*(University of Choice)*

# MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

**MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS**

**2023/2024 ACADEMIC YEAR**

**FOURT YEAR FIRST SEMESTER EXAMINATIONS**

**FOR THE DEGREE**

**OF**

**BACHELOR OF ENGINEERING IN MECHANICAL AND INDUSTRIAL ENGINEERING**

**COURSE CODE: MIE 401**

**COURSE TITLE: INDUSTRIAL ENGINEERING**

**DATE: 7/12/2023** **TIME: 15:00 – 17:00 HRS**

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning

**TIME: 2 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pag Please Turn Over

**QUESTION ONE COMPULSORY [30 MARKS]**

(a) The project manager of a task force planning the construction of a domed stadium in Nairobi had hoped to be able to complete construction prior to the start of the next Africa Cup of Nations (AFCON) 2027 in Kenya Uganda and Tanzania. After reviewing construction time estimates, it now appears that certain amount of crashing will be needed to ensure project completion before the AFCON opener. Given the following time and cost estimates, determine a minimum-cost crashing schedule that will shave **five Months** off the project length. Indicate clearly on a table, the affected paths, crashed activities and their costs. **[20 marks]**

| Activity | Precedes | Normal time (months) | Crashing costs | |
|---|---|---|---|---|
| | | | First (month) | Second (month) |
| a | b | 12 | $15,000 | $20,000 |
| b | k | 14 | 10,000 | 10,000 |
| c | d,e,f | 10 | 5,000 | 5,000 |
| d | g | 17 | 20,000 | 21,000 |
| e | h | 18 | 16,000 | 18,000 |
| f | i | 12 | 12,000 | 15,000 |
| g | m | 15 | 24,000 | 24,000 |
| h | n,p | 8 | — | — |
| i | j | 7 | 30,000 | — |
| j | p | 12 | 25,000 | 25,000 |
| k | End | 9 | 10,000 | 10,000 |
| m | End | 3 | — | — |
| n | End | 11 | 40,000 | — |
| p | End | 8 | 20,000 | 20,000 |

**TABLE Q 1. (a)**

(b) The new director of special events at MMUST has decided to completely revamp graduation ceremonies. Towards that end, a PERT chart of the major activities has been developed. The chart has five paths with expected completion times and variances as shown

in the **table Q.1 (b).** Graduation day is 17 weeks from now. Assume the project begins now, compute the probability that the project will be completed before:

(i) Graduation time

(ii) The end of week 16

**(iii)** The end of week 13 **[10 Marks]**

| Path | Expected duration (weeks) | Variance |
|---|---|---|
| A | 10 | 1.21 |
| B | 8 | 2.00 |
| C | 12 | 1.00 |
| D | 15 | 2.89 |
| E | 14 | 1.44 |

**TABLE Q1 (b)**

**QUESTION TWO [20 MARKS]**

(a) What are the requirements for effective inventory management? **[8marks]**

b) A company manufactures three products X, Y, and Z using the same manufacturing facilities arranged in six departments A, B, C, D, E and F. The material handling is done by a forklift. The containers can carry 500, 700 and 1000 pieces of the products X, Y and Z respectively. The annual demand for each product is 14,000 units. Sequence of operations of product movement are given below. Construct TO SCALE the travel chart.

| *Product* | *Movement* |
|---|---|
| ***X*** | $A \longrightarrow E \longrightarrow B \longrightarrow D \longrightarrow C \longrightarrow F$ |
| ***Y*** | $A \longrightarrow B \longrightarrow C \longrightarrow D \longrightarrow F \longrightarrow E$ |
| ***Z*** | $C \longrightarrow B \longrightarrow A \longrightarrow D \longrightarrow E \longrightarrow F$ |

**[12 marks]**

**QUESTION THREE [20 MARKS]**

(a) What are the major advantages and disadvantages of job specialization in manufacturing industry? **[8 marks]**

(b) A company is planning to undertake the production of medical testing equipment has to decide on the location of the plant. Three locations are being considered, namely, Kakamega, Eldoret and Naivasha. The fixed costs of three locations are estimated to be 200 M kShs, 250 M kShs and 400 M kShs respectively. The variable costs are 22,200 kShs, 16,600 kShs and 3500 kShs per unit respectively. The average sales price of the equipment is 7000 per unit. Using suitable graph paper, Find:

(i) The range of annual production/sales volume for which each location is most suitable.

(ii) Select the best location, if the sales volume is of 18,000 units.

***[12 marks]***

**QUESTION FOUR**

(a) Explain the ***term predictive maintenance*** and the importance of good records.

**[4 marks]**

(b) A special component used throughout a large machine tool. The component has a limited life and the following data have been collected on failures

| **%age of components which have failed by the end of that week (cumulative)** | **Week after replacement** |
|---|---|
| **15** | **1** |
| **30** | **2** |
| **50** | **3** |
| **75** | **4** |
| **100** | **5** |

**Table Q 4.**

3300 components are in use at any one time and they can be replaced on a mass replacement basis for kSh 400 per component. If they are replaced individually as they fail the cost is kSh 2000 representing kSh 200 for the component and Ksh 1800 labor charges.

It is required to establish the LEAST COST REPLACEMENT POLICY comparing individual replacement on failure with mass replacement at the end of the various weeks together with individual replacement of components which have failed in the preceding interval. ***[16 marks]***

## AREA UNDER STANDARDIZED NORMAL CURVE FROM - ∞ TO +Z

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

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