



5th Year Past papers - Exam materials

MECHANICAL ENGINEERING (Dedan Kimathi University of Technology)



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DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations 2022/2023

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE MECHANICAL ENGINEERING

SAS 2230/EMG 5218: Operations Research

DATE: 30th September 2022

TIME: 11.00am - 01.00pm

Instructions to Candidates:

- 1). Answer **QUESTION ONE** and any other **TWO QUESTIONS**.
- 2). Mobile phones are **NOT** allowed in the examination room.
- 3). You are **NOT** allowed to write on this examination question paper.

QUESTION ONE (30 Marks) (COMPULSORY)

- a). A man operates a pushcart. He sells hotdogs and sodas. His cart can support 210 lbs. A hotdog weighs 0.5 lbs and a soda 0.125 lbs. He knows from experience that, he must have at least 60 sodas and at least 80 hotdogs. He also knows that, for every two hotdogs he sells, he needs at least a soda. Given that he makes \$ 0.08 on a hotdog and \$ 0.04 on a soda, formulate the underlying linear program and solve graphically to find how many sodas and hotdogs he must have to maximize the profits. [6 Marks]
- b). Hyper Crusher Mines Company own two different mines that produce an ore which, after being crushed, is graded into three classes: high, medium and low-grade. The company has contracted to provide a smelting plant with 12 tons of high-grade, 8 tons of medium-grade and 24 tons of low-grade ore per week. The two mines have different operating characteristics as detailed below.

Mine	Cost per day (\$'000)	Production (tons/day)		
		High	Medium	Low
X	180	6	3	4
Y	160	1	1	6

Use the Simplex algorithm to find how many days per week should each mine be operated to fulfill the smelting plant contract? [10 Marks]

c). Express following LP model in the standard form.

$$\text{Max: } z = 3x_1 - 2x_2$$

Subject to:

$$x_1 - 2x_2 = 10$$

$$5x_1 + 2x_2 \geq 7$$

$$5x_1 - 2x_2 \leq 4$$

$$x_1(\text{unrestricted}), x_2 \geq 0$$

[4 Marks]

d). Ukrainian army wishes to assign four ships to patrol four sectors of the Russian border. In some areas ships are to be on the outlook for illegal fishing boats, and in other sectors to watch for enemy submarines, so the commander rates each ship in terms of its profitable efficiency in each sector. These relative efficiencies are illustrated in the table below. On the basis of the ratings shown, assist the commander who wants to determine the patrol assignments producing the greatest overall efficiencies.

[5 Marks]

Ship	Sector			
	A	B	C	D
1	20	60	50	55
2	60	30	80	75
3	80	100	90	80
4	65	80	75	70

e). The following details are available regarding a project:

Activity	Predecessor Activity	Duration (Weeks)
A	-	3
B	A	5
C	A	7
D	B	10
E	C	5
F	D,E	4

Carry out the forward and backward pass to determine the critical path, the critical activities and the project completion time.

[5 Marks]

QUESTION TWO (20 Marks) (Optional)

- a). Victoria Furniture makes beds, tables and chairs. Each product needs the limited resources of lumber, carpentry and finishing as described in the table below. Formulate the underlying linear program and advice the company on the best product mix so as to maximize on the profits. [10 Marks]

Resource	Bed	Table	Chair	Max Available
Lumber	8	6	1	48
Finishing (hrs)	4	2	1.5	20
Carpentry (hrs)	2	1.5	0.5	8
Max. Demand	unlimited	5	unlimited	
Price (\$)	60	30	20	

- b). A firm has three factories X, Y, and Z. It supplies goods to four dealers spread all over the country. The production capacities of these factories are 200, 500 and 300 per month respectively.

Factory	A	B	C	D	Capacity
X	12	18	6	25	200
Y	8	7	10	18	500
Z	14	3	11	20	300
Demand	180	320	100	400	

Determine suitable allocation to maximize the total net return by first obtaining the initial solution using VAM. [10 Marks]

QUESTION THREE (20 Marks) (Optional)

- a). Distinguish between a transportation problem and an assignment problem. [2 Marks]
- b). A marketing manager has five salesmen and sales districts. Considering the capabilities of the salesmen and the nature of the districts, the marketing manager estimates the sales per month in \$ for each salesman in each district would be as shown in the table below.

		Districts				
		A	B	C	D	E
Salesmen	1	70	30	-	60	63
	2	-	70	50	30	30
	3	60	-	50	70	60
	4	60	70	20	40	-
	5	30	30	40	-	70

Find the assignment of the salesmen to districts that will result in maximum sales. [6 Marks]

- c). An organization has three plants at X, Y, Z which supply to warehouses located at A, B, C, D , and E respectively. The capacity (in 00's tonnes) of the plants is 7, 9 and 18 per month and the requirement of the warehouses is 5, 8, 7, and 14 units respectively. The following table shows the unit transportation cost (in \$).

		Destination			
		A	B	C	D
Source	X	19	30	50	10
	Y	70	30	40	60
	Z	40	8	70	20

Determine the optimum distribution for the organization in order to minimize the total cost of transportation. (Use Least Cost Method to obtain the initial allocation)

[12 Marks]

QUESTION FOUR (20 Marks) (Optional)

- a). A manufacturer uses an item at a uniform rate of 25,000 units per year. Assume that no shortage is allowed and delivery is at an infinite rate. The ordering, receiving and handling cost is \$.23 per order, while inspection cost is \$.22 per order. Interest costs is \$.056 and deterioration and obsolescence cost is \$.004 respectively per year for each item actually held in inventory plus \$.02 per year per unit based on the maximum number of units in inventory.
- i). Determine the EOQ. [4 Marks]
 - ii). If lead time is 40 days, find re-order level. [2 Marks]
- b). The table below defines the activities within a given project.

Activity	Start Node	End Node	Completion Time (Weeks)
1	1	2	2
2	1	3	4
3	2	4	7
4	3	4	3
5	3	5	7
6	4	5	3
7	5	6	4
8	4	6	6
9	6	7	2
10	4	7	7

In addition to the above information, activity five cannot start until three weeks after the end of activity one.

- i). Draw the network diagram. [3 Marks]
 - ii). Calculate the minimum overall project completion time. [3 Marks]
 - iii). Calculate the float time for each activity and hence identify the critical path. [5 Marks]
- c). Thrifty peelers supply Almasi Bottlers with a sweetener at a rate of 5,500 barrels per day at a price of \$ 19.1 per barrel. It uses the chemical of 2,200 barrels per day and 550,000 barrels per year. The ordering (set up) cost is \$ 32.50 pr year and holding cost is 25% of the price per barrel per year. Compute the EOQ. [3 Marks]

QUESTION FIVE (20 Marks) (Optional)

- a). A project consists of seven activities with the time estimates given below.

Activity	Predecessor Activity	Optimistic Time (t_0)	Most-likely Time (t_m)	Pessimistic Time (t_p)
A	-	2	5	8
B	A	2	3	4
C	A	6	8	10
D	A	2	4	6
E	B	2	6	10
F	C	6	7	8
G	D,E,F	6	8	10

From the information given construct a network diagram, determine the critical path and find the probability that the project will be completed in 30 weeks or less. [10 Marks]

- b). The management of a company is interested in crashing of the following project by spending an additional amount not exceeding \$2,000 . Suggest how this can be accomplished. [10 Marks]

Activity	Predecessor Activity	Normal Time (Wks)	Crash Time (Wks)	Normal Cost (\$)	Crash Cost (\$)
A	-	7	6	15,000	18,000
B	A	12	9	11,000	14,000
C	A	22	21	18,500	19,000
D	B	11	10	8,000	9,000
E	C, D	6	5	4,000	4,500

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

SAS 2230/EMG 5218: Operations Research CAT I { $\frac{x}{30}$ }

Date: 27th July 2022

TIME: 9.00am - 10.30am

Instructions: Answer all questions.

Question One

A small plant makes two types of automobile parts. It buys castings that are machined, bored and polished. The data shown in the table is given.

