GOVERNMENT POLYTECHNIC, PUNE
'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**MODERN FOUNDRY ENGINEERING**
COURSE CODE	**MT41205**
PREREQUISITE COURSE CODE & TITLE	**MT41203 FOUNDRY ENGINEERING**
CD	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41205	MODERN FOUNDRY ENGINEERING	DSC	4	--	2	2	8	4	3	30	70	100	40	--	--	25#	10	25	10	150

Total IKS Hrs for Term: 01 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 semester.
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:

To enable the Metallurgical engineer with various foundry practices such as ferrous and non-ferrous alloys, which are popularly known as castings. He should also understand the other important aspects of foundry apart from only the production processes. This course aims to make the student familiar with ferrous & non ferrous foundry engineering practices and confident in entering foundry industry to make career.

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 - Design, Draw and Explain gating system & riser.

CO2 - Choose various fettling ,Cleaning , heat treatment and finishing operations over castings.

CO3 – Identify various casting defects and enlist their causes and remedies.

CO4 – Select proper melting practices and mould for ferrous and non-ferrous metals orcasting alloys.

CO5 - Enlist various aspects of foundry mechanization and layout.

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
SECTION I				
UNIT-I FLOW OF METALS AND GATING SYSTEM (CL Hrs-08 Marks-10)				
1	TLO 1.1 Explain about antient indian foundry practices. TLO 1.2 Explain Bernoulli's thermo/continuity equation. TLO 1.3 Explain fluidity and test of fluidity. TLO 1.4 Calculate pouring time. TLO 1.5 Compare pressurize and unpressurized gating ratio. TLO 1.6 Design gating system dimensions for given castings.	1.1 Historical development- Ancient Indian foundry practices & process of manufacturing casting article 1.2 Laws of fluid dynamics governing the design of gating system. Reynolds Number, Equation of Continuity Bernoulli`s theorem, Fluidity and fluidity test. 1.3 Calculation of pouring time for Ferrous and Non Ferrous alloys. 1.4 Importance and determination of dimensions of passages i.e. gating ratio, Gating system components, Requirements, calculation of gating system for particular or given castings.	Improved Lecture Assignment Demonstration	**CO1**
UNIT-II RISERING OF CASTING (CL Hrs-06 Marks-08)				
2	TLO 2.1 Explain functions of riser TLO 2.2 Enlist and explain various types of risers. TLO 2.3 Explain any one method to determine riser. TLO 2.4 Draw and explain blind riser TLO 2.5 State role of padding and chills.	2.1 Directional solidification, Necessity of riser, Functions, types of risers, riser shape, size and location 2.2 Methods to determine riser e.g. Chvorinov's rule, Cain's method; NRL Method, Modulus method, Inscribed circle method etc 2.3 Use of padding, exothermic material, chills.	Improved Lecture Assignment Demonstration	**CO1**
UNIT III FETTLING, CLEANING AND H.T. OF CASTINGS (CL Hrs-04 Marks-04)				
3	TLO 3.1 Enlist and Explain fettling operations. TLO 3.2 Explain necessity of cleaning of castings. TLO 3.3 Explain Heat treatment of castings.	3.1 Fettling, cleaning and H.T. of castings 3.2 Define fetlling , types of tool used 3.3 Types of cleaning of casting, importance of cleaning. 3.4 Various HT of casting.	Improved Lecture Assignment Demonstration	**CO2**
UNIT-IV CASTING INSPECTION (CL Hrs-06 Marks-06)				
4	TLO 4.1 Enlist and Explain method of casting inspection. TLO 4.2 Compare destructive and nondestructive testing of castings TLO 4.3 Explain various surface making methods.	4.1 Specifications, ISO, quality aspect, inspection procedure; destructive and non-destructive testing of casting. 4.2 Methods of surface finish measurements.	Improved Lecture Assignment Demonstration	**CO3**

Sr. No	Theory Learning Outcomes (TLO'S) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-V CASTING DEFECT ANALYSIS (CL Hrs-06 Marks-07)				
5	TLO 5.1 Enlist and Explain various casting defects. TLO 5.2 Explain dimensional error/compositional error. TLO 5.3 Explain causes and remedies for any one casting defects.	5.1 Faults arising in pouring, inclusion and sand defects, gas defect, shrinkage defect and contraction defect- free contraction and hindered contraction. 5.2 Dimensional errors, Compositional errors and segregation.	Improved Lecture Assignment Demonstration	**CO3**
SECTION II				
UNIT- VI MELTING PRACTICE AND METALLURGY OF CAST IRON & S.G.IRON (CL Hrs-10, Marks-12)				
6	TLO 6.1 Classify & state properties of different cast iron TLO 6.2 Explain properties and uses of Grey C I TLO 6.3 Compare G C I and W C I. TLO 6.4 Explain melt making of cast iron in cupola. TLO 6.5 Explain properties and uses of S. G. iron TLO 6.6 Explain procedure to produce S.G.Iron. TLO 6.7 Explain method to mg treatment on iron melts. TLO 6.8 Explain fading effect. TLO 6.9 Explain ADI production.	6.1Classification of C.I., chemical composition, effect on structure and properties. 6.2 Melting practice for Grey C.I and other grade 6.3. Molding practice for Grey C.I. 6.4 Chemical composition, various techniques of S.G. iron production – Sand witch Method, Convertor method and Core wire feeding method, Mg recovery. 6.5 Molding practice for S.G. iron. 6.6 Surface nodulization 6.7 Austempered Ductile Iron	Improved Lecture Assignment Demonstration Simulation	**CO4**
UNIT –VII PRODUCTION OF STEEL CASTINGS (CL Hrs- 04, Marks-06)				
7	TLO 7.1 State properties & uses of different steel castings. TLO 7.2 Explain melting of steel. TLO 7.3 Enlist and Explain effect of different alloying element on steel castings.	7.1 Specific characteristic of steel castings, melting practice, molding practice. 7.2 Alloying practice for steel casting.	Improved Lecture Assignment Demonstration	**CO4**
UNIT –VIII FOUNDRY PRACTICE FOR ALUMINUM ALLOYS (CL Hrs-07, Marks-08)				
8	TLO 8.1 Explain procedure to produce quality melts of Al. TLO 8.2 Enlist various problems related to Al melt. TLO 8.3 Explain Grain refinement and modification of Al-Si alloys. TLO 8.4 Explain degassing method of Al melts.	8.1 Production of Al Melt; Problems associate with melting, molding practice, alloys of Al castings, properties and application of Al casting alloys. 8.2 Grain refinement and Modification of Al-Si alloys. 8.3 Metal Treatment on Al- Degassing, fluxing, vacuum degassing, Ultrasonic treatment.	Improved Lecture Assignment Demonstration	**CO4**

Sr. No	Theory Learning Outcomes (TLO'S) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT –IX PRODUCTION OF CU, MG & ZN ALLOY CASTINGS (CL Hrs-04, Marks- 04)				
9	TLO 9.1 Explain melting practice of copper. TLO 9.2 Enlist properties and application of cu castings. TLO 9.3 Explain steps in production of Mg or Zn castings.	9.1 Metallurgical factors affecting foundry practice for Cu and Cu base casting alloys, melting furnaces, casting processes 9.2 Foundry techniques, melting of Mg-alloys, production of Zn and Zn alloy castings.	Improved Lecture Assignment Demonstration	**CO4**
UNIT –X FOUNDRY MECHANIZATION & LAY OUT OF FOUNDRY (CL Hrs-05, Marks- 05)				
10	TLO 10.1 Explain advantages of /mechanization and good layout of foundry. TLO 10.2 Draw a layout of medium scale GCI foundry showing all working units.	10.1 Foundry modernization, mechanization and lay out of foundry. 10.2 Introduction to foundry planning, Definition, advantages etc. 10.3 Factor consider for foundry layout.	Improved Lecture Assignment Demonstration	**CO5**

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) Design/ draw various types of gate. (b) Calculate gate area & select appropriate gate as per casting need.	Study of various types of gates.	04	CO1
2	LLO 2.1 (a) Design/ draw various types of riser. (b) Calculate riser volume & select appropriate riser as per casting need.	Study of various types of risers.	04	CO1
3	LLO 3.1 Familiar with gating system & types of riser.	Case study of design of gating system and riser.	04	CO1
4	LLO 4.1 To carry different fettling opration on given casting.	Study of fettling and finishing operations on castings.	04	CO2
5	LLO 5.1 Perform \DPT or NDT to inspect casting defect location & type.	To carry inspection & detection of various casting defects.	04	CO3
6	LLO 6.1 To carry production of Al alloy casting using crucible melting.	Prepare casting of Al using crucible melting process.	04	CO4
7	LLO 7.1 To draw good layout of ferrous & nonferrous foundry considering various factor.	Drawing a layout for Ferrous and Non-ferrous Foundry. (Medium Scale)	04	CO5
8	LLO 8.1 Perform MPIT test on common cast component.	Complete a micro project based on guidelines provided in Sr. No.11	02	CO5

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

Micro project

- Fluidity & castability of cast metal & alloys : Collect data of castability 7 fluidity of different cast metals & alloys . Make a pdf file.
- **Gating System** : Collect data about standards gating system, different parts and fuction. Calculate dimension of each parts..
- **Riser Design** :Preapare data about riser dimension as per need of casting requirement...
- Fettling opration : To observe various fettling & finishing operation of casting.
- **Casting Inespection** : Collect all information about all NDT procedure & result informationuse for casting examination.
- Prepare a comparative chart overall specifications of standard gating system and solve certain case studies on designing gating system for given casting dimensions.
- Survey of meting and molding methods used in manufacturing of castings (metallurgy
- Search information about Ratings and specifications of melting furnace, load/ melt size, quality aspect of melt, treatment on melt, molding practice selected, and possible defect with remedial action.
- Industrial visit to S G Iron casting industries and Cu casting manufactures.
- **Casting Defects :** Studycauses of different casting defect. Catagories typesv of defects..

