpretation of the results given that the totals for treatments were 54,31,41,33 and 29. **(20 marks)**

Source	Df	SS	MS	F-value
Replications	4	49.84	12.46	
Treatments	4	**A**	**B**	3.87
Error	**C**	86.56	**D**	
Total	24	**E**		

QUESTION 5

Write short notes on the following: **(5 marks each)**

a. Experimental unit vs experimental error
b. Factorial treatments
c. Differences between Randomized Complete Block Design (RCBD) and Completely Randomized Design (CRD)
d. Uses of Analysis of Covariance

UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

2010/2011 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS
MAY, 2011

AEG 6322 RURAL WATER SUPPLY

TIME: THREE (3) HOURS

INSTRUCTIONS:
ANSWER: ANY FOUR (4) QUESTIONS

INFORMATION:
1. **THIS EXAMINATION CONTAINS FIVE (5) QUESTIONS**
2. **ALL QUESTIONS CARRY 25 MARKS**
3. **THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS**

QUESTION 1

a) The local community has an important role to play in a rural water supply programme. Explain the importance of involving each of the various population components of the community (stakeholders) to achieve desirable results. **(15)**

b) A rural community with a population of 1200 households is to be supplied with water using yard standpipes at each household. On the basis of the per capita water requirements for rural communities, find the ***peak day demand*** and the ***peak hour demand on the peak day*** for the community. Use recommended factors for evaluating these requirements. Assume 6 people / household **(10)**

c) Define water quality and list basic requirements for rural drinking water supplies.

QUESTION 2

a) Tubewells are suitable for small-capacity water supplies. Describe briefly their construction and use in rural areas. **(10)**

b) An artesian well is pumped at the rate of 2 m^3/min. At observation wells 200 m and 320 m away the drawdowns noted are 0.75 and 0.60 m, respectively. The average thickness of the aquifer at the observation wells is 8 m. The aquifer of has a porosity of 0.3 and a hydraulic gradient of 0.002.

i. Compute the coefficient of permeability of the aquifer. **(10)**

ii. How many liters of water will pass per day through a strip 1 m wide with a depth equal to the thickness of the aquifer? **(5)**

QUESTION 3

(a) Describe using sketches any 2 types of roof catchments for rain water harvesting systems that can store and supply clean water from a tank situated next to the house. **(10)**

(b) The water supply for a farmstead is collected from roof catchments and stored in a single tank. The monthly rainfall is given in Table 1 and daily requirements for the maximum day in Table 2. If the farmer wishes to collect all the rainfall in the catchments, what is the required storage capacity of the tank given that the total catchment area is 760 m^2. **(15)**

Table 1 Monthly rainfall (mm)

Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Ma	Apr	May	Jun
-	-	-	7.9	204.7	335.5	347.5	148.8	176.8	103.7	-	-

Table 2 Daily water requirements (litres)

	Dairy Cows	Pigs	Layers
Number	8	32	135
Requirements	70	30	4

QUESTION 4

(a) What essential and additional information is needed when specifying a pump for a rural water supply system? (Discuss these pieces of information separately). **(10)**

(b) Water is to be pumped from a river intake through a 150mm diameter pipeline 950m long to a storage tank at a height of 45m above the river. A centrifugal pump with the discharge-head characteristics shown in Table 3 is available. Find the operating point (discharge and head) for the pump when the friction factor is 0.04. **(15)**

Table 3: Pump characteristics

Total head (m)	30	50	65	80
Discharge (litres/min)	2000	1750	1410	800

QUESTION 5

(a) Describe the design features of a hydraulic flocculator suitable for a medium to large-sized rural water treatment plant. **(5)**

(b) In a rural water distribution system, whether the water is obtained by gravity or by pumping, it is desirable to provide a distribution storage reservoir. Discuss briefly the main reasons for this? **(5)**

(c) Determine the pipe sizes for the distribution system shown in Figure 1. The design data is given in Table 4 below. **(15)**

Table 4 Design Data:

Number of persons served	2000
Total length of pipes	600 m
Average daily water use	50 litres/day/person
Daily water demand peak factor (k_1)	1.2
Hourly water demand peak factor (k_2)	1.5

Design velocity: 0.75 m/sec.

