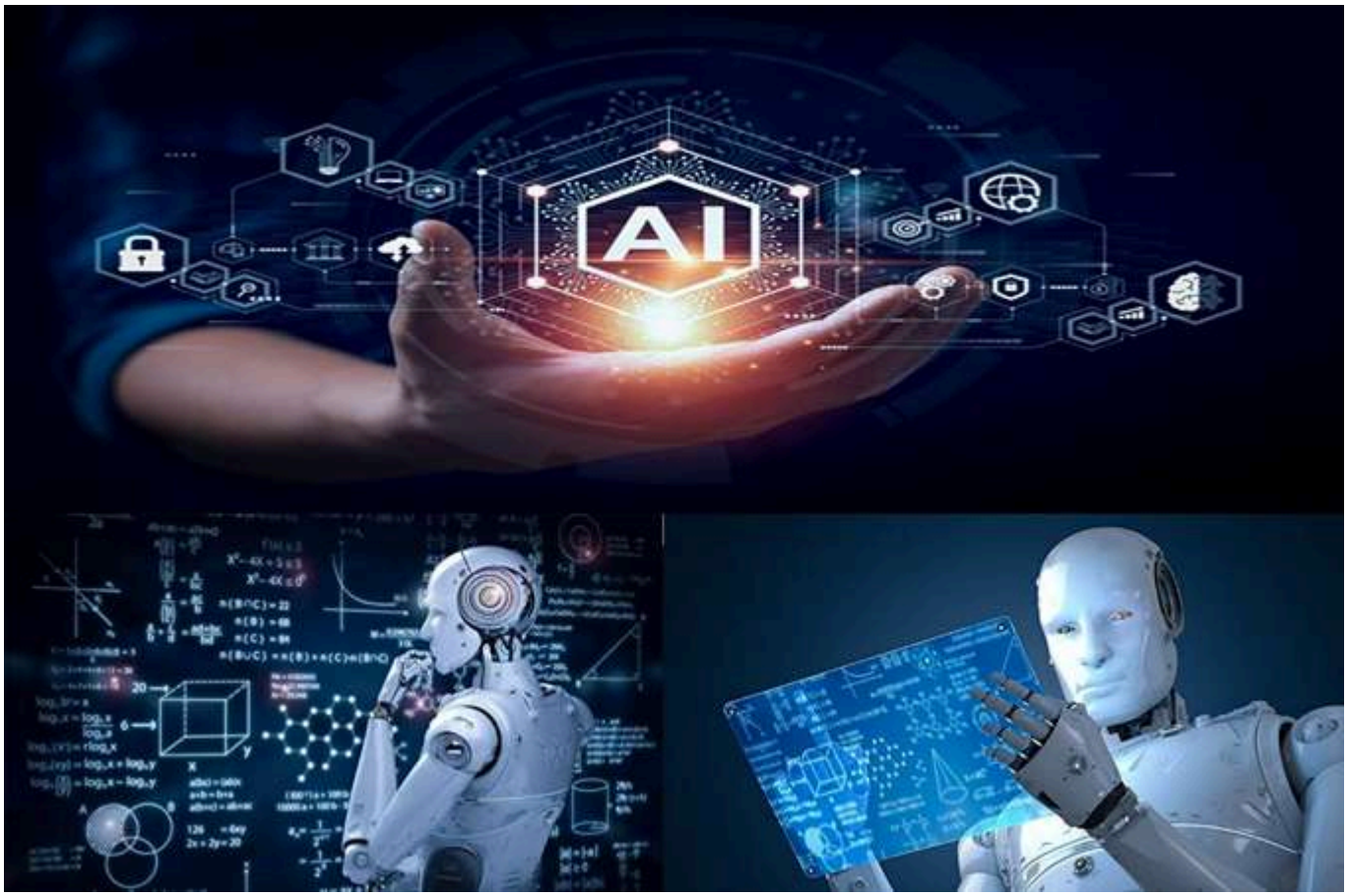
Qualification Pack



A.I (Artificial Intelligence) - Technocrat

Electives: Applications of AI in Metallurgy Domain

QP Code: ICE/ITS/Q0201 Instantiated QP Code: ICE/ITS/Q0201-SI006

Version: 1.0

NSQF Level: 5

Integrated Council for Entrepreneurship and Skilling || 533-R
Model Town Ludhiana || email:cmswami@ice.net.in

Contents

ICE/ITS/Q0201-SI006: A.I (Artificial Intelligence) - Technocrat 3
Brief Job Description 3
Applicable National Occupational Standards (NOS) 3
Compulsory NOS 3
Elective : Applications of AI in Metallurgy Domain 3
Qualification Pack (QP) Parameters 3
ICE/ITS/N0201: Fundamentals of Artificial Intelligence (AI) 5
ICE/ITS/N0202: Python Programming and data science for AI 12
ICE/ITS/N0203: Building Blocks of Artificial Intelligence (A.I) 19
DGT/VSQ/N0102: Employability Skills (60 Hours) 27
ICE/ITS/N0209: Applications of AI tools/algorithms in Metallurgical and Materials Engineering 35
Assessment Guidelines and Weightage 44
Assessment Guidelines 44
Assessment Weightage 45

Qualification Pack

ICE/ITS/Q0201-SI006: A.I (Artificial Intelligence) - Technocrat

Brief Job Description

AI Technocrats design and implement artificial intelligence solutions across diverse engineering disciplines. They optimize systems and processes using intelligent algorithms and automation, enhancing efficiency and innovation. Their work focuses on developing AI-driven tools that address industry challenges while promoting sustainability by reducing waste and energy consumption, ultimately fostering ecological balance and improving operational performance across various Engineering sectors.

Personal Attributes

They are analytical, adaptive collaborative with strong problem-solving skills and a commitment to continuous learning in AI technologies.

Applicable National Occupational Standards (NOS)

Compulsory NOS:

1. ICE/ITS/N0201: Fundamentals of Artificial Intelligence (AI)
2. ICE/ITS/N0202: Python Programming and data science for AI
3. ICE/ITS/N0203: Building Blocks of Artificial Intelligence (A.I)
4. DGT/VSQ/N0102: Employability Skills (60 Hours)

Electives*(mandatory to select at least one):*

Elective : Applications of AI in Metallurgy Domain

This document explores the applications of artificial intelligence (AI) tools and algorithms in the field of Metallurgical and Materials Engineering. It highlights how AI can enhance processes such as material design, quality control, and predictive maintenance, ultimately improving efficiency and innovation in metallurgy. By integrating advanced AI techniques, professionals in the metallurgy domain can unlock new opportunities for research and development, leading to better performance and sustainability of materials.

1. ICE/ITS/N0209: Applications of AI tools/algorithms in Metallurgical and Materials Engineering

Qualification Pack (QP) Parameters

Sector	Information Technology Sector

Qualification Pack

Sub-Sector	Future skills
Occupation	Artificial Intelligence
Country	India
NSQF Level	5
Credits	20
Aligned to NCO/ISCO/ISIC Code	NCO-2015/3123.0302 & 3123.0400 & 3122.5600
Minimum Educational Qualification & Experience	Completed 2nd year of UG (UG Diploma) OR Pursuing 2nd year of UG (3 years / 4 years) OR Completed 2nd year diploma after 12th OR Completed 3 year diploma after 10th with 1.5 years of experience relevant stream experience OR Previous relevant Qualification of NSQF Level (4.5) with 1.5 years of experience relevant stream experience
Minimum Level of Education for Training in School	Not Applicable
Pre-Requisite License or Training	NA
Minimum Job Entry Age	18 Years
Last Reviewed On	17/12/2024
Next Review Date	17/12/2027
NSQC Approval Date	17/12/2024
Version	1.0
Reference code on NQR	QG-05-IT-03423-2024-V1-TICE
NQR Version	1

Qualification Pack

ICE/ITS/N0201: Fundamentals of Artificial Intelligence (AI)

Description

This unit covers the Fundamental of Artificial Intelligence (AI) exploring the foundational ideas, key techniques and widespread use of A.I across various fields.