Assignment

- Prepare a report on calculation and design of different parts of gating system for given casting.
- Collect technical information on measurement and setup of fluidity of casting alloys.
- Prepare tabulated summary for different laws of fluid behavior (liquid flow).
- Prepare report on calculation / determination of riser dimension, size, number and location.
- Prepare report on working of NDT method for casting defect identification.
- Prepare tabulated summary for casting defect analysis and remedial suggestions.
- Prepare report on properties, composition and uses of different type of C.I.Castings.
- Prepare report on working of S.G.Iron design of mg treatment ladle.
- Prepare display board of property enhancement in steel casting through alloying.
- Prepare report on working of degassing technique of Al melts.
- Prepare a report of properties & application areas of Cu, Mg and Zn castings.
- Draw a layout of medium scale ferrous or non ferrous foundry.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Models of different gates	LLO 1.1
2	Models/charts /images of different riser with dimensions.	LLO 2.1
3	Models of gating system. Sand molding setup to construct gating in mold.	LLO 3.1
4	Various types of fettling and finishing tools.	LLO 4.1
5	DPT, MPIT OR any NDT setup	LLO 5.1
6	Melting setup of Al alloy melt making	LLO 6.1
7	Standard layout model	LLO 7.1
8	Previous microproject report for observation	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	FLOW OF METALS AND GATING SYSTEM	CO1	08	02	04	04	10
2	II	RISERING OF CASTING	CO1	06	02	04	02	08
3	III	FETTLING, CLEANING AND H.T. OF CASTINGS	CO2	04	01	01	02	04
4	IV	CASTING INSPECTION	CO3	06	02	02	02	06
5	V	CASTING DEFECT ANALYSIS	CO3	06	02	02	03	07
Grand Total				30	09	13	13	35
SECTION II								
6	VI	MELTING PRACTICE AND METALLURGY OF CAST IRON & S.G.IRON	CO4	10	04	04	04	12
7	VII	PRODUCTION OF STEEL CASTINGS	CO4	04	02	02	02	06
8	VIII	FOUNDRY PRACTICE FOR ALUMINUM ALLOYS	CO4	07	02	02	04	08
9	IX	PRODUCTION OF CU, MG & ZN ALLOY CASTINGS	CO4	04	01	01	02	04
10	X	FOUNDRY MECHANIZATION & LAY OUT OF FOUNDRY	CO5	05	01	01	03	05
Grand Total				30	10	10	15	35

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. 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	2	2	2	1	2	1	3	2	2	1
CO2	2	2	2	1	1	1	1	2	2	2	1
CO3	2	2	1	2	1	2	1	2	2	2	1
CO4	3	2	2	2	2	1	1	2	2	1	1
CO5	1	2	2	1	1	2	1	2	1	1	1
Legends:- High:03, **Medium:**02, **Low:**01, **NoMapping:** -											

XI. SUGGESTED LEARNING MATERIALS/BOOKS

Sr.No	Author	Title	Publisher
1	T.V.Ramana Rao	Metal Casting Principle and Practices	New Age International (P) Ltd. Publishers. ISBN10:8122408435 ISBN13:9788122408430
2	P.L.Jain	Principles of Foundry Technology	Mc Graw-Hill publishing Company ISBN10:0070151296 ISBN13:9780070151291
3	Richard W.Heine, Carl R. Loper, Philip C.Rosenthal	Principle of Metal Castings	Mc Graw-Hill publishing Company ISBN10:0070278962 ISBN13:9780070278967
4	--	Casting Design Hand Book	American Society of Metals. ISBN10:1258327465 ISBN13:9781258327460

XII. LEARNING WEBSITES & PORTALS

Sr.No	Link/Portal	Description
1.	www.nptel.com	Various content related video lecture series
2.	http://www.capabilitydevelopment.com	Online courses available to build content/ concept of students.

Name & Signature:

Pramble

Shri. Pravin B. Kamble
(Course Experts)

Name & Signature:	Name & Signature:
Pramble	
Shri. Pravin B. Kamble (I/C Programme Head)	**Shri. Sudin Baburao Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**ADVANCED PHYSICAL METALLURGY**
COURSE CODE	**MT41206**
PREREQUISITE COURSE CODE & TITLE	**MT41201, PHYSICAL METALLURGY**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41206	ADVANCED PHYSICAL METALLURGY	DSC	04	--	02	02	08	4	3	30	70	100	40	--	--	--	--	25	10	125

Total IKS Hrs for Term: 01 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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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:

Metallurgical engineers often have to select a suitable steel with specific properties for required applications, which requires detailed knowledge of different types of alloy steels- their composition, microstructure, properties and applications. This course deals with the relationship between properties and selection of alloy steels for particular application.

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- Correlate the effects of alloying elements on the properties and microstructures of steels.

CO2- Select suitable alloy steel for particular application (electrical, magnetic, machinability and wear resistance).

CO3- Enlist and explain various methods of X-ray diffraction.

CO4- Select suitable stainless and tool steel for given application.

CO5- Explain diffusion mechanisms and phase transformation.

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
		SECTION I		
		UNIT-I ALLOYING ELEMENTS (CL Hrs-13 Marks-15)		
1	TLO 1.1 State the needs for addition of alloying elements in steels. TLO 1.2 Describe classification of alloying elements. TLO 1.3 State the roles of different alloying elements in steel. TLO 1.4 Describe the effects of alloying elements on various parameters of steels. TLO 1.5 Explain different engineering alloy steels and other alloys w.r.t. their properties, compositions and applications.	1.1 Need for addition of alloying elements in steels. 1.2 Classification of alloying elements- (a) based on their relation with carbon: Carbide forming, graphitizing, neutral elements. (b) based on their effect on temperature intervals on allotropic forms of iron: Austenite and Ferrite stabilizers. 1.3 Roles of common alloying elements in steel. 1.4 Effect of alloying elements on Iron-Carbon equilibrium diagram. 1.5 Effect of alloying elements on T.T.T. diagram of steels. 1.6 Effect of alloying elements on grain growth, corrosion resistance and mechanical properties of steels. 1.7 Properties, compositions and applications of some engineering alloy steels and other alloys like- Free cutting, maraging, dual phase steels, high temperature alloys, low expansion alloys, alloys for heating elements. 1.8 Introduction to micro alloyed steels. 1.9 Ancient Indian alloy steel- Wootz steel.	Lecture Assignment	**CO1**
		UNIT-II PHYSICAL PROPERTIES & SELECTION OF MATERIALS (CL Hrs-12, Marks-14)		
2	TLO 2.1 Explain different electrical and magnetic properties. TLO 2.2 Suggest suitable materials for electrical and magnetic applications. TLO 2.3 State concept of machinability. TLO 2.4 Explain determination of machinability index of various metals and alloys. TLO 2.5 Define wear. TLO 2.6 Explain different types of wear.	2.1 Electrical properties: Conductivity and resistivity, selection of materials for electrical applications. 2.2 Magnetic properties: Ferromagnetism, paramagnetism and diamagnetism, selection of materials for magnetic applications. 2.3 Machinability: concept of machinability, measurement of machinability, machinability index of various metals and alloys. 2.4 Wear resistance, types of wear: Adhesive, abrasive, erosion, dry,	Lecture Assignment Videos	**CO2**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
	TLO 2.7 Suggest suitable materials for higher wear resistance.	lubricated. Selection of materials for higher wear resistance.		
UNIT-III X-RAY DIFFRACTION & ELECTRON MICROSCOPY (CL Hrs-05 Marks-06)				
3	TLO 3.1 State the principle of production, properties and applications of X-rays. TLO 3.2 Explain Bragg's law of X-ray diffraction. TLO 3.3 Explain different X-ray diffraction methods. TLO 3.4 Explain the principle and working of Electron microscopes. TLO 3.5 Differentiate between Electron and Optical microscopes.	3.1 X-rays: Principle of production, their properties and applications. 3.2 Bragg's law of X-ray diffraction. 3.3 X-ray diffraction methods: Lauve method, rotating crystal method, powder method. 3.4 Working principle and applications of Electron microscope-SEM and TEM. 3.5 Comparison between Electron and Optical microscopes.	Lecture Assignment Videos	**CO3**
SECTION II				
UNIT-IV HIGH TEMPERATURE PROPERTIES, CORROSION RESISTANCE & STAINLESS STEELS (CL Hrs-12, Marks-14)				
4	TLO 4.1 Explain the process of creep. TLO 4.2 Suggest suitable materials for high temperature applications. TLO 4.3 Explain the role of Cr in stainless steels. TLO 4.4 Explain different stainless steels w.r.t. their properties, compositions and applications. TLO 4.5 Explain carbide precipitation and stabilization treatment of stainless steels.	4.1 High temperature properties- Creep, creep resistant steels- Super alloys, selection of materials for use at elevated temperatures. 4.2 Role of chromium in stainless steels. 4.3 Classification of stainless steels- (Martensitic, Ferritic, Martensitic, Precipitation hardeneable & Duplex), properties, compositions and applications of different stainless steels. 4.4 Carbide precipitation in stainless steels, stabilization treatment.	Lecture Assignment	**CO4**
UNIT-V TOOLS STEELS (CL Hrs-11, Marks-12)				
5	TLO 5.1 Explain different types of tool steels w.r.t. their properties, compositions and applications. TLO 5.2 Explain heat treatment cycles of different tool steels. TLO 5.3 Explain spring steels with properties, compositions, and heat treatments. TLO 5.4 Describe PVD and CVD process with their parameters, stages, applications, advantages and limitations.	5.1 Tools steels, classification of tool steels, properties, compositions and applications of different tool steels. 5.2 Heat treatments of different tool steels: cold and hot working dies, cutting tools. 5.3 Spring steels: Properties, compositions, and heat treatments. 5.4 Introduction to PVD and CVD: Process, parameters, stages, applications, advantages and limitations.	Lecture Assignment	**CO4**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
	UNIT–VI DIFFUSION (CL Hrs-04, Marks-05)			
6	TLO 6.1 State the conditions required for diffusion. TLO 6.2 Describe different mechanisms of diffusion. TLO 6.3 Explain Fick's first law. TLO 6.4 Explain the process of growth of oxide layer in metals. TLO 6.5 Explain the variables that affect diffusion during carburizing process.	6.1 Diffusion, conditions required for diffusion, mechanisms of diffusion: Vacancy, interstitial, interstitialcy and ring. 6.2 Fick's first law. 6.3 Growth of oxide layer in metals. 6.4 Carburizing- variables that influence diffusion (temperature, concentration, crystal structure, impurities, grain size).	Lecture Assignment Videos	**CO5**
	UNIT-VII PHASE TRANSFORMATION (CL Hrs-03, Marks-04)			
7	TLO 7.1 Explain the process of nucleation and growth. TLO 7.2 Explain order- disorder changes in alloys. TLO 7.3 Explain the principle of precipitation hardening solution treatment, aging treatment.	7.1 Nucleation and growth consideration, order-disorder changes. 7.2 Precipitation hardening solution treatment, aging treatment.	Lecture Assignment	**CO5**