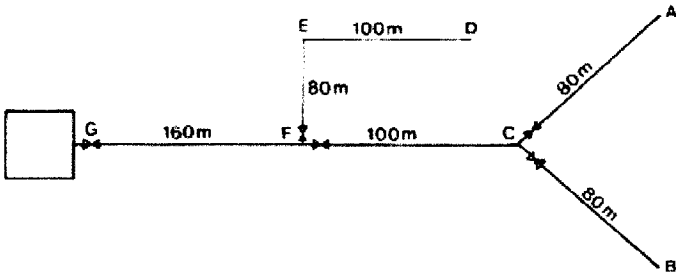


Figure 1 Simple water distribution system (schematic)

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

2012 ACADEMIC YEAR FIRST SEMESTER
FINAL EXAMINATIONS – NOVEMBER 2012

MEC 6121: PRODUCTION MANAGEMENT I

TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any **FOUR** questions. Marks for each question are indicated.
2. Candidates are NOT allowed to use books, and notes (closed book examination).
3. Calculators, drawing instruments are permitted.

QUESTION 1

(a) Quality costs can be organized into four major categories: prevention costs, appraisal costs, internal failure costs, and external failure costs. Should an organization invest heavily in appraisal or prevention costs? Explain your position.

[7 marks]

(b) What criterion is used to classify a failure cost as "internal" versus "external?" Give three examples of an internal failure cost and three examples of an external failure cost.

[8 marks]

(c) Management at Government Printers has identified the following costs over the last month.

Cost	Amount
Proofreading	$70,000
Quality planning	$10,000
Reprinting caused by inspector rejection of product	$405,000
Discarded material due to machine failure	$75,000
Inspection of printed product	$60,000
Reprinting due to customer complaints	$40,000
Quality improvement projects	$20,000
Correction of typographical errors found during proofreading	$30,000

For each of the four cost of quality categories, list the appropriate elements (with their costs) from the above table and total each of the four categories. What advice can you give Management?

[10 marks]

QUESTION 2

Organisations today have recognised the rising customer expectations and market standards that have resulted from quality improvements and competition. Consequently, customer service has become a rule, not the exception. With this in mind, answer the following questions:

(a) Why does an organisation need to measure customer satisfaction?

[5 marks]

(b) Explain the key dimensions of service quality.

[10 marks]

(c) Define each of the following terms as they relate to Kano's model: dissatisfier, satisfier, and exciters/delighters. Explain how an exciter/delighter can become a satisfier in general.

[10 marks]

QUESTION 3

(a) What is a materials requirement plan?

[5 marks]

(b) A company manufactures two products **A** and **B.** Each **A** requires two **C**'s and one **D.** Each **D** requires two **F**'s and one **E,** while each **E** requires one **F.** Each product **B** requires one **D** and two **E**'s. The table below shows data from the inventory records.

DATA CATEGORY	ITEM			
	C	**D**	**E**	**F**
Lot-Sizing Rule	Fixed Order Quantity = 220	Lot for Lot	Fixed Order Quantity = 300	Period Order Quantity P = 2
Lead Time	3 weeks	2 weeks	3 weeks	2 weeks
Scheduled Receipts	280 (week 1)	None	300 (week 3)	None
Beginning Inventory	25	0	150	600

The MPS for product **A** calls for 85 units to be started in week 3 and 100 units to be started in week 6. The MPS for product **B** calls for 180 units to be started in week 5.

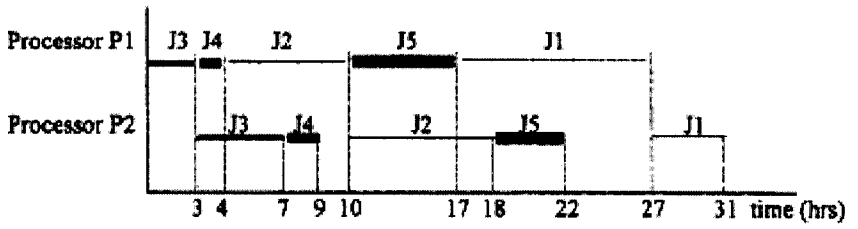
(i) Draw the product trees for the two products.