Scope

The scope covers the following :

- This introductory unit explores core concepts like machine learning, neural networks, and natural language processing. And on how AI is applied in automation, decision-making, and problem-solving. Furthermore, this also addresses the ethical implications, current limitations, and the exciting future prospects of AI technology.

Elements and Performance Criteria

Introduction to AI

To be competent, the user/individual on the job must be able to:

PC1. Understand the basic concepts and definitions of Artificial Intelligence and its significance in various technical trades.

PC2. Demonstrate knowledge of AI applications in technical fields, such as predictive maintenance, automation, quality control, and resource optimization.

PC3. Explain the role of machine learning and data analytics in enhancing decision-making processes within technical trades.

PC4. Understand the importance of data collection and management for effective AI implementation including the use of IoT devices and sensors.

PC5. Evaluate the impact of AI on workflow efficiency, cost reduction, and productivity improvement in various technical trades.

The Ethical Landscape of AI and its Societal Impact

To be competent, the user/individual on the job must be able to:

PC6. Understand the core principles of AI ethics, including fairness, accountability, transparency, and the responsible use of AI technologies.

PC7. Describe the impact of AI on privacy and surveillance, discussing the ethical considerations surrounding data collection and user consent.

PC8. Explore the implications of AI on employment and workforce dynamics including the potential for job displacement and the need for workforce reskilling.

PC9. Understand the importance of regulatory frameworks and policies in governing AI technologies to ensure ethical practices and protect societal interests.

PC10. Analyze ethical considerations and challenges associated with the adoption of AI technologies, such as data privacy concerns, potential job displacement, and algorithmic bias

PC11. Discuss the potential societal benefits of AI, such as improved healthcare, enhanced public safety, and advancements in education while recognising the associated ethical challenges.

Aptitude & Mathematics Fundamentals

To be competent, the user/individual on the job must be able to:

PC12. Describe basic mathematical concepts, including algebra, calculus, and statistics, essential for understanding AI algorithms and models.

PC13. Understand the principles of linear algebra, including vectors, matrices, and operations, and their applications in machine learning and data manipulation.

PC14. Discuss probability theory to analyse uncertainty in AI models, including concepts such as conditional probability, Bayes' theorem, and distributions

PC15. Explain statistical methods for data analysis, including hypothesis testing, regression analysis and descriptive statistics.

PC16. Understand the significance of optimization techniques, including gradient descent and convex optimization in training machine learning models.

Data Handling

To be competent, the user/individual on the job must be able to:

PC17. Understand the importance of data quality and data cleaning processes including handling missing values, outliers and duplicates to ensure reliable AI model performance.

PC18. Explain data pre-processing techniques, such as normalization, standardization, and encoding categorical variables, to prepare data for analysis

PC19. Describe data exploration and visualization techniques using tools like Matplotlib and Seaborn to understand data distributions, correlations, and trends.

PC20. Understand the significance of data splitting methods (e.g., training, validation, and test sets) in building robust AI models and preventing overfitting.

PC21. Examine techniques for storing and retrieving data, including databases, data lakes, and data warehouses, for effective data management.

Knowledge and Understanding (KU)

The individual on the job needs to know and understand:

KU1. Core definition of Artificial Intelligence and its distinction from traditional computing, including concepts like machine learning, deep learning, and neural networks.

KU2. Historical development of AI, key milestones, and influential figures in the field.

KU3. Different types of AI, including narrow AI (specific tasks) and general AI (human-like capabilities), along with their implications.

KU4. Fundamental concepts of machine learning, including supervised, unsupervised, and reinforcement learning paradigms

KU5. Critical role of data in AI, including data collection, pre-processing, and the significance of high- quality datasets for model training.

KU6. Key algorithms used in AI and machine learning, such as decision trees, support vector machines, and neural networks

KU7. Various applications of AI across industries, including healthcare, finance, transportation, and entertainment, and their societal impact.

KU8. Awareness of emerging trends in AI, such as advancements in natural language processing, computer vision.

Generic Skills (GS)

User/individual on the job needs to know how to:

GS1. Listen and communicate effectively and accurately.
GS2. Apply problem-solving approaches for different situations.
GS3. Work effectively in a team.
GS4. Employ proper time management.
GS5. Plan and organize work.
GS6. Maintain hygiene and sanitation.
GS7. Apply analytical skills for solving problems.

Assessment Criteria

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Introduction to AI	**10**	**10**	**-**	**2**
PC1. Understand the basic concepts and definitions of Artificial Intelligence and its significance in various technical trades.	-	-	-	-
PC2. Demonstrate knowledge of AI applications in technical fields, such as predictive maintenance, automation, quality control, and resource optimization.	-	-	-	-
PC3. Explain the role of machine learning and data analytics in enhancing decision-making processes within technical trades.	-	-	-	-
PC4. Understand the importance of data collection and management for effective AI implementation including the use of IoT devices and sensors.	-	-	-	-
PC5. Evaluate the impact of AI on workflow efficiency, cost reduction, and productivity improvement in various technical trades.	-	-	-	-
The Ethical Landscape of AI and its Societal Impact	**10**	**10**	**-**	**2**
PC6. Understand the core principles of AI ethics, including fairness, accountability, transparency, and the responsible use of AI technologies.	-	-	-	-
PC7. Describe the impact of AI on privacy and surveillance, discussing the ethical considerations surrounding data collection and user consent.	-	-	-	-
PC8. Explore the implications of AI on employment and workforce dynamics including the potential for job displacement and the need for workforce reskilling.	-	-	-	-
PC9. Understand the importance of regulatory frameworks and policies in governing AI technologies to ensure ethical practices and protect societal interests.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC10. Analyze ethical considerations and challenges associated with the adoption of AI technologies, such as data privacy concerns, potential job displacement, and algorithmic bias	-	-	-	-
PC11. Discuss the potential societal benefits of AI, such as improved healthcare, enhanced public safety, and advancements in education while recognising the associated ethical challenges.	-	-	-	-
Aptitude & Mathematics Fundamentals	**10**	**15**	**-**	**3**
PC12. Describe basic mathematical concepts, including algebra, calculus, and statistics, essential for understanding AI algorithms and models.	-	-	-	-
PC13. Understand the principles of linear algebra, including vectors, matrices, and operations, and their applications in machine learning and data manipulation.	-	-	-	-
PC14. Discuss probability theory to analyse uncertainty in AI models, including concepts such as conditional probability, Bayes' theorem, and distributions	-	-	-	-
PC15. Explain statistical methods for data analysis, including hypothesis testing, regression analysis and descriptive statistics.	-	-	-	-
PC16. Understand the significance of optimization techniques, including gradient descent and convex optimization in training machine learning models.	-	-	-	-
Data Handling	**10**	**15**	**-**	**3**
PC17. Understand the importance of data quality and data cleaning processes including handling missing values, outliers and duplicates to ensure reliable AI model performance.	-	-	-	-
PC18. Explain data pre-processing techniques, such as normalization, standardization, and encoding categorical variables, to prepare data for analysis	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC19. Describe data exploration and visualization techniques using tools like Matplotlib and Seaborn to understand data distributions, correlations, and trends.	-	-	-	-
PC20. Understand the significance of data splitting methods (e.g., training, validation, and test sets) in building robust AI models and preventing overfitting.	-	-	-	-
PC21. Examine techniques for storing and retrieving data, including databases, data lakes, and data warehouses, for effective data management.	-	-	-	-
NOS Total	**40**	**50**	**-**	**10**

National Occupational Standards (NOS) Parameters

NOS Code	ICE/ITS/N0201
NOS Name	Fundamentals of Artificial Intelligence (AI)
Sector	Information Technology Sector
Sub-Sector	
Occupation	Artificial Intelligence
NSQF Level	5
Credits	1.5
Version	1.0
Last Reviewed Date	17/12/2024
Next Review Date	17/12/2027
NSQC Clearance Date	17/12/2024

ICE/ITS/N0202: Python Programming and data science for AI

Description

This module emphasizes the use of Python for developing and applying AI algorithms. It provides a comprehensive overview of how to implement these technologies effectively. Participants will learn to harness Python's capabilities in the field of artificial intelligence.