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 different types of alloying elements and their effects on steels.	Study of alloying elements in steels.	04	CO1
2	LLO 2.1 Explain the concept of machinability and machinability index of materials.	Study of machinability and machinability index.	04	CO2
3	LLO 3.1 Explain different types of wear and materials suitable for wear resistance.	Study of wear in metals.	04	CO2
4	LLO 4.1 Explain principle of X-ray diffraction, different methods of X-ray diffraction and Bragg's law.	Study of Braggs's law and methods of X-ray diffraction.	02	CO3
5	LLO 5.1 Explain the working principle of SEM and TEM.	Study of Electron microscopes.	02	CO3
6	LLO 6.1 Explain procedure of creep test and various stages in creep with creep curve.	Study of creep and creep curves.	04	CO4
7	LLO 7.1 Explain different stainless steels w.r.t. their properties, compositions and applications.	Study of Stainless steels.	04	CO4
8	LLO 8.1 Explain different types of tool steels w.r.t. their properties, compositions and applications.	Study of Tool steels.	04	CO4
9	LLO 9.1 Explain Fick's first law of diffusion and various mechanisms of diffusion.	Study of Fick's first law and mechanisms of diffusion.	02	CO5

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

Micro project

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Prepare industrial survey report of alloy steels used for different applications.
- Prepare visit report on Heat treatment shop.
- Prepare tabulated summary for various alloy steels with their compositions, properties, heat treatments, applications.
- Prepare report on working of various PVD/CVD techniques.
- Prepare report on the effect of a particular heat treatment on the microstructure and properties of given alloy steel.
- Prepare metallographic specimen of different alloy steels, before and after heat treatments.
- Prepare display board of XRD patterns of different metals.
- Prepare detailed cycle of heat treatments for a given steel to achieve the required set of properties and/or applications.

Assignments

- Prepare journals based on practical performed in laboratory. Journal consists of write ups, diagrams, observations, required tools, equipment and date of performance with teacher signature.
- Prepare display boards of X-ray production method, diffraction methods, Bragg's law,
- Prepare display boards showing construction of Electron microscope- SEM and TEM
- Prepare chart of comparison of optical microscope and electron microscopes.
- Prepare display boards of Fe-C diagram and TTT diagram of various steels.
- Collecting data of various alloy steels, their compositions, microstructures and applications.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Charts of Fe-C equilibrium diagram and TTT diagram of standard steels	LLO 1.1
2	Wear testing machine	LLO 3.1
3	Charts showing X-ray production method and Bragg's law	LLO 4.1
4	Metallurgical microscope	LLO 5.1
5	Charts of construction of Electron microscope	LLO 5.1
6	Creep testing machine	LLO 6.1
7	Samples of standard stainless steels for metallographic observation	LLO 7.1
8	Samples of standard tool steels for metallographic observation	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	ALLOYING ELEMENTS	CO1	13	07	04	04	15
2	II	PHYSICAL PROPERTIES & SELECTION OF MATERIALS	CO2	12	08	04	02	14
3	III	X-RAY DIFFRACTION	CO3	05	02	02	02	06
			Grand Total	30	17	10	08	35
SECTION II								
4	IV	HIGH TEMPERATURE PROPERTIES, CORROSION RESISTANCE & STAINLESS STEELS	CO4	12	06	04	04	14
5	V	TOOLS STEELS	CO4	11	06	04	02	12
6	VI	DIFFUSION	CO5	04	03	02	00	05
7	VII	PHASE TRANSFORMATION	CO5	03	02	02	00	04
			Grand Total	30	17	12	06	35

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. Self-Learning: SLA (25 marks)	1. End Term Exam: SA-TH (70 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	2	3	3	2	2	2	3	3	2	3	2
CO2	3	2	3	3	3	3	3	2	1	1	1
CO3	3	1	1	1	1	1	2	3	3	3	2
CO4	2	3	3	3	3	3	3	3	2	3	2
CO5	2	1	1	1	2	2	2	2	1	1	1

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	Robert E. Reed-Hill	Physical Metallurgy Principles	Affiliated East-West Press ISBN: 9788176710459
2	D.S.Clark	Physical Metallurgy for Engineers	CBS Publishers and Distributors ISBN: 9789389396485
3	Sydney H. Avner	Introduction to Physical Metallurgy	Tata McGraw Hill Publishing Company Ltd, New Delhi. ISBN: 9780070024991

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://www.youtube.com/watch?v=lgJ51xt191Q	Why the resistance increases with temperature in conductor
2	https://www.youtube.com/watch?v=0MGuTSqhCUc	Magnetic properties
3	https://www.youtube.com/watch?v=c0-O03F-D68	Wear test
4	https://www.youtube.com/watch?v=QHMzFUo0NL8	X-ray diffraction
5	https://www.youtube.com/watch?v=a0G7iyz4McM	Electron microscopy
6	https://www.youtube.com/watch?v=pZuhK3jsMMY&t=9s	Chemical Vapor Deposition
7	https://www.youtube.com/watch?v=h0UGokTkxV0&list=PLQcKpS4i0cAHES0sjJTXDZnWa3wtuixQl&index=7	Physical Vapor Deposition
8	https://www.youtube.com/watch?v=pC4EdrC7zWo	Diffusion in Solids

Name & Signature: **Shri. Abhijit V. Mehtre** (Course Experts)	
Name & Signature: **Shri. Pravin B. Kamble** (I/C 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	**CAPSTONE PROJECT**
COURSE CODE	**MT41207**
PREREQUISITE COURSE CODE & TITLE	**ACQUIRED MINIMUM OF 60 CREDITS**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41207	CAPSTONE PROJECT	INP	--	--	4	--	4	2	--	--	--	--	--	50	20	50#	20	--	--	100

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:

1. If a candidate is not securing the 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 the 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 the 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:

Project work at the institute level serves as a vital bridge between theoretical learning and practical application. It offers students a valuable platform to apply the concepts, knowledge, and technical skills acquired in classrooms and laboratories to address real-world problems—ranging from well-defined tasks to complex, open-ended challenges. This experiential learning approach fosters a deeper understanding of engineering and technological principles by encouraging students to design, develop, and implement solutions in realistic contexts.

The course is strategically designed to integrate interdisciplinary knowledge gained throughout the diploma program, thereby enhancing students' ability to approach problems holistically. Furthermore, it plays a crucial role in nurturing essential professional competencies such as critical thinking, problem-solving, creativity, teamwork, project planning, and innovation.

In alignment with industry and societal expectations, students are encouraged to undertake projects that go beyond conventional solutions and aim to provide impactful, sustainable outcomes. By engaging in such projects, students not only reinforce their technical capabilities but also improve their employability by developing a mindset geared towards innovation, collaboration, and continuous improvement.

III. INDUSTRY EXPECTED OUTCOME

This course is designed to enable students to develop the industry-relevant competency of:

Effectively executing innovative solutions to real-world problems through collaborative teamwork, adhering to defined timelines, and delivering a well-documented project report.

IV. COURSE-LEVEL LEARNING OUTCOMES (CO'S)

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

CO1: Identify real-world field problems relevant to the project work conducted at the institute.

CO2: Analyse the feasibility and viability of the project by conducting data collection and experiments, as well as evaluating required resources, costs, and support.

CO3: Apply technical knowledge and engineering skills to develop effective solutions for real-life or industrial problems.

CO4: Evaluate the proposed project work's ethical considerations and societal impacts.

CO5: Create a comprehensive project report and present the methodology and results within the institute.

CO6: Demonstrate the project outcomes, findings, and achievements effectively through presentations and exhibits.

V. GENERAL GUIDELINES FOR PROJECT WORK

i) Project Selection and Scope

- The project must align with the field of engineering or technology. Interdisciplinary projects are permitted if expected to deliver outcomes aligned with industry relevance or societal needs.

  Indicative Project Focus Areas:

  i) Physical metallurgy
  ii) Heat treatment
  iii) Foundry
  iv) Welding
  v) Powder Metallurgy
  vi) Extraction of Metals
  vii) Metalworking
  viii) Advanced material science
  ix) Corrosion
  x) Failure analysis
  xi) Design and CAD/CAE Applications
  xii) Renewable Energy Technologies
  xiii) Environmental and Sustainable Engineering
  xiv) Interdisciplinary and Smart Systems
  xv) Agricultural and Rural Engineering Solutions

- Students should select projects that match their skills, knowledge and interests. Faculty should support students in identifying suitable topics.

- Study-based (theoretical-only) projects are **not encouraged**. Projects should involve practical implementation.

ii) Team Structure and Mentorship

- Each project must be executed by a group of 3–4 students under the guidance of an assigned faculty mentor.
- Faculty may organize teams based on:
  - Students' individual strengths and interests
  - Industry-relevant functional roles
  - Project requirements and scope
  - Balanced skill distribution among team members
  - Academic performance and specialization

iii) Nature and Type of Projects

Projects may involve:

- Model/Prototype/Hardware development
- Software development
- A combination of hardware and software
- Development of mechanical systems aimed at solving engineering problems
- Development of mechatronic systems for engineering applications
- Design and implementation of robotic or automation systems to address engineering challenges

All projects must demonstrate logic building, problem-solving, and application of technologies learned during the diploma program.