(ii) Develop the material requirements plan for the next six weeks for items **C, D, E** and **F.**

[20 marks]

QUESTION 4

(a) You have just been appointed Production Engineer at TDAU. Your supervisor has requested you to look at the schedule the previous Production Engineer made before leaving the organisation. The previous Production Engineer had sequenced and scheduled a number of jobs to be done on two machine serial setup P1-P2. A Gantt chart representation of the previous scheduler's plan is as shown below:



Use Johnson's Rule to set the sequence of the jobs and redraw the Gantt chart. How does your plan compare with the original plan?

[10 marks]

(b) The Workshop Manager at Toyota Zambia Service Centre must decide the sequence in which the four vehicles in the workshop must be serviced. He has developed these estimates based on the First-Come-First-Served sequence rule:

Vehicle ID Number	Estimated Maintenance Time (days)	Time to Promised Delivery (days)	FCFS Order Sequence
226	27	39	1
229	33	30	2
224	41	60	3
225	29	75	4

Rank the FCFS, SPT and CR sequencing rules on three evaluation criteria: average flow time, average number of jobs in the system, and average job lateness.

[15 marks]

QUESTIONS 5

(a) Define aggregate planning

[5 marks]

(b) A concrete block making company is developing an aggregate capacity plan from the sales forecast for its 6" and 8" concrete blocks shown in the table below.

Product	Sales Forecasts (Concrete Blocks)			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
6" Block	2,000	1,500	1,600	1,800
8" Block	1,200	1,000	800	1,000

Ample machine capacity exists to produce the forecast. Each 6" concrete block takes an average of 20 labour-hours while each 8" concrete block takes an average of 15 labour-hours.

(i) Compute the aggregate number of labour-hours in each quarter.

(ii) If each worker works 520 hours per quarter, how many workers will be required in each quarter?

(iii) It costs $1,000 to hire a worker and $500 to lay off a worker, and inventory carrying cost is $100 for each 6" concrete block and $100 for each 8" concrete block (this means that if one 6" concrete block were held in inventory for a year, it would cost $100 for finance charge, insurance, warehousing expense, etc.). The plant works the same number of days in each quarter, 13 five-day weeks. Evaluate two aggregate plans for next year – level capacity with inventory and matching demand. Beginning inventory is 275 for 6" concrete blocks and 200 for 8" concrete blocks in the level capacity plan and zero for both types of concrete blocks in the matching demand plan. Assume that the quarterly demand pattern repeats from year to year.

[20 marks]

QUESTION 6

(b) Describe a process-focused factory?

[7 marks]

(b) What are the implications of the characteristics of such a factory on scheduling decisions?

[8 marks]

(c) Given below is an input-output report at the end of Week 4:

(i) What production difficulties does the report indicate?

(ii) What corrective actions do you recommend?

	Week				
	-1	**1**	**2**	**3**	**4**
Planned Input (labour-hours)		200	300	300	200
Actual Input (labour-hours)		200	250	275	175
Cumulative Deviation		0	-50	-75	-100
Planned Output (labour-hours)		200	300	300	200
Actual Output (labour-hours)		200	250	275	175
Cumulative Deviation		0	-50	-75	-100
Planned Ending WIP (labour-hours)		200	200	200	200
Actual Ending WIP (labour-hours)	200	200	200	200	200

[10 marks]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

University Examinations

February / March 2014

REE 6011

ENERGY SYSTEMS AND SUSTAINABILITY

TIME	:	Three (3) hours
INSTRUCTIONS	:	Answer all five (5) questions
Additional information	:	Useful data is in the Appendix

Question 1.

(a) Analyze in detail with help of diagrams conventional and future energy system and climate change impacts on their energy supply.

[10 marks]

(b) Discuss and define with examples in values the indicators for assessing potential emission reduction costs and cost assessment for conventional and RE mitigation technologies.

[10 marks]

Question 2.