Scope

The scope covers the following :

- It covers Python libraries such as NumPy, Pandas, TensorFlow, and PyTorch, which are essential for machine learning and deep learning data processing. This also includes practical programming techniques for building AI models, handling datasets, and creating AI-powered solutions.

Elements and Performance Criteria

Introduction to Python Programming

To be competent, the user/individual on the job must be able to:

PC1. Understand Python syntax, including variables, data types, loops, and conditionals for basic programming tasks.

PC2. Discuss fundamental Python data structures such as lists, dictionaries, tuples, and sets in data manipulation.

PC3. Discuss to utilize Python functions and modules to write reusable and efficient code.

PC4. Understand to use Python for file handling operations such as reading from and writing to files.

PC5. Describe to use of Python libraries like NumPy and Pandas for basic data manipulation and analysis tasks.

PC6. Discuss basic debugging and error-handling techniques to identify and resolve issues in Python programs

Data Structures and Algorithms in Python

To be competent, the user/individual on the job must be able to:

PC7. Understand the fundamentals data structures such as arrays, linked lists, stacks, queues, trees, and graphs in Python.

PC8. Describe to utilize Python's built-in data structures, such as lists, dictionaries, sets, and tuples, to solve problems effectively.

PC9. Discuss common algorithms for sorting (e.g., bubble sort, quicksort, mergesort) and searching (e.g., linear search, binary search) on various data structures.

PC10. Understand the concepts of complexity analysis, including time and space complexity, to evaluate the efficiency of algorithms.

PC11. Describe recursion and its applications in solving problems, including tree traversal and backtracking algorithms.

PC12. Understand to solve practical problems and to utilize data structures to optimize performance in Python applications.

Object-Oriented Programming (OOP) in Python

To be competent, the user/individual on the job must be able to:

PC13. Understand the core principles of Object-Oriented Programming (OOP), including encapsulation, inheritance, and polymorphism.

PC14. Define to use classes and objects in Python to model real-world entities and behaviors.

PC15. Discuss constructor and destructor methods to initialize and clean up object attributes in Python classes.

PC16. Understand to utilize class inheritance to create subclasses to extend or modify the functionality of parent classes.

PC17. Describe method overriding to customize the behavior of inherited methods in derived classes.

PC18. Discuss the concept of abstraction through abstract classes and interfaces to understand the design concept of flexible and modular code.

Libraries for AI and Data Science

To be competent, the user/individual on the job must be able to:

PC19. Understand to use NumPy for numerical computations including array manipulation, mathematical operations and linear algebra.

PC20. Describe Pandas for data manipulation and analysis to utilize dataFrames for data cleaning, transformation and aggregation tasks.

PC21. Understand data visualization techniques using Matplotlib and Seaborn to create informative plots and graphs Seaborn.

PC22. Discuss to utilize Scikit-learn for building and evaluating machine learning models, including data preprocessing, feature selection and model selection techniques.

PC23. Understand to use TensorFlow or PyTorch for developing and training deep learning models, including defining architectures and optimizing performance.

PC24. Discuss Natural Language Toolkit (NLTK) or spaCy for text processing tasks in Natural Language Processing (NLP), including tokenization, stemming and recognition.

Knowledge and Understanding (KU)

The individual on the job needs to know and understand:

KU1. Core syntax and fundamental concepts of Python, including variables, data types, control structures, functions, and error handling.

KU2. Python data structures such as lists, tuples, dictionaries, and sets, and their appropriate use cases in programming.

KU3. Key Python libraries used in data science and AI, including NumPy for numerical operations, Pandas for data manipulation, and Matplotlib/Seaborn for data visualization

KU4. Methods for cleaning and preprocessing data, including handling missing values, normalization, standardization, and encoding categorical variables.

KU5. Principles of object-oriented programming (OOP) in Python, including classes, objects, inheritance, encapsulation, and polymorphism.

KU6. Ability to create visualizations to interpret data and communicate findings effectively using libraries like Matplotlib and Seaborn.

Generic Skills (GS)

User/individual on the job needs to know how to:

GS1. Listen and communicate effectively and accurately.
GS2. Apply problem-solving approaches for different situations
GS3. Work effectively in a team.
GS4. Employ proper time management.
GS5. Plan and organize work.
GS6. Maintain hygiene and sanitation.
GS7. Analytical skills.

Assessment Criteria

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Introduction to Python Programming	**10**	**10**	**-**	**2**
PC1. Understand Python syntax, including variables, data types, loops, and conditionals for basic programming tasks.	-	-	-	-
PC2. Discuss fundamental Python data structures such as lists, dictionaries, tuples, and sets in data manipulation.	-	-	-	-
PC3. Discuss to utilize Python functions and modules to write reusable and efficient code.	-	-	-	-
PC4. Understand to use Python for file handling operations such as reading from and writing to files.	-	-	-	-
PC5. Describe to use of Python libraries like NumPy and Pandas for basic data manipulation and analysis tasks.	-	-	-	-
PC6. Discuss basic debugging and error-handling techniques to identify and resolve issues in Python programs	-	-	-	-
Data Structures and Algorithms in Python	**10**	**15**	**-**	**3**
PC7. Understand the fundamentals data structures such as arrays, linked lists, stacks, queues, trees, and graphs in Python.	-	-	-	-
PC8. Describe to utilize Python's built-in data structures, such as lists, dictionaries, sets, and tuples, to solve problems effectively.	-	-	-	-
PC9. Discuss common algorithms for sorting (e.g., bubble sort, quicksort, mergesort) and searching (e.g., linear search, binary search) on various data structures.	-	-	-	-
PC10. Understand the concepts of complexity analysis, including time and space complexity, to evaluate the efficiency of algorithms.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC11. Describe recursion and its applications in solving problems, including tree traversal and backtracking algorithms.	-	-	-	-
PC12. Understand to solve practical problems and to utilize data structures to optimize performance in Python applications.	-	-	-	-
Object-Oriented Programming (OOP) in Python	**10**	**15**	**-**	**3**
PC13. Understand the core principles of Object-Oriented Programming (OOP), including encapsulation, inheritance, and polymorphism.	-	-	-	-
PC14. Define to use classes and objects in Python to model real-world entities and behaviors.	-	-	-	-
PC15. Discuss constructor and destructor methods to initialize and clean up object attributes in Python classes.	-	-	-	-
PC16. Understand to utilize class inheritance to create subclasses to extend or modify the functionality of parent classes.	-	-	-	-
PC17. Describe method overriding to customize the behavior of inherited methods in derived classes.	-	-	-	-
PC18. Discuss the concept of abstraction through abstract classes and interfaces to understand the design concept of flexible and modular code.	-	-	-	-
Libraries for AI and Data Science	**10**	**10**	**-**	**2**
PC19. Understand to use NumPy for numerical computations including array manipulation, mathematical operations and linear algebra.	-	-	-	-
PC20. Describe Pandas for data manipulation and analysis to utilize dataFrames for data cleaning, transformation and aggregation tasks.	-	-	-	-
PC21. Understand data visualization techniques using Matplotlib and Seaborn to create informative plots and graphs Seaborn.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC22. Discuss to utilize Scikit-learn for building and evaluating machine learning models, including data preprocessing, feature selection and model selection techniques.	-	-	-	-
PC23. Understand to use TensorFlow or PyTorch for developing and training deep learning models, including defining architectures and optimizing performance.	-	-	-	-
PC24. Discuss Natural Language Toolkit (NLTK) or spaCy for text processing tasks in Natural Language Processing (NLP), including tokenization, stemming and recognition.	-	-	-	-
NOS Total	**40**	**50**	**-**	**10**

National Occupational Standards (NOS) Parameters

NOS Code	ICE/ITS/N0202
NOS Name	Python Programming and data science for AI
Sector	Information Technology Sector
Sub-Sector	
Occupation	Artificial Intelligence
NSQF Level	5
Credits	3.5
Version	1.0
Last Reviewed Date	17/12/2024
Next Review Date	17/12/2027
NSQC Clearance Date	17/12/2024

ICE/ITS/N0203: Building Blocks of Artificial Intelligence (A.I)

Description

The Build Blocks of A.I. Specializations provide essential knowledge in AI concepts, algorithms, and methodologies across various domains, including machine learning and natural language processing, computer vision, Internet of things and Robotics.

