

GOVERNMENT POLYTECHNIC, PUNE
'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN CE/EE/ET/ME/MT/CM/IT/DDGM
PROGRAMME CODE	01/02/03/04/05/06/07/08
COURSE TITLE	SOCIAL AND LIFE SKILLS
COURSE CODE	HU21204
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARATION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Credits	Paper Duration	Assessment Scheme									
			Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TSL				Based on SL		Total Marks			
			CL	TL	LL			FA-TH			SA-TH	Total	Practical		SLA					
													FA-PR	SA-PR	Max	Min		Max	Min	
HU21204	SOCIAL AND LIFE SKILLS	VEC	1	--	2	1	4	2	--	--	--	--	25	10	--	--	25	10	50	

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, **IKS** – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, #- External Assessment,*# - Online Examination,@\$ - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

- If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course.
- If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
- Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
- 1 credit** is equivalent to **30 Notional hours**.
- * Self-learning hours shall not be reflected in the Timetable.
- * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

The introduction of a social and life skills course for diploma engineers is indeed a significant step forward in shaping well-rounded professionals. By integrating soft skills training with technical education, this curriculum addresses the growing need for engineers who are not only experts in their field but also adept in interpersonal communication, collaboration, and leadership. Such skills are crucial for success in the modern workforce, where the ability to navigate complex social dynamics can be just as important as technical know-how. Moreover, the emphasis on ethical decision-making prepares engineers to approach their work with integrity and responsibility. As these professionals progress in their careers, the benefits of this comprehensive education will manifest in their ability to innovate, lead, and contribute positively to their communities and the broader society. This forward-thinking approach ensures that the engineers of tomorrow are equipped not just with the tools to excel in their careers, but also with the vision to drive societal progress.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1: Achieve shared goals through effective teamwork in executing sustainable community development projects.

CO2: Improve cooperation and understanding through refined communication skills.

CO3: Encourage ethical choices and compassionate behaviour by nurturing moral values.

CO4: Foster ethical judgment, honesty, and societal accountability to shape principled and conscientious professionals.

CO5: Equip students with practical financial literacy skills for efficient financial management.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I ENGAGEMENTS WITHIN UNNAT MAHARASHTRA ABHIYAN (UMA) (CL Hrs-03, Marks-NIL)				
1.	<p>TLO1.1: Recognize the importance of addressing societal needs and involving relevant stakeholders in problem-solving efforts.</p> <p>TLO1.2: Integrate academia, society, and technology to devise comprehensive solutions for complex societal issues.</p> <p>TLO1.3: Enhance communication and negotiation skills to effectively engage stakeholders, ensuring diverse perspectives and productive collaboration in problem-solving.</p> <p>TLO1.4: Utilize critical data sources such as economic surveys, and environmental data to guide decision-making and solution development in problem-solving endeavours.</p> <p>TLO1.5: Identify key stakeholders and delineate their roles and interests in addressing societal challenges.</p> <p>TLO1.6: Identify essential attributes for measurement in the problem-solving process.</p> <p>TLO1.7: Explore diverse</p>	<p>1.1 Identifying Regional Societal Challenges: Recognizing Community Needs Requiring Engineering Solutions.</p> <p>1.2 Integrating Multidisciplinary Approaches: Linking Academia, Society, and Technology</p> <p>1.3 Involving Diverse Stakeholders: Engaging Various Actors in the Problem-Solving Process</p> <p>1.4 Accessing Secondary Data Sources: Utilizing Resources like Census and Economic Surveys</p> <p>1.5 Mapping Problems and Stakeholders: Understanding Activities' Relevance to System Components and Key Stakeholders</p> <p>1.6 Defining Measurement Metrics: Identifying Essential Attributes for Evaluation</p> <p>1.7 Employing Data Collection Tools: Exploring Surveys and Measurement Equipment</p> <p>1.8 Establishing Measurement Standards: Developing Survey Forms and Piloting Processes</p> <p>1.9 Conducting Field Surveys: Quantifying Local Systems such as Agriculture and Transportation</p> <p>1.10 Analyzing Data and Creating Reports: Summarizing Data and</p>	<p>Considering the unit design, it's vital to consider the following factors during the implementation of the unit:</p> <p>i) Organize students into smaller groups of 5-6 members to carry out fieldwork within the larger cohort.</p> <p>ii) Allocate multiple student groups evenly among all faculty members involved in the course.</p> <p>iii) A team of course faculty will visit local governing bodies like Municipal Corporations, Villages, Panchayats, Zilla Parishads, and Panchayat Samitis to assess small-scale technological or engineering needs within their jurisdiction.</p> <p>iv) The team of course instructors will conduct initial field visits to explore various scenarios and options</p>	CO1

	<p>tools and templates for data collection, including surveys and measurement equipment.</p> <p>TLO1.8: Establish a structured framework for measuring identified attributes, including the development of survey forms and piloting the measurement process.</p> <p>TLO1.9: Gain practical experience in conducting fieldwork to gather primary data, such as agricultural output, rainfall, and transportation networks.</p> <p>TLO1.10: Develop proficiency in data analysis to draw meaningful conclusions, informing decision-making and solution development processes.</p>	<p>Reflections in Reports, Utilizing Various Formats like Tables and Graphs</p>	<p>for student-led fieldwork to assess and quantify different parameters and characteristics.</p> <p>a) Session I will introduce the development approach, fieldwork methodology, and the utilization of case studies as instructional tools.</p> <p>b) Sessions II - VII will cover topics such as societal dynamics, stakeholder engagement, value creation, establishing metrics, basic analysis, and preliminary reporting.</p> <p>c) Session VIII will wrap up the program with feedback collection and assessment.</p> <p>d) Field Work:</p> <ol style="list-style-type: none"> 1. Pilot Visit - Testing the survey instrument 2. Survey Visit 1 - Gathering data/information Survey. 3. Visit 2- Further data collection. 4. Summary Visit- Concluding activities post-analysis. 	
<p>UNIT - II NATIONAL SERVICE SCHEME (NSS) (CL Hrs-03, Marks- NIL)</p>				
<p>2</p>	<p>TLO2.1: Enhance communication and leadership abilities to effectively interact with local leaders.</p> <p>TLO2.2: Develop proficiency in conducting socio-economic surveys using appropriate data collection techniques and analysis methods to understand community needs.</p> <p>TLO2.3: Identify suitable villages and devise activity plans based on community</p>	<ol style="list-style-type: none"> 2.1 Engaging with Village/Area 2.2 Conducting initial socio-economic surveys in nearby villages. 2.3 Selecting villages for adoption and initiating project activities. 2.4 Conducting thorough socio-economic surveys in the adopted village or area. 2.5 Identifying key issues and challenges within the community. 2.6 Raising awareness about advancements in agriculture, watershed management, wasteland reclamation, renewable energy, affordable housing, sanitation, 	<p>Considering the unit design, it's vital to consider the following factors during the implementation of the unit:</p> <ol style="list-style-type: none"> i) Organize students into smaller groups of 5-6 members to carry out fieldwork within the larger cohort. ii) Allocate multiple student groups evenly among all faculty members involved in the course. 	<p>CO2</p>

	<p>needs and available resources. TLO2.4: Analyze survey findings to discern socio-economic patterns, obstacles, and potential avenues for progress. TLO2.5: Prioritize community issues according to their significance and impact on community welfare. TLO2.6: Communicate information on agriculture, watershed management, renewable energy, housing, sanitation, nutrition, and hygiene effectively. TLO2.7: Cultivate networking and advocacy skills to foster collaboration among government agencies, development organizations, and the community.</p>	<p>nutrition, and personal hygiene. Also, informing about skill enhancement programs, income generation opportunities, government initiatives, legal aid, consumer rights, and related topics. 2.7 Facilitating collaboration between the government and development agencies to implement various schemes in the adopted village or slum.</p>	<p>iii) Before selecting a village or slum for NSS activities, it's advisable for teachers to conduct an initial visit. iv) The selected area should have a dense population. iv) Community members should exhibit a willingness to improve their living conditions and actively engage in projects initiated by the NSS for their benefit. vi) NSS units should avoid areas with a history of political conflicts. vii) The chosen area should be conveniently accessible for NSS volunteers to conduct regular visits to the slums.</p>	
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UNIT - III UNIVERSAL HUMAN VALUES (CL Hrs-03, Marks- NIL)

3	<p>TL03.1: Apply love and compassion to promote harmony and well-being. TL03.2: Demonstrate honesty and transparency to build trust and authenticity. TL03.3: Utilize non-violent approaches to resolve conflicts and enhance empathy. TL03.4: Align actions with moral principles to promote justice and fairness. TL03.5: Employ peace-building strategies for harmony and reconciliation. TL03.6: Engage in acts of service to cultivate empathy and social responsibility. TL03.7: Prioritize others' needs to foster altruism and generosity.</p>	<p>4.1 Exploring Love and Compassion (Prem and Karuna): Learning about and embodying the principles of love and compassion in daily life. 4.2 Embracing Truth (Satya): Understanding the significance of truthfulness and integrating it into one's actions and interactions. 4.3 Embracing Non-Violence (Ahimsa): Understanding the importance of non-violence and applying it in personal and societal contexts. 4.4 Upholding Righteousness (Dharma): Exploring the concept of righteousness and practising it through ethical conduct and moral values. 4.5 Cultivating Peace (Shanti): Reflecting on the essence of peace and cultivating</p>	<p>Proposed Learning Approaches for: i) Lecture Delivery ii) Demonstrations iii) Case Studies iv) Role-playing exercises v) Observational Learning vi) Portfolio Development vii) Simulations viii) Inspirational Talks from Industry Professionals ix) On-site Visits to sites or Industries</p>	CO3
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	<p>TL03.8: Exhibit behaviours that uphold gender equality and respect for diversity to create an inclusive</p>	<p>inner tranquillity while promoting harmony in relationships and communities.</p> <p>4.6 Embracing Service (Seva): Understanding the value of selfless service and actively engaging in acts of kindness and support for others.</p> <p>4.7 Embracing Renunciation (Sacrifice) Tyaga: Understanding the concept of renunciation and willingly letting go of self-interest for the greater good. and attitudes.</p> <p>4.8 Promoting Gender Equality and Sensitivity: Recognizing the importance of gender equality and fostering an environment of inclusivity and respect for all genders through actions and attitudes.</p>		
<p>UNIT - IV VALUE EDUCATION (UNNATI FOUNDATION) (CL Hrs-03, Marks- NIL)</p>				
<p>4</p>	<p>TLO4.1: Display comprehension of one's own identity, values, and beliefs.</p> <p>TLO4.2: Recognize and express personal strengths and weaknesses effectively.</p> <p>TLO4.3: Demonstrate adeptness in active listening by providing feedback and demonstrating empathy.</p> <p>TLO4.4: Acquire strategies for handling conflicts constructively and respectfully.</p> <p>TLO4.5: Assess and reflect on moral values and principles that influence personal actions and choices.</p> <p>TLO4.6: Analyze and assess the moral values and principles guiding individual actions and decisions.</p>	<p>4.1. Self-awareness and Personal Development Self-understanding, Identification of strengths and weaknesses, Setting goals and devising plans, Building self-esteem and confidence</p> <p>4.2. Interpersonal Skills and Effective Communication Engaging in active listening, Resolving conflicts, Cultivating healthy relationships</p> <p>4.3. Ethics and Morality Grasping ethical concepts, Upholding moral values and principles, Making ethical decisions, Demonstrating integrity and honesty</p> <p>4.4. Social Values and Responsibility Being punctual and initiating conversation, Managing emotions effectively, Introducing oneself and others, Maintaining a positive attitude Valuing family bonds, Creating favourable impressions,</p>	<p>i) Video Demonstrations ii) Flipped Learning Environment iii) Case Studies iv) Role-playing Activities v) Group-based Learning vi) Team-based Learning vii) Utilization of Chalkboard</p>	<p>CO4</p>

		<p>Communicating effectively, Emphasizing cleanliness, hygiene, and organization, Expressing preferences, Fostering confidence Enhancing listening skills, Demonstrating appropriate greetings, Promoting gender equality and sensitivity, Exercising responsibility, Integrating visual and verbal learning, Establishing and pursuing goals, Observing social media etiquette, Efficiently managing time and daily routines</p>		
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UNIT - V FINANCIAL LITERACY(CL Hrs-03, Marks- NIL)