(a) Analyze in detail available conventional and RE mitigation technologies and extent of their contribution to reduction of GHG emissions.

[7 marks]

(b) What are socio economic and environmental effects of conventional and RE technologies you have analyzed in Q2(a)?

[7 marks]

(c) Analyse the various ranges of sectoral policies required for accelerated development and deployment of RE technologies.

[6 marks]

Question 3.

As a Policy Maker, which RE technology would you recommend to supply a new mining town in Zambia requiring 40MW? The following resources are available: geothermal, solar, wind and biomass. Prior to your recommendation, which should be based on cost effectiveness, describe the design features of corresponding technologies using the resources available. Technical characteristics of all RE are provided on which basis you are expected to perform your calculations and make a well informed decision.

[20 marks]

Question 4.

(a) Give an outline of the main electric utility rate structures, indicating the merits and demerits of each.

[8 marks]

(b) A small business can elect to use either the time-of-use (ToU) rate schedule or the rate structure involving a demand charge as shown in table Q4. During the peak demand period, a business uses 100 kW of power and 24,000 kWh/month, while during off-peak it

uses 20 kW and 10,000 kWh/month. Assuming a 30-day month, determine which rate schedule gives the lowest bills. What is the load factor for this usage?

Table Q4

ToU schedule		Demand charge schedule	
On-peak	K0.60/kWh	**Energy charge**	K0.30/kWh
Off-Peak	K0.35 /kWh	**Demand charge**	K45/kW-month

[8 marks]

(c) A 10-kW PV solar system costs K250, 000 and produces annual energy of 1.25 MWh. If it is paid for with a 12%, 10-year loan, what is the cost of the electricity generated (K/kWh)?

[4 marks]

Question 5.

(a) Differentiate between the terms "energy efficiency" and "energy conservation", giving examples.

[6 marks]

(b) Four measures, designated A, B, C and D, are being proposed for a small industrial facility to reduce its need to purchase utility electricity. Table Q5 describes each measure and gives the capital costs and annual kWh savings. The owner uses a capital recovery factor (CRF) of 0.06/yr.

Table Q5

		Capital costs (K)	Savings (kWh/yr)
A	Better lighting system	500,000	150,000
B	High efficiency motors	100,000	120,000
C	More efficient chiller	900,000	180,000
D	Photovoltaic system	750,000	60,000

(i) Compute the cost of conserved energy (CCE) for each measure and plot an appropriate energy conservation supply curve.

[10 marks]

(ii) How much energy can be saved (kWh/yr) if the criterion is that each measure must have a CCE no more than 30 Ngwee/kWh?

[4 marks]

END OF REE 6011 EXAMINATION

Appendix

Capital recovery factors

CRF(n, i): n = loan term; i = interest

Years	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%
5	0.2184	0.2246	0.2310	0.2374	0.2439	0.2505	0.2571	0.2638	0.2706	0.2774	0.2843
10	0.1172	0.1233	0.1295	0.1359	0.1424	0.1490	0.1558	0.1627	0.1698	0.1770	0.1843
15	0.0838	0.0899	0.0963	0.1030	0.1098	0.1168	0.1241	0.1315	0.1391	0.1468	0.1547
20	0.0672	0.0736	0.0802	0.0872	0.0944	0.1019	0.1095	0.1175	0.1256	0.1339	0.1424
25	0.0574	0.0640	0.0710	0.0782	0.0858	0.0937	0.1018	0.1102	0.1187	0.1275	0.1364
30	0.0510	0.0578	0.0651	0.0726	0.0806	0.0888	0.0973	0.1061	0.1150	0.1241	0.1334

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

University Examinations

July / August 2014

REE 6052

ENERGY CONVERSION AND INTEGRATION SYSTEMS

TIME	:	Two (3) hours
INSTRUCTIONS	:	Answer any five (5) questions
Additional information	:	*No Materials Except Calculator Allowed in Examination*

Question 1. [20 marks]

(a) Figure Q1 shows a 66-kV, 50-Hz, 20-km, balanced, three-phase overhead transmission line in a symmetric triangular configuration. The centre distance between conductors is D = 2 m, and the radius of each phase conductor is r = 1.24 cm (diameter d).