Scope

The scope covers the following :

- Practical applications in diverse industries.
- Addresses ethical implications and responsible AI use.
- Fosters innovation to solve real-world problems with AI technologies.

Elements and Performance Criteria

Fundamentals of Machine Learning (ML)

To be competent, the user/individual on the job must be able to:

PC1. Explain the core concepts of supervised, unsupervised, and reinforcement learning.

PC2. Understand regression and classification models.

PC3. Discuss data preprocessing techniques, such as normalization and feature extraction to prepare data for ML models.

PC4. Explain key ML algorithms, such as decision trees, support vector machines, and k-means clustering.

PC5. Describe model performance using metrics like accuracy, precision, recall, F1-score, and ROC curves.

PC6. Understand model optimization techniques, including hyperparameter tuning and cross-validation.

Basics of Deep Learning

To be competent, the user/individual on the job must be able to:

PC7. Understand the core architecture of artificial neural networks (ANNs), including layers, nodes, and activation functions.

PC8. Discuss building and training feedforward neural networks using deep learning frameworks (e.g., TensorFlow, PyTorch).

PC9. Explain the concept of backpropagation and its role in optimizing neural networks.

PC10. Describe convolutional neural networks (CNNs) for image-related tasks such as classification and object detection.

PC11. Understand the basics of recurrent neural networks (RNNs) and their applications in sequence data like time series and natural language.

PC12. Understand to utilize regularization techniques to prevent overfitting in deep learning models.

Fundamentals of Natural Language Processing (NLP)

To be competent, the user/individual on the job must be able to:

PC13. Understand the basic concepts of tokenization, stemming, and lemmatization for text preprocessing.

PC14. Explain building and applying language models for text prediction and generation.

PC15. Explain the use of word embeddings (e.g., Word2Vec, GloVe) to represent text data as vectors in NLP tasks.

PC16. Describe NLP techniques for tasks such as sentiment analysis, text classification and named entity recognition (NER).

PC17. Understand sequence-to-sequence models for machine translation, summarization and other text-based tasks.

PC18. Understand to evaluate metrics like BLEU, ROUGE to assess the performance of NLP models.

Basics of Computer Vision

To be competent, the user/individual on the job must be able to:

PC19. Understand the key concepts of image processing such as filtering, edge detection and image enhancement.

PC20. Discuss building and applying Convolutional Neural Networks (CNNs) for tasks like image classification and object detection.

PC21. Describe techniques for image segmentation to separate objects or regions within an image.

PC22. Discuss image augmentation techniques to improve model generalization and performance on visual tasks.

PC23. Explain the principles of object tracking and motion detection in video processing.

PC24. Understand feature extraction methods like SIFT, SURF, and ORB for object recognition and computer vision applications.

Fundamentals of Internet of Things (IoT)

To be competent, the user/individual on the job must be able to:

PC25. Understand the basic architecture of IoT systems, including sensors, actuators, and communication protocols.

PC26. Explain to connect and configure IoT devices for data collection and monitoring.

PC27. Explain the role of edge computing and its integration with IoT to process data locally for faster responses.

PC28. Understand the principles of IoT communication protocols such as MQTT, CoAP, and HTTP, and their applications.

PC29. Describe data security and privacy concerns in IoT systems, including encryption and authentication techniques.

PC30. Describe IoT for smart systems design, such as smart homes, industrial automation, or environmental monitoring.

Basics of Robotics

To be competent, the user/individual on the job must be able to:

PC31. Explain the fundamental concepts of robot kinematics, including forward and inverse kinematics for robot movement and positioning.

PC32. Understand the programming robot control systems for tasks such as navigation, manipulation, and automation.

PC33. Discuss sensor integration (e.g., cameras, LIDAR, ultrasonic sensors) for robot perception and environment interaction.

PC34. Understand the basics of robot dynamics and forces and torques affect robot motion and stability.

PC35. Understand ability to implement robot path planning algorithms to enable autonomous navigation in dynamic environments.

PC36. Discuss robotic learning techniques, such as reinforcement learning, to improve robot decision-making and task execution.

Knowledge and Understanding (KU)

The individual on the job needs to know and understand:

KU1. Basic concepts of machine learning, including different types of learning (supervised, unsupervised, and reinforcement) and their applications in various domains.

KU2. Deep learning architectures, including neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs), and their role in AI advancements.

KU3. Fundamental techniques and tools used in NLP, such as tokenization, stemming, and sentiment analysis, and their applications in text and speech processing.

KU4. Principles of computer vision, including image processing techniques, feature extraction, and object detection, along with their applications in industries like healthcare and automotive.

KU5. IoT concepts, including sensor integration, data collection, and the use of AI in smart devices for automation and enhanced decision-making.

KU6. Principles of robotics, including perception, decision-making, and control systems, and AI technologies are integrated to improve robot functionalities.

Generic Skills (GS)

User/individual on the job needs to know how to:

GS1. Listen and communicate effectively and accurately.

GS2. Apply problem-solving approaches for different situations.

GS3. Work effectively in a team.

GS4. Employ proper time management.

GS5. Plan and organize work.

GS6. Maintain hygiene and sanitation.

GS7. Analytical Skills.