5	<p>TLO5.1:Comprehending Savings and Investment Practices. TLO5.2:Cultivating Proficiency in Financial Planning. TLO 5.3:Developing Competence in Transaction Handling. TLO5.4:Achieving Proficiency in Income, Spending, and Budget Management. TLO 5.5:Attaining Understanding of Inflation Concepts. TLO 5.6: Fostering Competence in Loan Administration. TLO5.7: Acknowledging the Significance of Insurance.</p>	<p>5.1. Fundamentals of Finances: Grasping concepts of income, expenses, and savings, Employing budgeting techniques, Understanding assets and liabilities, and Recognizing the significance of emergency funds. 5.2. Banking Essentials Initiating and managing bank accounts, Familiarizing oneself with various account types (savings, checking, etc.), Comprehending interest rates, and Safely utilizing ATMs. 5.3. Management of Credit and Debt Interpreting credit scores and reports, Identifying different credit types (credit cards, loans, etc.), Responsible debt management, and Preventing involvement in predatory lending. 5.4. Foundations of Investment Understanding investment types (stocks, bonds, mutual funds, etc.), Assessing risk and return, Implementing diversification strategies, and Formulating investment approaches. 5.5. Financial Planning and Goal Establishment Establishing financial objectives, Crafting a personalized financial blueprint, Continuously monitoring and adjusting financial goals, and Engaging in long-term financial</p>	<p>i) Video Demonstrations ii) Presentations iii) Case Studies iv) Chalkboard Utilization v) Collaborative Learning</p>	CO5
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	<p>strategizing.</p> <p>5.6. Consumer Rights and Duties Familiarizing oneself with consumer entitlements, Safeguarding against financial scams and fraudulent activities Exercising responsible borrowing and spending practices, Upholding financial privacy and security measures.</p> <p>5.7. Essentials of Insurance Exploring different insurance categories (health, life, auto, home, etc.), Understanding insurance policy specifics, Recognizing the importance of insurance coverage, and Navigating the insurance claims process.</p> <p>5.8. Economic Literacy Grasping fundamental economic principles, Understanding the concepts of inflation and deflation, Analyzing market trends, and Interpreting economic indicators.</p>		
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V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/ TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment/ Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO1.1: Communicating and interacting with residents or children with compassion and empathy, demonstrating an understanding of their needs and emotions.	1.1 Encouraging empathy and kindness through volunteer work at: i) a nearby nursing home ii) a care centre for children from disadvantaged families or similar types of facilities.	2	CO3
2	LLO 2.1 Enhance goal-setting abilities by engaging in collaborative planning, analyzing obstacles, and reflecting on personal aspirations to align them with broader academic or career goals.	2.1 Pathway to Success: Goal-Setting Exercise	2	CO4
3	LLO3.1: Develop effective communication skills by demonstrating compassion, empathy, and understanding towards residents or children, while acknowledging and addressing their needs and emotions.	3.1 Exploring Your Inner World: Self-Reflection Activity	2	CO4
4	LLO4.1: Laboratory Learning Outcome: Cultivate structured self-reflection skills to assess personal	4.1 Strengths and Weaknesses Identification and Analysis Exercise	2	CO4

	strengths and weaknesses.			
5	LLO 5.1: Display proficiency in time management through the creation and adherence to structured timelines for task coordination.	5.1 Time Management Simulation for Coordinating Industrial Visits	2	CO4
6	LLO 6.1: Demonstrate competency in social media etiquette through engaging in activities and adhering to established norms and guidelines.	6.1 Activity on Social Media Etiquette	2	CO4
7	LLO 7.1: Develop skills in mapping and analyzing family income and expenses through structured exercises.	7.1. Exercise on Mapping and Analyzing Family Income and Expenses	2	CO5
8	LLO 8.1: Apply their knowledge of interest rate calculation to real-world financial situations, improving decision-making skills.	8.1 Exploring Simple and Compound Interest: A Hands-On Exercise on Interest Rate Calculation and Its Impact on Savings and Loans.	2	CO5
9	LLO9.1: Enhance comprehension of interest rates and their impact on financial dealings, encompassing savings accounts, Fixed Deposits (FDs), and loans.	9.1 Interest Rate Comparison Exercise: Analyzing Rates for Savings, Fixed Deposits, and Loans.	2	CO5
10	LLO10.1: Mastering and implementing safety protocols for ensuring secure ATM transactions.	10.1 Safety Precautions for ATM Usage: Exploring Tips for Secure Transactions	2	CO5

Note: Out of the above suggestive LLOs –

1. A judicious mix of LLOs is to be performed to achieve the desired outcomes

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

SELF-LEARNING - MICRO PROJECT/ASSIGNMENT/ACTIVITIES (ANY ONE)

The following list provides examples of activities that can be pursued under the program. Each group has the flexibility to choose from these options or undertake any other activity deemed suitable based on local requirements. The group focuses on the holistic development of the selected area, whether it is a village or a slum.

a) Community clean-up drives

Group tasks for community clean-up drives are,

1. Site Survey and Planning: Identify areas needing attention and plan tasks.
2. Logistics Management: Coordinate supply distribution to volunteers.
3. Volunteer Coordination: Welcome, register, and assign tasks to volunteers.
4. Trash Collection and Segregation: Collect and sort waste into categories.
5. Street Sweeping and Cleaning: Sweep and clean streets, sidewalks, and public areas.
6. Beautification and Landscaping: Enhance aesthetics by planting and trimming.

7. Safety and First Aid: Ensure volunteer safety and manage emergencies.
8. Documentation and Reporting: Capture progress through photos and reports.
9. Community Engagement: Educate and raise awareness among residents.
10. Post-Clean-up Evaluation: Review success and plan future initiatives.

b) Tree plantation initiatives

Group tasks for Tree plantation initiatives,

1. Community Awareness: Workshops to educate on tree benefits.
2. Community Participation: Engage locals in all planting
3. Team Building: Group activities to strengthen community bonds.
4. Leadership Development: Empower individuals to lead initiatives.
5. Communication Workshops: Enhance effective messaging.
6. Problem-solving Discussions: Address planting challenges.
7. Environmental Responsibility: Foster care for green spaces.
8. Cultural Integration: Incorporate local traditions into initiatives.
9. Sustainability Education: Teach sustainable planting practices.
10. Monitoring and Evaluation: Assess impact and plan improvements.

c) Environmental conservation awareness

Group tasks for Environmental conservation awareness

1. Educational Workshops: Teach about conservation methods.
2. Art Competitions: Promote environmental themes through art.
3. Street Plays: Perform interactive skits in public spaces.
4. Awareness Walks: Organize marches with environmental messages.
5. Tree Plantation: Plant trees to enhance green spaces.
6. Clean-up Campaigns: Remove litter from local areas.
7. Guest Lectures: Invite experts to discuss environmental issues.
8. Film Screenings: Show documentaries on conservation topics.
9. Social Media Campaigns: Spread awareness through online platforms.
10. Community Workshops: Educate on waste management and sustainability.

d) Health and sanitation programs

1. Health Education Sessions: Conduct informative sessions on hygiene, disease prevention, and nutrition.
2. Sanitation Infrastructure Evaluation: Assess the effectiveness of existing sanitation facilities and propose improvements.
3. Community Clean-up Events: Organize collective efforts to clean and maintain public spaces for better health outcomes.
4. Distribution of Hygiene Kits: Provide essential hygiene items such as soap, toothpaste, and sanitary products to community members.
5. Vaccination Drives: Coordinate vaccination campaigns to protect against prevalent diseases and promote community health.
6. Water Quality Testing: Conduct regular testing of water sources to ensure safe drinking water for residents.
8. Personal Hygiene Workshops: Offer workshops focusing on personal grooming, handwashing techniques, and menstrual hygiene.
9. First Aid Training: Provide basic first aid training to community members to equip them with life-saving

skills.

10. Community Health Surveys: Conduct surveys to assess health needs and gather feedback for future program planning.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No.	Equipment Name with Broad Specifications	Relevant LLO Number
1	Basic engineering measurement instruments, GPS data collection devices, and open-sour GIS software like Google Earth and QGIS, along with the Microsoft Office suite.	ALL

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

NOT APPLICABLE

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
Formative assessment (Assessment for Learning) Report and presentation of fieldwork activities, Self- Learning (Assignment)	--

X. SUGGESTED COS- POS MATRIX FORM


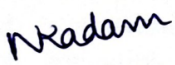
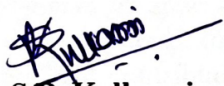
NOT APPLICABLE

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	Mark Stafford Smith and Pamela Matson	Sustainable Development: Principles, Frameworks, and Case Studies	Oxford University Press, ISBN: 9780199588952
2	Katar Singh	Rural Development: Principles, Policies and Management	SAGE Publications Pvt. Ltd, ISBN:978-9351502867.
3	Anand Kumar, Asim Kumar Mandal, and R. Venkata Rao	Maharashtra: Governance and Development"	Routledge India, ISBN: 978-0367709133
4	Dalai Lama and Howard C. Cutler	The Art of Happiness	Riverhead Books, and the ISBN: 978-1594488894.
5	Stephen R. Covey	The 7 Habits of Highly Effective People	Simon & Schuster, ISBN : 978-1982137274.
6	Local college students, UMA staff	Sample Case Studies on the UMA website	IITB-UMA team

XI. LEARNING WEBSITES & PORTALS

Sr.No.	Link/Portal	Description
1	https://www.ugc.gov.in/pdfnews/4371304_LifeSkill_JeevanKaushal_2023.pdf	UHV: UGC Course on life skills. Unit 4 i.e. Course 4 is to be referred
2	https://nss.gov.in/	The National Service Scheme (NSS) website provides information about the NSS program in India. It includes details about the objectives, history, and structure of NSS. Additionally, the website offers resources for NSS volunteers and coordinators, such as program guidelines, training materials, and reports.
3	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/201601131501523808.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan
4	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/201606151454073708.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan Guidelines
5	https://www.humanvaluesfoundation.com/	The Human Values Foundation website offers educators resources for teaching human values and social-emotional learning to children and youth. It provides curriculum-based programs, lesson plans, and activities to foster character development, resilience, and positive behaviour. Additionally, the website shares insights into the foundation's mission, values, and the global impact of its programs in schools.

Name & Signature:  Mr. S.B. Kulkarni Lecturer in Mechanical Engineering (Course Experts)	
Name & Signature:  Mrs. Namita S. Kadam (Programme Head)	Name & Signature:  Shri. S.B. Kulkarni (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE
'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN EE/ME/MT
PROGRAMME CODE	02/04/05
COURSE TITLE	FUNDAMENTALS OF PYTHON PROGRAMMING
COURSE CODE	ME41202
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARATION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
			Actual Contact Hrs./Week			SLH	NLH			Theory	Based on LL & TSL				Based on SL					
			CL	TL	LL						Practical				SLA					
			FA-TH	SA-TH	Total	FA-PR	SA-PR			SLA	Max	Min	Max	Min	Max	Min				
ME41202	FUNDAMENTALS OF PYTHON PROGRAMMING	AEC	1	-	2	1	4	2	--	--	--	--	25	10	25@	10	25	10	75	

Total IKS Hrs for Term: 0 Hrs

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II. RATIONALE:

Python's reputation as a powerful programming language is well-deserved. Its high-level data structures and object-oriented approach streamline complex software development, making it accessible for beginners and efficient for seasoned programmers. The simplicity and readability of Python code, alongside its intuitive nature, contribute to its widespread use in teaching computing and problem-solving concepts. Moreover, Python's elegant syntax and dynamic typing, combined with its interpreted nature, facilitate scripting and rapid application development across diverse fields and platforms, solidifying its position as a versatile tool in the developer's toolkit.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

- CO1:** Acquire fundamental Python programming skills, empowering them to create simple scripts and grasp essential concepts including variables and data types.
- CO2:** Develop Python programs using control flow statements.
- CO3:** Perform operations on various data structures in Python.

CO4: Develop functions, and modules to solve given problems using Python.

CO5: Represent data visually using a wide range of charts, plots, and graphs, including bar charts, line plots, scatter plots, and histograms.

THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to COs.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I INTRODUCTION TO PYTHON				
1	<p>TLO 1.1 Explain the given features of Python.</p> <p>TLO 1.2 Write a Python program to perform basic input-output operations.</p> <p>TLO 1.3 Write a Python program to solve a given expression.</p> <p>TLO 1.4 Implement the given decision-making statements and looping statements in the Python program.</p>	<p>1.1 Introduction: Features, History and Applications of Python, Python IDE's</p> <p>1.2 Python Environment Setup: Installation and working of IDE</p> <p>1.3 Python building blocks: Indentation, Identifiers, Variable, Comments, Keywords.</p> <p>1.4 Python Data Types: Numbers, String, Tuples, Lists, Dictionary. Declaration and use of data types.</p> <p>1.5 Basic input-output operations: input(), print().</p> <p>1.6 Running Simple Python scripts to display the given text messages.</p>	Chalk-Board, Demonstration Presentations, Hands-on	CO1
UNIT-II PYTHON OPERATORS AND CONTROL FLOW STATEMENTS				
2	<p>TLO 2.1 Write a simple Python program for the given arithmetic expressions.</p> <p>TLO 2.2 Write a Python program to manipulate tuples.</p> <p>TLO 2.3 Write a Python program to manipulate sets.</p> <p>TLO 2.4 Write a Python program to manipulate dictionaries.</p>	<p>2.1 Operators: Arithmetic, Relational, Assignment, Logical, Bitwise, Membership and Identity Operator.</p> <p>2.2 Control flow statements:</p> <p>2.2.1 Conditional Statements (if, if ... else, nested if)</p> <p>2.2.2 Looping in Python (while loop, for loop, nested loops)</p> <p>2.2.3 loop manipulation using continue, pass, break, or else.</p>	Chalk-Board Demonstration Presentations, Hands-on	CO2
UNIT- III DATA STRUCTURES IN PYTHON				
3	<p>TLO 3.1 Write a Python program to use and manipulate lists for the given problem</p> <p>TLO 3.2 Write a Python program to use and manipulate Tuples for the given problem</p> <p>TLO 3.3 Write a Python program to use and manipulate Sets for the given problem</p> <p>TLO 3.4 Write a Python program to use and</p>	<p>3.1 Lists: Defining Lists, Accessing values in lists, deleting values from lists, updating lists. Basic List Operations, Built-in List Functions.</p> <p>3.2 Tuples: Accessing values in Tuples, deleting values from Tuples and updating Tuples. Basic Tuple operations, Built-in Tuple Functions.</p> <p>3.3 Sets: Accessing values in Set, deleting values from Set and updating Sets. Basic Set operations, Built-in Set Functions.</p> <p>3.4 Dictionaries: Accessing values in Dictionary, deleting values from Dictionary and updating Dictionary. Basic Dictionary</p>	Chalk-Board Demonstration Presentations, Hands-on	CO3

	manipulate Dictionaries for the given Problem	operations, Built-in Dictionary Functions.		
UNIT-IV PYTHON FUNCTIONS, MODULES				
4	<p>TLO 4.1 Write relevant user-defined functions for the given problem.</p> <p>TLO 4.2 Write a relevant user-defined module for the given problem.</p> <p>TLO 4.3 Write packages for the given problem</p>	<p>4.1 Use of Python built-in functions (e.g. type/data conversion functions, math functions etc.).</p> <p>4.2 User-defined functions: Function definition, Function call, function arguments and parameter passing, return statement, scope of variable: Global variable and Local variable.</p> <p>4.3 Modules: Writing modules, importing modules, importing objects from modules, python built-in modules, (e.g. Numeric and mathematical module, Functional programming module), Namespace and Scoping.</p>	Chalk-Board Demonstration Presentations, Hands-on	CO4
UNIT-V GRAPHICS HANDLING IN PYTHON				
5	<p>TLO 5.1 Proficient in using Python libraries such as Matplotlib and Plotly for creating static and interactive visualizations.</p> <p>TLO 5.2 Representing data visually using various types of charts, plots, and graphs, including bar charts, line plots, scatter plots, histograms, and more</p> <p>TLO 5.3 Customizing and styling visualizations to enhance readability, including adjusting colours, fonts, labels, axes, legends, and annotations.</p>	<p>5.1 Introduction to Graphics handling in Python involves various libraries and tools for creating, manipulating, and displaying graphical content.</p> <p>5,2 Matplotlib: Matplotlib is a comprehensive library for creating static, interactive, and animated visualizations in Python. It provides a MATLAB-like interface and supports a wide range of plot types, including line plots, scatter plots, bar charts, histograms, and more.</p> <p>5.3 Plotly: Plotly is a library for creating interactive plots and dashboards in Python. It supports a wide range of plot types, including scatter plots, line plots, bar charts, 3D plots, and more.</p> <p>5.4 Numpy: NumPy is a fundamental package for scientific computing with Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays efficiently.</p>	Chalk-Board Demonstration Presentations, Hands-on	CO5