Acceptable project formats include:

- Prototype design (design, build, test, and evaluate)
- Application/software development

iv) Project Execution and Documentation

- Students must develop a working model/prototype/software and simultaneously prepare a comprehensive project report.
- Submissions must include:
- One hard copy and one soft copy of the project report
- A soft copy of the demonstration video/file of the working model or source code
- The project report should include (as applicable):
- Problem Definition
- Platform/Hardware Specifications
- Feasibility Study (Cost & Time Estimates)
- Design Diagrams (UML, Use Case, Activity, DFD, CFD, ERD, etc.)
- Testing Methodology and Results
- Limitations and Future Scope
- Conclusion
- References (Books, Journals, Websites)

v) Project Diary and Supervision

A project diary must be maintained by each group to log:

- Weekly progress and milestones
- Design decisions and challenges
- Faculty feedback and updates

- Faculty mentors should review the diary weekly and provide constructive feedback. The diary should be concise (5–10 pages) and follow the format outlined in Annexure IV.

vi) Learning Outcomes Expected (As Applicable)

Faculty should ensure students gain the following competencies through project execution:

- Identify and define real-world problems within their domain
- Investigate root causes and possible solutions
- Evaluate solution feasibility, including financial implications
- Gather and analyze data from reliable sources (e.g., books, web, experts, market)
- Develop required designs and execution plans
- Prepare and deliver effective seminar presentations.

vii) Industry-Sponsored Projects

- For industry-guided projects, implementation steps may vary as per industry standards.
- However, students must still meet institutional submission criteria:
  - Project report format
  - Project diary
  - Final demonstration
  - Assessment based on institutional RUBRICs

viii) National Relevance

Projects should ideally address national thrust areas such as:

- Environmental Sustainability
- Digitization and Smart Technologies
- Industrial and Process Automation
- Renewable Energy Systems
- Socio-technical Solutions for Community Development

VI. COURSE IMPLEMENTATION STAGES

1. Orientation Session

A Project Orientation Session shall be conducted during the last week of the fourth term by the Portfolio In-charge faculty. This session will brief students on:

- Project objectives.
- Scope and expected deliverables
- Guidelines for execution and assessment
- Faculty and institutional support

2. Mapping of Students and Faculty Mentors

Students will be organized into teams and assigned faculty mentors based on the following criteria:

- Alignment of student interests
- Faculty expertise
- Team size and project scope.

3. Problem Identification and Finalisation

Students are required to:

- Conduct a field survey or exploratory study under faculty supervision
- Identify a real-world, relevant, and feasible problem

- present the idea to a group of faculty members for approval
- This activity should commence in the final week of the 4th semester and be completed by the first week of the 5th semester.

4. Requirement Gathering

A dedicated week is allotted for collecting detailed project requirements, including:

- Estimation of human resources
- Identification of technical (hardware/software) needs
- Feasibility study and cost analysis

Outcome: Students must present their findings to the faculty mentor for approval.

5. Project Planning

Students must prepare a comprehensive project plan covering:

- Task allocation and resource planning
- Time frame and cost estimation
- Team member responsibilities
- Selection of an appropriate development model (e.g., Waterfall, Agile, Spiral)

Deliverables: A clear roadmap including timelines, milestones, and expected outcomes.

6. Project Proposal Submission

The finalized project proposal must be submitted in **soft copy format** and should include:

- Project title and objectives
- Detailed requirement analysis
- Project plan and execution strategy
- Expected deliverables and outcomes
- Development model and tools to be used

7. Project Development, Testing & Report Preparation

Under the continuous guidance of faculty mentors, students shall:

- Develop the project according to the approved plan
- Maintain project documentation throughout the development lifecycle
- Prepare a detailed final report that includes:
  - System design and architecture
  - Implementation details
  - Testing procedures and results
  - Challenges encountered and solutions adopted
  - Final outcomes and evaluation metrics.

8. Project Demonstration

Students must present their project in two stages:

- **Preliminary Demonstration:** A progress review shown to the faculty guide during the development phase.
- **Final Demonstration:** A complete presentation of the working model or application during the End Semester Examination (ESE).

VII. DETAILED WEEKWISE TIMELINE FOR THE COURSE IMPLEMENTATION STAGES:

Week	Activity	Responsibilities
Week 1	**Orientation Session (Last week of 4th Term)**	Portfolio In-charge Faculty: Brief students on project objectives, scope, deliverables, guidelines, execution, and assessment.
Week 2	**Mapping of Students and Faculty Mentors**	Portfolio In-charge Faculty: Organize students into teams based on interests, faculty expertise, team size, and project scope.
Week 3-4	**Problem Identification and Finalisation**	Students: Carry out a field survey or exploratory study under faculty supervision, identify a relevant real-world problem, finalise the issue, and submit a synopsis for faculty approval.
Week 5	**Requirement Gathering**	Students: Collect detailed project requirements (human resources, technical needs, feasibility study, and cost analysis).
Week 6	**Requirements Gathering Presentation**	Students: Present findings to the faculty mentor for approval.
Week 7	**Project Planning**	Students: Prepare a project plan including task allocation, resource planning, timeline, budget, development model, and deliverables. Faculty Mentor: Review plan.
Week 8	**Project Proposal Submission**	Students: Submit final project proposal (title, objectives, requirements, plan, tools, outcomes). Faculty Mentor: Review and approve.
Week 9-12	**Project Development, Testing & Report Preparation**	Students: Begin project development according to the plan. Maintain documentation. Test and iterate. Prepare final report (design, implementation, testing results).
Week 13	**Preliminary Demonstration**	Students: Present a progress review to the faculty mentor.
Week 14	**Project Finalisation & Report Completion**	Students: Finalise development. Prepare a detailed project report with system design, testing results, challenges, and outcomes.
According to the Examination Schedule	**Final Demonstration (End Semester Examination)**	Students: Conduct final demonstration of the working model/application during the ESE. Faculty: Evaluate the project based on the demonstration and report.

VIII. CRITERIA FOR ASSESSMENT/EVALUATION OF PROJECT WORK

A. Formative Assessment (FA) Criteria

The evaluation of students during the fifth semester for Progressive Assessment (PA), totalling **50 marks**, will be carried out based on the following criteria:

Category	Week(s)	Assessment Criteria	Max Marks	Performance Description (Rubric Scale: 1 to 5)	Group Enrollment Nos.	Group Marks
i) Team Assessment (30 Marks)	Week 3-4	Project Selection & Problem Definition	5	1–2 Lacks clarity & relevance 3 – Relevant and defined 4 - Clearly defined and suitable 5 – Innovative and impactful		
	Week 5	Literature Review & Data Collection	5	1 – Insufficient or irrelevant sources 2 – Limited data with unclear relevance 3 – Adequate review with relevant data 4 – Structured, relevant data 5 – Comprehensive and critically evaluated sources		
	Week 6	Project Design / Concept & Execution	10	1–2 Design is poorly structured; minimal or no execution 3–4 Weak concept, unclear goals, and limited execution 5–6 Basic concept with moderate execution; design may lack innovation or clarity 7–8 Solid, functional design with good planning and consistent execution 9–10 Creative, technically sound design with excellent planning and thorough execution		

	Week 7	Progress as per Action Plan / Milestones	5	1 – No measurable progress 2 – Progress is significantly behind schedule 3 – Moderate progress; some tasks completed 4 – Mostly on schedule with minor delays 5 – Fully on schedule and meeting milestones		
	Week 8	Quality & Presentation of Project Report	5	1 – Poorly organized and unclear 2 – Disorganized with formatting issues 3 – Fair structure and readability 4 – Well-organized and readable 5 – Professionally formatted and well-written report		

Category	Week(s)	Assessment Criteria	Max Marks	Performance Description (Rubric Scale: 1 to 5)	Individual Enrollment Nos.	Individual Marks
ii) Individual Assessment (20 Marks)	Week 2–13 (Ongoing)	Individual Contribution to the Team	10	1 -2 Rarely involved or shows minimal effort 3 -4 Occasionally contributes with limited involvement 4 –5 Participates adequately 6 – 7 Active and dependable team member 8 –10 Consistently proactive, often leads initiatives		
	Week 2–13 (Ongoing)	Subject Knowledge & Understanding	10	1–2 Very limited understanding of subject concepts; unable to answer questions 3–4 Basic awareness but with significant gaps in understanding 5–6 Fair knowledge of concepts; can answer general questions correctly 7–8 Good understanding of a subject; explains concepts clearly and applies them logically 9–10 Excellent grasp; demonstrates deep insight, applies concepts to real-world/project scenarios		
Total			**50**			

i) **Total Formative Assessment (FA) Marks**

Sr. No.	Assessment Criteria	Marks
1	Team Assessment	30
2	Individual Assessment	20
Total		**50**

Note: The Total **Formative Assessment (FA) Marks** for the individual student.

B. Summative Assessment Criteria

*The summative assessment for students in the Fifth Semester **SA-PR** will carry a total of **50 marks** and shall be conducted by the faculty. Appropriate rubrics may be developed by the faculty for evaluation.*

Course Name:		**Course Code:**	
Student Name:		**Enrolment Number:**	
Project Batch Number:		**Division:**	
Faculty Guide Name:		**Term:**	

Sr. No	Week	Assessment Criteria	Max Marks	Performance Description (Score Range)	Marks
1	According to the Examination Schedule	**Knowledge and Skill Set Developed**	10	**1–2**: Minimal knowledge gained	
				3–4: Basic understanding with limited skills	
				5–6: Moderate knowledge and practical exposure	
				7–8: Sound knowledge and good skill application	
				9–10: Excellent grasp and skill mastery with advanced application	
2	According to the Examination Schedule	**Quality and Potential of the Project**	10	**1–2**: Poor quality, unclear purpose	
				3–4: Basic functionality with low impact	
				5–6: Adequate quality with moderate potential	
				7–8: High-quality, practical utility	
				9–10: Exceptional quality and strong potential for real-world implementation	
3	According to the Examination Schedule	**Creativity, Innovation, and Teamwork**	10	**1–2**: Lacks originality, poor collaboration	
				3–4: Limited creativity and uneven teamwork	
				5–6: Shows creativity and fair teamwork	
				7–8: Innovative and well-coordinated efforts	
				9–10: Highly original ideas with exemplary team synergy	
4	According to the Examination Schedule	**Project Design, Development, Execution**	10	**1–2**: Poor design and implementation	
				3–4: Basic structure with several gaps	
				5–6: Functional design and moderate execution	
				7–8: Well-planned and executed efficiently	
				9–10: Robust, optimized design with flawless execution	
5	According to the Examination Schedule	**Project Presentation**	10	**1–2**: Disorganized and unclear	
				3–4: Lacks confidence and structure	
				5–6: Acceptable delivery with room for improvement	
				7–8: Clear, engaging, and well-structured	
				9–10: Highly professional, confident, and impactful presentation	

Note: The above rubric will be used as the summative assessment framework for evaluating individual student performance.