Assessment Criteria

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Fundamentals of Machine Learning (ML)	**7**	**9**	**-**	**2**
PC1. Explain the core concepts of supervised, unsupervised, and reinforcement learning.	-	-	-	-
PC2. Understand regression and classification models.	-	-	-	-
PC3. Discuss data preprocessing techniques, such as normalization and feature extraction to prepare data for ML models.	-	-	-	-
PC4. Explain key ML algorithms, such as decision trees, support vector machines, and k-means clustering.	-	-	-	-
PC5. Describe model performance using metrics like accuracy, precision, recall, F1-score, and ROC curves.	-	-	-	-
PC6. Understand model optimization techniques, including hyperparameter tuning and cross-validation.	-	-	-	-
Basics of Deep Learning	**7**	**9**	**-**	**2**
PC7. Understand the core architecture of artificial neural networks (ANNs), including layers, nodes, and activation functions.	-	-	-	-
PC8. Discuss building and training feedforward neural networks using deep learning frameworks (e.g., TensorFlow, PyTorch).	-	-	-	-
PC9. Explain the concept of backpropagation and its role in optimizing neural networks.	-	-	-	-
PC10. Describe convolutional neural networks (CNNs) for image-related tasks such as classification and object detection.	-	-	-	-
PC11. Understand the basics of recurrent neural networks (RNNs) and their applications in sequence data like time series and natural language.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC12. Understand to utilize regularization techniques to prevent overfitting in deep learning models.	-	-	-	-
Fundamentals of Natural Language Processing (NLP)	**7**	**8**	**-**	**2**
PC13. Understand the basic concepts of tokenization, stemming, and lemmatization for text preprocessing.	-	-	-	-
PC14. Explain building and applying language models for text prediction and generation.	-	-	-	-
PC15. Explain the use of word embeddings (e.g., Word2Vec, GloVe) to represent text data as vectors in NLP tasks.	-	-	-	-
PC16. Describe NLP techniques for tasks such as sentiment analysis, text classification and named entity recognition (NER).	-	-	-	-
PC17. Understand sequence-to-sequence models for machine translation, summarization and other text-based tasks.	-	-	-	-
PC18. Understand to evaluate metrics like BLEU, ROUGE to assess the performance of NLP models.	-	-	-	-
Basics of Computer Vision	**6**	**8**	**-**	**1**
PC19. Understand the key concepts of image processing such as filtering, edge detection and image enhancement.	-	-	-	-
PC20. Discuss building and applying Convolutional Neural Networks (CNNs) for tasks like image classification and object detection.	-	-	-	-
PC21. Describe techniques for image segmentation to separate objects or regions within an image.	-	-	-	-
PC22. Discuss image augmentation techniques to improve model generalization and performance on visual tasks.	-	-	-	-
PC23. Explain the principles of object tracking and motion detection in video processing.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC24. Understand feature extraction methods like SIFT, SURF, and ORB for object recognition and computer vision applications.	-	-	-	-
Fundamentals of Internet of Things (IoT)	**6**	**8**	**-**	**1**
PC25. Understand the basic architecture of IoT systems, including sensors, actuators, and communication protocols.	-	-	-	-
PC26. Explain to connect and configure IoT devices for data collection and monitoring.	-	-	-	-
PC27. Explain the role of edge computing and its integration with IoT to process data locally for faster responses.	-	-	-	-
PC28. Understand the principles of IoT communication protocols such as MQTT, CoAP, and HTTP, and their applications.	-	-	-	-
PC29. Describe data security and privacy concerns in IoT systems, including encryption and authentication techniques.	-	-	-	-
PC30. Describe IoT for smart systems design, such as smart homes, industrial automation, or environmental monitoring.	-	-	-	-
Basics of Robotics	**7**	**8**	**-**	**2**
PC31. Explain the fundamental concepts of robot kinematics, including forward and inverse kinematics for robot movement and positioning.	-	-	-	-
PC32. Understand the programming robot control systems for tasks such as navigation, manipulation, and automation.	-	-	-	-
PC33. Discuss sensor integration (e.g., cameras, LIDAR, ultrasonic sensors) for robot perception and environment interaction.	-	-	-	-
PC34. Understand the basics of robot dynamics and forces and torques affect robot motion and stability.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC35. Understand ability to implement robot path planning algorithms to enable autonomous navigation in dynamic environments.	-	-	-	-
PC36. Discuss robotic learning techniques, such as reinforcement learning, to improve robot decision-making and task execution.	-	-	-	-
NOS Total	**40**	**50**	**-**	**10**

National Occupational Standards (NOS) Parameters

NOS Code	ICE/ITS/N0203
NOS Name	Building Blocks of Artificial Intelligence (A.I)
Sector	Information Technology Sector
Sub-Sector	
Occupation	Artificial Intelligence
NSQF Level	5
Credits	3
Version	1.0
Last Reviewed Date	17/12/2024
Next Review Date	17/12/2027
NSQC Clearance Date	17/12/2024

Qualification Pack

DGT/VSQ/N0102: Employability Skills (60 Hours)

Description

This unit is about employability skills, Constitutional values, becoming a professional in the 21st Century, digital, financial, and legal literacy, diversity and Inclusion, English and communication skills, customer service, entrepreneurship, and apprenticeship, getting ready for jobs and career development.

Scope

The scope covers the following :

- Introduction to Employability Skills
- Constitutional values - Citizenship
- Becoming a Professional in the 21st Century
- Basic English Skills
- Career Development & Goal Setting
- Communication Skills
- Diversity & Inclusion
- Financial and Legal Literacy
- Essential Digital Skills
- Entrepreneurship
- Customer Service
- Getting ready for Apprenticeship & Jobs

Elements and Performance Criteria

Introduction to Employability Skills

To be competent, the user/individual on the job must be able to:

PC1. identify employability skills required for jobs in various industries

PC2. identify and explore learning and employability portals

Constitutional values – Citizenship

To be competent, the user/individual on the job must be able to:

PC3. recognize the significance of constitutional values, including civic rights and duties, citizenship, responsibility towards society etc. and personal values and ethics such as honesty, integrity, caring and respecting others, etc.

PC4. follow environmentally sustainable practices

Becoming a Professional in the 21st Century

To be competent, the user/individual on the job must be able to:

PC5. recognize the significance of 21st Century Skills for employment

PC6. practice the 21st Century Skills such as Self-Awareness, Behaviour Skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, learning to learn for continuous learning etc. in personal and professional life

Basic English Skills

To be competent, the user/individual on the job must be able to:

PC7. use basic English for everyday conversation in different contexts, in person and over the telephone

PC8. read and understand routine information, notes, instructions, mails, letters etc. written in English

PC9. write short messages, notes, letters, e-mails etc. in English

Career Development & Goal Setting

To be competent, the user/individual on the job must be able to:

PC10. understand the difference between job and career

PC11. prepare a career development plan with short- and long-term goals, based on aptitude

Communication Skills

To be competent, the user/individual on the job must be able to:

PC12. follow verbal and non-verbal communication etiquette and active listening techniques in various settings

PC13. work collaboratively with others in a team

Diversity & Inclusion

To be competent, the user/individual on the job must be able to:

PC14. communicate and behave appropriately with all genders and PwD

PC15. escalate any issues related to sexual harassment at workplace according to POSH Act

Financial and Legal Literacy

To be competent, the user/individual on the job must be able to:

PC16. select financial institutions, products and services as per requirement

PC17. carry out offline and online financial transactions, safely and securely

PC18. identify common components of salary and compute income, expenses, taxes, investments etc

PC19. identify relevant rights and laws and use legal aids to fight against legal exploitation

Essential Digital Skills

To be competent, the user/individual on the job must be able to:

PC20. operate digital devices and carry out basic internet operations securely and safely

PC21. use e- mail and social media platforms and virtual collaboration tools to work effectively

PC22. use basic features of word processor, spreadsheets, and presentations

Entrepreneurship

To be competent, the user/individual on the job must be able to:

PC23. identify different types of Entrepreneurship and Enterprises and assess opportunities for potential business through research

PC24. develop a business plan and a work model, considering the 4Ps of Marketing Product, Price, Place and Promotion

PC25. identify sources of funding, anticipate, and mitigate any financial/ legal hurdles for the potential business opportunity

Customer Service

To be competent, the user/individual on the job must be able to:

PC26. identify different types of customers

PC27. identify and respond to customer requests and needs in a professional manner.

PC28. follow appropriate hygiene and grooming standards

Getting ready for apprenticeship & Jobs

To be competent, the user/individual on the job must be able to:

PC29. create a professional Curriculum vitae (Résumé)

PC30. search for suitable jobs using reliable offline and online sources such as Employment exchange, recruitment agencies, newspapers etc. and job portals, respectively

PC31. apply to identified job openings using offline /online methods as per requirement

PC32. answer questions politely, with clarity and confidence, during recruitment and selection

PC33. identify apprenticeship opportunities and register for it as per guidelines and requirements

Knowledge and Understanding (KU)

The individual on the job needs to know and understand:

KU1. need for employability skills and different learning and employability related portals

KU2. various constitutional and personal values

KU3. different environmentally sustainable practices and their importance

KU4. Twenty first (21st) century skills and their importance

KU5. how to use English language for effective verbal (face to face and telephonic) and written communication in formal and informal set up

KU6. importance of career development and setting long- and short-term goals

KU7. about effective communication

KU8. POSH Act

KU9. Gender sensitivity and inclusivity

KU10. different types of financial institutes, products, and services

KU11. how to compute income and expenditure

KU12. importance of maintaining safety and security in offline and online financial transactions

KU13. different legal rights and laws

KU14. different types of digital devices and the procedure to operate them safely and securely

KU15. how to create and operate an e- mail account and use applications such as word processors, spreadsheets etc.