IV. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/ TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment/ Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Install the given Python IDE.	Install the given Python IDE.	2	CO1
2	LLO 2.1 Write a Python program for performing basic input and output operations in a given problem.	<p>1. Write a Python program to display a welcome message on the screen.</p> <p>2. Implement the Python program to read data from the user and display data on the screen.</p> <p>Practical Tasks:</p> <p>i) Write a Python program to display a welcome message on the screen.</p> <p>ii) Write a Python program to read data from the user and then print it on the screen.</p>	2	CO1
3	LLO 3.1 Write a Python program to solve a given expression.	<p>Implement a Python program using the following operators:</p> <ol style="list-style-type: none"> 1. Arithmetic 2. Relational & Logical 3. Assignment 4. Bitwise 5. Membership 6. Identity <p>Practical Tasks ((ANY ONE))</p> <p>i) Write down a Python program which will find the average (Percentage) of marks in three subjects.</p> <p>ii) Write down a Python program which will ask two numbers to the user, store them in two variables a and b then interchange their values.</p> <p>iii) Write a Python program to find Gross salary when basic is entered. Gross Salary = Basic + HRA+DA. (Given HRA=15% of basic, DA=25% of basic)</p>	2	CO2
4	LLO 4.1 Write a Python program for solving a given problem using various If statements. Implement a Python program to demonstrate the use of the following conditional statements:	<p>Implement a Python program to demonstrate the use of the following conditional statements:</p> <ol style="list-style-type: none"> 1. if statement 2. if..else statement 3. if..elif..else statement 	2	CO2

	<ol style="list-style-type: none"> 1. if statement 2. if..else statement 3. if..elif..else statement 4. nested if statement 	<ol style="list-style-type: none"> 4. nested if statement <p>Practical Tasks: (ANY TWO)</p> <ol style="list-style-type: none"> i) Write a program to find out if any integer is input through the keyboard. whether it is an odd number or an even number. ii) Write a program to determine whether the year is a leap year or not for any year is input through the keyboard. iii) Write down a program to find the biggest of three numbers. iv) Write a program to check whether a triangle is valid or not, when the three angles of the triangle are entered through the keyboard. v) If the three sides of a triangle are entered through the keyboard, write a program to check whether the triangle is an isosceles, equilateral, scalene or right-angled triangle. vi) Percentage marks obtained by a student are input through the keyboard. The student gets a division as per the following rules: <ol style="list-style-type: none"> 1) Percentage above or equal to 60 - First division 2) Percentage between 50 and 59 - Second division 3) Percentage between 40 and 49 - Third division 4) Percentage less than 40 - Fail <p>Write a program to calculate the division obtained by the student.</p>		
5	<p>LLO 5.1 Write a Python program for solving given problems using a while loop.</p> <p>LLO 5.2 Write a Python program for solving a given problem using a for loop.</p>	<p>Implement a Python program to showcase the utilization of the following looping statements:</p> <ol style="list-style-type: none"> 1. while loop 2. for loop 3. nested loop <p>Practical Tasks: (ANY TWO)</p> <ol style="list-style-type: none"> i) Program to find the factorial value of any number entered through the 	2	CO2

		<p>keyboard.</p> <p>ii) Program to print all prime numbers from 1 to 100.</p> <p>iii) Program to print the first 25 odd numbers.</p> <p>iv) The program calculates and prints the sum of the digits of the number input through the keyboard.</p> <p>v) Program to calculate the sum of all numbers from 1 to a given number.</p> <p>vi) Program to calculate the sum of all the odd numbers within the given range.</p> <p>vii) Program to count the total number of digits in a number.</p> <p>viii) Program to print all the even numbers within the given range.</p>		
6	<p>LLO 6.1 Use loop control statements in Python to solve a given problem.</p>	<p>Implement a Python program to showcase the application of loop control statements, including continue, pass, break, and else.</p> <p>Practical Tasks: (ANY TWO)</p> <p>i) Write a program that continuously prompts the user to enter a password until the correct password is entered. If the entered password is correct, it prints a message and exits the loop. Otherwise, it displays an error message and continues prompting for the password. (Hint: use break)</p> <p>ii) Write down a program to find whether a given number is prime or not. (Hint: use break and if..else)</p> <p>iii) Write down a program which will repeatedly accept a number and display its square root till the user enters 0. (Hint: Use break and continue)</p>	2	CO2
7	<p>LLO 7.1 Write a Python program to perform operations on a list.</p>	<p>Implement a Python program to showcase different list operations including appending elements, inserting elements at specific positions, removing elements, reversing the list, sorting the list, finding the index and count of elements, and clearing the list.</p>	2	CO3

		<p>Practical Tasks:(ANY ONE)</p> <p>i) Write a program to perform the following operations on a list of names.</p> <ul style="list-style-type: none"> a) Create a list of 5 names - 'Anil', 'Amol', 'Aditya', 'Avi', 'Alka' b) Insert the name 'Anuj' before 'Aditya' c) Append the name 'Zulu' d) Delete 'Avi' from the list -e) Replace 'Anil' with 'AnilKumar' Alka' f) Sort all the names in the list g) Print reversed sorted list <p>ii) Write a program to perform the following operations on a list of numbers.</p> <ul style="list-style-type: none"> a) Create a list of 5 odd numbers b) Create a list of 5 even numbers c) Combine the two lists d) Add prime numbers 11, 17, and 29 at the beginning of the combined list e) Report how many elements are present in the list f) Replace the last 3 numbers in the list with 100, 200, 300 g) Delete all the numbers in the list h) Delete the list <p>iii) Suppose a list contains positive and negative numbers. Write a program to create two lists—one containing positive numbers and another containing negative numbers.</p>		
8	<p>LLO 8.1 Write a Python program to perform operations on a tuple.</p>	<p>Implement a Python program to illustrate various operations on a tuple, such as accessing elements, slicing, concatenating, repeating, determining length, checking element existence, finding index, counting occurrences, and converting between tuple and list.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i) Given the following tuple ('F', 'a', 'b', 'b', 'e', 'r', 'g', 'a', 'Is', 't', 'd')</p>	2	CO3

		<p>Write a Python program to carry out the following operations:</p> <p>a) Add an ! at the end of the tuple Convert a tuple to a string Extract ('b', 'b') from the tuple</p> <p>b) Find out the number of occurrences of 'e' in the tuple Check whether 'r' exists in the tuple</p> <p>c) Convert the tuple to a list Delete characters 'b', 'e', and 'r' from the tuple.</p> <p>ii) Write a Python program that simulates a grade where student names and their corresponding grades are stored in a tuple of tuples. It performs various operations like accessing elements, determining length, checking element existence, finding index, and counting occurrences.</p> <p>iii) Write a Python program to manage an inventory of books using a tuple of dictionaries. It performs operations like accessing elements, slicing, and converting between tuples and lists.</p> <p>iv) Write a Python program to manage a list of employee details using a tuple of tuples. It performs operations like repeating and concatenating.</p>		
9	<p>LLO 9.1 Write a Python program to manipulate the set.</p>	<p>Implement a Python program to demonstrate various operations on sets, such as union, intersection, difference, symmetric difference, checking subset and superset, adding and removing elements, discarding elements, and clearing the set.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i. Given the following two sets</p> <pre>engineers = {'Vijay', 'Sanjay', 'Ajay', 'Sujay', 'Dinesh'}</pre> <pre>managers = {'Aditya', 'Sanjay'}</pre> <p>Write a program to perform union, intersection and difference operations that can be carried out on any two sets.</p> <p>ii) Write a python program for product inventory management where, we have</p>	2	CO3

		two sets representing available products in two different stores. We can use set operations such as Union, Intersection, Difference, Symmetric difference and Checking if one store's products are subset/superset of the other in products to manage the inventory.		
10	LLO 10.1 Write a Python program to perform operations on the dictionary.	<p>Implement a Python program to demonstrate various operations on dictionaries, such as accessing values, adding and modifying key-value pairs, removing key-value pairs, checking for key existence, getting keys and values, and clearing the dictionary.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i) Write a Python program where users can register by providing a username and password. The program stores the user credentials in a dictionary. After the registration process, it performs the basic operations on dictionaries, including accessing values, adding and modifying key-value pairs, removing key-value pairs, checking for key existence, getting keys and values, and clearing the dictionary.</p> <p>ii) Write a Python program where the teacher can enter student grades. The program stores the student's grades in a dictionary. After the student grade process, it performs the basic operations on dictionaries operations on a nested dictionary, including accessing values and modifying key-value pairs.</p> <p>iii) Write a Python program where the store manager can enter the inventory of products. The program stores the inventory of products in a dictionary After the inventory of products process, how to iterate over a dictionary to perform various operations such as Accessing values and keys using a loop, adding a prefix to all string values, Removing key-value pairs based on a condition.</p>	2	CO3

11	<p>LLO 11.1 Write a Python program to use built-in functions on the list.</p>	<p>Implement Python program to demonstrate the use of various built-in functions on a list, including len() to get the length of the list, sum() to calculate the sum of elements, min() and max() to find the minimum and maximum elements, sorted() to sort the list, and reversed() to reverse the list.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i) Write a Python program which analyzes student grades stored in a list. It uses built-in functions like len() sum(), min(), max(), sorted(), and reversed() to perform various operations.</p> <p>ii) Write a Python program which manages an inventory of products stored in a list. It uses built-in functions like len() sum(), min() , max() , sorted() , and reversed() for inventory analysis.</p> <p>iii) Write a Python program which manages a list of employee salaries. It utilizes built-in functions like len() sum(), min(), max(), sorted(), and reversed() to analyze employee salaries.</p>	2	CO4
12	<p>LLO 12.1 Write functions to solve a given problem.</p>	<p>Write a user define function to implement the following features:</p> <ol style="list-style-type: none"> 1. Function without argument 2. Function with argument 3. Function returning value <p>Practical Tasks:(ANY ONE)</p> <p>i) Write down a program which will use a function to find the value of $y=x^2+3x+5$; when the value of x is entered through the keyboard.</p> <p>ii) Write down a program which will use a function to display values of squares of numbers between 1 to 25.</p> <p>iii) Write down a program which will accept marks in three different subjects and show the result as pass or fail. Use</p>	2	CO4

		functions to find the average and minimum		
13	LLO 13.1 Write a user-defined module to solve a given problem.	<p>Implement a Python program to create and use a user-defined module for a given problem.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i) Write a Python program to create a module that contains functions to calculate the area and perimeter of a rectangle.</p> <p>ii) Write a Python program to define a module named temperature_converter that contains functions to convert temperature between Celsius and Fahrenheit scales.</p> <p>iii) Write a Python program to define a module named basic calculator that contains functions to perform basic arithmetic operations.</p>	2	CO4
14	LLO 14.1 Developing a program that employs parametric equations to compute and visualize coordinates on a specified curve.	<p>Implement a program that employs parametric equations to compute and visualize coordinates on a specified curve.</p> <p>Practical Tasks:(ANY ONE)</p> <p>i) Develop a Python program to calculate and plot the coordinates of points on an ellipse using parametric equations and Matplotlib, based on inputs of semi-major axis (a) and semi-minor axis (b).</p> <p>ii) Develop a Python program that computes and plots the This program plots a parametric spiral using parametric equations for a spiral curve. using Matplotlib, the coordinates of points on an involute curve based on the radius of the base circle and the number of points. Adjust the radius and num_points parameters according to your requirements.</p>	2	CO5

		iii) Develop a Python program that computes and plots an Archimedean spiral using parametric equations for a spiral curve using Matplotlib, the coordinates of points on a spiral curve based on the constant determining the distance between each turn. and values of t from 0 to 10π Adjust the distance between each turn. and values of t from 0 to 10π according to your requirements.		
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V. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

SELF-LEARNING - MICRO PROJECT/ASSIGNMENT/ACTIVITIES(ANY FOUR)

1. Develop a Python program to calculate the shear force at a given distance along the simple supported beam and the bending moment at the same distance. The input parameters include the point load magnitude, beam length and the distance of the point load from the left support. Adjust these parameters according to your specific beam configuration and point load.
2. Develop a Python program that computes the frictional force acting on an object on an inclined plane. The program's function should accept parameters such as the object's mass, acceleration due to gravity, angle of the inclined plane, and coefficient of friction. It should then calculate the normal force, maximum frictional force, and weight parallel to the inclined plane. By comparing the weight with the maximum frictional force, it determines the frictional force. Finally, the program should print the calculated frictional force. Adjust the input parameters as per your specific scenario.
3. Develop an Arithmetic Calculator Python program capable of executing fundamental arithmetic operations (addition, subtraction, multiplication, division) according to user input.
4. Develop a Python program that utilizes a dictionary for storing book details, comprising titles and authors. Enable users to search for books based on either title or author.
5. Develop a Python program featuring a module specifically designed to sort a list of numbers using diverse algorithms (e.g., bubble sort, insertion sort, selection sort).
6. **Develop a Student Grade Calculator Python program:**
 - Obtain input marks for various subjects from the user and compute the total score, average score, and grade according to predefined criteria (e.g., A, B, C, D).
 - Utilize functions to segment the code for calculating the total score; average score, and grade.
 - Incorporate error handling to validate input marks and furnish suitable feedback to the user.

7. Develop a simple Contact Management System:

- Construct a user-friendly contact management system allowing users to add, delete, search, and display contacts.
- Utilize dictionaries to store contact information, including name, phone number, and email.

