MAINTENANCE AND RELIABILITY ENGINEERING

ENIE 414

Lecture : 3 **Year : IV**
Tutorial : 1 **Part : I**
Practical : 3/2

Course Objectives:
The objective of this course is to provide students with fundamental knowledge of maintenance and reliability engineering for effective operation of industrial systems. It helps students understand maintenance functions, planning, organization, cost analysis and spare parts management. The course develops skills in applying reliability concepts, failure analysis, fault tracing and maintenance strategies to improve equipment performance.

1 Introduction to Maintenance Engineering (5 hours)

1.1 Definition and objectives of maintenance engineering
1.2 Primary and secondary functions and responsibility of maintenance department
1.3 Generation of maintenance, classification of maintenance
1.4 Types and applications of tools used for mechanical and electrical maintenance
1.5 Maintenance cost and its relation with replacement economy
1.6 Service life of equipment
1.7 Terotechnology
1.8 Difference between repair and maintenance
1.9 Challenges of maintenance management in Nepal

2 Maintenance Management (5 hours)

2.1 Need and importance
2.2 Maintenance forecasting and planning
2.3 Manpower allocation principle
2.4 Maintenance organization, its types and selection criteria
2.5 Maintenance facilities and its management
2.6 Store management and its function, spare part optimization
2.7 Quality circle in maintenance
2.8 Concept of 5s and its implementation in maintenance facilities

3 Reliability Engineering (6 hours)

3.1 Introduction
3.2 Reliability measures

3.3 Bathtub curve
3.4 Reliability functions and models, reliability block diagrams
3.5 Mean time concepts
3.6 Reliability of systems: Series, parallel and combined
3.7 Maintainability and availability
3.8 Reliability-centered maintenance (RCM): Steps of implementation and benefits of RCM
3.9 Reliability improvement techniques
3.10 Reliability testing: Life testing (Time - to - failure testing), accelerated life testing, environmental testing (Temperature, vibration)

4 Fault Tracing (6 hours)

4.1 Fault tracing-concept and importance
4.2 Decision tree-concept, need and applications
4.3 Sequence of fault-finding activities, show as decision tree
4.4 Draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment like: Lathe/Milling/Drilling, pump, air compressor, internal combustion engine, boiler, electrical motors
4.5 Root cause analysis: Concept and 5-why methods
4.6 Fault tree analysis and failure mode effect analysis
4.7 Techniques of fault tracing in industrial system

5 Periodic Inspection (4 hours)

5.1 Concept and need
5.2 Concept of degreasing, cleaning and repairing schemes
5.3 Condition monitoring techniques: Vibration analysis, thermography, ultrasonic evaluation, motor current signature analysis, lubrication oil analysis
5.4 Factor to be considered in overhauling of mechanical components
5.5 Factor to be considered in overhauling of electrical motor
5.6 Repair complexities and its use

6 Preventive and Predictive Maintenance (8 hours)

6.1 Definition, need and advantages of preventive maintenance
6.2 Steps/procedure for preventive maintenance of: Machine tools, pumps, air compressors, diesel generating(dg) sets, boiler
6.3 Program and schedule of preventive maintenance of mechanical and electrical equipment's
6.4 Repair cycle-concept and importance
6.5 Definition, need, advantages and techniques of predictive maintenance
6.6 Wear: types, causes, factors affecting, reduction method
6.7 Lubricants: types, applications and lubricating method
6.8 Corrosion, types, factor affecting corrosion and preventive method

7 Maintenance of Industrial Automation and Electrical System (6 hours)

7.1 Maintenance of components of Industrial automation: Control system, actuators, sensors, drives, interface and communication system
7.2 Basic concept of ladder programming
7.3 Basic concept of domestic and industrial wiring
7.4 Basic concept of motor control circuit: DOL control, contractor inter-locking
7.5 maintenance of transformer and generators

8 Maintenance of Industrial Automation and Electrical System (5 hours)

8.1 Concept and need for quality maintenance processes, quality assurance activities: Inspection and testing, calibration of instruments, maintenance documentation (Logs, reports) and quality performance metric: OEE (Overall equipment effectiveness)
8.2 Total productive maintenance (TPM)
8.3 Quality tools in maintenance
8.4 Hazard identification and risk assessment
8.5 Accident- causes, types, results and control
8.6 Fire prevention and fire-fighting equipment and methods
8.7 Safe maintenance practices: Lockout/Tagout (LOTO), Permit to work (PTW), machine guarding, energy isolation, safe tool handling, use of personal protective equipment (PPE)
8.8 Safety color codes

Tutorial (15 hours)

1. Categorize industrial maintenance strategies by identifying and justifying the specific types of maintenance used across various manufacturing sectors
2. Formulate comprehensive maintenance schedules for mechanical systems, including pumps, compressors and machine tools
3. Compute quantitative reliability metrics, including failure probability, mean time between failures (MTBF) and system availability through numerical exercises
4. Construct diagnostic decision trees and flowcharts to systematically isolate faults in pumps, lathes, air compressors and electric motors
5. Analyze condition monitoring data to diagnose equipment health and recommend data-driven maintenance interventions
6. Develop standardized preventive maintenance (PM) plans for critical utility and workshop equipment such as boilers, DG sets and stationary machinery
7. Interpret industrial automation schematics by identifying electrical control components and decoding complex ladder Logic diagrams
8. Evaluate total productive maintenance (TPM) implementations and safety protocols through comparative case studies of industrial accidents and successes

Practical **(22.5 hours)**

1. Applications of various maintenance tools and diagnostic equipment to perform routine servicing tasks
2. Install and configure domestic and industrial wiring systems in accordance with standard electrical codes and safety regulations
3. Construct and troubleshoot industrial motor control circuits, including DOL starters and forward-reverse configurations
4. Program and operate variable frequency drives (VFDs) and programmable logic controllers (PLCs) to automate motor sequences, including system boot/reboot procedures
5. Execute fire safety protocols and demonstrate the correct operation of firefighting and personal protective equipment (PPE)
6. Validate the performance of newly installed or repaired machine tools by generating comprehensive test charts based on technical manuals and logbooks
7. Field visit to develop decision tree to locate fault of the following: Internal combustion (IC) engine, boiler, pump, machine tool, air compressor, electric motor, air conditioner, hydropower
8. Field visit to demonstrate and practice on repair and maintenance of electro- mechanical and hydraulic and pneumatic based equipment/device/machine.
9. Field visit to prepare a preventive maintenance schedule of any workshop having- air compressors, hydraulic and pneumatic system, lifts, welding machines and machine tools

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	5	6
2	5	6
3	6	9
4	6	9
5	4	6
6	8	12
7	6	6
8	5	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Mishra, R. C., Pathak, K. (2012). Maintenance engineering and management. PHI Learning.
2. Jardine, A. K. S., Tsang, A. H. C., Taghipour, S. (2021). Maintenance, replacement and reliability: Theory and applications. CRC Press.
3. Ben-Daya, M., Kumar, U., Murthy, D. N. P. (2016). Introduction to maintenance engineering: Modelling, optimization and management. Wiley.
4. Gulati, R. (2021). Maintenance and reliability best practices. Industrial Press.
5. Garg, H. P. (1990). Industrial maintenance. S. Chand Publishing.
6. Campbell, J. D., Jardine, A. K. S. (Eds.). (2001). Maintenance excellence: Optimizing equipment life-cycle decisions. CRC Press.
7. Palmer, R. D. (2019). Maintenance planning and scheduling handbook. McGraw Hill.