# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Subject Code : ME03000161**

**Subject Name : Industrial Safety Engineering**

| | |
|---|---|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 3 |
| Category of the Course: | MOPEC |

| | |
|---|---|
| **Prerequisite:** | Zeal to learn the subject |
| **Rationale:** | Industrial Safety Engineering plays a crucial role in ensuring the safety, health, and well-being of workers, protecting assets, and maintaining environmental sustainability in industrial environments. It is designed to identify, assess, and mitigate potential risks and hazards that could lead to accidents, injuries, or damage to equipment and facilities. By fostering a safe working environment, it not only protects human lives but also enhances employee morale, productivity, and operational efficiency. Adhering to regulatory standards and safety protocols helps industries avoid legal liabilities, fines, and penalties, ensuring compliance with government and industry-specific regulations. Moreover, safety engineering minimizes operational disruptions, reduces costs associated with accidents, and extends the lifespan of machinery through preventive measures. It also emphasizes environmental protection by preventing incidents like chemical spills or gas leaks, ensuring sustainable industrial practices. By integrating advanced technologies such as IoT and AI, Industrial Safety Engineering enables real-time hazard monitoring and predictive maintenance, further enhancing safety and efficiency. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No | Course Outcomes |
|---|---|
| 1 | Understand general principles of safety management and their integration with productivity and quality optimization. |
| 2 | Apply tools and methodologies such as fault tree analysis, fishbone diagrams, and the 5-why method for analysing incidents. |
| 3 | Conduct systematic safety audits to assess compliance with safety standards, regulations, and organizational policies. |
| 4 | Apply systematic hazard identification techniques such as HAZOP, FMEA, What-If Analysis, and Checklists. |
| 5 | Design predictive maintenance strategies using IIoT to reduce equipment failures and improve operational safety. |

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**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial / Practical | | |
| L | T | PR | C | ESE (E) | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 3 | 0 | 0 | 3 | 70 | 30 | 00 | 00 | 100 |

**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1. | Introduction to Safety:<br>History of Safety movement, Evolution of modern safety concept-general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety. | 08 | 20 |
| 2. | Safety Management and Analysis:<br>Security management of industrial plants, Organization, administration & management responsibility in the field of safety. Salient points of factories act 1948 w.r.t. health & environment, plant & machinery.<br>Locating injury sources, identify causes of injury, injury investigation, safety analysis techniques: FAULT TREE, THERP, FMEA; Risk tolerability, ten-point scale for workplace hazards.<br>Hazard. Risk Issues and Hazard Assessment: hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, Risk estimation. Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis(PHA), human error analysis, hazard operability studies(HAZOP),safety warning systems. | 10 | 25 |
| 3 | Accident Investigation and Reporting:<br>Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities – principles of accident | 10 | 25 |

| | | | |
|---|---|---|---|
| | preventionaccident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and conditiondomino sequence supervisory role, role of safety committee, cost of accident.<br>Safety Performance Monitoring:<br>Recommended practices for compiling and measuring work injury experience, permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems. | | |
| 4 | Safety Audit:<br>Components of safety audit, types of audits, audit methodology, non-conformity reporting (NCR), audit checklist and report, review of inspection, remarks by government agencies, consultants, experts, perusal of accident and safety records, formats, implementation of audit indication, liaison with departments to ensure co-ordination, check list, identification of unsafe acts of workers and unsafe conditions in the shop floor. | 07 | 10 |
| 5 | Application of Industrial Internet of things for safety:<br>IIoT in Safety Engineering: Overview of the Industrial Internet of Things (IIoT), Role and significance of IIoT in enhancing industrial safety, Key components of an IIoT system (sensors, actuators, communication networks, data processing units).<br>Safety Monitoring and Hazard Detection: Real-time monitoring of environmental parameters (e.g., temperature, pressure, toxic gases), Detection and prevention of equipment failures through predictive maintenance, Integration of IIoT sensors for fire detection, gas leak monitoring, and vibration analysis.<br>IIoT-Based Safety Systems: Wearable devices for worker health and safety monitoring, Smart helmets, gloves, and vests equipped with IIoT technology, Proximity sensors for collision avoidance in industrial vehicles and machinery.<br>Future Trends in IIoT for Safety Engineering: Advancements in sensor technologies and their implications for safety, Role of AI and machine learning in predictive safety systems, Emerging IIoT platforms and their impact on industrial safety. | 10 | 20 |
| | **Total** | **45** | **100** |

* Topics must be taught during laboratory sessions

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **10** | **10** | **30** | **20** | **20** | **10** |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**References/Suggested Learning Resources:**

**(a) Books:**

1. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
2. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay,1997.
3. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.
4. John Ridley, "Safety at Work", Butterworth and Co., London, 1983.
5. Brown, D.B. System analysis and Design for safety, Prentice Hall, 1976.
6. Ismail Butun, "Industrial IoT: Challenges, Design Principles, and Best Practices" Springer,
7. Sabina Jeschke, "Industrial Internet of Things: Cybermanufacturing Systems", Springer
8. Pradeep Kumar Singh, P.G. Dastidar, Nidhi Gupta , "IoT and Analytics for Industrial Applications", Springer
9. Deepak Gupta, Ashish Khanna, et al, "Smart Sensors for Industrial Internet of Things: Design Challenges and Security Issues", Springer Nature

**Open-source software and website:**

1. Accident Analysis
2. Safety Audit Packages
3. Consequence Analysis (CISCON)
4. Fire, Explosion and Toxicity Index (FETI)
5. Reliability Analysis for Mechanical system and Electrical System Failure Mode Analysis

**Suggested Course Practical List:**

As per the content of the course, Case studies and Mini Project for Safety Engineering.

**Case Studies and Applications**

- Practical applications of IIoT in industries like manufacturing, oil and gas, and construction.
- Success stories of improved safety through IIoT.

**List of Laboratory/Learning Resources Required:**

nil

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