(Note: Faculty members can opt to choose and assign Microprojects/assignments from their specific programs instead of the aforementioned tasks.)

VI. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	a) Computer System with all necessary Peripherals and Internet connectivity. b) Any Open Office Software c) Any Browser (Any General Purpose Computer available in the Institute)	ALL

VII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

NOT APPLICABLE

VIII. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
Lab performance, Assignment, Self-learning and Seminar/Presentation	Lab. Performance, viva voce

IX. SUGGESTED COs- POs MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)	
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO1	2	3	2	3	--	--	2		
CO2	2	3	2	3	--	--	2		
CO3	2	3	2	3	--	--	2		
CO4	2	3	2	3	--	--	2		
CO5	2	3	2	3	--	--	2		

Legends:- High:03, Medium:02, Low:01, No Mapping: -

*PSOs are to be formulated at the institute level

X. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	Kenneth A. Lambert	Fundamentals of Python: First Programs 2E	Cengage Learning India Private Limited, ISBN:9789353502898
2	Yashavant Kanetkar, Aditya Kanetkar	Let Us Python - 6th Edition	BPB Publications, ISBN: 9789355515414
3	K. Nageswara Rao, Shaikh Akbar	Python Programming	Scitech Publications (India) Pvt. Ltd. ISBN:9789385983450
4	Mark Lutz	Learning Python	O'Reilly Publication, 5th Edition ISBN13:9781449355739
5	David Beazley	Python Essential Reference	Addison-Wesley Professional 4th Edition ISBN:9780672329784

XI. LEARNING WEBSITES & PORTALS

Sr.No.	Link/Portal	Description
1	https://www.w3schools.com/python	The website provides comprehensive resources for learning Python programming language. It includes tutorials, examples, and exercises covering various Python topics such as syntax, data types, control structures, functions, and modules.
2	https://www.tutorialspoint.com/index.htm	The website offers a comprehensive guide to Python programming, covering essential topics such as syntax, data types, control structures, functions, modules, and advanced concepts like object-oriented programming and exception handling.
3	https://www.python.org/	The website serves as the official resource for the Python programming language. Users can access Python documentation, tutorials, guides, and references to learn about Python's syntax, features, and libraries. Additionally, the website provides downloads for the latest Python releases, including the Python interpreter and standard library, as well as links to community forums, events, and development resources.,
4	https://realpython.com	The website is a comprehensive platform dedicated to providing high-quality tutorials, articles, and resources for Python programmers of all levels. The website covers a wide range of topics,
5	https://www.geeksforgeeks.org/python-programming-language/	Tutorials, articles, and coding challenges focused on Python programming, suitable for beginners and advanced learners.
6	https://stackoverflow.com/	Community-driven Q&A platform where you can find answers to common Python questions, seek help with programming challenges, and learn from experienced developers.

Name & Signature:


Mr.S.B.Kulkarni

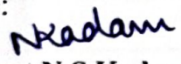
Lecturer in Mechanical Engineering


Mr. A.M. Joshi

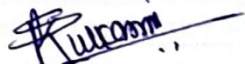
Lecturer in Mechanical Engineering

(Course Experts)

Name & Signature:


Smt.N.S.Kadam
 (Programme Head)

Name & Signature:


Shri. S.B. Kulkarni
 (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

‘120 – NEP’ SCHEME

PROGRAMME	DIPLOMA IN MT
PROGRAMME CODE	05
COURSE TITLE	MATERIAL TESTING & QUALITY ASSURANCE
COURSE CODE	MT31202
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARATION COURSE	YES

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
			Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TSL				Based on SL						
			CL	TL	LL			FA-TH			SA-TH	Total	Practical		SLA						
													FA-PR	SA-PR	Max	Min	Max	Min			
MT31202	MATERIAL TESTING & QUALITY ASSURANCE	SEC	04	--	04	--	08	4	3	30	70	100	40	25	10	25#	10	--	--	150	

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, **IKS** – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, #- External Assessment,*# - Online Examination,@\$ - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

- If a candidate is not securing minimum passing marks in **FA-PR** (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course.
- If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
- Notional learning hours** for the semester are **(CL + LL + TL + SL) hrs. * 15 Weeks**
- 1 credit** is equivalent to **30 Notional hours**.
- * Self-learning hours shall not be reflected in the Timetable.
- * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Engineers use different materials for various engineering purposes. These materials and solid objects are subjected to various kinds of forces and stresses during service and often involve the risk of breaking in service and in that situation, they cannot be welded or molded instantly. It may take a long to further rework the same to give them shape or they may not be re-shaped at all. Hence, it is necessary to make the material and objects strong enough. To ensure this, these solid objects require various types of destructive and non-destructive testing during the manufacturing process so that the risk factor is reduced, facilitating durability and long-lasting capacity (or endurance).

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

- CO1 – Perform tensile and compression test on materials.
- CO2 – Perform fatigue and creep test on materials.
- CO3 – Perform impact test on different materials.
- CO4 – Conduct different types of hardness tests on materials.

CO5 – Explain principle of various NDT methods.

CO6 – Explain various components of quality standards.

IV.THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I MECHANICAL PROPERTIES OF METALS (CL Hrs-08 Marks-12)				
1	<p>TLO 1.1 Compare the salient features</p> <p>TLO 1.2 Understand various loading conditions</p> <p>TLO 1.3 Compare elastic & plastic deformation</p> <p>TLO 1.4 Explain terms e.g. stress-strain, yield point etc.</p> <p>TLO 1.5 Explain Hooks law or modulus of elasticity</p> <p>TLO 1.6 Explain or compare the shear & torsion test</p> <p>TLO 1.7 Explain fracture mechanism & its type</p> <p>TLO 1.8 Explain the procedure for conducting a tensile test</p>	<p>1.1 A brief introduction to bonding arrangement in materials and especially in metals and alloys i.e. metallic bond</p> <p>1.2 Deformation of metals under various loading conditions i.e. tensile, compressive and shear.</p> <p>1.3 Elastic and plastic deformation, various terms used i.e. stress, strain, elasticity, plasticity, toughness, resilience. Stress-Strain curves, Yield point and yielding phenomenon, percentage elongation and reduction in area, proof stress. Hook's law, Modulus of elasticity, Young's modulus</p> <p>1.4 Shear and torsion tests.</p> <p>1.5 Fracture and its mechanism. Fracture of ductile and brittle materials. Operations with tensile testing machines, universal testing machines etc. for tensile, compressive, shear or bending strength.</p>	<p>Improved Lecture Tutorial Assignment Demonstration</p>	CO1
UNIT-II FATIGUE TEST (CL Hrs-08, Marks-08)				
2	<p>TLO2.1: Explain fatigue</p> <p>TLO 2.2:. Define repeated loading and state its types.</p> <p>TLO2.3: Explain fatigue strength and endurance limit.</p> <p>TLO2.4:. Explain the fatigue testing procedure.</p> <p>TLO 2.5:. Explain factors to improve fatigue properties.</p> <p>TLO2.6: Explain the effect of composition /surface condition/stress concentration /size on the strength of fatigue.</p>	<p>2.1 Concept of fatigue. Repeated loadings, and their types.</p> <p>2.2 Fatigue test, fatigue strength, and endurance limit. Orowan's and Wood's theories explain fatigue failure. Effect of composition, stress concentration, size and surface conditions on fatigue strength.</p> <p>2.3. Measures to be taken to improve fatigue life</p>	<p>Improved Lecture Tutorial Assignment Demonstration</p>	CO2

UNIT III CREEP TEST (CL Hrs-08 Marks-08)			
3	<p>TLO3.1: Explain the creep concept</p> <p>TLO 3.2: Explain the procedure for to creep test.</p> <p>TLO 3.3: Explain stages in the creep curve.</p> <p>TLO 3.4: Describe factors that affect on creep.</p> <p>TLO 3.5 Explain the relationship between creep rate, stress and temperature.</p>	<p>3.1 Concept of creep. Creep Test. Standard creep curve with the explanation of various stages. Effect of temperature on creep test, equi-cohesive temperature</p> <p>3.2 Factors affecting creep such as composition, grain size, method of steel making and heat treatment</p> <p>3.3 Relation between creep rate, stress and temperature</p>	<p>Improved Lecture Tutorial Assignment Demonstration</p> <p>CO2</p>
UNIT-IV IMPACT TESTS (CL Hrs-06, Marks-07)			
4	<p>TLO 4.1. Explain the significance of the impact test.</p> <p>TLO 4.2 Give an example of a dynamic test.</p> <p>.TLO 4.3 Explain/Compare Charpy and Izod in terms of principle, procedure and parameter</p> <p>TLO 4.4 Explain the factor effect on impact strength.</p>	<p>4.1 Significance of impact test.</p> <p>4.2 Izod and Charpy impact tests. Their specimen details, and mounting of specimens in each case. Effect of variables on the impact test values such as variation in striking velocity, size and shape of specimen, temperature, grain size and composition.</p> <p>4.3 Embrittlement phenomena: temper and hydrogen embrittlement.</p> <p>4.4 Impact strength- Temperature relationship and transition temperature range.</p>	<p>Improved Lecture Tutorial Assignment Demonstration</p> <p>CO3</p>
SECTION II			
UNIT- V HARDNESS TEST (CL Hrs-14, Marks-18)			
5	<p>TLO 5.1: Explain and compare the method of hardness test</p> <p>TLO 5.2: Enlist and Explain various indentations.</p> <p>TLO 5.3: Explain the working and advantages of Brinell, Vicker, Rockwell and Knoop</p> <p>TLO 5.4: Draw and explain the Poldi hardness test.</p> <p>TLO 5.5: State principle of Micro hardness tester.</p> <p>TLO 5.6: Explain the principle of the universal hardness test.</p>	<p>5.1 Concept of hardness. Methods of hardness test, such as indentation, scratch and rebound.</p> <p>5.2 Types of indentation hardness tests, such as Brinell, Vicker, Rockwell and Knoop, their indenters and measurements of hardness number.</p> <p>5.3 Rebound hardness test. Shore Scleroscope. Dynamic hardness tester. Poldi Hardness Tester.</p> <p>5.4 Scratch hardness test: Moh's scale of hardness, File test, Brief introduction to hardness machines and their operations.</p> <p>5.5 Principle of Microhardness Tester</p> <p>5.6 Introduction to universal hardness tester, working, advantages & uses.</p>	<p>Improved Lecture Tutorial Assignment Demonstration Simulation</p> <p>CO4</p>

UNIT –VI NON DESTRUCTIVE TESTING (CL Hrs-10, Marks-10)				
6	TLO 6.1: State the needs and requirements of NDT. TLO 6.2: Classify NDT. TLO 6.3: Enlist the advantages of NDT and state its type TLO 6.4: Compare NDT & DT. TLO 6.5: Explain the testing procedure of penetrant test/Magnetic method etc.	6.1 Need for non-destructive tests. Concept of nondestructive tests. 6.2 Comparison between destructive and non-destructive tests. 6.3. Introduction to various non-destructive tests such as Visual examination, Leakage testing, Penetrant test, Magnetic methods, Acoustic methods, Ultrasonic test, Radiography, Thermal tests, Electrical methods- Eddy current method.	Improved Lecture Tutorial Assignment Demonstration	CO5
UNIT –VII QUALITY ASPECT CL Hrs-06, Marks-07)				
7	TLO 7.1: Explain quality and state its importance. TLO 7.2: Enlist various quality standards. TLO 7.3: Explain ISO 9000 Series standards.	7.1 Concept of quality. Brief introduction to various quality standards, such as ISI, BIS and ISO. A brief introduction to ISO 9000 series standards. 7.2 Standard method/procedure for mechanical testing. 7.3 Validation method /procedure for mechanical testing.	Improved Lecture Tutorial Assignment Demonstration	CO6

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1: (a) Calculate Tensile strength, and compressive strength using UTM. (b) Calculate % elongation & reduction in area. (c) identify types of fracture.	To carry out tensile tests on mild steel and aluminium.	08	CO1
2	LLO 2.1: Study behaviour of stress-strain curve of ductile & brittle materials.	To draw a stress-strain curve. To interpret the curve concerning the applicability of materials.	08	CO1
3	LLO 3.1: Familiar with ASTM standards & procedures to conduct the tensile test.	To acquaint with various tensile test machines.	08	CO1
4	LLO 4.1: Perform fatigue test using fatigue testing machine.	To carry out fatigue tests on mild steel and aluminium specimens	08	CO2
5	LLO 5.1: Perform Creep test using fatigue testing machine.	To study creep test. Interpretation of test results.	08	CO2
6	LLO 6.1 Perform charpy or izod impact test on the given specimen.	To carry out impact tests on brass, aluminium and copper specimens.	08	CO3
7	LLO 7.1: perform hardness test using the standard procedure on different hardness machines.	To carry out hardness tests on samples using Vicker, Brinell, Rockwell and Poldi Hardness Testers.	08	CO4

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
8	LLO 8.1: Perform dye penetrant test on a common component.	To carry out dye penetrant test and magnetic particle test.	04	CO5

VI.SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Micro project

- Mechanical properties of metal: Collect data on the mechanical properties of different metals & alloys. Make a pdf file.
- **Hardness Test:** Collect data about standards, indenter, working procedure & calibration of hardness test.
- **Impact Test:** Prepare a Charpy test below zero temperature set-up.
- **Fatigue Test:** Collect data on component/job under constant cyclic load & plot a graph to measure endurance limit.
- **Creep Test:** Prepare a standard procedure & plot a graph to measure the creep of components.
- **Non-Destructive Test:** Collect all information about anyone NDT.
- **Quality assurance** Study the effect of quality policy on quality of work with one suitable example.