	Part A	Part B	
Machine Capacity	25/hr	40/hr	- 20
Boring Capacity	28/hr	35/hr	- 14
Polishing Capacity	35/hr	25/hr	- 17.5

Castings for Part A cost \$2 each, for Part B they cost \$3 each. They sell for \$5 and \$6 respectively. The three machines have running costs of \$20, \$14 and \$17.50 per hour. Assuming that, any combination of Parts A and Part B can be sold, using graphical method what product mix maximizes profits? [10]

Question Two

Write the following LP in standard form.

$$\text{Minimize: } z = 5x_1 + 12x_2 + 4x_3$$

Subject to:

$$x_1 + 2x_2 + x_3 \leq 5$$

$$2x_1 - 2x_2 + 3x_3 = 2$$

$$x_1 + 9x_2 - 7x_3 \geq 50$$

$$5x_1 - 8x_3 \leq 100$$

$$x_1 \geq 0, x_2 \geq 0, x_3 \text{ (unrestricted)}$$

Question Three

Victoria Furniture manufactures three products; tables, sideboards and chairs which require special material, timber and labour. In a given week, there are 92 units of special material, 116 pieces of timber and 140 hours of labour. The requirements of special materials are 2 units, 4 units and 2 units, for a table, sideboard and chair respectively. Manufacturing a table or a sideboard requires 2 hours of labour time while a chair requires 4 hours. Timber requirements are 4 pieces, 2 pieces and 2 pieces for a table, a sideboard and a chair respectively. (At least 2 tables and 4 chairs must be made) The profit contributions are \$30, \$40, \$20 for a table, sideboard and chair respectively. Formulate the underlying LP and solve it to advise Victoria Furniture how to maximize profits. [15]

Decisions
Material 92
Timber 116
Labour 140

$$30x_1 + 40x_2 + 20x_3 = 140$$

$$x_1 = 2$$



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR
FIFTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE
OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 5216: INDUSTRIAL MANAGEMENT

DATE: 26/09/2022

TIME: 11.00 A.M.-01.00 P.M.

INSTRUCTIONS

- i. This examination contains **FIVE** questions.
- ii. Attempt **ANY THREE** questions.
- iii. Marks will be awarded for neat and concise answers

QUESTION ONE

- a) Mention and briefly discuss the **FOUR** management functions (4 Marks)
- b) Differentiate between 'Management' and 'Administration', citing at least four differences (6 Marks)
- c) Differentiate between efficiency and effectiveness (2 Marks)
- d) A graduate engineer employed as first-line manager. (This is the level where actual operational work for the enterprise in the areas of is performed by workers. Discuss **five** functions the graduate engineer will have to perform in order to excel as a first-line manager. (5 Marks)
- e) In performing the duties of the first line manager, the graduate will require three key skills; conceptual skills, human skills, and technical skills. Briefly outline your understanding of the above skills, and discuss the extent to which the graduate engineer is likely to call upon each of the above skill sets, as a first line manager. (3 Marks)

QUESTION TWO

- a) What were the main challenges of scientific management theory (2 marks)
- b) Discuss the four Principles of Bureaucratic Management (4 marks)
- c) Differentiate between Rules and Standard Operating Procedure in a bureaucracy (2 Marks)
- d) Discuss the Behavioral Management theory, as championed by Mary Parker Follet, explaining the key observations, implications and Principles and how it

- differs with both the Taylor's Scientific Management theory, and Weber's Administrative Management theory.
- e) Differentiate between Theory X and Theory Y (6 Marks)
- f) Describe the "Hawthorne Effect" citing its significance to Management (3 marks)

QUESTION THREE

- a) You have been approached to help Kimathi Dairy Farmers Association locate a milk processing plant. The plant will be located within Nyeri County, and is expected to process both long life and short life milk. The long-life milk will be in a pouch and will have a shelf life of 6 months. The short life version will be sold in barrels to large consumers and has shelf life of 36 hours. Discuss Five main factors you would consider in locating the plant. (5 Marks)
- b) Mention and briefly explain any FIVE Principles of Facility Layout (5 Marks)
- c) Mention and briefly explain any FIVE factors considered in selecting material handling equipment (5 Marks)
- d) Differentiate between Capacity Requirement Planning and Material Requirement Planning (5 Marks)
- e) Mention three strategic implications of short term scheduling (2 Marks)
-
- (3 Marks)

QUESTION FOUR

- a) Quality has several Definitions. Give any Four definitions of quality (4 Marks)
- b) Discuss the following costs of quality
 - i. Prevention Costs (3 Marks)
 - ii. Internal failure costs (3 marks)
- c) With the aid of diagrams, discuss the following tools of quality management
 - i. Cause and Effect Diagram (3 marks)
 - ii. Control Charts (3 marks)
- d) Differentiate between Total Quality Management and ISO Certification (2 marks)
- e) There are two main causes of variation in quality. Distinguish between chance causes of variation and assignable causes of variation giving examples of each (2 Marks)

QUESTION FIVE ✓

- a) Mention SIX objectives of Inventory Control (3 Marks)
- b) Mention FOUR benefits of Inventory Control (2 Marks)
- c) Briefly discuss the following factors that affect productivity

- (2 Marks)
- (2 Marks)
- (2 Marks)
- a. Technology
b. Material and Energy
c. Economic and Social Changes

- d) The following information regarding the output produced and inputs consumed for a particular time period for a particular company is given below:
- Output - KSh. 10,000
Human input - KSh. 3,000 ✓
Material input - KSh. 2,000
Capital input - KSh. 3,000
Energy input - KSh. 1,000
Other misc. input - KSh. 500 The values are in terms of base year shilling value.

- Compute the following productivity indices;
 - i. Labour productivity (1 Mark)
 - ii. Capital Productivity (1 Mark)
 - iii. Material Productivity (1 Mark)
 - iv. Energy Productivity (1 Mark)
 - v. Other Expenses Productivity (1 Mark)
 - vi. Total Productivity — (2 Marks)
 - Assuming that the company purchases all its material including energy, miscellaneous and equipment (leasing), What is the Total Factor Productivity

Def of Quality
Performance to specifications - how well a product meets the targets & tolerances determined by its design
Fitness for use -> how well a product performs for its intended use
for price paid -> defined in terms of product or service usefulness for the price paid.
Post service - quality defined in terms of the support given after a product is purchased.
Methodological criteria.

EMG 5216: INDUSTRIAL MANAGEMENT

- a) Quality has several Definitions. Give any Four definitions of quality (4 Marks)

1. Perspective customer

2. Design Specs.

- b) Discuss the following costs of quality

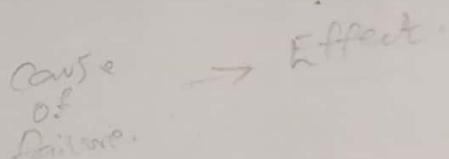
i. Prevention Costs - include quality planning costs involved in developing a plan.

ii. Internal failure costs

(3 marks)

- c) With the aid of diagrams, discuss the following tools of quality management

i. Cause and Effect Diagram



(3 marks)

ii. Control Charts

(3 marks)

- d) Differentiate between Total Quality Management and ISO Certification (2 marks)

- e) There are two main causes of variation in quality. Distinguish between chance causes of variation and assignable causes of variation giving examples of each. (2 Marks)

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2516: INDUSTRIAL MANAGEMENT

- CAT 1
- (i) Govt policy.
 - (ii) Supporting services to industries.
 - (iii) Community to labour attitudes.
 - (iv) Community infrastructure.
 - (v) Climatic conditions.

TIME: 1 HOUR

- (i) " " min distance.
- (ii) " " cubic space utilisation
- (iii) " " max flexibility
- (iv) " " flow.
- (v) " " min material handling.

1. Mention and briefly explain any FIVE uncontrollable factors that affect facility location (10 Marks)
2. Mention and briefly explain any FIVE Principles of Facility Layout (5 Marks)
3. Mention and briefly explain any FIVE factors considered in selecting material handling equipment (5 Marks)
4. Differentiate between Capacity Requirement Planning and Material Requirement Planning (4 Marks)
5. Mention and briefly explain five factors that affect productivity (5 Marks)
6. Mention SIX objectives of Inventory Control (6 Marks)
7. Briefly discuss the factors that affect productivity (10 Marks)

- 1. Product factor
- 2. Technology
- 3. Plant to Equipment
- 4. Structural adjustm
- 5. Material to energy
- 6. Human factors
- 7. Work methods
- 8. Mgt style
- 9. Natural resources
- 10. Govt to infrastructur

- Objectives of Inventory control:
- 1.) Ensure adequate supply of products to customer to avoid shortages as far as possible
 - 2.) Financial investment in inventories is min.
 - 3.) Efficient purchasing, storing, consumption & accounting for materials.
 - 4.) Maintain timely record of inventories and maintain stock within the desired limits.
 - 5.) Ensure timely action for replenishment.
 - 6.) Provide a reserve stock for variations in lead times of delivery of materials.
 - 7.) Provide scientific base for both short term to long-term planning.

