DEPARTMENT OF METALLURICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

M-TECH INDUSTRIAL METALLURGY, SEMESTER –I TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	IM0101	Advanced Ferrous Metallurgy	4	0	0	4	4	30	10	60	00	00	100
2	IM0102	Advances in Experimental Techniques of Metallurgy	4	0	2	5	6	30	10	60	40	60	200
3	IM0103	Advances in Metal Casting Practices	4	0	0	4	4	30	10	60	00	00	100
4	IM0104	Advanced Welding Technology	4	0	2	5	6	30	10	60	40	60	200
5	IM0105	Communication Research and Skills	3	0	0	3	3	30	10	60	00	00	100
6	IM0106	Energy Conservation & Pollution Control (EL-I)	4	0	0	4	4	30	10	60	00	00	100
7	IM0107	Process Modelling & Computer Applications in Metallurgy (EL-I)											
8	IM0108	High Temperature Materials (EL-I)											
9	IM0109	Ceramics and Polymer Technology (EL-I)											
TOTAL			**23**	**00**	**04**	**25**	**27**	**180**	**60**	**360**	**80**	**120**	**800**

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

DEPARTMENT OF METALLURICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

M-TECH INDUSTRIAL METALLURGY, SEMESTER –II TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
			L	T	P			CIE		ESE	CIE	ESE	
								MID	IE				
1	IM0201	Advanced Powder Metallurgy	4	0	2	5	6	30	10	60	40	60	200
2	IM0202	Advances in Heat Treating Practices	4	0	2	5	6	30	10	60	40	60	200
3	IM0203	Industrial Corrosion and its Control	4	0	2	5	6	30	10	60	40	60	200
4	IM0204	Surface Engineering	4	0	0	4	4	30	10	60	00	00	100
5	IM0205	Failure Analysis (EL– 2)	3	0	0	3	3	30	10	60	00	00	100
6	IM0206	Industrial Costing (EL– 2)											
7	IM0207	Quality Control Techniques (EL– 2)											
8	IM0208	Fracture Mechanics (EL– 2)											
9	IM0209	Advanced Non Ferrous Production Metallurgy (EL– 3)	3	0	0	3	3	30	10	60	00	00	100
10	IM0210	Composite Materials (EL– 3)											
11	IM0211	Advanced Metal Forming (EL – 3)											
12	IM0212	Treatment of Metallurgical Wastes and Recovery of By-products (EL – 3)											
TOTAL			**23**	**00**	**04**	**25**	**27**	**180**	**60**	**360**	**120**	**180**	**900**

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

DEPARTMENT OF METALLURICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

M-TECH INDUSTRIAL METALLURGY, SEMESTER –III TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
			L	T	P			CIE		ESE	CIE	ESE	
								MID	IE				
1	IM0301	Dissertation Phase I	00	00	40	20	40	00	00	00	150	150	300
TOTAL			**00**	**00**	**40**	**20**	**40**	00	00	00	150	150	300

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

DEPARTMENT OF METALLURICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

M-TECH INDUSTRIAL METALLURGY, SEMESTER –IV TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
			L	T	P			CIE		ESE	CIE	ESE	
								MID	IE				
1	IM0401	Dissertation Phase II	00	00	40	20	40	00	00	00	150	150	300
TOTAL			**00**	**00**	**40**	**20**	**40**	00	00	00	150	150	300

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

Department of Metallurgical Engineering, IITE,

Indus University

1st Semester

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

Subject: **Advanced Ferrous Technology**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0101			Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Review of conventional and modern steel making processes, Advances in agglomeration,Modern trends in blast furnace design and operation, Alternative routes of iron production.

Unit-2

Sponge Iron Processes: HYL, SL/RN, Midrex, HIB and Fluidised bed Processes. Uses of spongeIron, Smelt reduction Processes: COREX, INRED and ELRED and mini blast furnaces.

Unit-3

Recent advances in converter and electric arc steel making furnaces and continuous casting ofsteel, Continuous steel making, De-oxidation and impurity control, Vacuum degassing andElectro slag re-melting.

Unit-4

Refining techniques: ESR, VAR, vacuum degassing of liquid steel. Clean and super clean steels,Alloy steel making, tool steels and stainless steel making practice. Review of Iron and SteelIndustry in India

2. Reference Books:

1) R. J. Fruehan (Editor): The Making, Shaping and Treating of Steel, 11th Edition, SteelMaking and Refining Volume, AISE Steel Foundation, Pittsburg, USA, 1998 Irving.
2) A. K. Biswas: Principles of Blast Furnace Iron Making, Theory and Practice, SBAPublications, 1994.
3) Amit Chatterjee: Beyond the Blast Furnace, CRC Press Inc., 1994.
4) E. T. Turkdogan: Fundamentals of Steel making, The Inst. of Materials, London, 1996.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Advances in Experimental Techniques in Metallurgy**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0102			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	60	60	40	40	200

1. **Contents:**

Unit-1

Special Techniques in Metallography: Polarized beam, Phase Contrast, Interferrometry, Bright Field, Dark Field and Oblique illumination, Principles of above techniques & their applications.

