

| Course Type | Course Code | Name of Course               | L | T | P | Credit |
|-------------|-------------|------------------------------|---|---|---|--------|
| AEC         | NMNA201     | Mine Automation and Robotics | 3 | 0 | 0 | 3      |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Course Objective</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| This course provides a comprehensive understanding of automation and robotics in mining, covering fundamental concepts, advanced technologies, and practical applications. It examines how automation enhances safety, efficiency, and productivity, with a focus on autonomous vehicles, robotic drilling, remotely controlled equipment, and AI-driven systems. Learners will also examine the role of sensors, communication networks, and data processing in improving decision-making. Through real-world case studies, the course highlights the benefits, challenges, and future trends of automation, preparing learners for advancements in smart and sustainable mining technologies. |
| <b>Learning Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| In this course, robots and automated systems are being used to make mining safer, faster, and more efficient by reducing human involvement in dangerous areas. The focus is on self-driving trucks, robotic drills, remotely controlled machines, and smart technology that enhance mining operations. Challenges related to automation, including sensor technology, communication, and data handling, are also being explored. Through real-world examples, the impact of robotics on mining is being studied, demonstrating how it enhances operations by making them safer, more cost-effective, and more environmentally friendly.                                                         |

| Unit No. | Topics to be Covered                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Lecture Hours | Learning Outcome                                                                                                                                                                                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.       | <b>Introduction to Mine Automation and Robotics:</b> Overview of Mine Automation: History, Evolution, and Importance, Fundamentals of Robotics: Components, Types, and Applications in Mining, Automation Technologies in Mining: Sensors, Actuators, and Control Systems, Challenges and Opportunities in Mine Automation, Safety and Ethical Considerations in Automated Mining Systems, Case Studies: Successful Implementations of Automation in Mining, Future Trends: AI, IoT, and Industry 4.0 in Mining                     | 9             | Learners will understand the history of mine automation, key robotics concepts, automation technologies, challenges, safety aspects, real-world applications, and future trends in AI, IoT, and Industry 4.0.                                                                    |
| 2.       | <b>Robotics in Mining Operations:</b> Robotics for Exploration: Autonomous Drilling and Mapping Systems, Robotics in Extraction: Autonomous Haulage Systems (AHS) and Load-Haul-Dump (LHD) Vehicles, Robotics in Material Handling: Conveyors, Sorters, and Automated Transport Systems, Robotics for Maintenance and Inspection: Drones and Crawler Robots, Human-Robot Collaboration in Mining Environments, Design and Development of Mining Robots: Key Considerations Case Studies: Robotics in Underground and Surface Mining | 9             | Students will understand the role of robotics in mining operations, including exploration, extraction, material handling, maintenance, and human-robot collaboration. They will explore key design considerations and real-world case studies in underground and surface mining. |
| 3.       | <b>Automation Systems in Mining:</b> Automated Drilling and Blasting Systems, Autonomous Haulage and Fleet Management Systems, Automated Crushing, Grinding, and Processing Systems, Real-Time Monitoring and Control Systems, Communication Networks for Mine Automation: Wired and Wireless Systems, Integration of Automation with Mining Software and Platforms, Case Studies: Automation in Large-Scale Mining Operations                                                                                                      | 7             | Students will understand automation systems in mining, including drilling, haulage, processing, and real-time monitoring. They will explore communication networks, software integration, and case studies of large-scale mining automation.                                     |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                                                                                                                                                                                                                                                                          |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4.           | <b>Artificial Intelligence and Data Analytics in Mining:</b> Role of AI in Mine Automation and Robotics, Machine Learning for Predictive Maintenance and Fault Detection, AI-Driven Decision-Making in Mining Operations, Big Data Analytics for Mine Planning and Optimization, Computer Vision for Ore Sorting and Quality Control, AI Applications in Safety Monitoring and Hazard Detection, Case Studies: AI-Enabled Mining Operations | 9         | Learners will understand the role of AI and data analytics in mining, including machine learning for maintenance, AI-driven decision-making, big data for optimization, computer vision for ore sorting, and safety monitoring. Case studies will showcase AI-enabled mining operations. |
| 5.           | <b>Implementation and Challenges of Mine Automation:</b> Guest lectures from industry experts can provide real-world insights. Hands-on sessions with simulation tools (e.g., MATLAB, ROS) and robotics kits can be incorporated.                                                                                                                                                                                                           | 8         | Learners will understand the planning, design, and cost-benefit analysis of mine automation, workforce adaptation, regulatory and environmental factors, cybersecurity, and operational challenges. Case studies will highlight lessons from global mining automation projects.          |
| <b>Total</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>42</b> |                                                                                                                                                                                                                                                                                          |

### Course Books

1. *Industrial Automation and Robotics* (2nd ed.) — A. K. Gupta, S. K. Arora, Jean Riescher Westcott (2023)
2. Peter Darling, ed., *SME Mining Engineering Handbook*, 3rd ed. (Englewood, CO: Society for Mining, Metallurgy & Exploration, 2011).

### Reference Books

1. Elizabeth Mogopodi, *Automation in Mining: Revolutionizing Mine Planning and Management* (New York: Springer, 2024).
2. Luc Jaulin, *Automation for Robotics* (Chichester, UK: Wiley, 2015).