MRP → technique for determining the quantity & timing for the acquisition of dependent demand items needed to satisfy the master schedule requirement.

CRP → process of determining what personnel and equipment capacities are needed to satisfy the production objectives embodied in the master schedule and MR plan



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

FIFTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL
ENGINEERING

EMG 5219: MAINTENANCE ENGINEERING AND INDUSTRIAL SAFETY

DATE: 29/09/2022

TIME: 11.00 A.M.-01.00 P.M.

INSTRUCTIONS

- a) This examination contains FIVE questions
- b) Question ONE is Compulsory
- c) Answer question ONE and any other TWO questions

Question ONE (30 MARKS)

- a) Define the term maintenance. (2 marks)
- b) Briefly explain four objectives of maintenance. (4 marks)
- * c) List and give a brief outline of the various regulations/standards relating to safety in Kenya. (4 marks)
- d) Electrical hazards are the cause of numerous workplace fires each year. Discuss any three examples of common ignition hazards. (3 marks)
- * e) Illustrate four aims of proactive accident prevention. (4 marks)
- f) Define the Risk Priority Number (RPN) and briefly explain its constituent elements. (4 marks)
- g) Valves in a chemical processing plant have a MTBF of 30 years. If we assume the failure rate to be constant, then what is the probability for a valve to operate without any failures for 30 years? (3 marks)

h) A test of 100 light bulbs resulted in the following table

Life time (hours)	Number of bulbs
300 - 400	2
400 - 500	9
500 - 600	21
600 - 700	40
700 - 800	19
800 - 900	8
900 - 1000	1

- i. Draw the failure distribution
 - ii. Compute the MTBF
 - iii. Compute the fraction of failed light bulbs at $t = 600$
- (6 marks)

QUESTION TWO (20 MARKS)

- a) Define hazard.
- b) State and describe three automatic fire detection systems. (2 marks)
- c) Explain the main classes of fire and state their respective extinguishing medium. (3 marks)
- d) List and explain the four stages of the combustion process. (4 marks)
- e) A bottling company has invested in a machine retaining a maximum production speed of 60 bottles per minute and operates a single eight-hour shift. However, the machine operates at a lower speed producing one bottler in 1.5 seconds. During the one shift, 30 bottles produced are out of specification. There is 10 minutes morning, 30 minutes lunch and 10 minutes afternoon break. Two changeovers are undertaken in each shift, each taking 35 minutes. The planning factor is 0.95. What is the OEE of the machine? (4 marks)
- f) Define the maintenance concept and list at least four types of maintenance concepts. (3 marks)

2

1.5X

0.67

QUESTION THREE (20 MARKS)

- a) Define safety. (1 marks)
- b) Explain what you understand by safety engineering. (1 mark)
- c) Define the term risk management and list any two risk identification methods and give an example for each method. (3 marks)
- d) Predictive maintenance (pdm) techniques are designed to help determine the condition of in-service equipment to estimate when maintenance should be performed. Briefly state and explain three techniques that a company may adopt under PdM. (3 marks)
- e) Briefly explain four causes attributed to the Increased Failure Rate (IFR) phase of equipment as illustrated in the bath-tube curve. (4 marks)



- f) An aircraft landing gear has 4 tires. Experience shows that tire bursts occur on average on 1 landing in 1200. Assuming that tire bursts occur independently of one another, and that a safe landing can be made if not more than two tires burst, what is the probability of an unsafe landing? (4 marks)

- g) TPOS plant is studying the pumps performance and failure pattern. Under current working conditions, the mean time between failures of the pumps is 10 weeks. When a pump fails, it is replaced by a new one. Analysis of historical data shows that the failure probability is independent of the time a pump is replaced.
- i. What is the probability for a pump to fail during its first 5 weeks of operation? (2marks)

3

01/01/2008

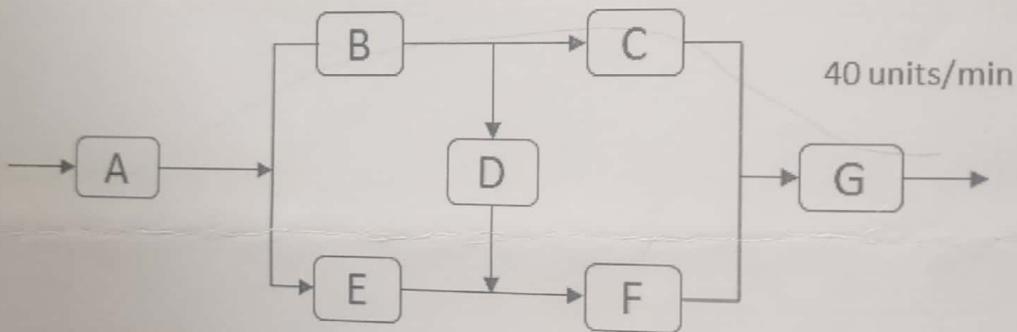
Page 1 of 4

- ii. If there are 10 such pumps in the plant, what is the probability that the time between replacements for any 2 pumps is less than 1 week? How often will this happen in 1 year? (2 marks)

QUESTION FOUR (20 MARKS) ✓

- a) Explain what is meant by maintenance policy. (2 marks)
- b) Outline at least three maintenance policies applied in maintenance engineering. (3 marks)
- c) State the two types of maintenance action and give example for each. (2 marks)
- d) Life cycle costing is a methodology for calculating the whole cost of a system. Outline the Life Cycle Costing steps. (6 marks)
- e) A roller production firm is confronted with a high demand for dustbowl, one of their products.

The production layout with 7 stations is simplified below.



Station	MTBF (h)	MTTR (h)
A	58	2.5
B	35	2
C	28	2.8
D	32	3
E	30	2
F	40	4
G	52	2.4

Compute the global system availability using

- i. TIE SET concept.
ii. Cutset technique.

(3 marks)

(4 marks)



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATIONS 2022/2023 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING AND BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING

EMG 5217: LAW FOR ENGINEERS

DATE: 29TH SEPTEMBER, 2022

TIME: 11:00AM-1:00PM

Instructions: Answer question ONE and any other TWO questions

QUESTION ONE

- a) Discuss the following defences that can be relied upon by an engineer

- i. Necessity (3 Marks)
- ii. Restitution (3 Marks)
- iii. Volenti non fit injuria (3 Marks)
- iv. Contributory negligence (3 Marks)
- v. Specific performance (3 Marks)

b) Discuss any five offences that can be committed by an engineer under the Engineers Act No.43 of 2011. (5 Marks)

- c) Distinguish between patents and utility models and give three (3) reasons why it is necessary for engineers to obtain intellectual property rights. (5 Marks)
- d) Discuss why it is necessary for an engineer to join a trade union (5 Marks)

QUESTION TWO

- a) Mugo was injured due to an engineer's failure to label and secure a construction site. He wishes to take a legal action against the construction company for the injuries suffered. Advise Mugo on the most appropriate remedy in tort and the elements that must be proved by him in order to succeed with the suit (15 Marks)

- b) Discuss any **Five** jurisdictions of the High Court in Kenya. (5 Marks)

QUESTION THREE

- a) With the aid of a well labelled diagram discuss the structure of the court system in Kenya (10 Marks)
- b) Discuss the doctrine of strict liability as expounded in *Rylands v Fletcher* [1868] UKHL 1 (10 Marks)

QUESTION FOUR

- a) As an engineer you have been sued for committing a tort, outline under which circumstances you may be sued for committing the below torts. (15 Marks)
- Intentional Tort
 - Tort of Negligence
 - Vicarious liability tort
 - Tort of Defamation
 - Tort of trespass to a person
- b) Discuss the Doctrine of Privity of Contracts and the exceptions thereof. (5 Marks)

- Agency
- Third Party insurance.

