Predicted Exam Paper 2025

Total Marks: 120 | **Time:** 3 Hours

Section A (Short Answer) - 2 Marks Each

Q1. Explain how the service life of a tool impacts productivity.

Q2. List two key provisions of the Factories Act, 1948, that are designed to ensure worker health and safety.

Q3. Define fault tracing and state its primary objective.

Q4. State two key reasons why effectively managing the repair cycle is important for an organization.

Q5. List two distinct types of workplace hazards and provide one specific example for each type.

Q6. List the three elements of the fire triangle required for combustion to occur.

Q7. List any two major categories of faults found in machine tools.

Q8. List two main categories of hazards and provide one example for each.

Q9. Describe the primary goal of maintenance economics.

Q10. List two major categories of tools used for maintaining industrial equipment.

Section B (Medium Answer) - 5 Marks Each

Q1. What are the merits and demerits of preventive maintenance?

Q2. Steps for periodic and preventive maintenance of:

I. Machine tools II. Pumps III. Air compressors IV. Diesel generating (DG) sets.

Q3. An industrial process requires two different pressure vessels:

- **Vessel A:** A cylindrical vessel with dished ends, designed to store compressed air at an internal pressure of 1.5 MPa.
- **Vessel B:** A spherical vessel of a similar volume, designed for storing a high-pressure gas at 25 MPa.

a) Classify each vessel as either thin-walled or thick-walled, stating the primary design criterion used to make this distinction. (2) b) Analyze the selection of a spherical geometry for the high-pressure application (Vessel B) compared to the cylindrical shape (Vessel A). Discuss the key differences in terms of stress distribution and manufacturing complexity. (3)

Q4. Organize the classification of pressure vessels.

Q5. A manufacturing company has recently installed a new, critical conveyor belt system in its packaging unit. To prevent costly breakdowns, they need to establish a robust preventive maintenance (PM) plan.

a) Outline the five key steps you would follow to create and implement this PM plan for the new conveyor system. (3 marks) b) Analyze the significance of the 'scheduling' and 'record-keeping' steps in this process. How do these two steps directly contribute to the long-term effectiveness and efficiency of the entire maintenance program? (2 marks)

Q6. Analyze the following fault scenario:

An industrial control panel, which was working correctly yesterday, now fails to start a connected motor. The main power indicator on the panel is ON, but the motor's 'RUN' indicator remains OFF when the start button is pressed.

Describe the logical sequence of fault-finding activities a technician should follow to diagnose this issue, starting from initial information gathering and proceeding to fault isolation. For each major stage in your sequence, provide a specific action the technician would take related to this scenario.

Q7. Discuss the concept of fault tracing and significance of decision tree in sequence of fault finding activities. Draw a decision tree by showing the usual problems found in machine tools and different equipments. Explain its significance in boiler and electrical motors.

Q8. Describe the importance of fault tracing.

Q9. Describe fault tree analysis.

Q10. What do you mean by equipment maintenance management? State the prime objectives fulfilled by it.

Q11. How do you draw a decision tree diagram?

Q12. A manufacturing facility uses a critical hydraulic press for its production line. To prevent costly breakdowns, a new preventive maintenance (PM) program is being designed.

a) Describe a systematic, five-step preventive maintenance procedure that should be performed on this hydraulic press. (3 marks) b) Analyze the potential consequences for the facility if the 'Record Keeping' step is consistently neglected in this PM program. (2 marks)

Q13. A safety audit of a new workshop reveals the following issues with their color-coding system: i. The main electrical control panel is painted bright green. ii. A large fire extinguisher is painted yellow. iii. An emergency stop button on a lathe machine is colored blue.

Analyze the potential safety hazards and confusion that could arise from each of these incorrect color choices. For each item, specify the correct standard safety color and provide a brief justification for its use.

Q14. Consider a hardened steel shaft rotating within a bronze bushing in a gearbox. a) If the lubrication system fails, identify and explain the two primary wear mechanisms you would expect to cause failure on the inner surface of the bushing. (2 marks) b) Contrast the mechanism of adhesive wear identified in part (a) with fretting wear, which might occur at the press-fit interface between the outer surface of the bushing and its housing. Your comparison should address the relative motion, operating environment, and characteristic surface damage for each. (3 marks)

Section C (Long Answer) - 10 Marks Each

Q1. a) Compare and contrast the 'half-split' method with the 'input-output' (or signal tracing) method for fault diagnosis in electronic or mechatronic systems. In your analysis, evaluate the suitability of each method for different system architectures, such as a simple serial signal path versus a complex system with multiple feedback loops. (5 marks)

b) A junior engineer argues that in time-critical situations, a 'shotgun' approach (replacing multiple suspected components at once) is more efficient than a systematic, step-by-step fault-tracing process. Evaluate this assertion from the perspective of a lead engineer responsible for a safety-critical industrial control system. Discuss the potential long-term consequences of this approach regarding system reliability, maintenance costs, and the risk of introducing new, masked faults. (5 marks)

Q2. Question:

A systematic approach is fundamental to efficient and accurate troubleshooting. The sequence of fault-finding activities provides a logical framework for diagnosing and resolving issues in complex systems.

a) Explain in detail the initial diagnostic stages of the fault-finding sequence, starting from symptom analysis up to the point of isolating the faulty functional unit. Discuss the significance of adhering strictly to this sequence in minimizing diagnostic time and preventing the unnecessary replacement of components. (6 Marks)

b) Once a fault has been isolated to a specific unit, describe the subsequent stages required to complete the repair and return the system to service. In your answer, explain why the final stage of performance checking and verification is critically important, even after a component has been replaced and the initial symptom has disappeared. (4 Marks)

Q3. Q1. The use of decision trees for diagnosing faults in complex electrical equipment like power transformers provides a systematic and interpretable approach to maintenance and troubleshooting.

(a) Explain in detail the step-by-step process of constructing a decision tree for the purpose of fault diagnosis. In your explanation, discuss the significance of attribute selection metrics, such as Information Gain, in identifying the most informative diagnostic tests (e.g., temperature checks, gas analysis) to perform at each stage of the diagnostic process. **(4 Marks)**

(b) A maintenance team has collected the following historical data for fault diagnosis in a distribution transformer. The goal is to classify the transformer's condition based on sensor readings.

Case ID	Oil Temperature	Key Gas (Acetylene)	Sound Level	Fault Condition
1	Normal	Low	Normal	Normal
2	High	Low	Humming	Overheating
3	High	High	Buzzing	Winding Fault
4	Normal	Moderate	Normal	Insulation Failure
5	Normal	Low	Normal	Normal
6	High	Moderate	Humming	Overheating
7	High	High	Buzzing	Winding Fault
8	Normal	High	Popping	Winding Fault

Based on the dataset provided above, construct a complete decision tree to classify the fault condition. You must clearly justify your choice for the root node and subsequent decision nodes by analyzing the purity of the splits they create. **(6 Marks)**