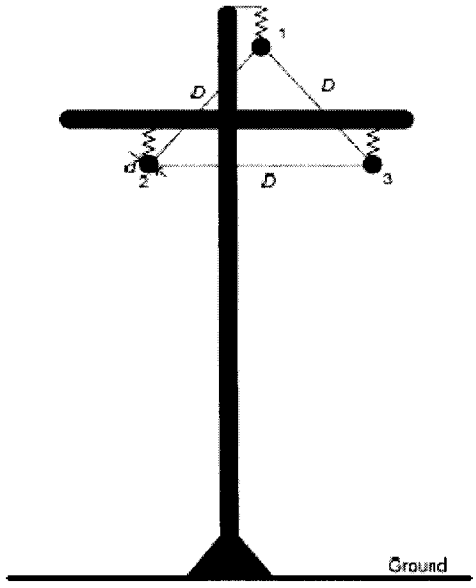


Figure Q1.

(i) Calculate the inductance and capacitance per phase of overhead transmission line.

[3 marks]

(ii) Calculate the total inductive reactance and capacitive reactance per phase of a 20-km section of the overhead transmission line.

[3 marks]

(ii) Assuming that each phase has four (4) conductors bundling with spacing between conductors in a square bundle, spaced at 0.30 m apart, and r = 1.24 cm, what is the new inductance, capacitance, total inductive reactance and total capacitive reactance per phase of transmission line? Assume further that the line is uniformly transposed.

[7 marks]

(b) In the context of power electronics converters,

(i) state two uses of power electronic converter topologies.

[2 marks]

(ii) briefly describe the classification of power electronic switches according to their degree of controllability, mentioning the types of power electronic converters topologies.

[5 marks]

Question 2. [20 marks]

(a) Discuss the characteristics which influence the performance of batteries as energy storage elements.

[6 marks]

(b) The flywheel is deemed to have the potential to be the least-cost energy storage choice per watt-hour of delivered energy. Defend this position.

[6 marks]

(c) Outline the developments in technology that are advancing the position of the flywheel as mechanism for storage of energy.

[4 marks]

(d) Why would you consider the compressed-air method of energy storage to be the least preferred among the conventional methods of energy storage for renewable energy applications?

[4 marks]

Question 3. [20 marks]

(a) What are the two main features of an induction motor?

[2 marks]

(b) Define the "slip" and "horsepower" as relates to induction motors.

[4 marks]

(c) For the power-balance diagram in figure Q3, derive the power relations for each of the named sections.

[6 marks]

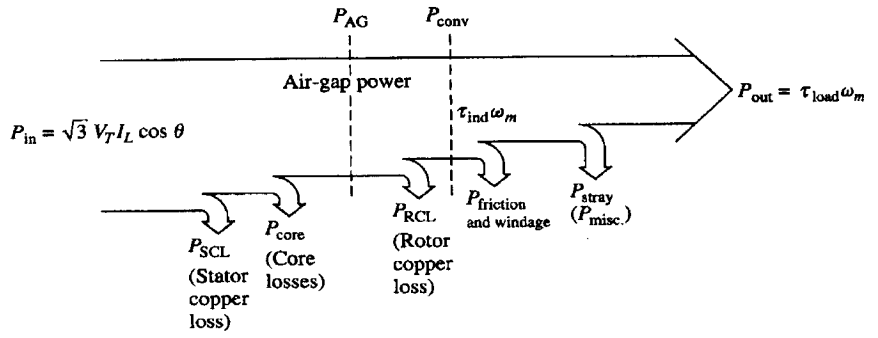


Figure Q3.

(d) A two-pole, 50-Hz induction motor supplies 15 kW to a load at a speed of 2950 rpm. Calculate the

(i) motor's slip

[2 marks]

(ii) induced torque in the motor in N.m under these conditions

[2 marks]

(iii) operating speed of the motor if its torque is doubled

[2 marks]

(iv) power that will be supplied by the motor when the torque is doubled.