Privity of contract

QUESTION FIVE

- a) Using a relevant example of your choice show the applicability of the doctrine of vicarious liability to the engineering profession (5 Marks)
- b) An engineer who is intending to hire you for repair of his drilling machines has approached you. You inform him that you need to enter into contract first. As an engineer describe any **FIVE** essentials of a valid contract you need to take into account before fully getting engaged with the developer. (10 Marks)
- c) Discuss the composition and jurisdiction of the Supreme Court of Kenya. (5 Marks)

questions

- is to the effect that only a person who is party to the contract can sue or be sued on it. exceptions: (i) Agency (ii) Legal assignment
(iii) third party (iv) negotiable instrument
(v) Trust.
- a) Discuss the Doctrine of Privity of Contracts and the exceptions thereof (5marks)
 - b) Distinguish between patents and utility models and give three (3) reasons why it is necessary for engineers to obtain intellectual property rights (5marks)

questions

- a) Discuss the Doctrine of Privity of Contracts and the exceptions thereof (5marks)
- b) Distinguish between patents and utility models and give three (3) reasons why it is necessary for engineers to obtain intellectual property rights (5marks)

questions

- a) Discuss the Doctrine of Privity of Contracts and the exceptions thereof (5marks)
- b) Distinguish between patents and utility models and give three (3) reasons why it is necessary for engineers to obtain intellectual property rights (5marks)

1. Tort is a civil wrong, describe any FOUR types of Torts and mention their relevance to engineering Profession (8marks).
2. Discuss any four ethical duties of an engineering practitioner as provided by the engineers Act No.43 of 2011. (2mks)

- a) Discuss capacity as an element of a valid contract (10marks)
- b) Discuss any five rules of an offer as an element of a valid contract (5marks)



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
UNIVERSITY EXAMINATION 2022/2023

ORDINARY EXAMINATION FOR
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

BCM 2103: ENTREPRENEURSHIP AND SMALL BUSINESS MANAGEMENT

DATE: 03/10/2022

TIME: 11.00-01.00 P.M

Instructions: Answer Question One (Compulsory) and any other two questions.

Question 1

- a) Read the following short passage and answer the questions that follow:

The president has appointed Ms Totto the Cabinet Secretary in charge of Trade and Small Business Enterprises. Congratulating Madam Totto, The President notes that the country potential of being an emerging market is anchored on growth of small and medium enterprises and technological absorption. Further, He highlighted the value contribution of SMEs in economic development. To achieve their potential, the President underscored the need to support start-ups SMEs manage their challenges and survive.

- i) Support the President pivot on value contribution of SMEs in the economy. (10 marks)
- ii) Explain five potential challenges that startup SMEs experience that the President need mitigated (5 marks)
- iii) Explain five reasons why SMEs need to be innovative. (5 marks)
- wider customer base
- higher profit margins
- meet people's needs
- competitive advantage
- b) Explain giving examples the skills entrepreneurs need to deploy in their business operation. (10 marks)
- technical skills

Question 2

- a) Giving examples, explain five reasons why entrepreneurs need to design new products. (10 marks)
- b) Explain five benefits of operating business ethically. (10 marks)

Question 3

- a) Explain the various features that would indicate an idea provides a good business opportunity. (10 marks)
- Attractive
 - Adds value to product
 - Feasible within the time period.
- b) Explain five reasons why it is important for SMEs to develop a business plan. (10 marks)

Question 4

- a) Detail five costs and five benefits of having corporate entrepreneurs in an organization (10 marks)
- b) Explain five Emerging issues or trends on Globalization and small business. (10 marks)
- 1. Standardization
 - 2. Tech issue
 - 3. ISO certification
 - 4. Labour laws
 - 5. How do we reach market
 - 6.

Question 5

- a) Explain five characteristics of a good entrepreneurial environment. (10 marks)
- b) Explain the steps in the rational decision making process (10 marks)

Costs

Characteristics of envt

Rational decision making

Laws
Federal Laws

1. Appropriate changes
2. Stimulus ideas & incentives
3. Provides fair competition

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
CAT EXAMINATION (1&2)

BSc-Bed mechanical 5.2

PRINCIPLES OF ENTREPRENEURSHIP
DATE: 07/09/2022 1400hrs Time: 2 Hours

Instructions: Answer the ALL questions.

Question 1

Read the following short passage and answer the questions that follow:

Breaking news !!!Favour Nyaberi Kazungu has been appointed the cabinet secretary Gender, Social and Youth empowerment. One of his key roles is to encourage and empower youth to venture into business. During the appointment the president emphasised the importance of small and medium enterprises as key pillar in economic growth and technology absorption. Messrs Nyaberi has employed you in the ministry as the director of youth and small business venture with a key role to help youth start their own businesses. As the Director,

→ listen to customer needs, frustration.
→ Lifestyle changes.
→ Law & situation changes.
→ Trends.

- i) Explain to the youth five ways of identifying business opportunities (5 marks)
- ii) Enlighten the youth on the skills that are necessary in the management of their smes (5 marks)
- iii) Explain five elements that would justify the president ^{his} position on smes (5 marks)
- iv) Educate the youth five reasons why the survival of their smes is rooted on their innovativeness. (5 marks)

Question 2

- a) Giving examples, Identify the various business risks and how organizations can mitigate them (10 marks)
1. Losses 3. Bankruptcy
2. Customer dissatisfaction 4. Unfavourable gvt Policies
- b) Explain the rational steps in decision making process (10 marks)

5. Trade
incentives

ISUZU EAST AFRICA LTD

MATERIALS MMG-PRODUCTIVE

Month	November
Payment Date	30/11/2021
Personnel No.	04483
Job Grade:	N/A
CHRISTOPHER STUDENT	KIRAGU

Contract start: 22/11/2021 End: 14/01/2022

Basic Pay	20,000.00
Basic Pay Adj.	-14,000.00
<hr/> <hr/> Gross	6,000.00
Round Down Kshs	6,000.00
Gross for tax Kshs	6,000.00
Tax Charged	600.00
Personal Relief	600.00
<hr/> DEDUCTIONS	
NHIF	300.00
Deductions Total	300.00
<hr/> Net Pay	5,700.00

Paid thru bank transfer

Acc/No: 055000045764

FAMILY BANK NYERI



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATION 2021/2022 ACADEMIC YEAR

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE
OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR THE
DEGREE OF BACHELOR OF SCIENCE IN CHEMICAL
ENGINEERING

EMG 5102: HEAT TRANSFER

DATE: 9TH APRIL 2022

TIME: 8:30AM - 10:30AM:

Instructions to Candidates

1. This paper contains FIVE questions. Each of the question carries 20 marks.
2. Answer ANY THREE questions.
3. Tables of thermodynamic properties (steam tables) are provided for your use.

QUESTION ONE (20 MARKS)

- (a) State three conditions that simplify the heat conduction equation into a Laplace form. (3 marks)
- (b) List *two* terms of energy equation that are volume phenomena. (2 marks)
- (c) A pyrolysis reactor for making activated char is designed by a group of engineers at DeKUT. The reactor has a cuboid geometry which is heated electrically so that the internal part is maintained at a constant temperature of 750 °C. The reactor wall is made of a 8 mm steel plate. In order to minimize heat losses, the reactor is insulated with three layers, namely, air gap, refractory bricks and aluminum silicate wool. The maximum heat loss permissible in this reactor that makes it economically feasible is 315 W/m². The reactor is operated in a place where the ambient temperature

conditions is 27 °C. Thermal conductivities for the refractory bricks, steel plate and aluminum silicate wool are 1.52, 45 and 0.138 W/m°C respectively. Taking the thickness of air gap (that is equivalent refractory brick insulation) as 245 mm and the thickness of refractory bricks as 230 mm, determine the thickness of the aluminum silicate wool required. (7 marks)

- (d) A peanut roaster is being design by a group of fifth year students. The roaster has a plane wall that is made of a material with a thermal conductivity K to be 1915 W/m K. The roaster wall is 150 mm and has an electric heater that generates a uniform heat of $q = 3560 \text{ kW/m}^3$. During operation, inside and outside of the wall are maintained at constant temperature of 950 °C and 50 °C, respectively. Assuming that heat conduction is taking place only across the wall:
- Derive an analytical expression for evaluating temperature distribution across the wall. (6 marks)
 - Determine the temperature at 56.25 mm from the inner layer of the roaster. (2 marks)

QUESTION TWO (20 MARKS)

- (a) Define the following terms that are used in finite volume method:
- Control volume (1 mark)
 - Node (1 mark)
 - Face (1 mark)

- (b) Broadway's bakery are in the processes of designing an oven for baking bread. The engineer of the company requires to estimate the temperature distribution in the oven in order to determine the position for placing the dough. The oven is fitted with an electrically heated rod that is 439 mm long. The heat source is $q = 2245 \text{ kW/m}^3$. During operation one end of the rod is maintained at constant temperature of 355 °C while the other end is maintained at constant temperature of 152 °C. Steady state temperature distribution across the length of the rod is to be evaluated using finite volume method. Assume that heat conduction is taking place only across the length of the rod, and the domain is to be divided into four equally spaced control volumes.

