

Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NMNC305	Mine Digitalization	3	1	0	4

Course Objective
Generating innovative solutions to mining problems and exploring how Industry 4.0 concepts, involving sensors, models, and systems, can be integrated to enable digital mining. Additionally, what are other possibilities for overcoming digitalization challenges, addressing cybersecurity risks, ensuring interoperability, and facilitating workforce adaptation?
Learning Outcomes
Upon successful completion of this course, students will: ✓ Understanding of digital technologies and their applications: Students will be able to identify and understand the different digital technologies, their capabilities and limitations, and their applications in mining ✓ Problem-solving skills: Students will be able to apply digital technologies to solve real-world problems in mining, think critically and creatively, and continuously adapt to new and emerging technologies. ✓ Entrepreneurial skills: Students will be able to identify and develop business opportunities in the current mining scenario and, utilizing digital technologies, come up with solutions

Unit No.	Topics to be Covered	Lecture + Tutorial Hours	Learning Outcome
1.	Introduction to Digitalization in Mining Introduction to digitization and digitalization in the mining industry; Cyber physical systems; Industry 4.0; Industrial IoT architecture; Integration of digital technologies into the mining processes and operations such as exploration, excavation, and logistics	4L	Students will understand the concepts and purpose of Digitalization in the mining industry.
2.	Intelligent Learning Techniques Fundamentals of support vector machines, random forest, clustering and classification, text analysis, etc. Machine learning models are used to solve mining-related problems, such as predicting spontaneous combustion, pillar stability, rockbursts, and subsidence.	4L+2T	Students will acquire the theory of Advanced Machine Learning Models using Python & MATLAB.
3.	Real-time IoT Monitoring Systems Study real-time monitoring systems (drones, wearables, smart sensors) for mine operations.	4L+2T	Learn Data Acquisition & Sensor Integration. Explore key technologies: IoT, AI/ML, automation, digital twins, and blockchain in mining operations.
4.	Data Visualization using Tableau Convert raw data into insightful diagrams and charts to inform your decisions. Visual representation of the mining company's key performance indicators (KPIs)	4L+2T	Students will develop an understanding of the Dashboard reporting on the latest tools.
5.	Deep Learning models Types and their applications in mining processes; Predictive maintenance of mining HEMM using time series modelling; Image analysis for safety inspection & rescue support	6L+4T	Students will study types of deep learning models and investigate their applications in mining scenarios.
6.	Multi-Criterion Decision Making (MCDM) Models Analytic Hierarchy Process (AHP) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) for the selection of the mining method, Mining equipment selection, and mine reutilization options	4L+1T	Students will pick up skills to make decisions by balancing stakeholder inputs (regulators, communities, investors)
7.	Discrete Event Simulation – Concepts and Applications	3L	Explain the fundamental concepts and principles of Discrete Event Simulation (DES), including entities,

	Analyze simulation outputs to evaluate system performance, including metrics like throughput, waiting time, utilization, and bottlenecks.		events, state variables, and time advancement mechanisms. Anylogic Software learning
8.	Time Series application in Mining data 1. Moving average and exponential smoothing 2. ARIMA/SARIMA for forecasting production, energy use, or emissions	4L	Understand the fundamentals of time series data and identify its characteristics (trend, seasonality, cyclicity, noise) in the context of mining operations.
9.	Case Studies Projects and Presentations Based on industry hackathons, Sample problem statements from mines, Open mining datasets, and mining accident reports. Invited talks from mining tech firms (Sandvik, Hexagon).	9L+3T	Students and industry experts will present international and national implementations of mine digitalization cases based on technical papers.
		42L+14T	

Textbooks

1. Nguyen, Hoang, Xuan Nam Bui, Nasser Khalili, Yosoon Choi, Wengang Zhang, and Jian Zhou, eds. Applications of Artificial Intelligence in Mining, Geotechnical and Geoengineering. 1st ed. Amsterdam: Elsevier, 2023.
2. Soofastaei, Ali, ed. Advanced Analytics in Mining Engineering: Leverage Advanced Analytics in Mining Industry to Make Better Business Decisions. Amsterdam: Elsevier, 2022.

Reference Books

3. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep Learning*. Cambridge, MA: MIT Press, 2016.
4. Shalev-Shwartz, Shai, and Shai Ben-David. *Understanding Machine Learning: From Theory to Algorithms*. Cambridge: Cambridge University Press, 2014.