



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR BACHELOR OF
SCIENCE IN MECHANICAL ENGINEERING

EMM 212: PRINCIPLES OF ENGINEERING DESIGN

DATE: 15/6/2017

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

- *Attempt question one (COMPULSORY) and any other two questions. You are advised to use 1 hour 40 minutes in Question 1, and 40 minutes on each of the remaining two questions.*

QUESTION ONE (COMPULSORY) (30 MARKS)

An institution has requested you develop a solar heating system for water to serve average of 200 people. The water will be supplied to twelve common shower points. The system is meant to replace an existing electricity based heating process.

- List and explain six main phases of design that can be followed in this design. (12 marks)
- As a facilitator, plan the sequence of the thinking applying the six thinking hat sequence and list two issues that can be discussed at each stage (6 marks)
- Briefly describe four safety considerations in your design (4 marks)
- Select suitable materials for; (i) hot water storage tank, (ii) piping, and justify your choices (4 marks)
- Using neat sketches in good proportions, sketch a possible design solution of the water heating system. (4 marks)

QUESTION TWO (20 MARKS)

- a) A part is often considered interchangeable with another when the form, fit and function are identical. Explain the terms form fit and function in the context of standardization and interchangeability of parts. (3 marks)
- b) Explain two strategies used in product life cycle management at each of the following phases in product life cycle (4 marks)
- i Development
 - ii Introduction,
 - iii Maturity
 - iv Decline
- c) Explain briefly the following terms as used in engineering design (5 marks)
- i. Balance
 - ii. Rhythm
 - iii. Scale and proportion
 - iv. Harmony
- d) Charts are used in material selection for components during engineering design in order to save time. The Fig. Qn2 below is a materials chart for selection of materials that would meet specified properties of Young's modulus and density of the material, briefly explain from which materials and reasons would the following be made. (8 marks)
- i. A car seat frames
 - ii. Engine crank shaft
 - iii. Anti-vibration generator mountings
 - iv. Wind turbine blades

QUESTION THREE (20 MARKS)

- a) Using examples, briefly explain the following levels of engineering design (4.5 marks)
- i. Adaptive design,
 - ii. Developed design,
 - iii. New design.
- b) In your own words, explain the following terms as used in work place design (3 marks)
- i. Ergonomics
 - ii. Work Space Envelope
 - iii. Man –machine system
- c) Describe any four aspects of aesthetics in design. (2 marks)
- d) Define lateral thinking and explain ‘The Six Thinking Hats Strategy’ developed by *Edward De Bono* (5 marks)
- e) Define reliability in design and briefly explain five ways to improve reliability by design. (5.5marks)

QUESTION FOUR (20 MARKS)

- a) Describe three domains of specialization as applied in ergonomics (4.5 marks)
- b) Using examples, briefly explain the following intellectual property rights (4.5 marks)
- i. Industrial design
 - ii. Patent
 - iii. Geographical indicators
- c) Distinguish briefly the following types of communications stating briefly when they are used and what they contain. (3 marks)
- i. Project Proposal
 - ii. Design report
- d) By way of an example, consider a case of a cordless hand drill. This is a tool used for household projects, it has a battery pack which is rechargeable. Fig Q4 shows the various subsystems and their interactions in the whole design. Outline four guidelines that can be considered at the design stage, each for; (8 marks)
- i. Design for assembly (DFA)
 - ii. Design for manufacture (DFM)

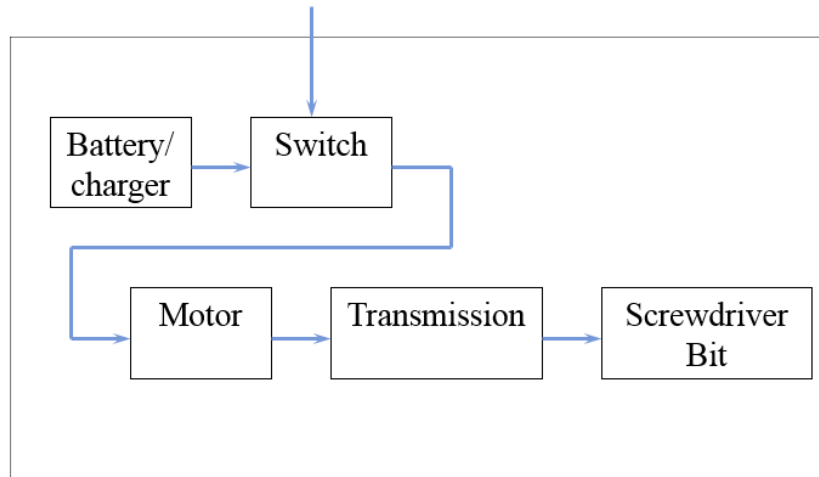


Fig Q4: Cordless Screwdriver Sub-Systems and Interactions

QUESTION FIVE (20 MARKS)

- a) Define economic lot size (2 marks)
- b) List three differences between costing and cost estimating (3 marks)
- c) Define breakeven point and explain its significance in economic project design (3 marks)
- d) From the following data, calculate the total cost and selling price for a job. (5 marks)

Direct material = Ksh: 5,500; Manufacturing wages = Ksh 3,000; Factory overheads to manufacturing wages = 100%; Non-manufacturing overheads to factory costs=15%; Profit on total cost = 12%
- e) A slot is to be cut on 1800 parts using a milling machine. Using the listed alternatives, prepare a comparative analysis and hence determine which of the listed alternatives is the most economically viable. (7 marks)
 - i Have a machinist earning Ksh: 100 per hour layout and drill each part for 2 minutes per part.
 - ii Use a template jig capable of producing 50 parts per hour and costing Ksh: 1200. The operator earns Ksh: 50 per hour.
 - iii Using a duplex jig which costs Ksh:3750 and can produce every part 30 seconds the operator earns Ksh: 65 per hour.

Which method would be most appropriate if only 500 parts were to be produced?