Unit-2

Quantitative Metallurgy and Image analysis, Applications Developments for Quantitative Image analysis in Metallurgy

X- Ray diffractometry such as phase analysis and structure analysis,

Unit-3

Electron microscope, Specimen Preparation, Image formation, Application of Electron microscopic technique, Scanning Electron Microscope, Field Ion Microscope, High Resolution Microscope and Electron Probe Micro Analysis

Unit-4

Thermal Analysis: D.T.A., T.G.A., & D.S.C. and Thermomechanical AnalysisPrinciples and Applications

Physicochemical Properties of Liquid metals and alloys such as Viscosity, Surface tension and electrical conductivity, Solid Electrolytic Cell, principle, experimental set-up and applications

2. **Reference Books:**

1) Experimental Techniques in Physical Metallurgy, V.T. Cherepin & A.K. Malik, I.I.T.,Bombay.
2) Techniques of Metals Research Vol.-I, Vol.-II, Bunshah Inter Science Publication.
3) Thermal Analysis by Bernhard Wiindrelich Academic Press.
4) Image Analysis & Metallography. (Microstructural Science Vol.-17) ASTM 1989

3. **Question Paper Pattern for End Sem Exam:**

As per Appendix A

4. Advances in Experimental Techniques in Metallurgy Lab(List of Experiments)

Experiment No.	Title
1	Study of optical microscope
2	Metallographic sample preparation and microstructural examination
3	Grain size measurement per ASTM E112 (1) Visual Comparison method (2) Linear intercept method (3) ALA
4	Image analysis (1) Volume fraction measurement (2) Particle size distribution (3) Coating thickness (4) Nodularity rating (5) Amount of pearlite in cast iron (6) Secondary dendritic arms spacing
5	Indexing of X-ray diffraction pattern (1) Powder diffraction method (2) Debye-Scherrer Method (3) Rotating crystal method
6	Indexing TEM SEAD pattern
7	Vickers Microhardness Measurement
8	Optical emission spectroscopy
9	External Lab visit report

Subject: **Advances in Metal Casting Practices**								
Program: **M-TECH Industrial Metallurgy**			Subject Code: IM0103				Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Introduction: Various special casting techniques

Shell moulding: Shell moulding machines – pattern equipments- sands, resins and other materials used for shell moulding- Application of shell moulding- Advantages of shell moulding over other methods of moulding.

Centrifugal casting: Types of centrifugal casting processes- Calculation of mould rotary speeds– Techniques, equipments and production processes – Advantages and limitations of centrifugal casting methods. Replica (full mould)

Investment casting: Introduction – Pattern and mould materials used- Techniques and production of investment moulds – Shaw process – Full mould process – Applications of investment casting process.

Unit-2

Organic processes: Cold box & Hot box. No bake processes.

Die casting: Die casting machines – Operation and details – Die materials – Metals cast by diecasting method- advantages of die casting.

Other processes: Fluid sand process, V process, squeeze casting, Rheo, Thixo and Compo Casting processes- Graphite moulding process, Magnetic moulding, Impulse moulding, high pressure moulding.

Solidification of metals and alloys: Solidification of casting, effect of composition on freezing pattern. Effect of moulding materials and cooling rate on freezing pattern. Shrinkage of casting and directional solidification of casting.

Unit-3

Cast iron: Graphitization, Types and sizes of graphite for grey cast iron and S.G. Iron. Effect of normal elements and alloying elements in cast irons. Compositional aspects production melting and properties of austenic cast irons. High silicon cast irons. High chrome cast iron and Ni Hard cast iron. Grey cast of S.G. Iron. Austempered S.G.iron. C.G. Iron and Malleable Cast iron. Different inoculation and inoculation techniques

Unit-4

Non ferrous cast alloys: Melting procedure and composition control of Al alloys, Mg alloys, Ni alloys Zn alloys, and Cu alloys Modification and grain refinement of Al alloys. Gases in metals and degassing practice.

2. Reference Books:

1) Clegg A J, “Precision Casting Processes”, Pergamon Press, London, U.K, 1991.
2) Beeley P R, “Foundry Technology”, Butterworths, London 2001.
3) Heine R.W. Loper, C R and Rosenthal P.C. “principle of metal castings” Tata- McGraw Hill Publishing Co, 1995.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Advanced Welding Technology**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0104			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	60	60	40	40	200

1. Contents:

Unit-1

Conventional welding processes.

Welding power source characteristics, Physic of arc, Arc Welding Processes: Principles of operation, process characteristics and applications of SMAW, GTAW, SAW, GMAW and PAW; Beam welding processes: Electron beam welding (EBW). Laser beam welding (LBW), Resistance welding processes: Spot, Projection and seam welding, Gas welding; Solid Phase welding processes; Friction welding process, Diffusion welding; Fundamental differences between soldering, brazing and welding. Effects of shielding gases, welding current, welding voltage speed on the weld bead shape.

Unit-2

Advanced Welding Processes

Modes of metal transfer, P-GMAW, Friction stir welding, Activated Flux TIG welding processes, Metal Core Arc Welding, Flux Core Arc Welding, Narrow gap welding, Hybrid Welding processes, Electro Slag Strip Cladding process, and Submerged Arc Strip Cladding process.

Unit-3

Surfacing and Cutting Processes

Gas Cutting, Plasma cutting, Water jet cutting, Laser cutting; advantages, disadvantages, application of cutting processes. Thermal spraying, plasma spraying, laser surface alloying and modification, cladding and its applications to improve wear resistance and corrosion resistance.