- Derive the discretized equations for each node. (12 marks)
- Calculate the temperature at each node. (5 marks)

Assume that the conduction is governed by one-dimensional equation in the form

$$\frac{d}{dx} \left(k \frac{dT}{dx} \right) + q = 0.$$

Take the thermal conductivity K to be 1321 W/m K and cross sectional area to be $69 \times 10^{-3} \text{ m}^2$

QUESTION THREE (20 MARKS)

(1 mark)

- Define the Newton's law of cooling. (1 mark)
- Differentiate between the overall heat transfer coefficient applicable to *multilayer plane wall* and that of *multilayer cylinder*. (2 marks)
- At Bidco company in Thika, oil for making soap is pass through a pipe with an inner radius of 50.54 mm. The thickness of the pipe is 23 mm. The pipe has a heat generation of 3875 kW/m³. The pipe is insulated with aluminum silicate wool with a thickness of 47 mm. Thermal conductivity of mild steel is 561 W/mK; thermal conductivity of asbestos wool is 0.61 W/mK; heat transfer coefficient at outside surface is 36 W/mK and the ambient temperature is 26 °C. The heat lost to the atmosphere is 450 W. It is assumed that axial conduction is negligible and the temperature of the oil is equal to that of the inner surface of the pipe. Determine, per unit time and per unit length:
 - the temperature of the inner surface of aluminum silicate wool; (5 marks)
 - the heat removed through forced convection; (4 marks)
 - the temperature of oil. (8 marks)

QUESTION FOUR (20 MARKS)

- Write an expression of the upthrust per unit volume of fluid in a natural convection system. (1 mark)
- State two conditions that make natural convection be significant when evaluating heat transfer problems. (2 marks)
- A group of final year student in chemical engineering are doing an experimental research to establish the effect of flow velocity on heat transfer in a large flat plate. In this experiment, air at temperature of 15 °C is blown across a flat plate with a surface temperature of 550 °C at a mean velocity of 6 m/s. In this research work the geometric factor is taken as $F_{1-2} = 1$ and the emissivity of the plate surface as 0.6. For the first 150 mm of the plate and per unit width, calculate
 - The properties of air at mean film temperature. (3 marks)
 - The rate of heat transfer by convection from both sides of the plate. (5 marks)
 - The radiation heat transfer coefficient. (2 marks)

- (iv) The total rate of heat transfer from both sides of the plate.
 (v) State three assumptions made while undertaking the experiments. (3 marks)

QUESTION FIVE (20 MARKS)

- (a) Define the following terms:
- (i) Wiens displacement Law.
 - (ii) Heat transfer effectiveness.
 - (iii) Kirchoff's law of radiation. (1 mark)
- (b) Briefly explain why it is preferable to use counter-flow arrangements in heat exchangers. (2 marks)
- (c) In Chemelil sugar company, a machine for heating the sugar solution is being designed. The temperature of the solution flowing at the rate of 1.7 kg/s is to be raised from 17 °C to 95 °C. The solution has specific heat of 4.18 kJ/kg °C and heat transfer coefficient of 2500 W/m² K. To achieve this purpose, the design engineer proposes the use of a double-pipe heat exchanger which is either parallel or counter-flow. Steam exiting the turbine of the company's power generation plant flowing at the rate of 3.1 kg/s is used to heat the sugar solution. The steam is at 260 °C with a heat capacity of 4.31 kJ/kg °C and heat transfer coefficient of 400 W/m² K. Using NTU method, evaluate each of the proposed design and select the best approach to achieve the intended purpose. (15 marks)

ADDITIONAL INFORMATION

Dimensionless groups

1. Reynold number, $Re = \frac{\rho Cl}{\mu}$
2. Prandtl number, $Pr = \frac{c\mu}{\lambda}$
3. Stanton, $St = \frac{h}{\rho c C}$
4. Nusselt number, $Nu = \frac{hl}{\lambda}$
5. Dimensionless friction factor, $f = \frac{\tau_w}{\rho C^2/2}$

Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{K}^4$
 For a turbulent flow in a tube, $Nu = 0.0243(Re)^{0.8}(Pr)^{0.4}$.

For a laminar flow in a tube, $Nu = 3.65$.
 Temperature distribution for extended surface:

$$\frac{t - t_F}{t_1 - t_F} = \frac{\cosh m(L - x)}{\cosh mL}$$

The general 3D heat conduction equation is given below:

$$\frac{\partial}{\partial x}(k \frac{\partial T}{\partial x}) + \frac{\partial}{\partial y}(k \frac{\partial T}{\partial y}) + \frac{\partial}{\partial z}(k \frac{\partial T}{\partial z}) + \dot{q} = \rho c_p \frac{\partial T}{\partial t}$$

The heat equation along the radial direction in a cylinder is given as follows:

$$\frac{d^2T}{dr^2} + \frac{1}{r} \frac{dT}{dr} + \frac{q}{r} = 0$$

For heat transfer from a flat plate with a large temperature difference between the plate and the fluid, the local Nusselt number is given by
 $Nu = 0.332(Re)^{1/2}(Pr)^{1/3}(T_w/T_s)^{0.117}$,

where T_w and T_s are the absolute temperatures of the plate and the free stream of the air.

EMG 5102: HEAT TRANSFER, DEKUT, CAT 2 - 27/4/2022, Duration: 1 hr

- (a) State any two factors that affect heat transfer by natural convection. (2 marks)
- (b) Briefly explain the behaviour of heat transfer coefficient associated with natural convection in a vertical wall. (2 marks)
- (c) A wire 1.5 mm in diameter and 150 mm long is submerged in water at atmospheric pressure. An electric current is passed through the wire and is increased until the water boils at 100°C. Calculate the electric power that must be supplied to the wire to maintain the wire surface at 120°C. Take convective heat transfer coefficient as 4500 W/m²°C. $Q = h_A (T_s - T_w)$ (3 marks)

- * (d) Mechanical engineering students are investigating the heat transfer in a hot flat plate using a wind tunnel. The air at temperature of 23 °C is blown across the plate with a surface temperature of 569 °C at a mean velocity of 13.5 m/s. For heat transfer from a flat plate with a large temperature difference between the plate and the fluid, the local Nusselt number is given by

$$Nu = 0.332(Re)^{1/2}(Pr)^{1/3}(T_w/T_s)^{0.117},$$

where all properties are at the mean film temperature, Re is based on the distance from the leading edge of the plate, and T_w and T_s are the absolute temperatures of the plate and the free stream of the air. For the first 217 mm of the plate (both sides) and per metre width, calculate

- (i) Averaged heat transfer coefficient. (5 marks)
- (ii) The rate of heat transfer by convection. (2 marks) $Q = h_A (\Delta T)$
- ✓ (iii) The radiation heat transfer coefficient. (2 marks) $h_r = F_{1-2} \sigma E [T_1^2 + T_2^2] (T_1 + T_2)$
- (iv) The total rate of heat transfer for the plate. (4 marks)

Take the geometric factor as $F_{1-2} = 1$ and the emissivity of the plate surface as 0.6.



$$Q_{rad} = h_r A (T_1 - T_2)$$

$$A = (L \times w) 2$$

$$\alpha_F = \frac{\tanh h mL}{h mL}$$

$$h_l = Q h_a$$

$$30 \quad 150$$



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations 2021/2022 Academic Year

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE MECHANICAL ENGINEERING

EMG 5222: VEHICLE SYSTEM ENGINEERING

DATE: 17th May 2022

TIME: 8.30am-10.30am

INSTRUCTIONS

- i) This examination contains **FIVE** questions.
- ii) You are required to answer **THREE** questions only
- iii) **Section A (Question ONE)** is compulsory
- iv) Attempt ONE question from Section B and ONE question from Section C
- v) Questions **ONE** carries **30 marks** and the others carry **20 marks** each.