Assignment

- Collect examples based on various properties of metals & alloys and prepare a PDF file.
- Collect examples of various hardness testing methods and prepare a PDF file.
- Represent the Graph of the stress-strain curve of ductile metals and interpret the nature of the graph. Make a PDF file.
- Measure the impact strength of different alloys using the Charpy method. Make a PDF file.
- Study fatigue failure and factors to control fatigue failure.
- Study fatigue Creep and factors to control Creep failure.
- Collect at least 10 examples based investigation of the component using NDT.
- Collect at least 10 examples based on Quality policy.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	UTM 40 T, V.C., Gauge length marker	LLO 1.1 to LLO 3.1
2	Fatigue testing machines-Rotating beam	LLO 4.1
3	Creep Testing setup	LLO 5.1
4	Impact Tester – Charpy or Izod	LLO 6.1
5	Vicker, Brinell, Rockwell and Poldi Hardness Testers.	LLO 7.1
6	DPT Setup and MPT Setup,	LLO 8.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
SECTION I								
1	I	MECHANICAL PROPERTIES OF METALS	CO1	08	04	04	04	12
2	II	FATIGUE TEST	CO2	08	04	02	02	08
3	III	CREEP TEST	CO2	08	04	02	02	08
3	III	IMPACT TESTS	CO3	06	03	02	02	07
Grand Total				30	15	10	10	35
SECTION II								
4	IV	HARDNESS TEST	CO4	14	06	06	06	18
6	V	NON DESTRUCTIVE TESTING	CO5	10	04	03	03	10
7	VI	QUALITY ASPECT	CO6	06	02	02	03	07
Grand Total				30	12	11	12	35

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Tests 2. Rubrics for COs 3. Assignment 4. Midterm Exam 5. Self-Learning 6. Term Work 7. Seminar/Presentation	1. End Term Exam 2. Micro-project 3. Tutorial Performance

X. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	2	2	1	2	1	-	1	2	2	1	1
CO2	3	2	3	3	1	2	2	2	3	2	1
CO3	2	2	1	2	1	2	2	2	3	1	1
CO4	2	2	2	2	1	-	2	1	3	2	1
CO5	2	2	2	2	1	1	2	2	2	1	2
CO6	2	1	1	1	1	1	1	1	1	1	1

Legends:- High:03, Medium:02, Low:01, NoMapping: -

*PSOs are to be formulated at the institute level

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	George E. Dieter	Mechanical Metallurgy	McGraw-Hill Book Company
2	Davis, Troxell and Wiskonell	Testing and Inspection of Engineering materials	McGraw-Hill Book Company
3	A.V.K. Suryanarayan	Testing of Metallic Materials	Prentice-Hall of India Pvt Ltd
4	Dr. V.D.Kodgire	Material Science And Metallurgy	Everest Publishing House

XII. LEARNING WEBSITES & PORTALS

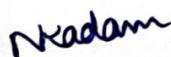
Sr.No	Link/Portal	Description
1.	https://www.youtube.com/watch?v=Ugfr_ULp2HM	Mechanical behaviour of metal: stress-strain curve, Elastic, plastic limit, yield strength, proof stress etc
2.	https://www.youtube.com/watch?v=pLt-MaxKW0o	Working on fatigue testing machine
3.	https://www.youtube.com/watch?v=FztoEU87B90	Explanation of creep test.
4.	https://www.youtube.com/watch?v=tpGhqQvftAo	The procedure of the Charpy impact test.
5.	https://www.youtube.com/watch?v=i1x-vJ85sBA	Rockwell hardness test
6.	https://www.youtube.com/watch?v=7Z90OZ7C2jI	Vickers hardness test
7.	https://www.youtube.com/watch?v=RJXJpeH78iU	Brinell Hardness test
8.	https://www.youtube.com/watch?v=QqmSzUxnrXo	Dye penetrant test

Name & Signature:



Mr. Pravin B. Kamble
(Course Experts)

Name & Signature:



Smt. Namita S Kadam
(Programme Head)

Name & Signature:



Shri. Sudin B Kulkarni
(CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN MT
PROGRAMME CODE	05
COURSE TITLE	STEEL MAKING
COURSE CODE	MT31205
PREREQUISITE COURSE CODE & TITLE	NA
CLASS ECLARATION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Credits	Paper Duration Hrs.	Assessment Scheme										Total Marks
			Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TSL				Based on SL						
			CL	TL	LL			FA-TH			SA-TH	Total	Practical		SLA						
													FA-PR	SA-PR	Max	Min	Max	Min			
MT31205	STEEL MAKING	DSC	4	--	2	--	6	3	3	30	70	100	40	25	10	25@	10	--	-	150	

Total IKS Hrs for Term: 2 Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, # - External Assessment, *# - Online Examination, @\$ - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

- If a candidate is not securing minimum passing marks in FA-PR (Formative Assessment - Practical) of any course, then the candidate shall be declared as 'Detained' in that course.
- If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as 'fail' and will have to repeat and resubmit SLA work.
- Notional learning hours** for the semester are (CL + LL + TL + SL) hrs. * 15 Weeks
- 1 credit** is equivalent to **30 Notional hours**.
- * Self-learning hours shall not be reflected in the Timetable.
- * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Steel is one of the most important materials. Applications of steel are much more. The use of steel is much more for construction as well as manufacturing industries. Because of this, knowledge of various methods of steelmaking is very much essential for metallurgists. In this course, the emphasis is given to the principles of steelmaking and different processes of steelmaking.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1. Understand the necessity of conversion of pig iron into steel.

CO2. Understand the principles of steel making to obtain quality steel.

CO3. Select proper raw materials for steel production.

CO4. Recommend suitable methods of production for different types of steel.

CO5. Understand the importance of oxygen addition in steel production and the role of secondary steel making.

CO6. Identify various components of various continuous casting machines

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I INTRODUCTION CL (Hrs- 06, Marks- 08)				
1	<p>TLO 1 Write down the history of steel making.</p> <p>TLO 2. Give classification of steels.</p> <p>TLO 3 States the necessity of conversion of pig iron into steel.</p> <p>TLO 4 . Enumerate various raw materials for steel making.</p> <p>TLO 45State status of different iron and steel industries in India.</p>	<p>1.1 History of steel making.</p> <p>1.2 Classification of steels.</p> <p>1.3 Necessity of conversion of pig iron into steel.</p> <p>1.4 Raw materials for steel making:</p> <p>a. Sources of metallic iron,</p> <p>b. Oxidizing agent,</p> <p>c. Fluxes,</p> <p>d. Sources of heat,</p> <p>e. Deoxidisers and alloying additions,</p> <p>f. Furnace Refractories.</p> <p>1.5 Present status of iron and steel industries in India.</p>	Lecture Assignment	CO1
UNIT-II PRINCIPLES OF STEEL MAKING (CL Hrs- 06, Marks- 08)				
2	<p>TLO 2.1 TLO 2 Use concepts given in Ancient Indian Metallurgy for metal extraction.</p> <p>TLO 2.2 Explain the classification of fuels.</p> <p>TLO 2.3 Explain factors for the selection of fuels.</p> <p>TLO 2.4 Explain the properties of fuels.</p> <p>TLO 2.5 Distinguish between solid, liquid and gaseous fuels.</p>	<p>2.1 Principles of steel making:</p> <p>a. Carbon reaction,</p> <p>b. Phosphorous reaction,</p> <p>c. Silicon reaction,</p> <p>d. Manganese reactions,</p> <p>e. Sulphur reaction,</p> <p>f. De-oxidation of steel.</p> <p>2.2 Types of steel-making processes- Acid and basic steel making.</p> <p>2.3 Efficiency of steel-making processes</p>	Lecture Assignment	CO2
UNIT-III STEEL MAKING PROCESS (CL Hrs- 18, Marks- 20)				
3	<p>TLO 3.1 Describe the Bessemer process and open hearth process.</p> <p>TLO 3.2. Describe the operation of an electric arc and induction furnace.</p> <p>TLO 3.3. Draw a neat sketch of the Bessemer, open hearth, electric arc and induction furnace.</p> <p>TLO 3.4. Describe constructional details of the Bessemer, open hearth and electric arc furnace.</p> <p>TLO 3.5. Compare characteristics of steel produced by the Bessemer process with the open hearth process.</p>	<p>3.1 Bessemer process - Principle, constructional details, process details, merits and demerits, characteristics of steel produced.</p> <p>3.2 Open-hearth process - Principle, constructional details, process details, merits and demerits, characteristics of steel produced, twin hearth furnace.</p> <p>3.3 Electric steel-making processes:</p> <p>a. Electric arc furnace: Principle, constructional details, charge materials, process detail, outline, merits and demerits, characteristics of steel produced.</p> <p>b. Induction furnace: Principles, charge materials, merits and demerits of process, characteristics of steel produced.</p>	Lecture Assignment Videos	CO3

UNIT-IV OXYGEN STEELMAKING PROCESSES (CL Hrs- 10, Marks- 12)			
4	<p>TLO 4.1. State the principle of steel making in the L.D. converter, Kaldo process, Rotor process and OBM process.</p> <p>TLO 4.2. Describe the constructional details of the L.D. converter.</p> <p>TLO 4.3. Describe the operation of L.D. converter, Kaldo process, Rotor process and OBM process.</p> <p>TLO 4.4. Draw the sketches of L.D. converter, Kaldo process, Rotor process and OBM process.</p> <p>TLO 4.5. State merits, demerits and characteristics of steel produced by L.D. converter, Kaldo process, Rotor process and OBM process.</p> <p>TLO 4.6. Draw plant layout of primary steel-making</p>	<p>4.1 L.D. Converter - Principle, constructional details, process details, outline, merits and demerits, characteristics of steel produced.</p> <p>4.2 Kaldo process - Principle, process, merits and demerits, characteristics of steel produced.</p> <p>4.3 Rotor Process - Principle, process, merits and demerits, characteristics of steel produced.</p> <p>4.4 OBM Process - Principle, process, merits and demerits, characteristics of steel produced.</p> <p>4.5 Plant layout of primary steel-making.</p>	<p>Lecture Assignment videos</p> <p>CO4</p>
UNIT-V SECONDARY STEEL MAKING (CL Hrs- 12, Marks- 14)			
5	<p>TLO 5.1. State the merits of secondary steel making.</p> <p>TLO 5.2. Describe various decarburizing techniques.</p> <p>TLO 5.3. Describe VAR and ESR.</p> <p>TLO 5.4. Draw a ladle furnace and explain its working.</p> <p>TLO 5.5 Explain the various degassing techniques with a neat sketch.</p> <p>TLO 5.6 Draw plant layout of secondary steel making.</p>	<p>5.1 Introduction and merits of the secondary steel-making process.</p> <p>5.2 Decarburization techniques - AOD, VOD, CLU.</p> <p>5.3 VAR and ESR processes.</p> <p>5.4 Ladle furnace.</p> <p>5.5 Vacuum Treatment of Steel – Functions, principles, Degassing techniques: a. Ladle degassing b. Stream degassing c. Recirculation degassing –R.H. and D-H degassing processes.</p> <p>5.6 Plant layout of secondary steel making.</p>	<p>Lecture Assignment</p> <p>CO5</p>
UNIT-VI CONTINUOUS CASTING OF STEEL (CL Hrs- 08, Marks- 08)			
6	<p>TLO 6.1. State principle of continuous casting.</p> <p>TLO 6.2. Describe the essential details of a continuous casting machine.</p> <p>TLO 6.3. Compare different continuous casting machines. 6d. State the merits and demerits of continuous casting.</p>	<p>6.1 State principle of continuous casting.</p> <p>6.2 Describe the essential details of a continuous casting machine.</p> <p>6.3 Compare different continuous casting machines.</p> <p>6.4 State the merits and demerits of continuous casting.</p>	<p>Lecture Assignment videos</p> <p>CO6</p>

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Explain the classification of steel.	Study of classification of steel	2	CO1
2	LLO 2.1 Explain the construction and working of the Bessemer converter.	Study of construction and working of Bessemer converter.	2	CO1
3	LLO 3.1 Explain the construction and working of an open-heart furnace.	Study of construction and working of open-heart furnace.	4	CO2
4	LLO 4.1 Explain the construction and working of an Electric Arc furnace.	Study of construction and working of Electric Arc furnace.	2	CO3
5	LLO 5.1 Explain the construction and working of the Induction furnace	Study of construction and working of Induction furnace	2	CO3
6	LLO 6.1 Explain the construction and working of the LD Converter.	Study of construction and working of LD Converter.	2	CO3
7	LLO 7.1 Explain the working principle of the Kaldo and Rotor process.	Study of working principle of Kaldo and Rotor process.	2	CO4
8	LLO 8.1 Explain Decarburization techniques - AOD, VOD, CLU.	Study of Decarburization techniques - AOD, VOD, CLU.	2	CO4
9	LLO 9.1 Explain various types of continuous casting machines	Study various types of continuous casting machines	4	CO6
10	LLO 10.1 Explain the Plant layout of primary steel making.	Draw Plant layout of primary steel making.	4	CO5
11	LLO 11.1 Explain Plant layout of secondary steel making	Draw Plant layout of secondary steel making.	4	CO5

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

- Prepare a tabulated summary for various steel making process
- Collect the information on the present scenario of steel industries in India.
- Prepare the poster of the layout of the modern steel plant.
- Gather the data of modern techniques of steel making.
- Prepare the sheets of various steel-making furnaces.
- Prepare the poster of the continuous casting machine.
- Prepare the report on Ancient Steel making.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of Bessemer converter.	LLO 2.1
2	Model of Open - hearth furnace.	LLO 3.1
3	Model of Electric Arc furnace.	LLO 4.1
4	Model of Induction furnace	LLO 5.1
5	Drawing board Chart of primary steel making.	LLO 9.1
6	Drawing board Chart secondary steel making	LLO 10.1
7	Drawing board Chart Continuous casting machines	LLO 11.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE**(Specification Table)**

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	INTRODUCTION	CO1	06	2	6	--	08
2	II	PRINCIPLES OF STEEL MAKING	CO2	06	2	4	2	08
3	III	STEEL MAKING PROCESSES	CO3	18	4	8	8	20
4	IV	OXYGEN STEEL MAKING	CO4	10	2	6	4	12
5	V	SECONDARY STEEL MAKING	CO5	12	2	8	4	14
6	VI	CONTINUOUS CASTING OF STEEL	CO6	08	2	4	2	08
Grand Total				60	14	36	20	70

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks)	1. End Term Exam: SA-TH (70 marks)
2. Term Work: FA-PR (25 marks)	2. End Term Exam: SA-PR (25 marks)
3. Self-Learning: SLA (25 marks)	

X. SUGGESTED COs- POs MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	1	1	1	2	1	2	3	--	--	2
CO2	3	1	2	1	1	1	1	3	--	--	2
CO3	3	2	2	1	1	2	2	3	--	--	3
CO4	3	1	2	2	2	2	2	3	--	--	3
CO5	2	2	2	1	1	1	2	3	--	--	2
CO6	3	1	2	1	1	1	2	3	--	--	2

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: --

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr. No	Author	Title	Publisher
1	Dr. R.H. Tupkary, V.R. Tupkary	An Introduction to Modern Iron Making	Khanna Publication, 4th Edition, 2016. 978-81-7409-021-5
2	Dr. R.H. Tupkary, V.R. Tupkary	An Introduction to Modern Steel Making	Khanna Publication, 7th Edition, 2017. 978-81-7409-026-6
3	Boris Kuznetsov	General Metallurgy	Mir Publishers, Moscow, 2nd Edition, 1979. 5-03-000026-7

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://nptel.ac.in/courses/113/104/113104013/	Steel-making
2	https://nptel.ac.in/courses/113/107/113107096/	Modelling of Tundish Steel-making
3	https://www.steel.org/steel-technology/steel-production	Steel production.