IX. SUGGESTED COS- POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)			
	PO1 -Basic and Discipline-Specific Knowledge	PO2-Problem analysis	PO3-Design/ Development of Solutions	PO-4 Engineering Tools, Experimentation and Testing	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Lifelong Learning	PSO-1	PSO-2	PSO-3	PSO-4
CO1	2	2	--	--	2	2	2	2	--	2	1
CO2	2	3	2	2	--	3	2	3	2	2	2
CO3	3	3	3	3	2	2	2	3	2	2	2
CO4	--	--	--	--	3	2	2	2	--	--	2
CO5	2	2	2	2	--	3	2	1	--	--	3
CO6	2	2	2	2	2	3	3	3	--	--	3

X. TYPOGRAPHICAL GUIDELINES FOR PROJECT REPORT WRITING:

After the completion of the project work, each student is required to submit a project report. The report should adhere to the following structure and formatting guidelines:

A. STRUCTURE OF THE REPORT

The project report must include the following sections in the given order:

1. **Cover Page** – As per *Annexure I*.
2. **Title Page** – As per *Annexure I*.
3. **Certificate** – As per *Annexure II*.
4. **Acknowledgment** – A brief section in which the student may express gratitude to individuals and organizations who supported the project. As per *Annexure III*.
5. **Abstract** – A one-page summary outlining the objective of the project and the methodology adopted. As per *Annexure IV*.
6. **Table of Contents** – Prepared as per general guidelines. As per *Annexure V*.
7. **List of Figures-**The **purpose of the List of Figures** in a project report is to provide a clear and organized index of all visual representations used throughout the document. As per *Annexure VI*
8. **List of Tables -**The **purpose of the List of Tables** in a project report is to provide a structured overview of all tabular data included in the document. As per *Annexure VI*
9. **Project Description** –
   - Divided into chapters or sections.
   - Each chapter should comprehensively describe a specific phase or component of the project.
   - Include properly labelled diagrams, tables, and flowcharts wherever applicable.
10. **Conclusion** – Summarizes findings and outcomes of the project work.

11. **References** –
    - Begin two spaces below the heading "**REFERENCES**", aligned to the left.
    - Use **single spacing** within entries and list in **alphabetical order**.
    - References must be cited in the text using **square brackets [ ]**, numbered according to their first appearance.
    - Include author name(s), publication year, and other relevant details.

B. REPORT SPECIFICATIONS

1. **Binding**: Hard-bound only
2. **Cover Color**: Black with gold-embossed text (as per *Annexure 1*)
3. **Number of Copies**: Five – One per student and one departmental copy

Paper Size: A4 (portrait orientation)

4. **Margins**:
    - Top: 1 inch
    - Bottom: 1 inch
    - Right: 1 inch
    - Left: 1.5 inches
5. **Font Style**: Times New Roman
6. **Font Sizes**:
    - **Chapter Titles:** 16-point**, Bold, Uppercase**
    - **Headings:** 14-point, **Bold**
    - **Body Text:** 12-point, **Regular**
7. **Line Spacing**: 1.5 throughout the report
8. **Page Numbering**: Bottom center in the format "Page X of N"

Annexure-I

GOVERNMENT POLYTECHNIC, PUNE

(An Autonomous Institute of the Government of Maharashtra)

DEPARTMENT OF METALLURGICAL ENGINEERING

PROJECT REPORT

ON

"[TITLE OF THE PROJECT IN CAPITAL LETTERS]"

Submitted By

Student name 1 (enrollment no.)
Student name 2 (enrollment no.)
Student name 3 (enrollment no.)
Student name 4 (enrollment no.)

UNDER THE GUIDANCE OF

[Guide's Full Name]
(Designation, e.g., Lecturer, Department of Metallurgical Engineering)

Submitted in Partial Fulfilment

of

The Requirements for the Award of the Diploma in

METALLURGICAL ENGINEERING

ACADEMIC YEAR: 20__–20__

GOVERNMENT POLYTECHNIC, PUNE, Ganeshkhind Road, Shivajinagar, Pune – 411016

Annexure-II

GOVERNMENT POLYTECHNIC, PUNE

(An Autonomous Institute of the Government of Maharashtra)

DEPARTMENT OF METALLURGICAL ENGINEERING

CERTIFICATE

This is to certify that

1)Name of Student Enrollment Number

2)Name of Student Enrollment Number

3)Name of Student Enrollment Number

4)Name of Student Enrollment Number

has completed the necessary project work and prepared the bonafide report on

"PROJECT TITLE"

in a satisfactory manner as a partial fulfillment of the requirements for the

DIPLOMA IN

METALLURGICAL ENGINEERING

FOR THE ACADEMIC YEAR

20__- 20__

(Internal Guide) **(External Examiner)**

(H.O.D) **(Principal)**

Annexure-III

Acknowledgment

(Sample Format)

We would like to express our sincere gratitude to all those who supported and guided us throughout the successful completion of this project.

We are especially thankful to **[Guide's Name]**, our project guide, for their constant encouragement, valuable suggestions, and constructive feedback during the entire duration of this project work.

We would also like to thank **[Head of Department's Name]**, Head of the Department of **[Branch Name]**, Government Polytechnic, Pune, for providing us with the necessary infrastructure and support.

We are deeply grateful to **[Principal's Name]**, Principal, Government Polytechnic, Pune, for providing us with this valuable opportunity and for fostering an academic environment conducive to learning and innovation.

Our heartfelt thanks go to all the faculty members and technical staff of the **[Department Name]** for their help in various ways during this project.

We also wish to acknowledge the support of our classmates, friends, and family members who encouraged and motivated us throughout the journey.

Lastly, we are thankful to the **Government Polytechnic, Pune**, for allowing us to work on this project as a part of our academic curriculum.

Student name 1 (enrollment no.)
Student name 2 (enrollment no.)
Student name 3 (enrollment no.)
Student name 4 (enrollment no.)

Annexure-IV

Abstract

The abstract serves as a one-page comprehensive summary that encapsulates the core aspects of the project. It begins by clearly stating the primary objective or goal of the work, providing the reader with an understanding of the problem being addressed or the purpose behind the study. Following this, the abstract outlines the methodology employed, detailing the approach, techniques, tools, and processes used to achieve the project's objectives. This section may also briefly touch on the scope of the work, key findings, and any conclusions or implications derived from the results. The abstract offers a concise yet informative overview, enabling readers to quickly grasp the essence and significance of the project without delving into the full report.

Annexure-V

Table of Contents

Annexure-VI

List of Figures

List of Tables

Annexure-VII
PROJECT DAIRY

Course code:		**Course Name:**	
Student Name:		**Enrolment Number:**	
Project Batch Number:		**Division:**	
Faculty Guide Name:		**Term:**	

Date	Enrolment Numbers of Present Students	Work Assigned/Corrections Suggested	Faculty Remarks	Faculty Signature

Signature of Faculty **Signature of HOD**

Name & Signature:

Shri.A. V. Mehtre
Lecturer in Metallurgical Engineering

Shri. S. B. Kulkarni
Lecturer in Mechanical Engineering

Dr. N. G. Kulkarni
HoD in Mechanical Engineering

(Course Experts)

Name & Signature:

Shri. Pravin B. Kamble
(I/C 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	**SELECTION OF MATERIALS AND FAILURE ANALYSIS**
COURSE CODE	**MT41210**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT41210	SELECTION OF MATERIALS AND FAILURE ANALYSIS	DSC	04	--	02	02	08	4	3	30	70	100	40	-	-	25#	10	25	10	150

Total IKS Hrs for Term: 01 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:

The course includes study of mechanical properties,methods to evaluate alternatives and determine performance requirements. The student will be able to select a material for strength, resistance to corrosion, temperature, wear and select steels and tool steel for various applications.The course gives knowledge of fracture toughness to predict performance of components.It defines failure and explains its causes. This knowledge is very useful for design 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 – Evaluate alternatives, determine performance requirements.

CO2 – Select a material for strength, resistance to corrosion, temperature, wear.

CO3 – Select steels for high strength, heat resistant and corrosion resistant applications.

CO4 – Select tool steels required for cutting, cold-working dies, hot working dies.

CO5 – Apply knowledge of fracture toughness to predict performance of components.

CO6 – Define failure, state its causes, correlate failure with microstructure and state categories of material stressors- Mechanical, chemical, electrochemical, thermal, radiation and electrical.

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
SECTION-1				
UNIT-I INTRODUCTION (CL Hrs-08 Marks-10)				
1	TLO 1.1 Enlist materials used in ancient period and explain history of study of fracture in materials. TLO 1.2 Explain principles involved in the selection of materials. TLO 1.3 Explain the selection processes. TLO 1.4 State the factors affecting material prices and material substitution. TLO 1.5 Explain computer's use for selection of material.	1.1 Early materials used in stone age, Bronze age and Iron age. History of study of fractures in materials. 1.2 Principles involved in the selection of materials 1.3Selection process- determination of performance requirements, evaluation of alternatives. 1.4 Factors affecting material prices, material substitution. 1.5 Computer's use for selection of material.	Lectures Assignment	**CO1**
UNIT-II FUNCTIONAL REQUIREMENT OF ENGINEERING MATERIALS (CL Hrs-12 Marks-12)				
2	TLO 2.1 Select material for conditions of strength, resistance to corrosion, temperature, wear. TLO 2.2 Select non-ferrous materials for various applications. TLO 2.3 State the various lightweight materials used in battery and enlist their properties.	2.1 Selections of material for strength, resistance to corrosion, temperature, wear with practical examples 2.2 Selection of Polymeric, Ceramic and composite materials for specific applications 2.3 Study of lightweight materials used in battery -Titanium	Improved Lecture Assignment	**CO2**
UNIT-III STEEL SELECTION (CL Hrs-10 Marks-13)				
3	TLO 3.1 Select high strength, heat resistant alloys, corrosion resistant steels required for good weldability, formability, forgeability. TLO 3.2 Select Tool steels required for cutting, cold-working dies, hot working dies. TLO 3.3 Select materials and processes for tools and a few components of automobile engines, machine tools, foundry metal-working equipment, testing machine, ore-dressing equipment.	3.1 Selection of high strength, heat resistant alloys, corrosion resistant steels required for good weldability, formability, forgeability. 3.2 Selection of Tool steels required for cutting, cold-working dies, hot working dies. 3.3 Selection of materials and processes for tools and a few components of automobile engines, machine tools, foundry metal-working equipment, testing machine, ore-dressing equipment.	Improved Lecture Assignment	**CO3, CO4**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
		SECTION II		
		UNIT-IV FRACTURE TOUGHNESS (CL Hrs-14 Marks-17)		
4	TLO 4.1 Apply knowledge of fracture toughness to predict performance of components. TLO 4.2 Explain Plain strain fracture, critical crack size, crack growth under cyclic loads.	4.1 Use of fracture toughness to predict performance of components on various paraters. 4.2 Plain strain fracture, critical crack size, crack growth under cyclic loads. (No mathematical details)	Improved Lecture Assignment	**CO5**
		UNIT-V FAILURE ANALYSIS (CL Hrs-16 Marks-18)		
5	TLO 5.1 Define failure, state its causes and explain correlation of failure with microstructure. TLO 5.2 Explain categories of material stressors- Mechanical, chemical, electrochemical, thermal, radiation and electrical. TLO 5.3 State and explain Modes of fracture. TLO 5.4 Explain factors influencing Brittle fracture. TLO 5.5 Explain importance of failure investigation TLO 5.6 Explain procedure of failure analysis	5.1 Failure- Definition, its causes, correlation of failure with microstructure. 5.2 Categories of material stressors- Mechanical, chemical, electrochemical, thermal, radiation and electrical. 5.3 Modes of fracture. 5.4 Factors influencing Brittle fracture. 5.5 Importance of failure investigation . 5.6 Procedure of failure analysis	Improved Lecture Assignment	**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 Familiar with steps in selection of materials	Study of factors/Creteria in selection of materials	02	1
2	LLO 2.1 Familiar with different types of failures	Study of different types of failures; ductile, brittle, wear, fatigue, corrosion, stress corrosion.	02	6
3	LLO 3.1 Examine different types of fractured surfaces	Study and examination of different types of fractured surfaces. Transgranular and intergranular fractured samples to be examined.	04	5
4	LLO 4.1 Select a material for resistance to corrosion.	Case studies of selection of materials for resistance to corrosion.	04	2
5	LLO 5.1 Select a material for resistance to heat.	Case studies of selection of materials for resistance to heat.	04	3
6	LLO 6.1 Select a material for resistance to wear.	Case studies of selection of materials for resistance to wear.	04	2