SECTION A (COMPULSORY)

QUESTION ONE [30 Marks]

a) Match A and B as applied in chassis frame system design.

- | | |
|-----------------------|------------------------------------|
| i Short duration load | • Beyond Design Capacity [5 marks] |
| ii Impact Load | • While Crossing a Broken Patch |
| iii Inertia Load | • While Applying Brakes |
| iv Static Load | • Due to Collision of Vehicle |
| v Overload | • Due to Chassis Parts |

b) List SIX functions of suspension system in a vehicle.

c) The block brake, as shown in Figure 1, provides a braking torque of 360 N-m. The diameter

of the brake drum is 300 mm. The coefficient of friction is 0.3. Find:
i The force (P) to be applied at the end of the lever for the clockwise and counter

clockwise rotation of the brake drum; and
ii The location of the pivot or fulcrum to make the brake self-locking for the clockwise
rotation of the brake drum.

[11 marks]

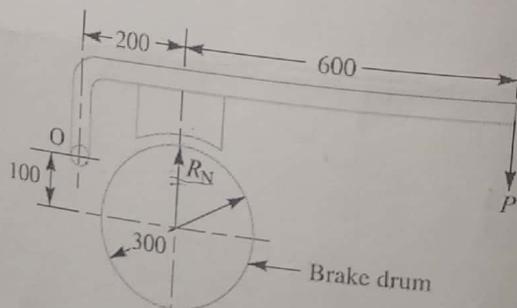


Figure 1

d) Define the following terms as applied in tires construction.

- i Undertread
- ii Shoulder
- iii Bead Filler
- iv Groove

[4 marks]

e) Illustrate the major components of a steering system using a neat sketch.

[4 marks]

SECTION B

QUESTION TWO [20 Marks]

[4 marks]

a) List EIGHT characteristics of a good chassis frame.

b) Discuss THREE types of chassis frames giving TWO applications in each case. [6 marks]

c) In design and analysis of Eicher E2 (Model No.11.10) Truck chassis made from ASTMA
A710 steel, you are provided the following data.

Front Overhang (a)	935 mm
Rear overhang (c)	1,620 mm
Wheel base (b)	3,800 mm
Modulus of Elasticity, E	$2.10 \times 10^5 \text{ N/mm}^2$
Poisson Ratio	0.28
Capacity of Truck	8 tons
Capacity of Truck with 1.25%	98100 N
Weight of the body and engine	2 tons

With the assumption that the chassis has two and each beam is simply clamp with shock absorber and leaf spring, Calculate the reaction at support points, shear force, bending moment, bending stress & shear stress of the system [10 marks]

QUESTION THREE [20 Marks]

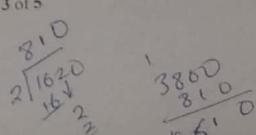
[4 marks]

a) Enumerate FOUR factors considered in design of brakes.

[6 marks]

b) Using a neat sketch, illustrate the working principle of a hydraulic brake

c) Figure 2 shows a brake shoe applied to a drum by a lever AB which is pivoted at a fixed-point A and rigidly fixed to the shoe. The radius of the drum is 160 mm. The coefficient of friction of the brake lining is 0.3. If the drum rotates clockwise, find the braking torque due to the horizontal force of 600 N applied at B. [10 marks]



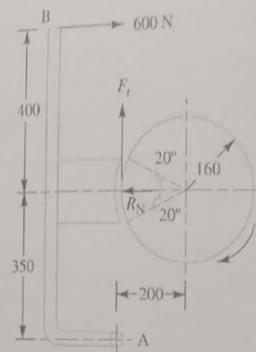


Figure 2

QUESTION FOUR [20 Marks]

- a) A motor car with wheel base 275 cm with a centre of gravity 85 cm above the ground and 115 cm behind the front axle has a coefficient of adhesion 0.6 between the tyre and the ground. Calculate the maximum possible acceleration when the vehicle, is
- i) driven on four wheels, [6 marks]
 - ii) driven on the front wheels only [4 marks]
 - iii) driven on the rear wheels only. [4 marks]
- b) outline any six effects of lowering the aspect ratio of a tyre. [6 marks]

QUESTION FIVE [20 Marks]

- a) Using a well labelled diagram, illustrate and explain the basic principle of the Ackermann layout. [5 marks]
- b) State any three factors that influence the cornering power of a tyre. [3 marks]
- c) Briefly describe the three causes of oversteer. [3 marks]
- d) A vehicle of total weight 5000 kg, is held at rest on a slope of 10° . It has a wheel base of 225 cm and its centre of gravity is 100 cm in front of the rear axle and 150 cm above the ground level.
- i) What are the normal reactions at the wheels? [4 marks]
 - ii) Assuming that sliding does not occur first, what will be the angle of slope so that the vehicle will overturn? [3 marks]

- iii) Assuming all the wheels are to be braked, what will be the angle of the slope so that the vehicle will begin to slide if the co-efficient of adhesion between the type and the ground is 0.35? [2 marks]



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

EMG 5222: VEHICLE SYSTEM ENGINEERING

DATE: 7TH APRIL 2022

TIME: 35 MINS

Instructions: Attempt All Questions

1. The central part of the axle beam is offset downwards to: [1 mark]
 - Give improved resistance to end thrusts during cornering
 - Give better bending strength
 - Give improved torsional strength during brake application
 - Clear the engine sump and lower vehicle centre of gravity
2. On rebound, in the direct acting shock absorber, fluid flows out of the upper part of the cylinder and also (ii) driven on front wheels only; (iii) driven on rear wheels. [1 mark]

$$f = \frac{Nl g}{b + 2wh} = \frac{0.6 \times 1.6 \times 9.81}{2.75 + 0.6 \times 0.85} = 2.89 \text{ m/s}^2$$

$$f = \frac{N(b-1)g}{b - wh} = \frac{0.6(2.75 - 1.6)9.81}{2.75 - 0.6(0.85)} = 3.022 \text{ m/s}^2$$
3. Enumerate **EIGHT** functions of chassis frame.
4. Discuss the **TWO** main types of suspension system
5. Using a neat sketch, illustrate any **FIVE** main components of a tire structure. ✓ [5 marks]
6. A motor car with wheel base 275 cm with a centre of gravity 85 cm above the ground and 115 cm behind the front axle has a coefficient of adhesion 0.6 between the tyre and the ground. Calculate the maximum possible acceleration when the vehicle, is
 - driven on four wheels,
 - driven on the front wheels only
 - driven on the rear wheels only.

(i) driven on four wheels.