[2 marks]

Question 4. [20 marks]

(a) A 480-V, 60-Hz, 50-hp, three-phase induction motor is drawing 60 A at 0.85 PF lagging. The stator copper losses are 2 kW, and the rotor copper losses are 700 W. The friction and windage losses are 600 W, the core losses are 1800 W, and the stray losses are negligible. Find the:

(i) air-gap power $P_{AG.}$

[2 marks]

(ii) power converted P_{conv}

[2 marks]

(iii) output power P_{out}

[2 marks]

(iv) efficiency of the motor.

[2 marks]

(b) A 460-V, 25-hp, 60-Hz, four-pole, Y-connected induction motor has the following impedances in ohms per phase referred to the stator circuit:

$R_1 = 0.641\ \Omega$ $R_2 = 0.332\ \Omega$

$X_1 = 1.106\ \Omega$ $X_2 = 0.464\ \Omega$ $X_M = 26.3\ \Omega$

The total rotational losses are 1100 W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2.2 percent at the rated voltage and rated frequency, find the motor's:

(i) speed

[4 marks]

(ii) stator current

[4 marks]

(iii) power factor

[4 marks]

Question 5. [20 marks]

(a) What are the RE fuels which have been developed in the transport sector, and which features and structures you need for their integration into existing petroleum systems? Describe also various technologies involved in their production.

[5 marks]

(b) What are the challenges of integration of RE fuels into current petroleum system, and associated measures to facilitate their integration?

[5 marks]

(c) Nakambala Sugar has decided to install 30 million litres per year bioethanol production plant at their home in Mazabuka, and requires to transport this fuel to Indeni Refinery in Ndola, a distance of 500 km.

(i) Recommend a suitable transportation system for this purpose.

(ii) What would be the capacity and investment requirements, Nakambala Sugar will need to ensure a sustainable daily delivery of bioethanol from Mazabuka to Ndola for blending purposes?

(iii) If the investments in (ii) above are found to be excessive, what other cost-effective alternatives would you recommend?

[10 marks]

Question 6. [20 marks]

It is very clear that ZESCO in the next 30 years will not be able to reach all the remote parts of Zambia. In view of this status quo, the only solution available is application of RE technologies to serve as off-grid systems.

(a) Name possible RE technologies for this purpose and their possible configuration and combinations, if account is taken of some of the challenges associated with intermittency of some of the RE technologies you have recommended.

[5 marks]

(b) A village Centre situated 100 km from the national grid in North Western Province intends to install a 150 kW electricity generating plant. You as a Consultant has been requested to recommend a cost effective tariff from a portfolio of RE technologies to include mini-hydro, biomass gasification, wind turbine and solar PV, against grid extension. The specifications in table Q6 are provided for RE technologies and grid extension.

[10 marks]

Table Q6

Technology	Capital Cost (US$)	Operations and Maintenance
Mini hydro	10,000/kW	1.3% of total investment cost
Biomass gasification	1,200/kW	95% of total investment cost
Wind turbine	12,000/kW	4.5% of total investment cost
Solar PV	15,000/kW	1.8% of total investment cost
11kV Grid Extension	25,000/km	1.0% of total investment cost

[It is assumed that the lifespan of all the technologies is 15 years with a load factor of 80%.]

(c) Assuming the tariff you obtained from your recommendation is beyond what ZESCO is charging, what policy measures would you recommend to leverage the apparent high tariff for the sake of bringing development to rural areas?

[5 marks]

END OF REE 6052 EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING
REE 6062-BIO ENERGY
FINAL EXAMINATION JULY 2014

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

Instructions

1. Answer any two (2) questions from each Section;
2. State all assumptions, and comment as much as possible on the implications of the answers obtained;
3. Draw neat graphs and sketches were necessary;
4. Work with algebraic expressions as far as possible before final computations;
5. Use metric units, where possible, in all your computations;
6. Use a separate answer scripts for each Section;
7. All solutions must be written in a legible handwriting and or manner, otherwise the solution/s will attract no marks;
8. Tie or staple the answer script/s in the left-hand corner; and
9. Each question carries twenty five (25) marks.

Allowable Materials:

(a) Non-Programmable Calculator;

(b) Heat transfer graphs, tables, and

(c) Graph Paper.