KU16. how to identify business opportunities

KU17. types and needs of customers

KU18. how to apply for a job and prepare for an interview

KU19. apprenticeship scheme and the process of registering on apprenticeship portal

Generic Skills (GS)

User/individual on the job needs to know how to:

GS1. read and write different types of documents/instructions/correspondence

GS2. communicate effectively using appropriate language in formal and informal settings

GS3. behave politely and appropriately with all
GS4. how to work in a virtual mode
GS5. perform calculations efficiently
GS6. solve problems effectively
GS7. pay attention to details
GS8. manage time efficiently
GS9. maintain hygiene and sanitization to avoid infection

Assessment Criteria

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Introduction to Employability Skills	**1**	**1**	**-**	**-**
PC1. identify employability skills required for jobs in various industries	-	-	-	-
PC2. identify and explore learning and employability portals	-	-	-	-
Constitutional values – Citizenship	**1**	**1**	**-**	**-**
PC3. recognize the significance of constitutional values, including civic rights and duties, citizenship, responsibility towards society etc. and personal values and ethics such as honesty, integrity, caring and respecting others, etc.	-	-	-	-
PC4. follow environmentally sustainable practices	-	-	-	-
Becoming a Professional in the 21st Century	**2**	**4**	**-**	**-**
PC5. recognize the significance of 21st Century Skills for employment	-	-	-	-
PC6. practice the 21st Century Skills such as Self-Awareness, Behaviour Skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, learning to learn for continuous learning etc. in personal and professional life	-	-	-	-
Basic English Skills	**2**	**3**	**-**	**-**
PC7. use basic English for everyday conversation in different contexts, in person and over the telephone	-	-	-	-
PC8. read and understand routine information, notes, instructions, mails, letters etc. written in English	-	-	-	-
PC9. write short messages, notes, letters, e-mails etc. in English	-	-	-	-
Career Development & Goal Setting	**1**	**2**	**-**	**-**

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC10. understand the difference between job and career	-	-	-	-
PC11. prepare a career development plan with short- and long-term goals, based on aptitude	-	-	-	-
Communication Skills	**2**	**2**	**-**	**-**
PC12. follow verbal and non-verbal communication etiquette and active listening techniques in various settings	-	-	-	-
PC13. work collaboratively with others in a team	-	-	-	-
Diversity & Inclusion	**1**	**2**	**-**	**-**
PC14. communicate and behave appropriately with all genders and PwD	-	-	-	-
PC15. escalate any issues related to sexual harassment at workplace according to POSH Act	-	-	-	-
Financial and Legal Literacy	**2**	**3**	**-**	**-**
PC16. select financial institutions, products and services as per requirement	-	-	-	-
PC17. carry out offline and online financial transactions, safely and securely	-	-	-	-
PC18. identify common components of salary and compute income, expenses, taxes, investments etc	-	-	-	-
PC19. identify relevant rights and laws and use legal aids to fight against legal exploitation	-	-	-	-
Essential Digital Skills	**3**	**4**	**-**	**-**
PC20. operate digital devices and carry out basic internet operations securely and safely	-	-	-	-
PC21. use e- mail and social media platforms and virtual collaboration tools to work effectively	-	-	-	-
PC22. use basic features of word processor, spreadsheets, and presentations	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Entrepreneurship	**2**	**3**	**-**	**-**
PC23. identify different types of Entrepreneurship and Enterprises and assess opportunities for potential business through research	-	-	-	-
PC24. develop a business plan and a work model, considering the 4Ps of Marketing Product, Price, Place and Promotion	-	-	-	-
PC25. identify sources of funding, anticipate, and mitigate any financial/ legal hurdles for the potential business opportunity	-	-	-	-
Customer Service	**1**	**2**	**-**	**-**
PC26. identify different types of customers	-	-	-	-
PC27. identify and respond to customer requests and needs in a professional manner.	-	-	-	-
PC28. follow appropriate hygiene and grooming standards	-	-	-	-
Getting ready for apprenticeship & Jobs	**2**	**3**	**-**	**-**
PC29. create a professional Curriculum vitae (Résumé)	-	-	-	-
PC30. search for suitable jobs using reliable offline and online sources such as Employment exchange, recruitment agencies, newspapers etc. and job portals, respectively	-	-	-	-
PC31. apply to identified job openings using offline /online methods as per requirement	-	-	-	-
PC32. answer questions politely, with clarity and confidence, during recruitment and selection	-	-	-	-
PC33. identify apprenticeship opportunities and register for it as per guidelines and requirements	-	-	-	-
NOS Total	**20**	**30**	**-**	**-**

National Occupational Standards (NOS) Parameters

NOS Code	DGT/VSQ/N0102
NOS Name	Employability Skills (60 Hours)
Sector	Cross Sectoral
Sub-Sector	Professional Skills
Occupation	Employability
NSQF Level	4
Credits	2
Version	1.0
Last Reviewed Date	22/07/2026
Next Review Date	22/07/2029
NSQC Clearance Date	22/07/2026

ICE/ITS/N0209: Applications of AI tools/algorithms in Metallurgical and Materials Engineering

Description

This module encompasses the applications of AI tools in Metallurgical and Materials Engineering enhance material properties, optimize processes, and facilitate the design of advanced materials through data-driven methodologies.

Scope

The scope covers the following :

- Focuses on developing new materials using AI algorithms.
- Aims to improve efficiency in material processing.
- Explain material structure for better performance prediction.
- Forecasts material behavior under various conditions.
- Integrates AI with Industry 4.0 for advanced manufacturing processes.
- Enhances recycling processes for a circular economy in materials usage.

Elements and Performance Criteria

Use AI tools/algorithms for Materials Design

To be competent, the user/individual on the job must be able to:

PC1. Explain AI algorithms analyze large datasets of material properties and structures to identify promising for new materials.

PC2. Understand machine learning models predict the mechanical, thermal, and electrical properties of materials based on their composition and microstructure.

PC3. Discuss AI tools optimize the compositions of metal alloys by simulating different combinations of elements and predicting their performance, enhancing the development of high- strength, lightweight, and corrosion-resistant materials.

PC4. Describe AI algorithms are employed to design and control the microstructure of materials during processing (e.g., casting, forging, or additive manufacturing), leading to improved mechanical properties and performance.

PC5. Understand AI tools in designing materials specifically for additive manufacturing processes by optimizing the geometry and material properties, thus ensuring better manufacturability and performance in 3D-printed components.

PC6. Explore AI algorithms to analyze historical data from materials testing and operational environments to predict failure modes and enhance the durability and reliability of materials under various loading conditions.

Utilize Process Optimization and Control in Metallurgy

To be competent, the user/individual on the job must be able to:

PC7. Discuss AI algorithms integrated into metallurgical processes to monitor parameters such as temperature, pressure, and chemical composition in real-time.

PC8. Describe machine learning models, metallurgical plants predict equipment failures.

PC9. Discuss AI tools analyze historical process data to identify optimal settings for various parameters (e.g., heating rates, cooling rates, and material flow), resulting in enhanced efficiency, reduced energy consumption, and improved yield.

PC10. Understand advanced AI-driven simulations model complex metallurgical processes, such as casting, welding, and heat treatment.

PC11. Explain AI algorithms be trained to detect defects in materials and products through image analysis or sensor data, ensuring high quality and consistency in metallurgical output by automating quality control processes.

PC12. Discuss AI tools optimize the flow of materials through the production process, enhancing logistics and inventory management, reducing waste, and improving overall operational efficiency in metallurgical operations.

Use Computational Techniques in Microstructure Analysis

To be competent, the user/individual on the job must be able to:

PC13. Discuss AI algorithms automate the analysis of microstructural images obtained from microscopy techniques, such as electron microscopy (SEM) and transmission electron microscopy (TEM), enabling faster and more accurate identification of phase distributions, grain boundaries, and defects.