Name & Signature: <i>Sarika</i> (Mrs. Sarika Satish Aglave Lecturer in Metallurgical Engineering (Course Expert)	
Name & Signature: <i>Nkadam</i> Mrs. Namita S. Kadam (Programme Head)	Name & Signature: <i>Sudhakar</i> Mr. Sudin B Kulkarni (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN MT
PROGRAMME CODE	05
COURSE TITLE	EXTRACTION OF NON-FERROUS METALS
COURSE CODE	MT31206
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARARION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Credits	Paper Duration	Assessment Scheme										Total Marks
			Actual Contact Hrs./Week			SLH	NLH	Theory			Based on LL & TSL				Based on SL						
			CL	TL	LL			FA-TH			SA-TH	Total		Practical		SLA					
												Max	Min	Max	Min	Max	Min	Max	Min		
MT31206	EXTRACTION OF NON-FERROUS METALS	DSC	3	--	2	1	6	3	3	30	70	100	40	25	10	25@	10	25	10	175	

Total IKS Hrs for Term: Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, #- External Assessment, *# - Online Examination, @\$ - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in FA-PR (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are (CL + LL + TL + SL) hrs. * 15 Weeks
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.
- 6.* Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

This course provides information about mineral dressing, extraction of non-ferrous metals, and refining thereafter for various metals, which will be useful for effective management in industry. The basic principles and methods involved in the extraction and refining of non-ferrous metals can be employed by students for engineering and commercial applications.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

- CO1 –Draw a flow sheet for the extraction processes of different non-ferrous metals.
- CO2 - Identify and select the basic ore dressing processes and equipment based on the type of non-ferrous metal to be extracted.
- CO3 –Explain the steps involved in the extraction of copper.
- CO4 - Illustrate the process of extraction of titanium and lithium.
- CO5 - Explain the steps followed in the extraction of zinc and aluminium.
- CO6 - Illustrate the process of extraction of gold - silver and the steps in metal recycling.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I BASICS OF ORE / MINERAL DRESSING (CL Hrs 08, Marks- 10)				
1	<p>TLO 1.1 Define ore, gangue and concentrate.</p> <p>TLO 1.2 Define Pyrometallurgy, Hydrometallurgy and Electrometallurgy.</p> <p>TLO 1.3 Write down the general sequence in the extraction of metals from their ores.</p> <p>TLO 1.4 Explain various comminution processes with a sketch.</p> <p>TLO 1.5 Describe various ore dressing processes.</p>	<p>1.1 Definitions: Ore, gangue, concentrate etc.</p> <p>1.2 Introduction to Pyrometallurgy, Hydrometallurgy and Electrometallurgy.</p> <p>1.3 The general sequence of operations involved in the extraction of metals from their ores.</p> <p>1.4 Comminution: Crushing and Grinding with jaw crusher, cone crusher, gyratory crusher, roll crusher, rod mill, ball mill etc.</p> <p>1.5 Classification, jigging, tabling, floatation, magnetic separation, electrostatic separation.</p>	<p>Lectures, Assignments, Digital media, images, technical content videos.</p>	CO2
UNIT-II EXTRACTION OF COPPER (CL Hrs 08, Marks- 12)				
2	<p>TLO 2.1 List uses of copper.</p> <p>TLO 2.2 State types of sources of copper.</p> <p>TLO 2.3 State properties of copper.</p> <p>TLO 2.4 Draw flow sheet for pyrometallurgical extraction of copper.</p> <p>TLO 2.5 Describe the Hydrometallurgical extraction of copper.</p> <p>TLO 2.6 Select the proper refining process of copper extraction.</p> <p>TLO 2.7 Describe ferric chloride leaching of copper.</p> <p>TLO 2.8 State the merits and demerits of the Hydrometallurgical extraction of copper.</p> <p>TLO 2.9 State applications of OFHC copper.</p>	<p>2.1 Properties and uses of copper.</p> <p>2.2 Ores/minerals of copper-oxides, sulphide and native copper. Ore dressing processes to obtain concentration, particularly from sulphide ores, the current status of copper production in India.</p> <p>2.3 Production of copper by pyrometallurgy–production flow sheet (by conventional and newer route), stages of pyrometallurgy.</p> <p>2.4 Flash smelting of copper.</p> <p>2.5 Refining of Copper - fire and electrolytic refining.</p> <p>2.6 Hydrometallurgy of copper-ferric chloride leaching of copper ore, advantages and disadvantages.</p> <p>2.7 OFHC copper and its applications.</p>	<p>Lectures, Assignments, Digital media, images, technical content videos.</p>	CO1,CO3

UNIT- III EXTRACTION OF TITANIUM AND LITHIUM (CL Hrs 08, Marks- 10)			
3	<p>TLO 3.1 State properties and uses of titanium.</p> <p>TLO 3.2 Select sources of Titanium.</p> <p>TLO 3.3 Describe the Kroll process for the extraction of Titanium.</p> <p>TLO 3.4 Describe the refining of Titanium by the Van Arkel process.</p> <p>TLO 3.5 State properties and uses of lithium.</p> <p>TLO 3.6 Draw flow sheet for the extraction of Titanium.</p> <p>TLO 3.7 Describe the electrolysis of lithium chloride for extraction of lithium.</p>	<p>3.1 Properties and Uses of Titanium.</p> <p>3.2 Ores/minerals of Titanium and preparation of ore.</p> <p>3.3 Extraction of Titanium: Flowsheet – Kroll’s process, Magnesium reduction, refining by Van Arkel’s process.</p> <p>3.4 Properties and uses of Lithium.</p> <p>3.5 Extraction of Lithium - Minerals of lithium, preparation of lithium chloride, electrolysis of lithium chloride.</p>	<p>Lectures, Assignments, Digital media, images, technical content videos.</p> <p>CO1,CO4</p>
UNIT-IV EXTRACTION OF ZINC (CL Hrs 06, Marks-10)			
4	<p>TLO 4.1 State properties and uses of zinc.</p> <p>TLO 4.2 List various sources of zinc.</p> <p>TLO 4.3 Describe pyrometallurgical extraction of Zinc.</p> <p>TLO 4.4 State current status of zinc production in India.</p> <p>TLO 4.5 Draw flow sheet for extraction of zinc.</p>	<p>4.1 Properties and uses of Zinc.</p> <p>4.2 Ores/minerals of Zinc.</p> <p>4.3 Roasting of zinc concentrates. Suspension roasting and Fluidized-bed roasting processes, the current status of zinc production in India.</p> <p>4.4 Pyrometallurgical extraction of zinc with flow sheet Extraction of metallic zinc by distillation in horizontal and vertical retort.</p> <p>4.5 Hydrometallurgical processes for zinc Extraction, Flow sheets of various processes.</p> <p>4.6 Refining of Zn by liquation and redistillation.</p>	<p>Lectures, Assignments, Digital media, images, technical content videos.</p> <p>CO1,CO5</p>
UNIT- V EXTRACTION OF ALUMINIUM (CL Hrs 08, Marks- 12)			
5	<p>TLO 5.1 State properties and uses of aluminium.</p> <p>TLO 5.2 Select sources of aluminium</p> <p>TLO 5.3 Describe Bayer's process for the extraction of aluminium</p> <p>TLO 5.4 Describe Hall Heroult's process of Al extraction.</p> <p>TLO 5.5 Explain the refining process to obtain pure aluminium.</p> <p>TLO 5.6 Describe the manufacturing of carbon electrodes in the extraction of aluminium.</p> <p>TLO 5.7 Describe the anode effect in the electrolyte.</p> <p>TLO 5.8 Explain the method of refining aluminium.</p>	<p>5.1 Ores/minerals used in the extraction of aluminium, properties and applications of aluminium and its alloys.</p> <p>5.2 Bayer's process- flow sheet, stages involved, factors affecting Bayer’s process, reduction of Alumina.</p> <p>5.3 Preparation of Cryolite- flow sheet and description with reactions involved.</p> <p>5.4 Production of metallic aluminium by electrolysis (Hall Heroult Process), construction and working of aluminium reduction cells, the composition of bath and its properties, the anode effect,</p> <p>5.5 Refining of aluminium by chlorination and electrolytic processes.</p>	<p>Lectures, Assignments, Digital media, images, technical content videos.</p> <p>CO1,CO5</p>

UNIT- VI EXTRACTION OF GOLD AND SILVER (CL Hrs 04, Marks- 08)

TLO 6.1 State sources of gold.	6.1 Sources of gold.	Lectures, Assignments, Digital media, images, technical content videos.	CO6
TLO 6.2 Describe methods of gold recovery.	6.2 Methods of gold recovery: Gravity concentration, Amalgamation, Cyanidation and gold precipitation from cyanide solutions. Typical flow sheets.		
TLO 6.3 Describe the production of silver.	6.3 A brief introduction to the production of silver.		
TLO 6.4 Explain the refining of gold and silver bullion.	6.4 Refining of gold and silver bullion.		

UNIT- VII RECYCLING OF METALS (CL Hrs 03, Marks- 08)

TLO 7.1 State the importance of metal recycling.	7.1 Need for the recycling of metals, sources of metals for recycling.	Lectures, Assignments, Digital media, images, technical content videos.	CO6
TLO 7.2 Write down different sources of aluminium scrap, copper scrap, steel scrap.	7.2 Commonly recycled metals (Steels, Aluminium and its alloys, Copper and its alloys).		
TLO 7.3 Draw flow chart for steps in the metal recycling process.	7.3 Steps followed in recycling of metals, Equipments / machinaries used in metal recycling.		

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Draw the schematic of jaw crusher design and cone crusher design and describe its operation.	Study the design and operation of Jaw crusher and Cone crusher.	4	CO 2
2	LLO 2.1 Draw the schematic of gyratory crusher design and roll crusher design and describe its operation.	Study the design and operation of Gyratory crusher and roll crusher.	4	CO 2
3	LLO 3.1 Draw the schematic of ball mill design and rod mill design and describe its operation.	Study the design and operation of the Ball mill and Rod Mill.	4	CO 2
4	LLO 4.1 Draw the schematic of flash smelter and explain its working in copper extraction.	Study construction and the operation of Flash smelter used in copper extraction.	4	CO 1,3
5	LLO 5.1 Explain construction and operation of Kroll process reactor with suitable sketch.	Study construction and the operation of the Kroll process reactor for titanium production.	4	CO 1,4
6	LLO 6.1 Describe the design and working principle of vertical retort used in the extraction of zinc.	Study design and working principle of the vertical retort for zinc extraction.	2	CO 1,5

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
7	LLO 7.1 Draw the schematic of construction of electrolytic cell used in aluminium extraction; explain its operation.	Study construction and operation of electrolytic cells used in aluminium extraction (Hall Heroult Process); note down the process variables.	4	CO 1,5
8	LLO 8.1 Describe the cyanidation process used in the extraction of gold.	Study the cyanidation process (with reactions) used for gold extraction.	2	CO 6
9	LLO 9.1 Describe the steps involved in the metal recycling process.	Study the process of recycling of metals.	2	CO 6

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF-LEARNING)

Micro project

1. To draw a flow chart of the pyrometallurgical operations in the extraction of copper.
2. To prepare a static model of Multiple hearth roaster.
3. To prepare a static model of the Jaw crusher and Cone crusher.
4. To prepare a static model of the Gyratory crusher and Roll crusher.
5. To draw a flow chart representing the steps of the pyrometallurgical extraction of zinc.
6. To draw a flow chart representing the steps of the hydrometallurgical extraction of zinc.
7. To draw a flow chart representing the steps of the titanium and lithium extraction.
8. To draw a flow chart representing the steps of the extraction of aluminium.
9. To draw a flow chart representing the steps of the gold and silver extraction process.
10. To draw a flow chart representing the steps of the metal recycling process.