Unit-4

Weldability

Concept of Weldability, Carbon Equivalent, Weldability tests, Welding metallurgy of steels and Stainless steels, Weldability of non ferrous systems- aluminum, copper alloys, Metallurgy of dissimilar metal welds, Clad metals etc. Destructive testing of welds, welding defects and significance. Important welding codes and standards, welding safety.

2. Reference Books:

1) Robert W Messler, Jr, Principles of Welding- processes, Physics, Chemistry, and Metallurgy, John Wilesy and Sons, Inc. 1999.
2) Parmar R S, Welding Engineering and Technology, Khanna Publishers, 1997
3) Nasir Ahmed 'New Development in Advance Welding' publishers, Wood head publishing Limited, England, 2007
4) John Norrish, 'Advance Welding Processes- Technologies and Process Control' Wood head publishing Limited, England, 2006
5) Welding Hand Book, Volume I and IV , 7th Edition , American Welding Society, 1980
6) Metal hand book, "Welding, Brazing and Soldering, Vol 6, ASM.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

4. Advanced Welding Technology Lab (List of Experiments)

Experiment No.	Title
1	Surface preparation and types of weld based on geometrical configuration
2	Manual arc welding of steel plates • Measure weld penetration depth • Microstructural examination (Heat affected zone, microcrack, porosity) • Microhardness measurement
3	MIG welding of steel plates • Measure weld penetration depth • Microstructural evaluation (Heat affected zone, microcrack, porosity) • Microhardness measurement
4	TIG welding of steel plates • Measure weld penetration depth • Microstructural evaluation (Heat affected zone, microcrack, porosity) • Microhardness measurement
5	Gas Welding of Steel Plates • Measure weld penetration depth • Microstructural evaluation (Heat affected zone, microcrack, porosity) • Microhardness measurement
6	Gas cutting of metal plates
7	Spot welding of steel sheet

Subject: **Communication and Research Skills**								
Program: **M-TECH Industrial Metallurgy**			Subject Code: IM0105				Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Communication skills

Importance of communication, what is communication, what are communication skills, the communication process

Introduction, Visual perception, Language, other factors affecting our perspective.

Introduction, Face to face communication, Physical communication

Unit-2

Communication skills

Introduction, The communication styles matrix, Examples of communication of reach style.

Introduction, self awareness, active listening, becoming an active listener, listening in difficult situation.

Introduction, when and when not tto use written communication, writing effectively

Unit-3

Research Skills

Meaning of research - Purpose of research, Types of research , Significance of research in Social and Business Sciences, Choosing the problem, Review of literature, Formulating the problem, Criteria of a good research problem

Needs of research design, Components of research design - Different research designs

Sampling procedure, Characteristics of good sample, Methods of sampling

Unit-4

Research Skills

Primary sources of data, Methods of collecting primary data, Secondary sources of data

Checking - Editing – Coding, Transcriptions and Tabulation, Data analysis

Types of reports, Contents; Styles of reporting, Steps in drafting reports, Editing the final draft, Evaluating the final drafts

2. Reference Books:

1) Lesikar, R. V. & Flatley Basic Business Communication Skills for Empowering theInternet Generation. Tata McGraw Hill 2005 or Latest
2) Meenakshi Raman, Sangeeta Sharma Technical Communications -Oxford Latest Edition
3) D. K. Bhattacharya Research Methodology Excel Books 2nd Edition

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Energy Conservation & Pollution Control**								
Program: **M-TECH Industrial Metallurgy**			Subject Code: IM0106				Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Energy Conservation:

Forms of energy, energy conversion, energy sources and resources, present and future energy demands. Review of commercial energies from solid, liquid and gaseous fuels. Nuclear energy systems.

Unit-2

Energy Conservation:

Alternate energy sources. Improving energy efficiency in extractive metallurgical processes with emphasis on alternate processes of aluminum production. Design and management of energy conservation. Recycling of energy. Energy conversion techniques.

Unit-3

Pollution Control:

Gas recovery in metal processing industries, gas cleaning andremoval of particulate matter from gases. Heat exchangers and water cleaning of solids.

Unit-4

Pollution Control:

Pollution control in specific metal process industries, viz. Iron and steel, Cu, Ni, Pb, Zn, Al, Coetc. Environmental considerations in metal casting, metal forming, metal plating and heat treatment industries.

2. Reference Books:

1) Harker and Backhurst , Fuel and Energy, Academic Press, London, 1981.
2) C. B. Gill , Non- Ferrous Extractive Metallurgy, John Wiley, 1980.
3) Proceedings of National Seminar on Energy for Steel Industry- IIM, 1977.
4) S. P. Mahajan, Pollution control in Process Industries, Tata Mc Graw Hill, 1985.
5) Cheremisionoff and Young, Hand Book of Pollution Engineering Practice, Ann Arbor Science Publications, 1975

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Process Modeling & Computer Applications in Metallurgy**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0107			Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Basic Orientation of Mathematics : Ordinary Differential Equations, Laplace Transformation, Partial Differential Equations, Statistics-Methods & Probability, Finite Methods, Numerical Methods-Regression Analysis, Interpolation, Solution of algebraic equation, Solution of Ordinary Differential Equation.

