ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

(2)

Final Semester Examination
Course No.: IPE 4101
Course Title: *Introduction to Industrial and Production Engineering*

Winter Semester: A.Y. 2024-2025
Time: 2 Hours
Full Marks: 120

There are **04 (Four)** Questions. Answer all of them. Marks in the margin indicate full marks. Do not write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are not allowed.

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1. A mid-sized manufacturing company produces electronic appliances. Recently, the company has been facing several operational issues such as excess inventory piling up in warehouses, frequent machine downtime causing delays, and inconsistent product quality leading to customer complaints and returns. The production manager observes that workers often spend time waiting for materials, unnecessary movement of components occurs between workstations, and production sometimes exceeds actual customer demand. Additionally, there is no proper system to signal when new materials are needed, and processes vary depending on the worker, leading to inefficiencies. To address these issues, the company decides to adopt lean manufacturing principles, focusing on waste elimination, reducing variability, and improving throughput using techniques such as Kaizen, 5S, Kanban, and Just-in-Time (JIT).

(a) List the seven categories of **Waste** of **Toyota Production System.** Identify the **wastes** present in the scenario and justify why they are considered waste according to lean manufacturing principles. **[10]** CO1, PO1 WK1, WK3

(b) Discuss how the company can **reduce variability and improve throughput** using lean concepts. Explain the role of **pull systems** in solving the problems described in the scenario. **[10]** CO1, PO1 WK1, WK3

(c) Evaluate how the implementation of **Kaizen, 5S, Kanban, and Just-in-Time (JIT)** can improve the company's operations. Provide specific actions for each technique and explain their expected impact on efficiency and waste reduction. **[10]** CO1, PO1 WK1, WK3

2. A factory introduces a new workstation design and task system to improve productivity. However, workers begin to experience discomfort, make frequent errors while operating machines, and take longer to complete tasks. Additionally, poor communication between supervisors and workers delays problem-solving, leading to reduced efficiency and increased safety risks. The management realizes that the issues may be due to improper consideration of human capabilities, poor system design, and ineffective organizational structure.

(a) Define **Human Factors Engineering (HFE)**. Discuss the **scope of HFE**, highlighting its key domains. **[10]** CO3, PO1 WK2, WK3

(b) Explain the concept of the **systems approach** in Human Factors Engineering. Discuss the **primary goals of HFE** with appropriate explanation. **[10]** CO3, PO1 WK2, WK3

(c) Outline the **steps involved in ergonomic design**. Explain how **macroergonomic principles** can be applied to improve organizational performance, safety, and efficiency. **[10]** CO3, PO1 WK2, WK3

3 **(a)** Define the concept of Operations Research and explain its significance in optimizing organizational processes and decision-making. Provide practical examples illustrating **[10]** CO5, PO1

the applications of Linear Programming in real-world decision-making scenarios. WK2, WK3

(b) An airport is planning the deployment of two types of ground service units: baggage handling units and aircraft cleaning units. The goal is to minimize the total daily operating cost while meeting operational requirements. Each baggage handling unit can serve 4 aircraft per day, and each cleaning unit can serve 3 aircraft per day. The airport must handle at least 24 aircraft daily. To ensure service efficiency, the number of cleaning units must be at least 3. At least 6 total units must be used each day, and at least 2 baggage handling units must always be in operation. The daily cost is 500 units for each baggage handling unit and 300 units for each cleaning unit. Determine the number of each type of unit required to minimize total cost using the graphical method. **[20]** CO5, PO1 WK2, WK3

4 A city hospital is planning to allocate its limited daily resources among three types of healthcare services: general checkups, diagnostic tests, and minor surgeries. Each general checkup requires 1 hour of doctor time, 1 hour of nursing staff time, no equipment usage time, and 1 hour of support staff time. Each diagnostic test requires 2 hours of doctor time, 1 hour of nursing staff time, 2 hours of equipment usage time, and 1 hour of support staff time. Each minor surgery requires 4 hours of doctor time, 3 hours of nursing staff time, 3 hours of equipment usage time, and 2 hours of support staff time. The hospital has a maximum of 100 hours of doctor time, 80 hours of nursing staff time, 90 hours of equipment usage time, and 70 hours of support staff time available per day. The hospital earns a profit of 30 units for each general checkup, 50 units for each diagnostic test, and 70 units for each minor surgery. The objective of the hospital is to determine the optimal number of each type of service to provide daily to maximize total profit while staying within the available resource limits. Formulate this situation as a linear programming problem and solve it using the simplex method. **[30]** CO4, PO1 WK3, WK4