Assignment

1. To study the current status of Copper extraction in India and to prepare a report.
2. To study the current status of Titanium extraction in India and to prepare a report.
3. To study the current status of Lithium extraction in India and to prepare a report.
4. To study the current status of Zinc extraction in India and to prepare a report.
5. To study the current status of Aluminium extraction in India and to prepare a report.
6. To study the current status of Gold and Silver extraction in India and to prepare a report.
7. To study the current status of Metal recycling industries in India and to prepare a report.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of Jaw crusher and Cone crusher for demonstration in the laboratory.	LLO 1.1
2	Model of Gyratory crusher and Roll crusher for demonstration in the laboratory.	LLO 2.1
3	Model of Ball mill and Rod mill for demonstration in the laboratory.	LLO 3.1
4	Model of Flash smelter for demonstration in the laboratory.	LLO 4.1
5	Kroll process reactor model cut section for demonstration in the laboratory.	LLO 5.1
6	Vertical retort static model for demonstration in the laboratory.	LLO 6.1
7	Electrolytic cell mini set-up / model for the demonstration of extraction of aluminium.	LLO 7.1

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

(Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	BASICS OF ORE / MINERAL DRESSING	CO1, CO2	08	06	02	02	10
2	II	EXTRACTION OF COPPER	CO1,CO3	08	04	06	02	12
3	III	EXTRACTION OF TITANIUM AND LITHIUM	CO1,CO4	08	02	04	04	10
4	IV	EXTRACTION OF ZINC	CO1,CO4	06	02	04	04	10
5	V	EXTRACTION OF ALUMINIUM	CO1,CO5	08	04	04	04	12
6	VI	EXTRACTION OF GOLD AND SILVER	CO1,CO6	04	02	02	04	08
7	VII	RECYCLING OF METALS	CO1,CO6	03	02	04	02	08
Grand Total				45	20	26	22	70

IX. ASSESSMENT METHODOLOGIES /TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Tests 2. Rubrics for COs 3. Assignment 4. Midterm Exam 5. Self-Learning 6. Term Work 7. Seminar/Presentation	1. End Term Exam 2. Micro-project

X. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes(POs)							Programme Specific Outcomes *(PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	2	2	1	2	2	2	3	1	1	2
CO2	3	2	2	2	2	2	2	3	2	1	2
CO3	3	3	2	2	2	2	2	3	1	2	2
CO4	3	3	2	2	2	2	2	3	2	2	2
CO5	3	2	2	2	2	2	2	3	2	2	2
CO6	3	2	2	2	2	2	2	3	2	2	2


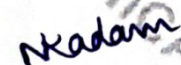

Legends:-High:03, Medium:02, Low:01, No Mapping: -
 *PSOs are to be formulated at the institute level

XI.SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	K. S. Roy, R. Shridhar & K. P. Abraham	Extraction of Non-Ferrous Metals	Affiliated East – West Press Pvt. Ltd., 2008 ISBN13:9788185095639
2	R. Raghavan	Extractive Metallurgy of Non-Ferrous Metals	ISBN 9789394524408 Vijay Nicole Imprints Pvt. Ltd. Chennai
3	Sujay Kumar Dutta, Dharmesh R. Lodhari	Extraction of Nuclear and Non-Ferrous Metals	Springer Singapore ISBN 978-981-10-5171-5
4	A. M. Gaudin	Mineral Dressing	McGraw-Hill Inc., US, December 1939 13:9780070230309

XIII. LEARNING WEBSITES & PORTALS

Sr.No	Link/Portal	Description
1	www.nptel.ac.in	Basic of ore dressing
2	www.digimat.in/nptel	Extraction of copper
3	www.totalmateria.com	Extraction of titanium and lithium
4.	www.sciencedirect.com	Extraction of gold and silver
5.	www.core.ac.uk	Extraction of aluminium
6.	www.mdpi.com	Extraction of zinc
7.	www.eprints.nmlindia.org	Recycling of metals

Name & Signature:  Shri. R. S. Tuljapurkar Lecturer in Metallurgical Engg (Course Expert)	
Name & Signature:  Smt. Namita S Kadam (Programme Head)	Name & Signature:  Shri. Sudin B Kulkarni (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN MT
PROGRAMME CODE	05
COURSE TITLE	NON DESTRUCTIVE TESTING
COURSE CODE	MT31207
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARATION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Credits	Paper Duration Hrs.	Assessment Scheme										Total Marks
			Actual Contact Hrs./Week			SL	LH	NLH			Theory			Based on LL & TSL				Based on SL			
			CL	TL	LL						FA-TH	SA-TH	Total	FA-PR		SA-PR		SLA			
														Max	Min	Max	Min	Max	Min		
MT31207	NON DESTRUCTIVE TESTING	SEC	1	-	2	1	4	2	-	-	-	-	25	10	25@	10	25	10	75		

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, #- External Assessment, *# - Online Examination, @\$ - Internal Online Examination

Note:

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- If a candidate is not securing minimum passing marks in FA-PR (Formative Assessment - Practical) of any course, then the candidate shall be declared as 'Detained' in that course.
- If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as 'fail' and will have to repeat and resubmit SLA work.
- Notional learning hours for the semester are (CL + LL + TL + SL) hrs. * 15 Weeks
- 1 credit is equivalent to 30 Notional hours.
- * Self-learning hours shall not be reflected in the Timetable.
- * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Non Non-destructive testing (NDT) is conducted on a component without destroying it or its structure. It plays an extremely important role in flaw detection and structural quality of components, covering a wide range of industries such as automobile, railways, aerospace, oil and gas, nuclear, power generation, medical and general manufacturing. This course is designed to make the students, aware of the principles behind the commonly used NDT methods and perform these tests to interpret the observations.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

- CO1: Perform visual testing on common components.
 CO2: Perform dye penetrant testing on common components.
 CO3: Perform magnetic particle testing on common components.
 CO4: Perform ultrasonic testing on common components.
 CO5: Perform radiography testing on common components.
 CO6: Perform eddy current testing on common components.

CO7: Perform leakage testing of common components.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I VISUAL INSPECTION (CL Hrs- 02, Marks- Nil)				
1	TLO 1.1 Explain the importance and scope of visual inspection in material testing. TLO 1.2 Prepare specimen (surface) for visual inspection. TLO 1.3 Identify and use simple tools for visual inspection. TLO 1.4 Perform visual testing on common components.	1.1 Importance and scope of visual inspection of materials. 1.2 Preparation of specimen (surface). 1.3 Use of simple tools for visual inspection- magnifying glasses, rules, callipers, gauges, and micrometers. 1.4 Visual testing of some common components such as castings, welding and forgings.	Lecture Demonstration Videos Assignment	CO1
UNIT-II DYE PENETRANT TESTING (CL Hrs- 02, Marks- Nil)				
2	TLO 2.1 Explain the importance and scope of dye penetrant testing in material testing. TLO 2.2 Prepare specimen (surface) for dye penetrant testing. TLO 2.3 Identify and use different types of consumables for dye penetrant testing. TLO 2.4 Perform dye penetrant testing on common components. TLO 2.5 Perform post-testing cleaning of components. TLO 2.6 Follow safety precautions during dye penetrant testing.	2.1 Importance and scope of dye penetrant testing of materials. 2.2 Preparation of specimen (surface). 2.3 Use of different types of consumables for dye penetrant testing- degreasing solution, dye penetrant, solvent remover, developer. 2.4 Dye penetrant testing of some common components such as castings, welding and forgings. 2.5 Post-testing cleaning of components. 2.6 Safety precautions are to be taken during dye penetrant testing.	Lecture Demonstration Videos Assignment	CO2
UNIT-III MAGNETIC PARTICLE TESTING (CL Hrs- 02, Marks- Nil)				
3	TLO 3.1 Explain the importance and scope of magnetic particle testing. TLO 3.2 Prepare specimen (surface) for magnetic particle testing. TLO 3.3 Identify and use equipment for magnetic particle testing. TLO 3.4 Perform magnetic particle testing on common components. TLO 3.5 Perform demagnetization of components. TLO 3.6 Follow safety	3.1 Importance and scope of magnetic particle testing of materials. 3.2 Preparation of specimen (surface). 3.3 Use of equipment and magnetic powder/suspension for magnetic particle testing. 3.4 Magnetic particle testing of some common (ferrous) components such as castings, welding and forgings. 3.5 Post-test procedure- demagnetization of the component. 3.6 Safety precautions are to be taken during magnetic particle testing.	Lecture Demonstration Videos Assignment	CO3

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
	precautions during magnetic particle testing.			
UNIT-IV ULTRASONIC TESTING (CL Hrs- 03, Marks- Nil)				
4	TLO 4.1 Explain the importance and scope of ultrasonic testing. TLO 4.2 Prepare specimen (surface) for ultrasonic testing. TLO 4.3 Identify and use equipment for ultrasonic testing. TLO 4.4 Perform ultrasonic testing on common components. TLO 4.5 Perform post-testing cleaning of components. TLO 4.6 Follow safety precautions during ultrasonic testing.	4.1 Importance and scope of ultrasonic testing of materials. 4.2 Preparation of specimen (surface). 4.3 Use of testing equipment and couplant (oil/glycerine) for ultrasonic testing. 4.4 Ultrasonic testing of some common components such as castings, welding and forgings. 4.5 Post-testing cleaning of components. 4.6 Safety precautions are to be taken during ultrasonic testing.	Lecture Demonstration Videos Assignment	CO4
UNIT-V RADIOGRAPHY TESTING (CL Hrs- 02, Marks- Nil)				
5	TLO 5.1 Explain the importance and scope of radiography testing. TLO 5.2 Prepare specimen (surface) for radiography testing. TLO 5.3 Identify and use equipment for radiography testing. TLO 5.4 Perform radiography testing on common components. TLO 5.5 Follow safety precautions during radiography testing.	5.1 Importance and scope of radiographic testing of materials. 5.2 Preparation of specimen (surface). 5.3 Use of testing equipment and accessories for radiography testing. 5.4 Radiography testing of some common components such as castings, welding and forgings. 5.5 Safety precautions are to be taken during radiography testing.	Lecture Demonstration Videos Assignment	CO5
UNIT-VI EDDY CURRENT TESTING (CL Hrs- 02, Marks- Nil)				
6	TLO 6.1 Explain the importance and scope of eddy current testing. TLO 6.2 Prepare specimen (surface) for eddy current testing. TLO 6.3 Identify and use equipment for eddy current testing. TLO 6.4 Perform eddy current testing on common components. TLO 6.5 Follow safety precautions during eddy current testing.	6.1 Importance and scope of eddy current testing of materials. 6.2 Preparation of specimen (surface). 6.3 Use of testing equipment and accessories for eddy current testing. 6.4 Eddy's current testing of some common components such as castings, welding and forgings. 6.5 Safety precautions are to be taken during eddy current testing.	Lecture Demonstration Videos Assignment	CO6
UNIT-VII LEAKAGE TESTING (CL Hrs- 02, Marks- Nil)				
7	TLO 7.1 Explain the importance and scope of leakage testing. TLO 7.2 Prepare specimen	7.1 Importance and scope of leakage testing of materials. 7.2 Preparation of specimen (surface).	Lecture Demonstration Videos	CO7

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
	(surface) for leakage testing. TLO 7.3 Identify and use equipment for leakage testing. TLO 7.4 Perform leakage testing on common components. TLO 7.5 Follow safety precautions during leakage testing.	7.3 Use of testing equipment and accessories for leakage testing. 7.4 Leakage testing of some common (hollow) components. 7.5 Safety precautions are to be taken during leakage testing.	Assignment	

V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Perform visual testing on components.	Visual testing of components.	4	CO1
2	LLO 2.1 Perform dye penetrant testing on the component.	Dye penetrant testing of the component.	4	CO1
3	LLO 3.1 Perform magnetic particle testing on the component.	Magnetic particle testing of components.	4	CO2
4	LLO 4.1 Perform ultrasonic testing on components.	Ultrasonic testing of components.	6	CO3
5	LLO 5.1 Perform radiography testing on components.	Radiography testing of the component.	4	CO3
6	LLO 6.1 Perform eddy current testing on components.	Eddy's current testing of components.	4	CO3
7	LLO 7.1 Perform leakage testing on components.	Leakage testing of components.	4	CO4

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Micro projects-

- Prepare prototype/model of working of any of the NDT methods.
- Collect technical specifications of equipment used for different NDT methods.
- Prepare display charts to explain the working procedure of different NDT methods.
- Prepare a comparative report of working principle, surface requirements of components, applications, advantages and limitations of different NDT methods.

Assignments-

- Prepare a flow sheet to explain the working procedure of different NDT methods.
- Prepare a report on the type of materials that can be and cannot be tested by different NDT methods.
- Prepare a report on safety precautions that should be taken while using different NDT methods.
- Prepare visit report on NDT Laboratory.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Magnifying glasses, rules, callipers, gauges, micrometers	1
2	The degreasing solution, dye penetrant, solvent remover, developer solution	2
3	Magnetic particle testing equipment	3
4	Ultrasonic testing equipment	4
5	Radiography testing equipment	5
6	Eddy's current testing equipment	6
7	Leakage testing equipment	7

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

NOT APPLICABLE

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Term Work: FA-PR (25 marks) 2. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COs- POs MATRIX FORM

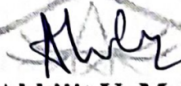
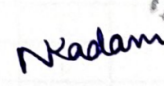

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	3	2	3	1	2	3	3	3	2	2
CO2	3	3	2	3	1	2	3	3	3	2	2
CO3	3	3	2	3	1	2	3	3	3	2	2
CO4	3	3	2	3	1	2	3	3	3	2	2
CO5	3	3	2	3	1	2	3	3	3	2	2
CO6	3	3	2	3	1	2	3	3	3	2	2
CO7	3	3	2	3	1	2	3	3	3	2	2
Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -											

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr. No	Author	Title	Publisher
1	A.V.K. Suryanarayan	Testing of Metallic Materials	Prentice-Hall of India Pvt Ltd ISBN-10: 9352300378 ISBN-13: 9789352300372
2	Dr.V.D.Kodgire	Material Science and Metallurgy	Everest Publishing House ISBN-13: 9788186314008

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	www.nptel.com- https://www.youtube.com/watch?v=5cNWF61Tmj0&list=PLyAZSyX8Qy5AePdV6vbGP4OJQOpbga-0Q	Theory and Practice of Non-Destructive Testing
2	https://www.youtube.com/watch?v=xEK-clpkTUI&t=4s	Dye Penetrant Inspection
3	https://www.youtube.com/watch?v=qpgcD5k1494&t=2s	Magnetic Particle Inspection
4	https://www.youtube.com/watch?v=IcWjZbXiFkM	X-ray Inspection and Industrial Computed Tomography
5	https://www.youtube.com/watch?v=UM6XKvXWVFA&t=4s	Ultrasonic Testing
6	https://www.youtube.com/watch?v=oriFJByl6Hs&t=3s	Eddy Current Testing

Name & Signature:		 Mr. Abhijit V. Mehtre Lecturer in Metallurgical Engineering (Course Expert)	
Name & Signature:	 Mrs. Namita S. Kadam (Programme Head)	Name & Signature:	 Mr. Sudin B Kulkarni (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	DIPLOMA IN MT
PROGRAMME CODE	05
COURSE TITLE	POWDER METALLURGY
COURSE CODE	MT41202
PREREQUISITE COURSE CODE & TITLE	NA
CLASS DECLARATION COURSE	NO

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme						Assessment Scheme										Total Marks	
			Actual Contact Hrs./Week			SLH	NLH	Credits	Paper Duration Hrs.	Theory				Based on LL & TSL				Based on SL		
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
						Max	Min	Max				Min	Max	Min	Max	Min				
MT41202	POWDER METALLURGY	DSC	4	--	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Term: 0 Hrs

Abbreviations: CL-Classroom Learning, TL-Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS – Indian Knowledge System, SLA- Self Learning Assessment

Legends: @-Internal Assessment, # - External Assessment, *# - Online Examination, @\$ - Internal Online Examination

Note:

FA-TH represents an average of two class tests of 30 marks each conducted during the semester.