Unit-2

Introduction to Modeling and simulation : Dynamic model building and steady state process simulation : Lumos parameter and distributed parameter systems as Applied to Metallurgical processes and operations

Unit-3

Parameter estimation, response surface and model evolution, Functions of continuous variable analytical methods & numerical methods Models in mass and heat transfer.

Computer – aided design systems: Estimation & computation of reaction rate, transport properties, Development of design calculation, procedure order and flowsheet calculation, Dynamics & Modeling of Metallurgical reactors, steady state multiplicity etc.

Unit-4

Models in Metallurgical Processes. Principles of model development, models based on balance equations, models for gas solid reactions, packed bed and fluidized bed, jet impingement, Blast furnace and converters, simulation models, Mathematical Modeling of diffusional processes, Mathematical model for flux balance and local equilibrium, Application of model to the single layer growth and bi-layer growth during Nitriding, Nitrocarburizing of iron, Process modeling in Welding-Heat flow and Temperature distribution in welding, Unsteady state heat conduction (uni, bi and tri axial heat conduction), Instantaneous heat sources (plane source, line source and

point source), Finite Element Model of one dimensional transient heat problem. Kinetic model for Nucleation and Grain Growth, Reaction between a solid and fluid, Some case studies.

2. Reference Books:

1) Applied Numerical Method – Chapra & Canel.
2) Advance Engg. Mathematics – E. Kreyszing.
3) Programming for Basics – K. Subramaniam.
4) Exploring your P C With Basic – N. Kannan, V. Subramaniam Szekely, J., Evans, J.E. and Brimacambe, J.K., The Mathematical and Physical Modelling of Primary Metal Processing Operations, Wiley, 1988.
5) Hem Shankar Ray, Kinetics of Metallurgical reactions, Oxford & IBH Publishing Co. Pvt. Ltd., 1993.
6) A. K. Mohanty , Rate processes in Metallurgy, Prentice-Hall India Ltd., 2000.
7) G.H. Geiger and D. R. Poirier, Transport Phenomena in Metallurgy, Addison- Wesley Publishing Co., Reading, Mass., 1974.
8) J. Szekely, J.W. Evans and H.Y. Sohn, Gas – Solid Reactions, Academic Press, New York, 1976

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **High Temperature Materials**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0108			Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

High temperature materials requirements of Metallurgical Industries. Hot Working tools, Furnace Parts, Electrical-heating elements etc.

Unit-2

Metals and alloys for high temperature applications. Property requirements for High temperature applications super alloys and their physical metallurgy background, Strengthening mechanism, Thermal effects.

Processing techniques of above materials. Processing effect on purity and microstructure. Processing for composites. Fabrication problems. Refractory metals.

Unit-3

High temperature thermodynamics. Phase diagrams of high temperature systems and their applications

Selection of materials for high temperature applications. Thermal conductivity.

High strength. Thermal shock, Chemical resistance. Permeability, Abrasion resistance, Refractoriness.

Unit-4

Various high temperature materials and their applications. Refractory metals and Oxides, Carbides, Nitrides, Borides, Sulphides, Silicates. Method of preparation and characteristic properties.

Thermal protection and protective coatings. Coating requirements, Diffusion Coatings, Overlay Coatings. Development of improved coatings.

2. Reference Books:

1) Source Book on materials for elevated temperature applications. ASM Publications,1979.
2) High temperature materials and technology. Campbell and Sherwood. John Wiley &Sons Publication, 1967.

3) Introduction to Ceramic W. D. Kingery, John Wiley & Sons Publication, 1976

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Ceramics & Polymer Technology**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0109			Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Ceramics

Crystal structure and bonding, crystalline ceramic materials, silicate structure and clay materials, polymorphism, non - crystalline phases, equilibria and reactions between ceramic phases. Raw materials and their characteristics, Forming processes: hydro plastic forming, slip casting, cementation, vitreous shaping.

Unit-2

Ceramics

Thermal Treatment- drying, firing, annealing crystallization, glazing. Mechanical, electrical, magnetic and thermal properties; high temperature behaviour. Ceramic products: Chemical ceramics, filters, abrasive materials, cermets, ceramic insulators, conductors and dielectric materials, piezo-electric materials, ferrites, nuclear applications, modern structural ceramics like zirconia toughened alumina.

Unit-3

Polymers

Basic concept, classification, Chemical bonding and molecular forces in polymers.

Electrical properties; basic concepts, dielectric and relaxation of polymers, mechanism of relaxation, experimental methods to study dielectric properties of polymers, dielectric behaviour of polyethylene.

Unit-4

Polymers

Optical properties; conditions of optical activity in macro molecular systems, prediction of configurations, dissymmetry in macromolecular structure, optical testing of polymers.

Heat capacity, heat capacity of crystalline and amorphous polymers, thermal conductivity. Thermal analysis of polymers (DTA and TGA).Acoustic properties; Dynamic modulus of elasticity, less modulus, viscosity of propagation and absorption coefficient of elastic waves in polymers.

Compounding and vulcanisation, natural and synthetic fibers, criteria for fiber formation, testing and modification of fibers. Medical application of polymers. Application of polymers in engineering and industry, high temperature conducting polymers.