→ Since it has not been mentioned about the use of third differential, take up both cases:

Without the use of third differential and assuming that slip only occurs at the front wheels.

$$f = Nl g = 0.6 \times 9.81 \text{ m/s}^2 = 5.886 \text{ m/s}^2$$

With 3rd differential and assuming that slip first occurs at front wheels, then :

$$f = \frac{2Nl g}{b + 2wh} = \frac{2 \times 0.6 \times 1.6 \times 9.81}{2.75 + 2 \times 0.6 \times 0.85} = 4.996 \text{ m/s}^2$$

Conventional/rigid axle

Independent suspension

[4 marks] [4 marks]

$$= 3.022 \text{ m/s}^2$$

Checking R_F

$$R_F = \frac{L}{b + 2wh} W = \frac{1.6}{2.75 + (0.6 \times 0.85 \times 2)} W = 0.424 W$$

Since $R_F < R_R$ ($0.575 W$) hence our assumption is correct.

$$R_F = \frac{b + 1 + 2wh}{b + 2wh} W$$

$$= \frac{(2.75 - 1.6) + 0.6 \times 0.85}{2.75 + 2(0.6)0.85} W$$

car wheels
 $\frac{N(b-l)}{b-nh}$

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE MECHANICAL ENGINEERING

EMG 5222: VEHICLE SYSTEM ENGINEERING

CAT 2

- a) A motor car with wheel base 275 cm with a centre of gravity 85 cm above the ground and 115 cm behind the front axle has a coefficient of adhesion 0.6 between the tyre and the ground. Calculate the maximum possible acceleration when the vehicle, is *without third diff.*

i) driven on four wheels, [6 marks]

$$\text{ii) driven on the front wheels only} \rightarrow f = \frac{Nl g}{b+nh} = \frac{0.6(1.6)(9.81)}{2.75 + (0.6)0.85} [4 \text{ marks}]$$

$\frac{N(b-l)}{b-nh} \leftarrow$ iii) driven on the rear wheels only. [4 marks]

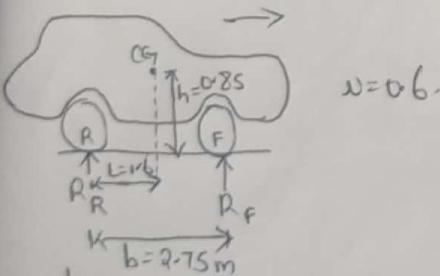
b) outline any six effects of lowering the aspect ratio of a tyre. [6 marks]

c) Illustrate the major components of a steering system using a neat sketch. [4 marks]

d) State any three factors that influence the cornering power of a tyre. [3 marks]

e) Briefly describe the three causes of oversteer. [3 marks]

Qst a



$$n = 0.6.$$

(i) driven on four wheels.

→ Since it has not been mentioned about the use of third differential, take up both cases.

(a) without third differential.

$$f = Nl g = 0.6 \times 9.81 \\ = 5.886 \text{ m/s}^2$$

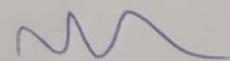
(b) with third differential, assuming that slip occurs first at front wheels, then:

$$f = \frac{2Nl g}{b+2nh} = \frac{2 \times 0.6 \times 1.6 \times 9.81}{2.75 + 2(0.6)(0.85)} \\ = \frac{18.8352}{3.77} = 5 \text{ m/s}^2 \quad 6.80$$

Check $R_F = \frac{L}{b+2nh} W = \frac{1.6}{2.75 + 2(0.6)(0.85)} W$

$$= 0.424 W$$

∴ $R_F \propto R_R (= 0.575 W)$, hence our assumption is correct.





DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATION ACADEMIC YEAR 2021/2022

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 5101: POWER PLANTS

DATE: 10TH MAY 2022

TIME: 8:30-10:30AM

INSTRUCTIONS

1. The paper has **FIVE** questions
2. Attempt **QUESTION 1** and **ANY OTHER TWO** Questions

QUESTION 1 (Compulsory) 30 Marks

- a) Define the concept powerplant. [2 mks]
- b)
 - i. Explain the Rankine cycle with reference to steam thermal power plant. [2 mks]
 - ii. Using a labelled diagram, describe how extraction condensing steam turbine, can be used to generate electrical power and also meet process heat demand of a facility for example a sugar mill. [8 mks]
 - iii. A boiler produces superheated steam at 50 bar and 400°C. This is expanded to 3 bar with an isentropic efficiency of 0.9. The exhaust steam is used for a process. The returning feed water is at 1 bar and 40°C. This is pumped to the boiler. The water leaving the pump is at 40°C and 50 bar. The net power output of the cycle is 60 MW. Calculate the mass flow rate of steam. [11 mks]
- c) A commercial facility has the following appliances and energy use timelines as presented in **Table 1c**. The facility owner is planning to invest in a roof top Solar Photovoltaic system to meet the facility energy demand. As part of the PV plant system design determine the following:
 - i. The facility daily energy (kWh) consumption [3 mks]
 - ii. The required number of solar PV panels/modules [4 mks]

Note: The system is to be powered by 12Vdc, 400Wp, 7.5Asc PV module and PV module generation factor is 3.4. The system is to be oversized by a factor of 1.3.

#	Appliance	Quantity	Power Rating (W)	Daily Operating Hours (Hrs.)	Daily total (Wh)
1	Lighting	20	50	8	
2	TV Sets	10	80	4	
3	Water Pump	1	500	8	
4	Kitchen appliances	5	500	8	

Table 1c

QUESTION 2 (20 marks)

- a) (i) Briefly describe the difference between a wet back and dry back steam boiler. [2 mks]
(ii) List six considerations when selecting a boiler for a particular application. [6 mks]
- b) A Geothermal powerplant with nameplate rating of 80 MW uses saturated steam from a steam well with a shutoff pressure of 28 bar. Steam enters the turbine at 5.5 bar and condenses at 0.15 bar. The turbine polytropic efficiency is 0.82 and the turbine-generator combined mechanical efficiency is 0.85. The cooling tower exist is at 20°C. Determine:
(i) Actual turbine work [9 mks]
(ii) Turbine steam flow (kg/hr.) [1.5 mks]
(iii) Turbine volumetric flow (m³/min) [1.5 mks]

QUESTION 3 (20 marks)

- a) i. Using a well labelled diagram briefly describe the working principle of a combined cycle powerplant that operates on gas and steam cycles respectively. [7 mks]
ii. A gas turbine expands gas 1 MPa pressure and 600 °C to 100 kPa. The gas expansion process isentropic efficiency is 0.92 and mass flow rate is 20 kg/s. Calculate the exit temperature (K) and the power output (kW). Assume, c_v=718 J/kg K and c_p=1005 J/kg K. [7 mks]
- b) A hydro power plant is to be used for peaking at 60% annual load factor and 20% capacity factor. The electrical energy obtained during the year is 40GWh. Determine:
(i) Average load (kW) [1.5 mks]
(ii) Maximum demand (kW) [1.5 mks]
(iii) Capacity load (kW) [1.5 mks]
(iv) Reserve capacity (kW) [1.5 mks]

QUESTION 4 (20 marks)

- a) List four applications of temporal thermal powerplant that operates on internal combustion engine (ICE) technology. [4 mks]
- b) i. State the different components that make up a nuclear reactor. [3 mks]
ii. Neglecting losses, how much matter is converted into electrical energy by a 500 MW power plant that operates for 3000 hours per year? [3 mks]
- c) Table 4c presents wind speed data in meters per second (m/s) for a particular location at different altitudes. Reproduce the table and:
ii. Determine the power density (W/m²) for respective wind speed [5 mks]
iii. Draw a graph of power density (W/m²) versus wind speeds (m/s) [5 mks]

Wind speed (m/s)	Power Density (W/m ²)
1	
3	
5	
7	
9	
12	
15	
20	
30	
40	

Table 4c

QUESTION 5 (20 marks)

- a) Briefly explain the working principle of electrical dust collectors as environmental pollution control mechanism for steam boilers/furnaces that burns solid fuels such as coal. [2 mks]
- b) Identify the hydro turbines in figure 5b1 and 5b2 respectively and briefly describe their working principles. [5 mks]

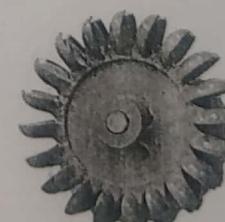


Figure 5b1



Figure 5b2

- c) The peak load on a power plant nameplate rated 100 MW is 80 MW at an annual load factor of 40%. Determine:
- Average load on the power station (MW) [1.5mks]
 - Energy generated (in kWh) if the plant operates for 250 days, 24hours per day [1.5 mks]
- d) An ocean wave along the Kenyan coast has the following data: Amplitude, 1 m, Period, 8s, width, 40 m, ocean water density 1000 kg/m³. Determine the following:
- The wavelength (m) [1.5mks]
 - The wave velocity (m/s) [1.5mks]
 - Wave frequency [1 mk]
 - Surface density (J/m²) [1.5mks]
 - Total energy extracted from the 40m width wave (MJ) [3 mks]
 - Wave power (W) [1.5mks]
- $P = E \times f \times (w)$



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations – 2022/2023

FIFTH YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 5105: MEASUREMENTS & INSTRUMENTATION

DATE: 13th MAY 2022

2 HOURS

TIME: 8.30am

INSTRUCTIONS

This paper consists of **FIVE** questions. Answer questions **ONE** and **ANY OTHER TWO**.