1. If a candidate is not securing minimum passing marks in FA-PR (Formative Assessment - Practical) of any course, then the candidate shall be declared as '**Detained**' in that course.
2. If a candidate does not secure minimum passing marks in SLA (Self Learning Assessment) of any course, then the candidate shall be declared as '**fail**' and will have to repeat and resubmit SLA work.
3. **Notional learning hours** for the semester are (CL + LL + TL + SL) hrs. * 15 Weeks
4. **1 credit** is equivalent to **30 Notional hours**.
5. * Self-learning hours shall not be reflected in the Timetable.
6. * Self-learning includes micro-projects/assignments/other activities.

II. RATIONALE:

Powder metallurgy is one of the important techniques of manufacturing metallic components used in several fields of engineering like automotive, atomic energy, defence, high-temperature technology etc. This course deals with the production, testing, blending, and compaction of metal powders and sintering. It also included the manufacturing of various powder metallurgical products.

III. COURSE-LEVEL LEARNING OUTCOMES (CO's)

Students will be able to achieve & demonstrate the following CO's on completion of course-based learning

CO1: Compare the powder metallurgy method with other manufacturing processes.

CO2: Produce the metal powder with some metal powder production processes.

CO3: Measure different properties of powders using various tests.

CO4: Select the appropriate compaction process for a particular application.

CO5: Understand the mechanism of sintering.

CO6: Draw the flowsheet for manufacturing various powder metallurgical products.

IV. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-I INTRODUCTION TO POWDER METALLURGY (CL Hrs-04, Marks-06)				
1	<p>TLO 1.1 State the principle of powder metallurgy.</p> <p>TLO 1.2 State the applications, advantages and limitations of powder metallurgy.</p> <p>TLO 1.3 Compare the powder metallurgy method with other manufacturing processes.</p> <p>TLO 1.4 Enlist five powder metallurgical companies in India.</p>	<p>1.1 Principle of powder metallurgy, its applications, advantages and limitations.</p> <p>1.2 Comparison of powder method with other shaping or forming methods of production.</p> <p>1.3 Scope of powder metallurgy in industry.</p>	Lecture Assignment	CO1
UNIT-II METAL POWDER PRODUCTION (CL Hrs-10, Marks-14)				
2	<p>TLO 2.1 Enumerate metal powder production methods.</p> <p>TLO 2.2 Explain the working principle of the mentioned powder production methods.</p> <p>TLO 2.3 Sketch the milling and atomization processes.</p>	<p>2.1 Classification of Metal Powder Production Methods.</p> <p>2.2 Various methods of metal powder production such as:</p> <p>a. Machining,</p> <p>b. Crushing,</p> <p>c. Milling,</p> <p>d. Atomization,</p> <p>e. Condensation,</p> <p>f. Thermal Decomposition,</p> <p>g. Reduction,</p> <p>h. Electrodeposition,</p> <p>i. Intergranular Corrosion</p>	Lecture Assignment	CO2
UNIT-III CHARACTERISTICS AND TESTING OF METAL POWDERS (CL Hrs-08, Marks-10)				
3	<p>TLO 3.1 Explain coning and quartering.</p> <p>TLO 3.2 Explain particle size measurement techniques with a neat sketch.</p> <p>TLO 3.3 State the importance of particle shape, size, and size distribution.</p> <p>TLO 3.4 Draw Hall Flow meter.</p> <p>TLO 3.5 Measure apparent and tap densities.</p> <p>TLO 3.6 Measure flow rate.</p> <p>TLO 3.7 Define Compressibility, compatibility, specific surface, and green strength.</p>	<p>3.1 Sampling – Coning and Quartering.</p> <p>3.2 Particle size measurement – Sieving method, Sedimentation and decantation method, Elutriation method.</p> <p>3.3 Particle shape and size distribution, its measurement, Hall flow meter.</p> <p>3.4 Density of metal powders- Apparent density and its measurement, tap density and its measurement.</p> <p>3.5 Flow rate and its measurement.</p> <p>3.6 Definitions – Compressibility, compatibility, specific surface, green strength.</p>	Lecture Assignment	CO3

UNIT-IV POWDER CONDITIONING AND COMPACTION (CL Hrs-14, Marks-16)				
4	<p>TLO 4.1 Describe the role of powder conditioning and blending.</p> <p>TLO 4.2 State the purpose of powder compaction.</p> <p>TLO 4.3 Classify powder compaction methods.</p> <p>TLO 4.4 Describe the various pressureless shaping techniques.</p> <p>TLO 4.5 Describe the mechanism of the cold pressure shaping technique. TLO 4.6. State roles of lubrication. TLO 4.7 Enlist properties of dies and materials for dies.</p> <p>TLO 4.8 Describe the working of presses.</p> <p>TLO 4.9 Explain the working of different types of cold compaction and pressure shaping techniques with heat.</p> <p>TLO 4.10 Explain the principle of additive manufacturing.</p> <p>TLO 4.11 Describe Metal Injection Molding of Ti Powder.</p>	<p>4.1 Powder conditioning – Preliminary heat treatment, blending process.</p> <p>4.2 Powder compaction: Classification of powder compaction</p> <p>a. Pressureless shaping techniques: Loose sintering, slip casting, slurry casting.</p> <p>b. Cold pressure shaping techniques: Mechanism, role of lubrication, die materials and its properties, Presses- mechanical press, hydraulic press, die compaction techniques, types – isostatic pressing, explosive forming, powder rolling, cycle compaction, powder extrusion.</p> <p>c. Pressure shaping technique with heat: Hot pressing, sinter forging, hot rolling, hot isostatic compaction.</p> <p>4.3 Additive Manufacturing – Introduction, principle, advantages, limitations.</p> <p>4.4 Metal Injection Molding of Ti Powder.</p>	<p>Lecture Assignment</p>	<p>CO4</p>
UNIT-V SINTERING (CL Hrs- 08, Marks- 10)				
5	<p>TLO 5.1 State the principle and purpose of sintering.</p> <p>TLO 5.2 Explain the stages of sintering and its mechanism.</p> <p>TLO 5.3 Define liquid phase sintering.</p> <p>TLO 5.4 Describe the stages of liquid phase sintering,</p> <p>TLO 5.5 Describe the construction of a sintering furnace and its atmosphere.</p> <p>TLO 5.6 Classify sintering furnaces.</p> <p>TLO 5.7 Describe sizing, coining and impregnation.</p>	<p>5.1 Sintering – Principle, purpose.</p> <p>5.2 Stages of sintering.</p> <p>5.3 Mechanism of sintering.</p> <p>5.4 Liquid phase sintering – Definition, stages, advantages.</p> <p>5.5 Sintering Furnace – Construction, classification, atmosphere.</p> <p>5.6 Post sintering operations- sizing, coining, impregnation.</p>	<p>Lecture Assignment</p>	<p>CO5</p>
UNIT-VI APPLICATIONS (CL Hrs- 16, Marks- 14)				
6	<p>TLO 6.1 State the applications and properties of bearing, friction and tool materials.</p> <p>TLO 6.2 State the applications of ferrites</p> <p>TLO 6.3 Describe the production</p>	<p>6.1 Bearing Materials – Applications, properties, methods of production, oil-impregnated bearings.</p> <p>6.2 Friction Materials - Applications, properties, methods of production, formulation.</p>	<p>Lecture Assignment</p>	<p>CO6</p>

of bearing, friction, tool and ferrites materials.	6.3 Tool Materials - Applications, properties, and production of cemented carbide. 6.4 Ferrites – Applications, production.		
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V. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL/TUTORIAL EXPERIENCES.

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
1	LLO 1.1 Explain powder metallurgy advantages, limitations and applications	To study powder metallurgy advantages, limitations and applications.	2	CO1
2	LLO 2.1 Explain various metal powder manufacturing processes.	Study various metal powder manufacturing processes.	2	CO1
3	LLO 3.1 Measure size distribution of metal powder by sieving method.	Measure the size distribution of metal powder by the sieving method.	4	CO2
4	LLO 4.1 Perform metallography to explain powder particle shape.	To study powder particle shape by metallography.	4	CO3
5	LLO 5.1 Calculate apparent density of metal powder	Calculate the apparent density of metal powder	2	CO3
6	LLO 6.1 Calculate tap density of metal powder	Calculate the tap density of metal powder	2	CO3
7	LLO 7.1 Calculate flow rate of metal powder.	Calculate the flow rate of metal powder.	2	CO4
8	LLO 8.1 Explain various types of die compaction techniques.	Study various types of die compaction techniques.	2	CO4
9	LLO 9.1 Explain sintering of compacted products.	Study sintering of compacted products.	2	CO5
10	LLO 10.1 Draw the flow sheets for the production of bearings, friction materials and Sintered Cemented Carbides.	Draw the flow sheets for the production of bearings, friction materials and Sintered Cemented Carbides.	4	CO6
11	LLO 11.1 Metallography of common powder metallurgical components.	Metallography of common powder metallurgical components.	4	CO6

VI. SUGGESTED MICRO PROJECT/ASSIGNMENT/ACTIVITIES FOR SPECIFIC LEARNING/SKILLS DEVELOPMENT (SELF-LEARNING)

Microproject:

- Prepare the flowsheet for the production of particular applications by powder metallurgy process.
- Search for information about presses for compaction.
- Collect information on new developments in powder metallurgy.
- To prepare a paper model for the Production of metal powder by any one method.
- To prepare a chart for the Compaction of powder with any one method of pressureless technique.
- Prepare the flowsheet for compaction of powder with any one method of cold pressure shaping technique.
- Prepare the flowsheet Compaction of powder with any one method of pressure shaping technique with heat.
- To prepare a chart diagram for the construction, working and atmospheres of a sintering furnace.
- Draw the detailed flow sheet of production of any one powder metallurgy application and explain it.

Assignment

1. List the basic steps in Powder Metallurgy.
2. Write about the mechanism of milling for metal powder production.
3. Enumerate the variables affecting the process of mixing metal powders.
4. Brief about the major metal powder characteristics.
5. Describe, a) apparent density b) compression ratio
6. Describe rapid sintering methods.
7. Detail about applications of powder rolling.
8. Outline the various post-sintering operations adopted in powder metallurgy.
9. Explain the powder extrusion process.
10. Illustrate the different mechanical methods of metal powder production.
11. Explain the various methods used in determining the following powder particle characteristics: i) Particle size and ii) Porosity. iii) Surface area. iv) Particle density.
12. Explain the different pressureless powder shaping methods.
13. Differentiate between the various Mechanical and thermal methods of powder compaction
14. Discuss sintering furnaces, the atmospheres and the various factors to be considered in their selection.
15. Explain the various types of high-temperature compaction processes
16. Suggest manufacturing method to make the following components by powder metallurgy
a. Porous bearings b. Electrical contact materials c. Friction materials d. Composites
17. Paraphrase the application of powder metallurgy products in automobile and power generation industries.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sieves Shaker, Metal Powder, Stop Watch, Weighing Machine	3-7
2	Hall-Flow Meter, Density Cup, Stand, Weighing Machine	5-7
3	Metallurgical microscope	4,11
4	Standard specimen of common powder metallurgical components for microscopic observation	11

VIII. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

(Specification Table)

Sr. No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	INTRODUCTION	CO1	04	02	02	02	06
2	II	METAL POWDER PRODUCTION	CO2	10	02	08	06	14
3	III	CHARACTERISTICS AND TESTING OF METAL POWDERS	CO3	08	02	04	04	10
4	IV	POWDER CONDITIONING AND COMPACTION	CO4	14	02	06	08	16
5	V	SINTERING	CO5	08	04	06	02	10
6	VI	APPLICATIONS	CO6	16	02	02	06	14
Grand Total				60	14	28	28	70

IX. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)	Summative Assessment (Assessment of Learning)
1. Unit Tests: Average of two unit tests (30 marks) 2. Term Work: FA-PR (25 marks) 3. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 marks) 2. End Term Exam: SA-PR (25 marks)

X. SUGGESTED COs- POs MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	3	1	1	1	1	2	2	3	-	1	1
CO2	3	1	2	2	1	2	2	3	1	1	2
CO3	3	3	3	3	1	2	2	3	3	1	2
CO4	3	2	2	1	2	2	2	3	1	1	2
CO5	3	2	2	1	1	1	1	3	-	1	1
CO6	3	2	2	1	1	3	2	3	-	1	2

Legends:- High: 03, Medium: 02, Low: 01, No Mapping: -

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr. No	Author	Title	Publisher
1	A.K. Sinha	Powder Metallurgy	Dhanpat Rai Publications. ISBN-10 : 9383182148 ISBN-13 : 978-9383182145
2	V.D. Kodgire	Material Science and Metallurgy for Engineers	Everest Publishing House. ISBN-10: 8186314008 ISBN-13: 978-8186314005
3	G. S. Upadhyaya	Powder Metallurgy: Science, Technology and Materials	Cambridge International Science Publishing Ltd ISBN-13: 9781138075016 ISBN-10: 1138075019
4	P.C.Angelo, R.Subramaniam	Powder Metallurgy: Science, Technology and Applications	Prentice Hall India Learning Private Limited ISBN : 9789391818487

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://youtu.be/uRVaLUQUmA8?si=ibTwB1IwKysHoYIp	Powder Metallurgy - 1
2	https://www.youtube.com/watch?v=oDA3aIDmkv8	Powder manufacture and characteristics.
3	https://youtu.be/H8wxmJoJW8M?si=Lsq06ULY_eN5zJu6	Sintering furnace mechanism/

Name & Signature:

Sarika
Mrs. Sarika S. Aglave
 Lecturer in Metallurgical Engineering
 (Course Expert)

Name & Signature:

Nadama
Mrs. Namita S. Kadam
 (Programme Head)

Name & Signature:

Kulkarni
Mr. Sudin B. Kulkarni
 (CDC In-charge)