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University of Ruhuna- Faculty of Technology

Bachelor of Engineering Technology Honours Degree
Level 3 (Semester I) Examination, June/July 2025
Academic year 2023/2024

Course Unit: ENT3122 - Electrical/Electronic and Mechanical Equipment Maintenance (Written) **Duration: 02 hours**

- All symbols have their usual meanings.
- This paper contains **four (4)** questions on **four (03)** pages.
- Answer all the questions.
- This is a **closed-book** examination.
- University approved calculators are only allowed.

Q1.

a) Briefly explain what is meant by "Corrective Maintenance Management Method" and list down four (04) major types of corrective maintenance methods. (06 marks)

b) Illustrate the statistical life of a machine/equipment using the "Bathtub Curve" and briefly explain the three parts of the bathtub curve. (10 marks)

c) A manufacturing company conducted a monthly reliability analysis of a critical CNC milling machine to evaluate its maintenance performance. The machine was scheduled for continuous operation over 30 days (1 month). Table 01 presents the details of six breakdown incidents that occurred during the specified period.

Table 01: Breakdown Data of CNC Milling Machine (30-Day Observation)

Breakdown description	Number of days of the month the breakdown occurred	Average repair time (min.)
Spindle Motor Failure	01	120
Lubrication Pump Failure	04	60
Controller Overheat	10	45
Servo Drive Failure	15	150
Tool Changer Jam	21	90
Encoder Signal Loss	28	75

i. Calculate the **Mean Time to Repair** (MTTR) of the CNC milling machine. (03 marks)

ii. Calculate the **Mean Time Between Failures** (MTBF) of the CNC milling machine. (03 marks)

d) A batch of 500 identical non-repairable components was tested until failure. The total accumulated operational time before all units failed was 1,250,000 hours. Calculate the **Mean Time To Failure** (MTTF) for a single unit. (03 marks)

Q2.

a) Name three (03) pillars of **Total Productive Maintenance** (TPM). (03 marks)

b) Using a comparison table or bullet points, explain two (02) key differences between **Reliability- Centered Maintenance** (RCM) and **Total Productive Maintenance** (TPM).

(04 marks)

c) Write down the primary purpose of each of the following ISO standards used in maintenance and asset management.

i. ISO 55000 Series
ii. ISO 14224
iii. ISO 9001
iv. ISO 18436 Series (04 marks)

d) **Overall Equipment Effectiveness** (OEE) is a framework for measuring the effectiveness and efficiency of a manufacturing process. A small manufacturing plant is scheduled to 8-hour operations. Data has been collected from operation as per the table 02 presented below:

Table 02

Item	Data
Working Hours	8 Hours = 480 mihs
Break Time	2×10 min = 20 mins
Lunch Break	1×45 min = 45 mins
Breakdown	32 min.
Hourly Standard Output	55 parts per min.
Total Output	20,456 parts
Scrap Parts	386 parts

i. Calculate the OEE value for the operations. (08 marks)

ii. Discuss the six big losses that would impact the operational performance. Relate your answer with relevant examples in a manufacturing operation.

(06 marks)

Q3.

a) What is the difference between a benefit and a cost? Provide one relevant example for each. (04 marks)

b) The management of Alpha Tech Industries is evaluating two machines (Machine Alpha and Machine Beta) to improve their electronics assembly line. The machines differ in terms of initial cost, operating expenses, and cash inflows. The details are as follows:

Table 03

Machine	Initial Cost	Annual Operating Cost	Expected Annual Cash Inflow	Estimated Life (Years)
Machine Alpha	\$28,000	\$1,200	\$6,000	6 years
Machine Beta	\$24,000	\$1,800	\$6,000	6 years

i. Calculate the payback period for each machine. (04 marks)

ii. Which is the best machine to purchase according to payback method of project analysis? Explain your answer.

(02 marks)

c) A precision tool manufacturing company invested \$150,000 in a new CNC machining center. After training and setup costing an additional \$30,000, the machine contributed to increased output and cost savings totalling \$220,000 over the first year. Calculate the Return on Investment (ROI) based on the total investment and benefits received.

(04 marks)

d) A small manufacturing business has recently spent \$25,000 to upgrade its automated packaging system to reduce labor dependency and improve efficiency. The upgrade is expected to yield incremental benefits of \$9,000 annually over a useful life of 4 years. Assuming the benefits are constant each year and that the total benefit is calculated over the full useful life, calculate the Benefit-Cost Ratio (BCR) of the project. Based on your result, evaluate whether the investment is economically justified.

(06 marks)

e) In 2022, Kamal invested \$10,000 in a renewable energy startup by purchasing company shares. By the end of the year, the market value of these shares had increased to \$11,800. In addition, Kamal received \$400 in dividends during the same period from the company. Based on this information, calculate the Percent Rate of Return (PRR) on Kamal's investment for the year 2022.

(05 marks)

Q4.

a) List down three (03) requirements for an effective maintenance program. (03 marks)

b) Write three (03) indices to evaluate the effectiveness of a maintenance organization.

(03 marks)

c) Explain what information are given by the first digit and second digit of the IP code.

(04 marks)

d) The label below of a Danfoss VSD (Model FC 302, 3.37 kW to 75 kW) states it has IP55 protection. Explain the meaning of the IP55 rating in the context of this Variable Speed Drive. (04 marks)

Danfoss VSD, Model **FC 302,**
0.37kW to 75kW, IP55

For High Performance and IP55 Protections

e) Explain the following testing methods with their applications. (06 marks)

i. Continuity testing

ii. Insulation resistance testing

- Draw the diagram for the insulation resistance testing of a cable. (05 marks)

***** End of the Paper *****