PC14. Understand Computational techniques, including machine learning and image processing, quantitatively characterize microstructural features, such as grain size, shape, and orientation, facilitating a deeper understanding of microstructure affects material properties and performance.

PC15. Explain AI tools to develop models that simulate microstructural evolution during processes like solidification, heat treatment, and deformation, allowing researchers to predict changes in processing conditions affect microstructure and resulting material properties.

PC16. Discuss microstructure data with materials property databases, AI tools identify correlations between microstructural features and mechanical, thermal, or electrical properties, aiding in the design of materials with tailored performance characteristics.

PC17. Explain machine learning algorithms to be trained on existing datasets to predict microstructural outcomes based on processing parameters.

PC18. Understand AI-powered visualization techniques to analyze complex microstructures, enabling better understanding and interpretation of material.

Utilize AI tools/algorithms for Predictive Modelling of Material Behaviour

To be competent, the user/individual on the job must be able to:

PC19. Discuss AI tools leverage large datasets obtained from experimental and simulation studies to understand create predictive models.

PC20. Understand machine learning algorithms, such as regression analysis, decision trees, and neural networks, facilitate the development of robust models that accurately predict mechanical properties, fatigue life, and failure modes of materials.

PC21. Explain predictive modelling help optimize processing parameters (e.g., temperature, pressure, and time) to enhance material properties and AI algorithms identify the best processing routes to achieve desired characteristics like strength, ductility, or corrosion resistance.

PC22. Understand AI with finite element analysis (FEA) and other computational mechanics tools enables the simulation of complex material behavior under real-world conditions.

Use AI tools/algorithms Utilize in Smart Manufacturing and Industry 4.0

To be competent, the user/individual on the job must be able to:

PC23. Discuss AI algorithms enable real-time monitoring of manufacturing processes by analyzing data from sensors and IoT devices. This facilitates immediate adjustments to optimize conditions, improve quality, and reduce waste in metallurgical processes.

PC24. Understand AI tools for predictive maintenance helps anticipate equipment failures and schedule maintenance proactively.

PC25. Decsribe machine learning models analyze operational data to identify patterns indicating potential breakdowns, thereby minimizing downtime and increasing productivity.

PC26. Explain AI algorithms analyze complex datasets to optimize metallurgical processes such as casting, welding, and heat treatment.

PC27. Understand AI tools streamline supply chain operations by predicting demand, optimizing inventory levels, and managing logistics.

PC28. Explain AI algorithms enhance quality control processes through advanced image recognition and anomaly detection.

Utilize AI in Materials Recycling and Circular Economy

To be competent, the user/individual on the job must be able to:

PC29. Understand AI algorithms enhance the efficiency of sorting recyclable materials by using computer vision and machine learning techniques to identify different types of metals and materials.

PC30. Explain AI optimizes recycling processes by analyzing data from various stages of material recovery.

PC31. Explain AI-driven predictive modeling forecast the yield of recycled materials from various waste streams.

PC32. Understand AI tools in the design and development of sustainable materials.

PC33. Discuss AI algorithms support the implementation of circular economy strategies by analyzing data on resource flows, usage patterns, and waste generation.

Advancement in AI for Metallurgy and Materials

To be competent, the user/individual on the job must be able to:

PC34. Explain AI algorithms significantly speed up the discovery of new materials by predicting their properties based on existing data, allowing metallurgists to identify for specific applications.

PC35. Understand advanced AI tools are employed to optimize metallurgical processes, such as casting, forging, and heat treatment, by analyzing large datasets to find the best parameters that enhance yield, reduce waste, and improve product quality.

PC36. Explore AI-powered systems enable real-time monitoring of metallurgical processes, providing insights and alerts about deviations from optimal conditions quality and reducing defects.

PC37. Understand machine learning algorithms to analyze equipment performance data, metallurgical facilities anticipate equipment failures and schedule maintenance, minimizing downtime and extending machinery lifespan.

PC38. Explain AI tools facilitate complex simulations of metallurgical processes, allowing engineers to model and predict different variables affect material performance.

PC39. Discuss advancement of AI tools aligns with Industry 4.0 initiatives.

Knowledge and Understanding (KU)

The individual on the job needs to know and understand:

KU1. AI algorithms analyze historical data to predict the properties of new materials based on their composition and processing conditions, streamlining the materials development process.

KU2. Data analytics tools allow engineers to make informed decisions based on empirical evidence, enhancing the design and optimization of metallurgical processes.

KU3. Machine learning methods such as supervised and unsupervised learning helps metallurgical engineers identify patterns in data that lead to improved material performance and process efficiency.

KU4. AI tools enable the analysis of microstructural images, allowing for the identification of defects and the correlation of microstructure with material properties, crucial for quality assurance in materials manufacturing.

KU5. Optimization algorithms (e.g., genetic algorithms, gradient descent) are essential for enhancing metallurgical processes by finding the best parameters that maximize performance and minimize costs.

KU6. Awareness of AI integrates with smart manufacturing concepts, such as IoT and Industry 4.0, enables metallurgical engineers to implement technologies that enhance process automation and data collection.

KU7. AI tools to be applied to improve recycling processes and develop sustainable materials contribute to reducing the environmental impact of metallurgical practices.

Generic Skills (GS)

User/individual on the job needs to know how to:

GS1. Listen and communicate effectively and accurately.

GS2. Apply problem-solving approaches for different situations.

GS3. Work effectively in a team.

GS4. Employ proper time management.

GS5. Plan and organize work.

GS6. Maintain hygiene and sanitation.

GS7. Analytical skills

Assessment Criteria

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
Use AI tools/algorithms for Materials Design	**6**	**7**	**-**	**2**
PC1. Explain AI algorithms analyze large datasets of material properties and structures to identify promising for new materials.	-	-	-	-
PC2. Understand machine learning models predict the mechanical, thermal, and electrical properties of materials based on their composition and microstructure.	-	-	-	-
PC3. Discuss AI tools optimize the compositions of metal alloys by simulating different combinations of elements and predicting their performance, enhancing the development of high- strength, lightweight, and corrosion-resistant materials.	-	-	-	-
PC4. Describe AI algorithms are employed to design and control the microstructure of materials during processing (e.g., casting, forging, or additive manufacturing), leading to improved mechanical properties and performance.	-	-	-	-
PC5. Understand AI tools in designing materials specifically for additive manufacturing processes by optimizing the geometry and material properties, thus ensuring better manufacturability and performance in 3D-printed components.	-	-	-	-
PC6. Explore AI algorithms to analyze historical data from materials testing and operational environments to predict failure modes and enhance the durability and reliability of materials under various loading conditions.	-	-	-	-
Utilize Process Optimization and Control in Metallurgy	**6**	**8**	**-**	**2**
PC7. Discuss AI algorithms integrated into metallurgical processes to monitor parameters such as temperature, pressure, and chemical composition in real-time.	-	-	-	-
PC8. Describe machine learning models, metallurgical plants predict equipment failures.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC9. Discuss AI tools analyze historical process data to identify optimal settings for various parameters (e.g., heating rates, cooling rates, and material flow), resulting in enhanced efficiency, reduced energy consumption, and improved yield.	-	-	-	-
PC10. Understand advanced AI-driven simulations model complex metallurgical processes, such as casting, welding, and heat treatment.	-	-	-	-
PC11. Explain AI algorithms be trained to detect defects in materials and products through image analysis or sensor data, ensuring high quality and consistency in metallurgical output by automating quality control processes.	-	-	-	-
PC12. Discuss AI tools optimize the flow of materials through the production process, enhancing logistics and inventory management, reducing waste, and improving overall operational efficiency in metallurgical operations.	-	-	-	-
Use Computational Techniques in Microstructure Analysis	**6**	**7**	**-**	**2**
PC13. Discuss AI algorithms automate the analysis of microstructural images obtained from microscopy techniques, such as electron microscopy (SEM) and transmission electron microscopy (TEM), enabling faster and more accurate identification of phase distributions, grain boundaries, and defects.	-	-	-	-
PC14. Understand Computational techniques, including machine learning and image processing, quantitatively characterize microstructural features, such as grain size, shape, and orientation, facilitating a deeper understanding of microstructure affects material properties and performance.	-	-	-	-
PC15. Explain AI tools to develop models that simulate microstructural evolution during processes like solidification, heat treatment, and deformation, allowing researchers to predict changes in processing conditions affect microstructure and resulting material properties.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC16. Discuss microstructure data with materials property databases, AI tools identify correlations between microstructural features and mechanical, thermal, or electrical properties, aiding in the design of materials with tailored performance characteristics.	-	-	-	-
PC17. Explain machine learning algorithms to be trained on existing datasets to predict microstructural outcomes based on processing parameters.	-	-	-	-
PC18. Understand AI-powered visualization techniques to analyze complex microstructures, enabling better understanding and interpretation of material.	-	-	-	-
Utilize AI tools/algorithms for Predictive Modelling of Material Behaviour	**6**	**7**	**-**	**1**
PC19. Discuss AI tools leverage large datasets obtained from experimental and simulation studies to understand create predictive models.	-	-	-	-
PC20. Understand machine learning algorithms, such as regression analysis, decision trees, and neural networks, facilitate the development of robust models that accurately predict mechanical properties, fatigue life, and failure modes of materials.	-	-	-	-
PC21. Explain predictive modelling help optimize processing parameters (e.g., temperature, pressure, and time) to enhance material properties and AI algorithms identify the best processing routes to achieve desired characteristics like strength, ductility, or corrosion resistance.	-	-	-	-
PC22. Understand AI with finite element analysis (FEA) and other computational mechanics tools enables the simulation of complex material behavior under real-world conditions.	-	-	-	-
Use AI tools/algorithms Utilize in Smart Manufacturing and Industry 4.0	**6**	**7**	**-**	**1**