2. Reference Books:

1) B. Ramond, Seymour and Charles E. Carraher(Jr.), Polymer Chemistry – An Introduction. 2nd Edition, Marcel Dekkar, Inc. New York, 1987.
2) Alan King, Ceramic Technology and Processing, Standard Publishers Distributors, 2004.
3) David W. Richerson, Modern Ceramic Engineering: Properties, Processing, and Use in Design (Engineered Materials 1), Marcel Dekker, 1992.
4) Anil Kumar, S. K. Gupta, Fundamentals of Polymer Science and Engineering, Tata McGraw Hill, 1978.
5) James S. Reed, Introduction to the Principles of Ceramic processing, John Wiley-Wiley - Inter Science Publication,1995
6) Introduction to Ceramic W. D. Kingery, John Wiley & Sons Publication, 1976

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Department of Metallurgical Engineering, IITE,

Indus University

2nd Semester

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

Subject: **Advanced Powder Metallurgy**								
Program: **M-TECH Industrial Metallurgy**			Subject Code: IM0201				Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	60	60	40	40	200

1. Contents:

Unit-1

Brief review and history of developments in Powder Metallurgical Science and Technology. Scope and limitation of Powder Metallurgy.

Unit-2

Advanced powder and particulate production techniques-such as subsonic and ultrasonic atomization, rapid solidification process (RSP) by splat quenching, spray- co-precipitation technique, freeze-drying process, sol-gel method, spray-drying method, mechanical alloying etc.

Unit-3

Powder characterization-morphology characterization, crystallographic characterization and chemical characterization- a general review of fundamentals.

Special consolidation processes-such as injection moulding, isostatic pressing, hot pressing hot isostatic pressing, forging and rolling of powder metallurgical billets, powder extrusion, spray and plasma coating of powders, dynamic compaction processes.

Unit-4

Sintering of metal and alloy powders-sintering practice, sintering atmosphere, sintering furnaces, atmosphere generators. Concept of solid-state sintering, liquid phase sintering, infiltration process. Sintering mechanisms, driving forces in sintering reaction, sintering and various activated sintering processes.

Application of Powder Metallurgy in cutting tools, friction and antifriction components, porous materials, dispersion strengthened alloy systems, electrical and magnetic materials, and automobile applications of Powder Metallurgy parts.

2. Advanced Powder Metallurgy Lab (List of Experiments)

Experiment No.	Title
1	Water atomization of metal powder
2	Gas atomization metal powder
3	Powder production by electrolysis
4	Sieve analysis of metal powder
5	Study of flow characteristics of metal powder
6	Characterization of metal powder
7	Study on compaction behavior of metal powder
8	Sintering of metal powder
9	Study on sintering behavior of metal powder

3. Reference Books:

1) Metal Handbook, Vol.-7, Powder Metallurgy, 9th Ed.
2) Advances in Powder Metallurgy, 1981, Seminar, Edited by G. Y. Chin, ASM Ohio.
3) Powder Metallurgy-Recent Advances by V. S. Arunachanlam & O. V. Roman, Oxford & IBH Publication House, Bombay.
4) R. M. German, Powder Metallurgy Sciences, MPIE, Princeton, New Jersey.
5) Powder Metallugy by Hirshon, ASM, Ohio

4. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Advances in Heat Treating Practices**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0202			Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	60	60	40	40	200

1. Contents:

Unit-1

Choice of heat treatment equipment. Heat treatment plant for bulk steel production. Heat transmission in reheating and heat treatment furnaces. Design of heat treatment furnaces for specific applications.

Vacuum Heat treatment, Advance Quenching Techniques& Quenchants, Gas Quenching, &Plasma Heat treatment processes

Unit-2

Steels for structural applications. Steels not heat-treated to martensite state. Hardenable carbon steels and alloy steels. Super strength steels for aerospace use. Vacuum processed steels.

Heat treatment process. Operations involved in the heat treatment of hot rolled, cold drawn and cold rolled steels. Heat treatment of machine parts. Heat treatment of steel castings. Forging of shaft and axles. Springs. Gears.

Unit-3

Heat treatment of tool and die steels. Principles of heat treatment of low alloy tool steels, Tungsten chisel steel, Non-tempering chisel steel, Semi high-speed steel, Graphite tool steels, Free machining tool steels, Oil hardening cold worked die steels, Air hardening cold work dies steels, Special wear resistance cold work dies steels, Hot work dies steels, High speed steels, Heat treatment practices for special grade steels & alloys. Heat treatment of iron castings. Heat treatment of gray iron castings. White iron castings. High strength iron castings, ADI – Austempering

Unit-4

Heat treatment of non-ferrous alloys. Heat treatment of Copper, Brass, Wrought Aluminum alloys, Aluminum alloy castings, Magnesium alloys, Titanium alloys, Nickel base alloys, Turbine disc steels.