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
7	LLO 7.1: Select a material for cold working Dies.	Case studies of selection of materials for cold working Dies.	04	4
8	LLO 8.1: Select a material for hot working Dies.	Case studies of selection of materials for hot working Dies.	02	4
9	LLO 9.1: Select a non ferrous material for a given application.	Case studies of selection of non ferrous material for a given application.	02	2
10	LLO 10.1 For self learning activity	Complete a micro project based on guidelines.	02	All
		Total Hrs	30	

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

Micro project-

- Prepare a chart showing a case study on selection of ferrous materials for various applications.
- Prepare a chart showing a case study on selection of non-ferrous materials for various applications.
- Prepare a chart showing a case study on selection of non ferrous materials for various applications
- Prepare a chart showing various types of failures.
- Prepare a chart showing comparison of different types of failure
- Prepare chart explaining factors influencing Brittle fracture.
- Prepare chart explaining procedure of failure analysis.

Assignment-

- Explain factors affecting material prices.
- Explain use of computers in material selection.
- Select a materials for tools and a few components of automobile engines, machine tools, foundry metal-working equipment, testing machine, ore-dressing equipment.
- Explain fatigue and creep failure.
- Case study of steps in failure investigation/analysis.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	NIL	

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	INTRODUCTION	CO1	8	6	2	2	10
2	II	FUNCTIONAL REQUIREMENT OF ENGINEERING MATERIALS	CO2	12	4	2	6	12
3	III	STEEL SELECTION	CO3	10	5	2	6	13
			Grand Total	30	15	6	14	35
SECTION II								
4	IV	FRACTURE TOUGHNESS	CO4	14	9	4	4	17
5	V	FAILURE ANALYSIS	CO5	16	9	4	5	18
			Grand Total	30	18	8	9	35

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. 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	2	2	1	3	1	3	2	2	1	3
CO2	3	3	3	3	3	1	3	3	3	3	3
CO3	3	3	3	3	3	1	3	3	3	3	3
CO4	3	3	3	3	3	1	3	3	3	3	3
CO5	3	3	3	3	3	1	3	3	3	3	3
CO6	3	3	3	3	3	1	3	3	3	3	3

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	Dieter	Mechanical Metallurgy	McGraw-Hill international
2	Reed-Hill	Physical Metallurgy Principles	East-West Press Pvt. Ltd., New Delhi.
3	A.K.Bhargava	Engineering Materials Polymers, Ceramics and Composites	PHI Learning Private Limited
4.	Dr.V.D.Kodgire	Material Science and Metallurgy	Everest Publication

XII. LEARNING WEBSITES & PORTALS

Sr.No	Link/Portal	Description
1.	https://www.youtube.com/watch?v=WERoSRcnafA	Selection of materials
2.	https://www.youtube.com/watch?v=Ukxrmyntl0Q	Selection of materials
3.	https://youtu.be/QjI3E4haOp4?feature=shared	Fracture
4.	https://www.youtube.com/watch?v=jopKXJtZUcE	Fatigue failure
5.	https://www.youtube.com/watch?v=zH05sDLKMoU	Creep failure

Name & Signature: **Shri. Pravin B. Kamble** (Course Experts)	**Smt. Sarika S. Aglave**
Name & Signature: **Shri. Pravin B. Kamble** (I/C Programme Head)	Name & Signature: **Shri. Sudin B. Kulkarni** (CDC In-charge)

GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN METALLURGICAL ENGINEERING**
PROGRAMME CODE	**05**
COURSE TITLE	**METAL JOINING PROCESSES**
COURSE CODE	**MT51201**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme											
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT51201	MATERIAL JOINING PROCESSES	DSE	03	00	02	01	06	3	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.

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:

In the world, various parts of engineering components are required to be joined on a regular basis. The growing competition & developments in the production methods create intricate problems as regards to maintenance & repairs. Metal joining is the solution for this. It is therefore necessary to impart the basic knowledge of joining to the students.

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 welding with riveting and casting.

CO2- Select appropriate welding process for particular application.

CO3- Draw welds positions, weld joint design and microstructure of Heat Affected Zone.

CO4- Compare soldering with brazing.

CO5- Suggest suitable remedies for various welding defects.

CO6- Perform various destructive and non-destructive tests on welded parts.

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
SECTION I				
UNIT-I INTRODUCTION TO WELDING (CL Hrs-04 Marks-08)				
1	TLO 1.1 State the principle, advantages, limitations, applications & classification of welding methods. TLO 1.2 Compare welding with riveting and casting. TLO 1.3 State the requirements of welding processes. TLO 1.4 Define weldability. TLO 1.5 Draw weld positions and weld joint design. TLO 1.6 Aware safety rules and regulations in welding shops.	1.1 Welding – Principle, Advantages, Limitations, Applications & Classification. 1.2 Principle of casting (Fusion welding), comparison of welding with riveting and casting. 1.3 Requirements of welding processes. 1.4 Weldability, Factors effect on weldability. 1.5 Weld positions, weld joint design. 1.6 Safety rules and regulations in a welding shop.	Lecture Assignment	**CO1** **CO3**
UNIT-II WELDING METHODS (CL Hrs-08 Marks-12)				
2	TLO 2.1 State the principle of mentioned welding methods. TLO 2.2 Explain the chemistry of oxy-acetylene flame. TLO 2.3 State the functions of fluxes in welding. TLO 2.4 Explain the working of mentioned welding methods with a neat sketch. TLO 2.5 State the advantages, limitations and applications of mentioned welding methods.	2.1 Gas Welding Process: Principle, Types of Flames, Chemistry of oxy-acetylene flame, Welding techniques– Leftward and Rightward, Fluxes and its functions, Equipments, Working, Advantages, Limitations & Applications. 2.2 Shielded Metal Arc Welding Process (SMAW): Principle, Equipments, Working, Advantages, Limitations & Applications. 2.3 Metal Inert Gas (MIG) Welding /Metal Active Gas (MAG) Welding Process: Principle, Equipment, Working, Advantages, Limitations & Applications. 2.4 CO_2 (Carbon dioxide) Welding Process: Principle, Equipment, Working, Advantages, Limitations & Applications. 2.5 Tungsten Inert Gas (TIG) Welding Process: Principle, Equipments, Working, Advantages, Limitations & Applications. 2.6 Submerged Arc Welding Process: Principle, Equipments, Working, Advantages, Limitations & Applications.	Lecture Assignment	**CO2**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
		2.7 Flux-Cored Arc Welding: Principle, Equipments, Working, Advantages, Limitations & Applications.		
UNIT-III OTHER WELDING PROCESSES (CL Hrs-08 Marks-10)				
3	TLO 3.1 State the principle, advantages, limitations and applications of mentioned welding methods.	3.1 Principle, Working, Advantages, Limitations and Applications of: a) Resistance Welding – Spot welding, Flash butt welding and Seam welding, b) Thermit Welding, c) Friction Welding, d) Electron Beam Welding, e) Laser Beam Welding.	Lecture Assignment Demonstration	**CO2**
UNIT-IV INTRODUCTION TO ROBOTIC WELDING (CL Hrs-03 Marks-05)				
4	TLO 4.1 Define Industrial Robotics. TLO 4.2 Describe Basic Components of industrial robot- Base, Manipulator arm, End effectors, Sensors & Transducers, Actuators and Drives, Control systems, Teach pendant. TLO 4.3 Explain Basic Motions & Joints of Robot. TLO 4.4 Application of Robot in MIG Welding	4.1 Introduction to Industrial Robotics & safety 4.2 Basic Components of industrial robot- Base, Manipulator arm, End effectors, Sensors & Transducers, Actuators and Drives, Control systems, Teach pendant. 4.3 Basic Motions & Joints of Robot 4.4 Application of Robot in MIG Welding.	Lecture Assignment	**CO2**
SECTION II				
UNIT-V METAL TRANSFORMATION IN WELDING (CL Hrs-05 Marks-10)				
5	TLO 5.1 Explain HAZ and structure of welded joint with neat sketch TLO 5.2 State the importance of pre and post heat treatment of welding. TLO 5.3 Recognize Metallurgical changes occur in welding.	5.1 Various zones of weld region, Heat Affected Zone (HAZ). 5.2 Structure of welded joints. 5.3 Pre and post heat treatment of welding. 5.4 Metallurgical changes occur in welding.	Lecture Assignment	**CO3**
UNIT–VI SOLDERING AND BRAZING (CL Hrs-08 Marks-12)				
6	TLO 6.1 State the principle, advantages, limitations and applications of brazing and soldering. TLO 6.2 Describe the process of brazing and soldering. TLO 6.3 Compare brazing with soldering.	6.1 Brazing: Principle, Procedure, Filler metals. 6.2 Brazing Fluxes – Functions and Requirements, Advantages, Limitations, Applications, Brazing processes. 6.3 Soldering: Principle, Solders, Fluxes, 6.4Requirements of Soldering, Advantages, Limitations, Applications, Soldering Methods.	Lecture Assignment	**CO4**