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC23. Discuss AI algorithms enable real-time monitoring of manufacturing processes by analyzing data from sensors and IoT devices. This facilitates immediate adjustments to optimize conditions, improve quality, and reduce waste in metallurgical processes.	-	-	-	-
PC24. Understand AI tools for predictive maintenance helps anticipate equipment failures and schedule maintenance proactively.	-	-	-	-
PC25. Decsribe machine learning models analyze operational data to identify patterns indicating potential breakdowns, thereby minimizing downtime and increasing productivity.	-	-	-	-
PC26. Explain AI algorithms analyze complex datasets to optimize metallurgical processes such as casting, welding, and heat treatment.	-	-	-	-
PC27. Understand AI tools streamline supply chain operations by predicting demand, optimizing inventory levels, and managing logistics.	-	-	-	-
PC28. Explain AI algorithms enhance quality control processes through advanced image recognition and anomaly detection.	-	-	-	-
Utilize AI in Materials Recycling and Circular Economy	**5**	**7**	**-**	**1**
PC29. Understand AI algorithms enhance the efficiency of sorting recyclable materials by using computer vision and machine learning techniques to identify different types of metals and materials.	-	-	-	-
PC30. Explain AI optimizes recycling processes by analyzing data from various stages of material recovery.	-	-	-	-
PC31. Explain AI-driven predictive modeling forecast the yield of recycled materials from various waste streams.	-	-	-	-
PC32. Understand AI tools in the design and development of sustainable materials.	-	-	-	-

Assessment Criteria for Outcomes	Theory Marks	Practical Marks	Project Marks	Viva Marks
PC33. Discuss AI algorithms support the implementation of circular economy strategies by analyzing data on resource flows, usage patterns, and waste generation.	-	-	-	-
Advancement in AI for Metallurgy and Materials	**5**	**7**	**-**	**1**
PC34. Explain AI algorithms significantly speed up the discovery of new materials by predicting their properties based on existing data, allowing metallurgists to identify for specific applications.	-	-	-	-
PC35. Understand advanced AI tools are employed to optimize metallurgical processes, such as casting, forging, and heat treatment, by analyzing large datasets to find the best parameters that enhance yield, reduce waste, and improve product quality.	-	-	-	-
PC36. Explore AI-powered systems enable real-time monitoring of metallurgical processes, providing insights and alerts about deviations from optimal conditions quality and reducing defects.	-	-	-	-
PC37. Understand machine learning algorithms to analyze equipment performance data, metallurgical facilities anticipate equipment failures and schedule maintenance, minimizing downtime and extending machinery lifespan.	-	-	-	-
PC38. Explain AI tools facilitate complex simulations of metallurgical processes, allowing engineers to model and predict different variables affect material performance.	-	-	-	-
PC39. Discuss advancement of AI tools aligns with Industry 4.0 initiatives.	-	-	-	-
NOS Total	**40**	**50**	**-**	**10**

National Occupational Standards (NOS) Parameters

NOS Code	ICE/ITS/N0209
NOS Name	Applications of AI tools/algorithms in Metallurgical and Materials Engineering
Sector	Information Technology Sector
Sub-Sector	
Occupation	Artificial Intelligence
NSQF Level	5
Credits	10
Version	1.0
Last Reviewed Date	17/12/2024
Next Review Date	17/12/2027
NSQC Clearance Date	17/12/2024

Assessment Guidelines and Assessment Weightage

Assessment Guidelines

Criteria for assessment for each Qualification Pack will be created by the Awarding Body. Each Performance Criteria (PC)/ Element will be assigned marks proportional to its importance in NOS. AB will also lay down proportion of marks for Theory and Skills Practical for each PC/ Element.

2. The assessment for the knowledge part will be based on knowledge bank of questions created by Assessment Bodies subject to approval by AB

3. Individual assessment agencies will create unique question papers for knowledge/theory part for assessment of candidates as per assessment criteria given below

4. Individual assessment agencies will create unique evaluations for skill practical for every student at each examination/training center based on assessment criteria.

5. The passing percentage for each QP will be 70%. To pass the Qualification Pack, every trainee should score a minimum of 70% individually in each NOS.

6. The Assessor shall check the final outcome of the practices while evaluating the steps performed to achieve the final outcome.

7. The trainee shall be provided with a chance to repeat the test to correct his procedures in case of improper performance, with a deduction of marks for each iteration.

8. After the certain number of iterations as decided by AB the trainee is marked as fail, scoring zero marks for the procedure for the practical activity.

9. In case of successfully passing only certain number of NOS's, the trainee is eligible to take subsequent assessment on the balance NOS's to pass the Qualification Pack within the specified time frame set by AB.

10. Minimum duration of Assessment of each QP shall be of 4hrs/trainee

Minimum Aggregate Passing % at QP Level : 70

(**Please note**: Every Trainee should score a minimum aggregate passing percentage as specified above, to successfully clear the Qualification Pack assessment.)

Assessment Weightage

Compulsory NOS

National Occupational Standards	Theory Marks	Practical Marks	Project Marks	Viva Marks	Total Marks	Weightage
ICE/ITS/N0201.Fundamentals of Artificial Intelligence (AI)	40	50	0	10	100	15
ICE/ITS/N0202.Python Programming and data science for AI	40	50	0	10	100	30
ICE/ITS/N0203.Building Blocks of Artificial Intelligence (A.I)	40	50	-	10	100	15
DGT/VSQ/N0102.Employability Skills (60 Hours)	20	30	-	-	50	10
Total	**140**	**180**	**-**	**30**	**350**	**70**

Elective: 1 Applications of AI in Metallurgy Domain

National Occupational Standards	Theory Marks	Practical Marks	Project Marks	Viva Marks	Total Marks	Weightage
ICE/ITS/N0209.Applications of AI tools/algorithms in Metallurgical and Materials Engineering	40	50	0	10	100	30

Qualification Pack

National Occupational Standards	Theory Marks	Practical Marks	Project Marks	Viva Marks	Total Marks	Weightage
Total	**40**	**50**	**-**	**10**	**100**	**30**