2. Advances in Heat Treating Practices Lab (List of Experiments)

Experiment No.	Title
1	Normalizing of steel, microstructural examination, hardness measurement
2	Annealing of steel, microstructural examination, hardness measurement
3	Hardening of steel, microstructural examination, hardness measurement
4	Jominy end quench test of steel, microstructural examination, hardness measurement
5	Austempering of steel, microstructural examination, hardness measurement
6	Martempering of steel, microstructural examination, hardness measurement
7	Rockwell Hardness Test
8	Brinell Hardness Test
9	Tensile and Compression Test

3. Reference Books:

1) Heat treatment –Principles and Techniques, T. V. Rajan and Sharma, Prince Hall.
2) Metals Handbook-Vol.-II, ASM Metal Park, Ohio.
3) Heat treatment of Metals – Dovey Gadd and Mitchell Oven.
4) Industrial Furnaces – Trinks.
5) Tool Steels-G. A. Roberts, J. C. Hamnker, & A. R. Johnson.
6) Heat treatment of Metals-Special Report 95, Iron & Steel Institute.
7) Heat Treatment handbook by K H Prabhudeva

4. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Industrial Corrosion & its Control**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0203			Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	60	60	40	40	200

1. Contents:

Unit-1

Corrosion and its importance, thermodynamic aspect, e.m.f. and Galvanic Series.

Potential – pH diagram, H_2& O_2 line, its application to important corrosion system.

Unit-2

Kinetic aspect of corrosion, Polarization, its types, its importance in corrosion control, Anodic, Cathodic and resistance control, passivity.

Mixed Potential Theory, Application in corrosion, Principles and interpretation.

Unit-3

Classification of corrosion - dry & wet, chemical and electrochemical, forms of corrosion - uniform, pitting crevice, galvanic & Intergranular corrosions.

Electro-mechanical principles - fretting, erosion-corrosion, S.C.C. H_2 damage, etc.

Unit-4

Corrosion protection – Material selection, environmental control and inhibitors, design aspects, Cathodic and anodic protections, Coatings – Metallic, non-metallic, organic corrosion resistant materials

Corrosion testing – Laboratory & Field tests, preparation of samples. Standard (NACE, ASTM) corrosion tests. Accelerated corrosion tests.

2. Industrial Corrosion & its Control Lab (List of Experiments)

Experiment No.	Title
1	Salt spray test as per ASTM B117
2	Study of general corrosion behavior by Immersion method (weight loss method) using different corrosive media
3	Electrochemical tests • Polarization resistance

- Impedance
- Cyclic potentiodynamic polarization
- Galvanostatic polarization
- Pitting and repassivation

4 Study EMF and galvanic series

5 pH measurement of corrosive media

6 Study of Eh-Ph diagram

7 Effect of plating on corrosion resistance of steel sheet

8 Study on the use of Zn in corrosion protection of steel

3. Reference Books:

1) Corrosion Engineering – M.C. Fontana and H.D. Greene, Mc. Graw Hill.
2) Corrosion and Corrosion Engineering – H.H. Uhlig. Jom. Wiley.
3) Corrosion, Vol. 1-2, L.L. Sheir, Mcwances Butterwerth.
4) Water Treatment – F.I. Belan, Mir Publishers.

4. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Surface Engineering**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0204			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	60	00	40	00	100

1. Contents:

Unit-1

Introduction to surface engineering, Scope of surface engineering in metals, ceramics, polymers and composites, Surface Preparation methods such as Chemical, Electrochemical, Mechanical- Sand Blasting, Shot peening, Shot blasting, Hydroblasting, Vapor Phase Degreasing etc., Properties of Various Coating, Coating Methods.

Unit-2

Chemical Conversion Coating: Chromating, Phosphating, Anodizing, Thermochemical processes, industrial practice, economy and energy considerations.

Unit-3

Metallic coating: Surface pre-treatments, Hot Dipping, galvanizing, Electrolytic and Electroless plating of important metals and alloys, testing/evaluation of surface properties.

Coating from Vapour Phase: PVD, CVD, Various Methods used, mechanisms, important reactions involved and applications.

Unit-4

Plasma Coating: Sputtering, Plasma Spray & Ion Implantation Methods, mechanisms & applications. Surface modification by directed energy beams like ion, electron and laser beams, novelty of composition and microstructures.

Diffusion Coating: Various Techniques For Single And Multiple Element Coating, High Temperature Coating- Carburising, Carbonitriding, Silicanizing,Chromizing,, Aluminizing, Boronizing, Boronitriding.

2. Reference Books:

1) J. R. Davis-Surface Engineering for Corrosion and Wear Resistance.
2) George J. Rudzki -Surface Finishing Systems. metal annd non-metal finishing handbook-guide, Metals Park : ASM, 1983.
3) James A. Murphy- Surface Preparation and Finishes for Metal, McGraw-Hill, New York 1971.

4) P. G. Sheasby and R. Pinner - Surface treatment and finishing of Aluminum and its alloy,Volume-2, 5th ed., ASM, Metals Park, 1987
5) K. E. Thelning -Steel and its Heat Treatment Bofors Handbook, London : Butterworths, 1975.
6) Surface Engineering Hand Book, edited by Keith Austin, London : Kogan Page, 1998.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Failure Analysis**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0205			Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Fundamentals of Failure Analysis: General Practice in Failure Analysis, Causes of materials failure. Introduction to Ductile and Brittle Fracture: Types of loading and their effect on mode of fracture. Characteristics of ductile and brittle fracture. Fracture mechanics approach to investigation of fracture mode.

Unit-2

Theories of Ductile and Brittle Fracture: Concept of fracture toughness and its role in failure analysis.

Study of optical, scanning and transmission electron fractrographic features of ductile and brittle fracture.

Unit-3

Fatigue Fracture: Basic theory of fatigue. Factors affecting fatigue failure and loading conditions and types of fatigue fracture.