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT–VII WELDING DEFECTS AND TESTING OF WELDS (CL Hrs-09 Marks-13)				
7	TLO 7.1 Enlist welding defects. TLO 7.2 Suggest remedies of causes for various welding defects. TLO 7.3 Inspect welded structures TLO 7.4 Perform destructive and non-destructive tests on welded parts.	7.1 Causes and Remedies of Weld Defects a) Cracks, b) Distortion, c) Incomplete penetration, d) Inclusions, e) Porosity and Blow holes, f) Undercutting, g) Overlapping. 7.2 Inspection of welded structures. 7.3 Weld Tests – Destructive testing, Non-Destructive Tests.	Lecture Assignment	**CO5** **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 To draw weld positions and Weld joint design.	Draw weld positions and weld joint design.	04	CO1
2	LLO 2.1 Perform Shielded Metal Arc Welding process.	Perform Shielded Metal Arc Welding process.	04	CO3
3	LLO 3.1 Conduct spot welding and seam welding.	Conduct spot welding and seam welding.	04	CO3
4	LLO 4.1 Identify different basic robotic components and its working for a given system.	Identify different basic robotic components and its working for a given system.	02	CO3
5	LLO 5.1 Make use of teach Pendant.	Make use of teach Pendant.	02	CO3
6	LLO 6.1 Jogging robot with different motion commands for given application.	Jogging robot with different motion commands for a given application.	02	CO3
7	LLO 7.1 Demonstration of Robotic MIG Welding.	Demonstration of Robotic MIG Welding.	02	CO3
8	LLO 8.1 Draw the Heat Affected Zone of the welded part and explain it in detail for low carbon steel.	Draw the Heat Affected Zone of the welded part and explain it in detail for steel.	04	CO2
9	LLO 9.1 Perform soldering and brazing.	Perform soldering and brazing.	02	CO4
10	LLO 10.1 Prepare a report on causes and remedies on various welding defects.	Prepare a report on causes and remedies on various welding defects.	02	CO5
11	LLO 11.1 Perform Nick-Break Test.	Perform Nick-Break Test.	02	CO6

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

Micro project

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Prepare a report on a visit to a welding shop.
- Collect the detailed data of any one new welding process.
- Prepare a report on Defects– definition, causes & remedies for any one welding process.
- Prepare a poster on comparison of welding, brazing and soldering.
- Prepare a report on radiant energy welding processes.
- Prepare a report on destructive tests on welded parts.
- Prepare a report on non-destructive tests on welded parts.

Assignments

- Prepare journals based on practical performed in the laboratory. Journal consists of write ups, diagrams, observations, required tools, equipment and date of performance with teacher signature.
- Power Point Presentation on different welding processes by a group of two/three students. (Duration:10 minutes)
- Case study on oxy-acetylene welding defects
- Draw arrangement of oxy-acetylene welding process and types of flames of it.
- Prepare a report on Submerged Arc Welding Process
- To study Thermit Welding.
- Prepare a report Cold welding process, parameters and applications.
- Search information on computer aided welding.
- Collect information about new development in welding.
- Collect information on application of Robotic welding.
- Collect information regarding principle, procedure, parameter and product for new welding processes such as Magnetic Welding.
- Collect information on Explosive welding, Electro-slag welding and prepare reports regarding principle, parameter and application.
- Prepare a report on Auto Brazing parameter, procedure and application.
- Prepare a report on ISO 5817 standardization for various defect acceptance.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Power supply, welding electrode, electrode holder, Helmet	LLO 2.1
2	Spot and seam welding machine.	LLO 3.1

3	Soldering and brazing equipments	LLO 9.1
4	Former, welded part, support	LLO 2.1, 3.1
5	Arc welding machine, transformer	LLO 2.1

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	INTRODUCTION TO WELDING	CO1, CO3	04	04	02	02	8
2	II	WELDING METHODS	CO2	08	04	04	04	12
3	III	OTHER WELDING PROCESSES	CO2	08	06	02	02	10
4	IV	INTRODUCTION TO ROBOTIC WELDING	CO2	03	02	02	01	5
Grand Total				23	20	08	07	35
SECTION II								
5	V	METAL TRANSFORMATION OF WELDING	CO3	05	02	04	04	10
6	VI	SOLDERING & BRAZING	CO4	08	04	04	04	12
7	VII	WELDING DEFECTS AND TESTING OF WELDS	CO5, CO6	09	06	03	04	13
Grand Total				22	12	11	12	35

IX. ASSESSMENT METHODOLOGIES/TOOLS

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

2. 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	1	1	2	3	1	2	1
CO2	3	2	2	2	1	1	2	3	--	1	2
CO3	3	1	1	1	1	1	1	3	--	1	1
CO4	3	1	1	1	1	1	2	3	1	1	1
CO5	3	2	3	3	2	2	2	3	1	1	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	Welding Technology	O.P. Khanna	Dhanpat Rai Publications, First Edition, Revised Edition 2015. ISBN: 978-93-83182-55-8
2	Welding and welding technology	Little, Richard L	McGraw-Hill, January 1973. ISBN13: 9780070380950
3	Welding Technology	N.K. Shrinivasan	Khanna Publishers, 4th Edition, 6th Reprint 2016. ISBN: 978-81-7409-159-9
4	Welding, Brazing, and Soldering	--	ASM Handbook, Volume 6 ISBN13: 9780871703828

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://nptel.ac.in/courses/112/107/112107090/	Introduction to the joining process.
2	https://nptel.ac.in/courses/113/106/113106087/	Welding Processes.

3	https://nptel.ac.in/courses/112/103/112103263/	Introduction to welding.
4	https://nptel.ac.in/courses/113107092/	Distinct zones in fusion welded specimens.

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GOVERNMENT POLYTECHNIC, PUNE

'120 – NEP' SCHEME

PROGRAMME	**DIPLOMA IN MT**
PROGRAMME CODE	**05**
COURSE TITLE	**METAL WORKING PROCESSES**
COURSE CODE	**MT51204**
PREREQUISITE COURSE CODE & TITLE	**NA**
CLASS DECLARATION COURSE	**YES**

I. LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Course Type	Learning Scheme					Credits	Assessment Scheme										
			Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
														Practical						
			CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
										Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
MT51204	METAL WORKING PROCESSES	DSE	03	--	02	01	06	3	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.

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:

A number of metallic engineering products are used in construction, fabrication and transportation industries. Most of the metallic products can be manufactured by various methods of metal forming such as rolling, forging, extrusion, drawing, sheet metal working etc. A Diploma engineer is expected to work at supervisory level in various production units. Therefore, the student must be conversant with metallurgical aspects of metal forming processes, along with the basic knowledge of equipments and production of various components by suitable process. This course aims to equip the student with the knowledge of various metal working operations that leads to get the best metallurgical qualities and economic 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- Apply knowledge of metal rolling processes to identify and resolve defects in rolled metal products.
CO2- Apply knowledge of wire, rod, tube drawing to analyze and solve defects in drawn metal products.
CO3- Relate various defects in spinning products with metal spinning parameters to resolve the defects.
CO4- Identify issues related to metal forging processes and apply knowledge to improve the process.
CO5- Illustrate different metal extrusion processes and explain the defects in extruded products and their remedies.
CO6- Select sheet metal forming operations, identify product defects, causes of defects and plan remedies.

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
		SECTION I		
		UNIT-I ROLLING OF METALS (CL Hrs-08 Marks-13)		
1	TLO 1.1 Describe various forces involved in the metal rolling process. TLO 1.2 Classify rolling mills / rolling processes. TLO 1.3 State the purpose of a good roll pass design. TLO 1.4 Identify the defects in rolled products. TLO 1.5 Explain tube making by rolling process.	1.1 Schematic representation of Rolling process, Theory of rolling, Forces acting on metal during rolling process, Angle of bite, Arc of contact, Roll bite condition, Neutral point or No slip point, Distribution of roll pressure along the arc of contact. 1.2 Classification of rolling processes, Hot rolling and cold rolling, Classification of rolling mills based on design / construction, Two high pullover mill, two high reversing mill, three high mill, four high mill, cluster mill, planetary mill, Elastic deformation of rolls. 1.3 Variables in metal rolling - Roll diameter, deformation resistance of metal, friction, front and back tension, material temperature, Roll pass design, Objectives of roll pass design, open roll pass and closed roll pass. 1.4 Construction and working of rolling mill, Types of Rolled products - bloom, billet, slab, plate, sheet, strip, rails, rods, bars, structural shapes, Defects in rolled products, causes of defects and their remedies. 1.5 Tube making by rolling - rotary piercing, Mannesmann process - construction and working principle of Mannesmann mill, Pilger process - construction and operation of pilger mill, Plug rolling process - design and operation of plug rolling mill.	Lectures, Assignments, Online videos - Simulations.	CO1

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
UNIT-II DRAWING OF WIRES AND RODS (CL Hrs-08 Marks-12)				
2	TLO 2.1 State the principle of wire drawing and tube drawing, classify drawing processes. TLO 2.2 Describe procedure for the preparation of raw material for wire - rod - tube drawing operation. TLO 2.3 Select the die material for wire drawing die and write justification for the same. TLO 2.4 Describe the working principle of drawbench, bull block and stepped cone wire drawing machine. TLO 2.5 Interpret various defects in drawn wires / rods / tubes; suggest the remedial action for each defect.	2.1 Introduction to drawing of rods, wires and tubes, Principle of Drawing, Classification of drawing processes, Comparison of Wire drawing and rod drawing, Tube drawing processes - tube sinking, tube drawing with fixed plug - floating plug, tube drawing with mandrel. 2.2 Raw materials for wire/rod drawing, Need for the preparation of raw material for wire drawing process, Cleaning - pickling - surface coating – lubrication. Lubrication in wire drawing- Functions of lubricants, types of lubricants. 2.3 Drawing die – cross sectional view of drawing die, different sections in die and their functions, Die materials used for making drawing dies, Properties required in the drawing die material. 2.4 Wire / rod drawing machines - Drawbench, Bull block, Stepped cone multiple pass wire drawing machine, Working principle and construction of Drawbench, Bull block and Stepped cone multiple pass wire drawing machine, Advantages and limitations of each type of wire drawing machines. 2.5 Heat treatment of wires- annealing and patenting, Defects in drawn products, wires, rods and tubes, causes of defects and their remedies.	Lectures Assignments, Online videos - Simulations.	CO2
UNIT-III SPINNING OF METALS (CL Hrs-06 Marks-10)				
3	TLO 3.1 Define the concept of manual metal spinning and power spinning. TLO 3.2 State the properties required in metals / alloys for spinning operation. TLO 3.3 Draw set up of manual metal spinning and power spinning. TLO 3.4 State the role of mandrel in the metal spinning operation.	3.1 Concept and principle of metal spinning, Manual spinning, Power spinning / shear spinning, Hot spinning, Parts produced by spinning. 3.2 Metal properties to be considered for spinning operation - Ductility, elongation, hardness, strain hardening / work hardening, formability w.r.t. temperature, Suitable metal grades for spinning - Aluminum 1100, 3003, 5052, 2024, 7075, Stainless steel SS304, SS316, Brass 70-30. 3.3 Manual metal spinning set up, Equipment and tools used in manual metal spinning, Shear spinning (Power spinning): Power spinning in vertical machines. 3.4 Role of mandrel in metal spinning, Selection	Lecture Assignment Demonstration	CO3