QUESTION ONE.

30 MARKS

(a) With aid of a diagram illustrate the interfacing circuitry for controlling desktop computer temperature using an LM35 sensor. Support your answer with the reasons why sensors need interfacing system/circuit as they are applied in instrumentation systems. [6 Marks]

(b) A Barium titanate pick up has the dimensions of 5mm by 5mm by 1.25mm. The force acting on it is 150 pC/N and its permittivity is 12.5 nF/m . If the modulus of elasticity of Barium titanate is $12 \times 10^6 \text{ N/m}^2$, calculate;

- i) the strain. [2 Marks]
- ii) the charge. [1 Marks]
- iii) the capacitance. [3 marks]

(c) It is difficult if not impossible to carry out space research (exploration) without data telemetry. Discuss this school of thought. [5 Marks]

(d) The system highlighted in Fig. Q1(d) represents a PLC controlled heating and mixing system in which two materials are collected in one tank. The materials are to be mixed till a predefined set point of the temperature is achieved. **NOTE:** Material B will only enter the tank provided the conditions for Material A are

fulfilled, i.e., Level Material A give a signal about the Level status. When the tank full of Material A & B, mixing and heating takes place up to a certain temperature set value. When entire mixing process and heating are completed, outlet valve will be activated.

- Identify the inputs and outputs and give them the proper addresses. [5 Marks]
- Formulate a PLC ladder diagram program for automatic control of the heating and mixing system. [8 Marks]

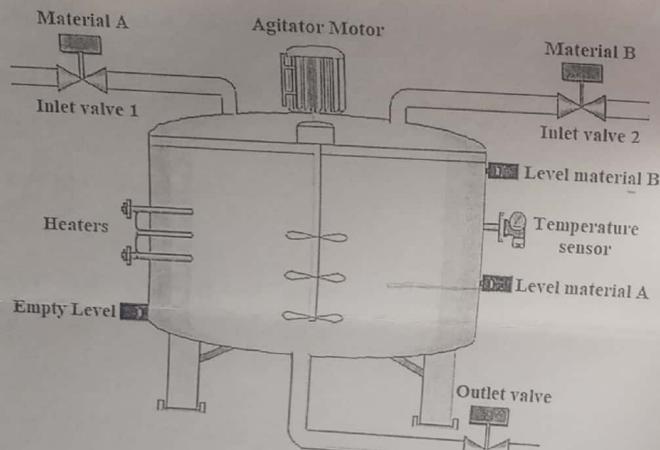


Fig. Q1(d)

QUESTION TWO.

- Briefly explain the different types of torque produced in PMMC instrument. [20 Marks]
- A 50Ω basic movement requiring a full-scale current of $1mA$ is to be used as an ohmmeter. The internal battery voltage is $3V$. A half scale deflection marking desired is $1k\Omega$. Determine the:
 - value of R_1 and R_2
 - maximum value of R_2 to compensate for a 5% drop in battery voltage. [4 Marks]

- With the aid of a diagram, explain how a microprocessor-based measurement and instrumentation system is used to monitor the condition of a patient in a hospital intensive care unit (ICU). (Utilize any disease of your choice). [6 Marks]

20 MARKS

QUESTION THREE.

- Highlight three sensing methods of photoelectric sensors and illustrate their principle of operation. [6 Marks]
- The potential coil of an electrodynamic wattmeter has an inductance of 8 mH and a resistance of $2k\Omega$. Draw the circuit and determine the percentage error of the instrument when measuring power in an inductive load having a power factor (p.f.) of 0.707 lagging at 50Hz . Neglect the impedance of current coil and assume the current drawn by potential circuit to be negligible. [6 Marks]
- A weighbridge is used to weigh entire rail or road vehicles and their contents. The load carried by the vehicle is calculated by weighing the vehicle both empty and loaded. With your knowledge of instrumentation systems, illustrate with aid of block diagram and explain how an operator in the control room will be able to visualize the weight of a trailer passing through a loadcell based weighbridge. [8 Marks]

20 MARKS

QUESTION FOUR.

- Giving examples in each case, outline the relationship between secondary standards and working standards as applied to the field of measurement and instrumentation systems. [4 Marks]
- With aid of suitable diagrams, explain the construction and operation of a thermocouple instruments in temperature measurement. [6 Marks]
- In the field of Marine Engineering under the defense forces of developed countries, a military **NAVY Submarine Ship** is a complicated and intricate vessel used for defense in military service. To enable safe navigation, launching of missiles and torpedoes, and defense mechanism during abnormalities, several measurements, sensing and detections must be made through complicated instrumentation systems in and out of the Submarine Ship. You have been employed to be in-charge of the Submarine Ship Instrumentation systems, explain systematically as an

intelligent fresh engineer how and what you should study to fit your job within the shortest time possible. [10 Marks]

20 MARKS

QUESTION FIVE.

(a) Differentiate clearly the following terms as used in instrumentation systems:

[2 Marks]

i) Signal conditioning from signal processing.

[2 Marks]

ii) Active instrument from passive instrument.

(b) For the Wheatstone bridge shown in Fig. Q5(b), the galvanometer has a current sensitivity of $12\text{mm}/\mu\text{A}$. The internal resistance of the galvanometer is 200Ω . Determine the deflection of the galvanometer caused due to 5Ω unbalance in the arm BD. [6 Marks]

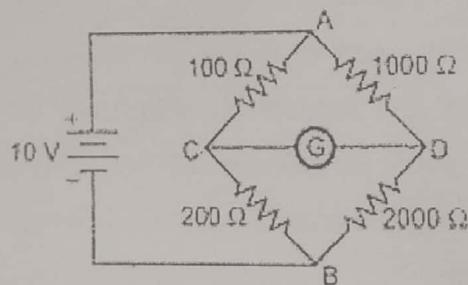


Fig. Q5(b)

(c) As a young innovative instrumentation fresh engineer, you are tasked by DeKUT management to design an automated regulating and counting vehicle entry system for the newly constructed main gate of the university. Illuminate your design with aid of block diagram, proper sensor/transducer; controller and actuator selection and highlight the working principle of your system. [10 Marks]

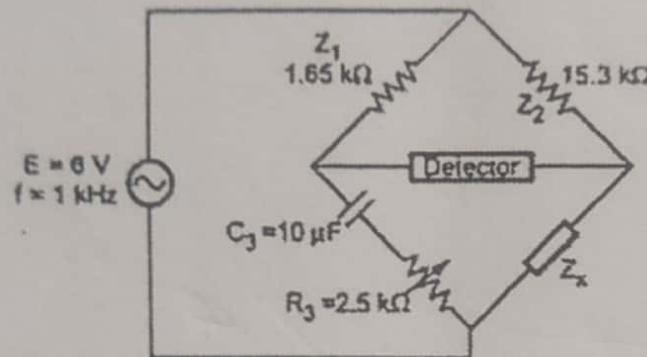
.....THE END.....

EMG 5105

CAT 1

55mins

- (a) Instrumentation technology has promoted advanced researches and exploration of the universe. Explain why it is unfeasible to carry out space exploration without data telemetry. [6]
- (b) For the bridge circuit shown below, determine the constants of Z_x , considering it as series circuit. [8]



- (c) A fighter jet is a complicated and intricate vessel used for defense in military service. To enable safe flight, launching of missiles or ejection of the pilot during abnormalities, several measurements must be made through complicated instrumentation systems in and out of the aircraft. You have been employed to be in-charge of the fighter jet instrumentation systems in Kenya Defense Forces (Military). Explain systematically as an intelligent fresh Engineer (how and what you should study) to fit your job within the shortest time possible. [10]
- (d) The Water Resource Authority of Kenya wants to transmit bulk water flowing from its pumping stations situated in Nyeri County to its control centre in Nyeri town. With aid of block diagram, identify any measurands and design a micro-controller-based system that illustrate measurement/control technique using proper sensor, transducers, signal type, signal processing, transmission technique and actuators up to an output that can be read by the end user. [8]