Various forms of loading conditions and fracture appearances in fatigue. Effect of stress concentration on fatigue. Optical and electron microscopic features of fatigue. Special forms of fatigue such as corrosion fatigue, thermal fatigue, contact fatigue etc.

Corrosion Fatigue: Forms of corrosion and various mechanism of corrosion. General aspect of analysis of corrosion related failures including Hydrogen embrittlement

Unit-4

Wear Failure: Types of wear. General features of wear failure. Mechanism of wear.

High temperature Failures: Failure of boiler and power plant related equipment. Study of various types of tube failure in thermal power plants.

Defects in materials and their role in failure of engineering components. Representative case studies in failure analysis.

2. Reference Books:

1) Analysis of Metallurgical Failures - Colangelo and Heiser, ASM Publication, Ohio.
2) Understanding How Components Fail – Donald J. Wulpi, ASM Publication, Ohio.
3) Handbook on Fractography, Vol.-10, 8th Edition, ASM Publication, Ohio.
4) Defects and Failure of Metals – Polunskin

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Industrial Costing**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0206			Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Introduction to Costs and Its impact on Firm Operation. Review of Costing Method: Meaning of cost, Direct and Indirect Cost, Overheads and their allocation, Short run and long run costs, incremental & sunk costs.

Unit-2

Conceptual difference in cost reports & economic analysis: Emphasis on future costs, depreciation, capital gains & losses, current & historic costs, value of currency & impact of in flat inventory evolution.

Unit-3

Cost analysis: Decision making costs & cost reduction: Cost & Output rate, cost & size of the plant, concept of value addition, impact of technology, prices of input factors. Lot size, efficiency, value engineering, inventory costs, cost of environmental protection, cost of quality. Project costing & analysis: Capital costs & their estimation, Ratio estimates, capacity ratio exponents, computer analysis, accurate cost estimation.

Unit-4

Estimation of manufacturing costs: Direct costs, overheads, interest, other costs, Standard costing.

Profitability analysis: Return on investment, payback period, net present value, and internal rate of return Monte Carlo method.

Capital rationing.

2. Reference Books:

1. Lesikar, R. V. & Flatley Basic Business Communication Skills for Empowering the Internet Generation. Tata McGraw Hill 2005 or Latest
2. Meenakshi Raman, Sangeeta Sharma Technical Communications -Oxford Latest Edition
3. D. K. Bhattacharya Research Methodology Excel Books 2nd Edition

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Quality Control Techniques**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0207			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

The meaning of quality, Goalpost philosophy, comparison of philosophies, case study, concept of T.Q.M. & ISO 9000.

Unit-2

Analysis of variance (ANOVA): Understanding variation, No-way Anone, one way Anone, Two-way Anova, Three-way Anova with examples and case studies, critique of the F test.

Unit-3

Orthogonal Arrays: Test Strategies, steps in designing conducting and analyzing equipment, examples and experiments and Fractional factorial Designs.

Unit-4

Optimization parameters and selection of model, step by step principle, polynomial models, Factorial experiments and Fractional factorial designs.

Processing of experimental Results, Method of Least squares, Regression analysis, Testing Adequacy of Model, Testing significance of coefficients. Process control using mathematical model, control chart

2. Reference Books:

1) Statistical methods for Engineers & Scientists, Robert M. Bethea, B. S. Duran & T. L.Bollion, Marcel Dekker Inc. USA, 1975.
2) Taguchi Techniques for Quality Engineers, Phillip J. Ross, 1990.
3) Design & Analysis of Experiment, M. N. Das, N. C. Giri, Wiley Eastern Ltd., 1988.
4) Design of Experiments to find optical conditions, Mir Publication, 1975

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Fracture Mechanics**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0208			Semester**: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Conventional Design Concepts and their relation to occurrence of Fracture, Inadequacies of Conventional Design Concepts.

Unit-2

The Mechanics of Fracture, Types of Fracture, Types of Fracture under Uniaxial Testing Loading, The Mechanics of Elastic Crack Propagation, The Mechanics of Plastically Induced Fracture, Physical Significance of Fracture Toughness.

Unit-3

Designing and Testing for Fracture Resistance, Principles of Fracture Safe design, Visual Analysis of Fracture, Testing Procedures, and Time dependent fracture.

Microscopic Aspects of Plastic Deformation and Crack Propagation, Cleavage Crack Propagation (Mode I), Normal rupture and Ductile Rupture.

Cleavage Crack Nucleation and Ductile to Brittle Transition Flaw Free Low strength Materials.

Unit-4

Relation Between Macroscopic and Microscopic Aspects of Plane Strain Fracture, Physical Meaning of Fracture Toughness.

Fracture Under Cyclic Loading, Effect of Environmental and Temperature on Fatigue.

Fracture Under Static Loading, Creep, S.C.C., Hydrogen Embrittlement, Fracture of Steels, Non-ferrous Metals and composite Materials as examples.

2. Reference Books:

1) An Introduction to Fracture Mechanics-Tetelman and Mc Eliue.
2) Fatigue and Fracture Control in Structures-Rolfe.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Advanced Non Ferrous Production Metallurgy**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0209			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Advanced extraction and refining techniques for the production of copper and zinc.