***University of Zambia Examination Rules and Regulations Apply**

SECTION A

Question 1

(a) State the various routes of biomass energy conversion to other forms of energy.

(b) Using a neat sketch, state the major phases in anaerobic digestion of biomass for the production of biogas. Also list the major gases found in biogas.

Question 2

(a) Why is the world interested in bioenergy? Give your answer with specific reference to Zambia.

(b) What is the role of biotechnology?

(c) What are the prospects of biotechnology by 2050?

Question 3

(a) Explain how you would go about assessing bioenergy development in your country.

(b) What are the pros and cons for switching from biomass to biogas for cooking?

SECTION B

Question 4

(i) Discuss a sustainable cycle of biogas from an anaerobic digestion, and the main feedstock requirements and characteristics for electricity production.

(ii) Elaborate on the biogas end –use utilization processes and technologies

(iii) Discuss design features for electricity production based on biogas utilization

(iv) A 500KW gas engine – generator with a thermal efficiency of 25% and 80% of load factor has been selected to provide electricity to a farming community. Determine the biogas yield and feedstock requirements, and volume (size) of the anaerobic digester for sustaining the supply of biogas for electricity generation. The following available feedstocks characteristics are given as follows:

Feedstock	Biogas yield based on feedstock M^3/tonne feedstock	Biogas yield based on dry matter of feedstock M^3/tonne Dry Matter
Cattle manure	25	340
Pig manure	24	400
Grass silage	227	650
Maize silage	187	611

(v) Which of the feedstock would you recommend for implementation

Question 5

(i) Discuss various biomass resources available in a country like Zambia which can be used for thermal, biological and mechanical conversions, and their corresponding products and markets.

(ii) Discuss the thermal properties of biomass and their effect on combustion process performance for electricity generation

(iii) What innovation technologies with design features would you recommend for electricity production from biomass?

(iv) A farming Community growing maize and cotton in an area without electricity decide to invest in 1500KW biomass based electricity generation facility for their needs and eventual export of electricity to the national grid. Determine the amount of maize and cotton required for generating electricity, respectively, if the following biomass based technologies and their corresponding overall efficiencies are given as follows:

a. Low pressure boiler 20%
b. Steam reciprocating engine 22%
c. High pressure boiler 32%

Which of these technologies would recommend if the following technical specifications are provided?

Technology	Capital Cost(US$)	Operation and Maintenance cost(US$) fixed and variable costs
Low pressure boiler	3,500/KW	86/KW and UScents 0.4KWh
Steam reciprocating engine	7,000/KW	80/KW and UScents 5.0 KWh
High pressure boiler	4,100/KW	87/KW and UScents 0.4 KWh

Assumptions: the residue ratio for maize and cotton are given as 0.3 and 3.0, respectively and corresponding calorific value are given as 13,000KJ/Kg and 15,000KJ/Kg, respectively.

Question 6

(i) Define gasification and discuss various reactor design features for a gasification system

(ii) Describe the composition of a combustible gas from gasification system and their chemical equations to produce this gas

(iii) Discuss the various gasification technologies which can be used to produce electricity from biomass.

(v) A farming Community growing rice in an area without electricity decide to invest in 1500KW biomass based electricity generation facility for their needs and eventual export of electricity to the national grid. Determine the amount of rice required for generating electricity, respectively, if the following

biomass based technologies and their corresponding overall efficiencies are given as follows:

a. Gasification coupled to gas engine 20%
b. Gasification coupled to Gas turbine 22%
c. Integrated Biomass Combined cycle 45%

Which of these technologies would recommend if the following technical specifications are provided?

Technology	Capital Cost(US$)	Operation and Maintenance cost(US$) fixed and variable costs
Gasification coupled to gas engine	1,000/KW	30/KW and UScents 1.1 KWh
Gasification coupled to Gas turbine	1,200/KW	50/KW and UScents 2.5 KWh
Integrated Biomass Combined cycle	2,100/KW	65/KW and UScents 1.3 KWh

Assumptions: The residue ratio for rice 1.

End of REE 6062 Examination 2014

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