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
		of mandrel material based on part design, part material grade, desired life - tool steels - O2, A2, D2, D4, Gray cast iron, Alloy cast iron, SAE 52100.		
	TLO 3.5 State lubricants used for manual and power spinning. Describe defects in spinning products.	3.5 Need of lubrication in metal spinning, metal spinning lubricants, Defects in parts produced by metal spinning, causes of defects and their remedial actions.		
		SECTION II		
		UNIT-IV FORGING OF METALS (CL Hrs-08 Marks-13)		
4	TLO 4.1 Define Forging and types of forging. TLO 4.2 Enlist properties required in forging die materials. TLO 4.3 State forging temperatures for hot forging of different metals / alloys. TLO 4.4 Describe different Hammers and presses used in forging Operations. TLO 4.5 Draw grain flow observed in forged parts, enlist forging defects and write its causes and remedies.	4.1 Forging: definition, principle, Types of forgings –Principle of Open die forging and Closed die forging, Press forging and hammer forging, Cold forging, Hot forging, Warm forging, Isothermal forging. 4.2 Selection of steel for forging, Metal grades suitable for the forging operations, Forgings die- die materials, Properties required in the forging dies / die materials for good service life. 4.3 Forging temperatures for different metals and alloys and time for Heating, Heating methods – Gas fired furnace, Induction heating, Resistance heating, changes in properties of metals on heating, oxidation and decarburization of steel, overheating and burning of steel. 4.4 Equipments used in Forging, Working principle of Steam Hammer, Pneumatic Hammer, Board drop Hammer, Spring Hammer, Mechanical Press, Hydraulic Press 4.5 Grain flow in forgings, Defects in forged products, causes of defects and remedial actions, Cooling of forgings.	Lecture, Assignment, Demonstration	CO4
		UNIT-V EXTRUSION OF METALS (CL Hrs-07 Marks-10)		
5	TLO 5.1 Define metal extrusion and types of extrusion. TLO 5.2 Describe direct and indirect extrusion process. TLO 5.3 State benefits of lubrication in metal extrusion. TLO 5.4 Describe parameters	5.1 Extrusion – Definition of metal extrusion, Working principle of extrusion, Deformation in extrusion, Types of metal Extrusion. 5.2 Direct extrusion - schematic and working principle, Indirect extrusion – schematic and working principle, Hydrostatic extrusion – schematic and working principle, Impact extrusion – schematic and working principle. 5.3 Extrusion Equipments / machineries basics, Extrusion dies, Solid dies, Hollow Dies, Supporting toolings for dies,	Lecture, Assignment, Demonstration	CO5

Sr. No	Theory Learning Outcomes (TLO's) aligned to CO's.	Learning content mapped with TLO's.	Suggested Learning Pedagogies	Relevant COs
	affecting extrusion process and extruded product quality. TLO 5.5 Describe extrusion defects and their causes, State applications of extrusion.	Lubrication in metal extrusion, Benefits of lubrication, Lubricants used in metal extrusion. 5.4 Variables in extrusion - Type of extrusion process, extrusion ratio, working temperature, speed of deformation and frictional conditions, lubrication. 5.5 Applications of metal extrusion, Products / profiles manufactured by extrusion, Defects in extruded products, causes of defects and their remedial actions.		
UNIT-VI SHEET METAL WORKING (CL Hrs-08 Marks-12)				
6	TLO 6.1 State the parts made by sheet metal working operations. TLO 6.2 Enlist different sheet metal working operations, describe deep drawing operation. TLO 6.3 Define the principle of bending, state the spring back effect. TLO 6.4 Describe the stretch forming operation with set up. TLO 6.5 State the purpose of Erichsen cupping test, analyze various defects in sheet metal products and their causes.	6.1 Parts made by sheet metal working, Properties required in sheet metals for better forming operations - defect free products, Sheet metal formability. 6.2 Introduction to different sheet metal forming operations, Deep drawing, Set up schematic of deep drawing process, limiting draw ratio, Factors affecting deep drawing, 6.3 Bending operation, The minimum bend radius, Springback in sheet metals, Reasons of springback, Method of compensating springback. 6.4 Stretch forming operation, Set up schematic of stretch forming, Applications of stretch forming, Shearing operation and set up schematic, Blanking - Piercing operation and set up schematic, Trimming, shaving, notching or slitting. 6.5 Erichsen cupping test and its procedure, Defects in sheet metal working products, causes of defects and remedial actions.	Lecture, 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 Draw set up schematic of metal rolling mill.	Observe the operations of metal rolling mill and draw its set up (industry visit / process videos).	04	CO1
2	LLO 2.1 Draw full set up schematic of draw bench machine with proper labeling.	Observe the function of the draw bench machine and draw its set up (industry visit / process videos).	04	CO2

Sr. No	Practical/Tutorial/Laboratory Learning Outcome (LLO)	Laboratory Experiment / Practical Titles /Tutorial Titles	Number of hrs.	Relevant COs
3	LLO 3.1 Draw set up schematic of metal spinning and write down variables in metal spinning.	Observe the process of metal spinning and draw its set up (industry visit / process videos).	02	CO3
4	LLO 4.1 Draw deep drawing process set up and note process parameters.	Observe the operational steps in the deep drawing process and draw its set up (industry visit / process videos).	04	CO6
5	LLO 5.1 Draw set up schematic of power press and explain its working.	Observe the working of power press and draw its set up (industry visit / process videos).	02	CO4, CO6
6	LLO 6.1 Explain the functioning of hydraulic press and draw its set up.	Observe the functioning of hydraulic press and draw its set up (industry visit / process videos).	02	CO4, CO6
7	LLO 7.1 Explain the steps in closed die forging process of connecting rod and bolt and the factors affecting the forging process.	Observe the steps for production of connecting rod by closed die forging and production of bolt by upset forging and draw set up of metal forging (industry visit / process videos).	04	CO4
8	LLO 8.1 Explain metal extrusion process and draw full set up.	Observe the metal extrusion processes (industry visit / process videos) and draw extrusion process set up.	04	CO5
9	LLO 9.1 Draw set up schematic of stretch forming operation.	Observe sheet metal stretch forming operation and draw its set up (industry visit / process videos).	02	CO6
10	LLO 10.1 Study of Micro project.	Complete a micro project based on guidelines provided.	02	ALL

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

Micro project

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Study any two parts manufactured by closed die forging process and make a report on process details.
- Study the applications and properties of materials manufactured by drawing process.
- Study any five metal grades used in metal spinning operations and study their properties.
- Make a report on extrusion process of any two metal grades and metallurgical defects observed in it.
- Power Point Presentation and report on different metal working operations / technologies.
- Power Point Presentation and report on specifications of metal rolling mills, forging presses - hammers.
- Power Point Presentation and report on specifications of metal spinning machines, extrusion presses.
- Power Point Presentation and report on specifications of sheet metal forming equipments, presses.

Assignments

- Prepare journals based on practical performed in laboratory. Journal consists of write ups, diagrams, observations, required tools, equipment and date of performance with teacher signature.

VII. LABORATORY EQUIPMENT/INSTRUMENTS/TOOLS/SOFTWARE REQUIRED

Sr. No.	Major Equipment/ Instruments Required	Relevant LLO Number

1	Draw bench machine	LLO 2.1
2	Lathe machine	LLO 3.1
3	Anvil, Hammer, Muffle furnace	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
SECTION I								
1	I	ROLLING OF METALS	CO1	08	06	04	03	13
2	II	DRAWING OF WIRES AND RODS	CO2	08	06	04	02	12
3	III	SPINNING OF METALS	CO3	06	06	02	02	10
			Total	22	18	10	07	35
SECTION II								
4	IV	FORGING OF METALS	CO4	08	06	04	03	13
5	V	EXTRUSION OF METALS	CO5	07	06	02	02	10
6	VI	SHEET METAL WORKING	CO6	08	06	04	02	12
			Total	23	18	10	07	35

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. 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	2	2	2	2	2	2	3	2	2	2
CO2	3	2	2	2	1	2	3	3	2	2	2
CO3	3	3	2	2	2	2	2	3	2	2	2
CO4	3	2	3	2	2	3	2	3	2	2	2
CO5	3	2	2	2	2	2	2	3	2	2	2
CO6	3	2	2	2	1	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	Higgins	Engineering Metallurgy	R.A. ELBS, New Delhi 3. ISBN 10: 0340568305, ISBN 13: 9780340568309
2	George, E. Dieter	Mechanical Metallurgy	McGraw Hill, New Delhi ISBN 0-07-100406-8
3	William F. Hosford Robert M. Caddell	Metal Forming Mechanics and Metallurgy	Cambridge University Press ISBN-13 978-0-511-35453-3

XII. LEARNING WEBSITES & PORTALS

Sr. No	Link/Portal	Description
1	https://www.youtube.com/watch?v=VD61WHGKSIs	Hot rolling of steel
2	https://www.youtube.com/watch?v=Rc8FyKDd55Y	Drawing of Rods, Wires and Tubes, NPTEL
3	https://www.youtube.com/watch?v=yGKym19qxiM&list=PLNbED5J9RQDHCqDUsIiQHZZdkPov0rpdf	Introduction to Metal Forming Technology
4	https://www.youtube.com/watch?v=N6IgaDLOAg8	Steel Forging Technology
5	https://nptel.ac.in/courses/112107219	Fundamentals of Manufacturing Processes

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