Unit-2

Advanced extraction and refining techniques for the production of aluminum and titanium.

Unit-3

Processing techniques for the extraction of nuclear reactor materials viz., uranium, thorium and zirconium

Unit-4

Review of nuclear energy fundamentals, types of reactors; components; characteristics and requirements; Reprocessing of spent fuel; Separation of plutonium; Breeding; Nuclear waste treatment.

2. Reference Books:

1) S. Glasstone and A. Sesonke, Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 2003.
2) C. B. Gill, Non- Ferrous Extractive Metallurgy, John Wiley and Sons, 1980.
3) Fathi Habashi, Hand Book of Extractive Metallurgy, Vols. II and III, Wiley- VCH, 1997.
4) W. G. L. Davenport, M. King, M. Schelesinger and A. K. Biswas, Extractive Metallurgy of Copper, Elsevier

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Composite Materials**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0210			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Introduction, advantages and limitations. Classification of composite materials, Metals, polymers: Thermoplastic and thermosets, ceramics and glasses, carbon/ graphite matrix materials.

Unit-2

Particulates, whiskers, fibers, wires and laminar composites (laminates). Processing of fibre reinforced composites, open and closed mould processes, processing of metal matrix composites by melting route and powder metallurgy route.

Unit-3

Prediction of composite properties, tensile strength of fibre reinforced composites, modulus of elasticity, poission's ratio, density, tribological and thermal properties. Influence of environmental effects such as elevated temperature, moisture etc. on composite properties.

Unit-4

Studies on aluminum, magnesium and titanium matrix composities. Ceramic matrix composites and nano composites. Principles of dispersion strengthened composites; particulate composites, laminates. Applications in automotive, aerospace, marine and chemical industries.

2. Reference Books:

1) M. M. Schwartz, Composite Materials: Properties, Nondestructive testing and repair, Prentice Hall, 1996.
2) ASM Metal Hand Book, Composites, Vol. 21, ASM Int, 2004.
3) L. Halliday , Composite Materials, Elsevier Publishing, 1996.

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Advanced Metal Forming**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0211			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. Contents:

Unit-1

Metal forming processes in manufacturing. Variables. Classifications and brief description of metal processes.

Plastic Deformation: Strain and strain rate. Simple state of stress. Flow stress of metals. Diffusion tests. Representation of flow stress data. Tresca and Von Mises yield criteria. Power and energy of deformation. Effective strain and effective strain rate.

Unit-2

Friction and temperature in metal forming. Characteristics of lubricants used in metal forming. Lubricity and frictional shear stress. Ring compression test. Heat generation and heat transfer in metal forming processes. Temperature in quasi-continuous forming and those used for forming discrete parts.

Unit-3

Principles of forming machines: Interaction between process requirements and machines. Machine classification data for load. Energy and for accuracy. Time dependent characteristic data. Processes and hammer for cold and hot forming of discrete parts like different types of hydraulic presses. Mechanical and screw presses. Hammers.

Approximate methods of analysis and application to simple forming operations and to impression and closed die forging with examples.

Unit-4

Computer aided design and manufacturing and application to impression die forging. Hot extrusion of rods. Tubes and shapes. CAD/CAM applications in hot and cold extrusion.

Rolling of strips. Plate and shapes. Drawing of rods. Wires. Shapes and tubes. Energy and stresses in these processes.

Die materials and die manufacture. Recent developments in metal forming technology and application of FEM to simulation of metal forming.

2. Reference Books:

1) Mechanical Metallurgy – G. E. Dieter, Mc. Graw Hill.
2) Metal forming – Fundamentals and Applications, ASM.
3) Handbook of Metal Forming by ASM

3. Question Paper Pattern for End Sem Exam:

As per Appendix A

Subject: **Treatment of Metallurgical Wastes and Recovery of By-products**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0212			Semester: **II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	60	00	40	00	100

1. **Contents:**

Unit-1

Techniques of Processing-Principles and Practice

Introduction, Waste Characterization Techniques, Physical and Physico-Chemical Processes

Unit-2

Techniques of Processing-Principles and Practice

Hydrometallurgical Processing, Biotechnological processes, Pyrometallurgical processing

Unit-3

Resource Recovery Operations

Metal Recycling, Metallurgical Slags, Dust and Fumes, Resource Recovery from Process Wastes

Unit-4

Resource Recovery Operations

Converting Wastes into Saleable Products-Biproduct Utilization, Water and Reagents-Recycle and Reuse, Emerging Technologies

2. **Reference Books:**

1) S. Ramachandra Rao, Resource Recovery and Recycling from Metallurgical Wastes, Vol. 7. Waste Management Series 7, 1st Edition, Elsevier Netherlands.

3. **Question Paper Pattern for End Sem Exam:**

As per Appendix A

Department of Metallurgical Engineering, IITE,

Indus University

3rd Semester

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

Subject**: Dissertation Phase I**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0301			Semester**: III**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
0	0	40	20	00	150	00	150	300

Department of Metallurgical Engineering, IITE,

Indus University

4th Semester

Approved Vide Agenda Item No. 03 of Minutes of Meeting of Academic Council held on 11 July 17

Subject**: Dissertation Phase II**								
Program: **M-TECH Industrial Metallurgy**				Subject Code: IM0401			Semester**: IV**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
0	0	40	20	00	150	00	150	300