National Institute of Technology, Jamshedpur

Department of Chemistry

M.Tech. Surface Science and Engineering

Credit Structure

Course Work	Sem I	Sem II	Sem III	Sem IV
Core Course	16	16	-	-
Electives	04	04	-	-
Project /Dissertation	-	-	20	20
Credit	20	20	20	20
Total Credit		80		

COURSE STRUCTURE

Department of Chemistry

M. Tech. in Surface Science & Engineering

SEMESTER-I

Sl. No.	Subject Code	Course Name	L-T-P	Credits
1.	CHG7111	Surface Science & Engineering	3-1-0	4
2.	CHG7112	Electrochemical Interfaces	3-1-0	4
3.	CHG7113	Material Science and Engineering	3-1-0	4
4.	CHG7114	Corrosion Science and Engineering	3-1-0	4
5.		Elective	3-1-0	4
		TOTAL		20

SEMESTER-II

Sl. No.	Subject Code	Course Name	L-T-P	Credits
1.	CHG7121	Mechanistic Models of Corrosion	3-1-0	4
2.	CHG7122	Corrosion Test & Pollution Aspects	3-1-0	4
3.	CHG7123	Design of Corrosion Protection	3-1-0	4
4.	CHG7124	Paint Technology	3-1-0	4
5.		Elective	3-1-0	4
		TOTAL		20

SEMESTER-III

Sl. No.	Subject Code	Course Name	L-T-P	Credits
1.	CHG8151 CHG8161	Dissertation-1 OR Project (I)		20
		TOTAL		20

SEMESTER-IV

Sl. No.	Subject Code	Course Name	L-T-P	Credits
1.	CHG8152 CHG8162	Dissertation-1 OR Project (II)		20
		TOTAL		20

List of Electives

Course Code	Course Name
CHG7131	Characterization of Materials
CHG7132	Tribology
CHG7133	Composite Materials
CHG7134	Corrosion in Oil and Gas Industries
CHG7135	Nanoscience and Engineering
CHG7136	Thermodynamics and kinetics of Materials

Semester I

CHG7111: Surface Science and Engineering (3-1-0)

Capillarity: Surface Tension and surface free energy; Young Laplace equation and experimental Treatment of capillary rise; exact solution of capillary rise problem; Experimental aspects of capillary rise: (a) Maximum bubble pressure method, (b) Drop weight method (Detachment Technology), (c) Ring method (du Nuoy method), (d) Whihelmy slide method, (e) Pendant drop method, (f) Static drop, Hanging bubble and sessile bubble method, (g) Rotating drop method, (h) Oscillation in jet method, (i) Capillary wave.

Thermodynamics of liquid interfaces: Surface thermodynamic quantities;, Structural treatment of liquid interface; Surface tension in binary solution; Surface excess; Derivation of Gibbs equation of surface excess; Determination of surface excess; Gibbs monolayer; Two dimensional ideal gas law; Spreading of liquid, Kinetics of spreading

State of molecular film: (a) Gases film, (b) Gas-Liquid transition, (c) Condensed phases, (d) Solid state, (e) Monolayer Collapse Mixed film, Contact angle at solid-liquid interface; Contact angle hysteresis; Experimental methods for measurement of contact angles.

Theories of contact angle phenomena:(a) Thermodynamics of Young's equation, (b) Semi-empirical model by G-G-F-Y equation, (c) Potential –Distribution model, Wetting as a contact angle phenomena;Wetting as a capillary action phenomena; Water repellency; Floatation; Micelle formation and properties of micelles.

Rheological characteristics; Theories of viscosity: Rheological measurements: (a) Co-axial cylinder viscometer, (b) Cone plate viscometer, (c) Capillary flow viscometer, (d) Falling sphere viscometer, (e) Efflux viscometer.

Friction between lubricated surfaces: (a) Boundary lubrication, (b) Mechanism-Hardy's mode Bowden-Tabor model.**Adhesion:** (a) Ideal adhesion, Work of adhesion, (b) Practical adhesion (Griffit-Irwin criteria)

Adsorption of gas on solids: Chemisorption: Molecular view, Work function, Kinetics of desorption.

Surface Engineering Practices: Metallic Coatings; Surface engineering for Tribology problems-Nitriding, Boronising; Carbide coating; Carburising; Thermal barrier coating for gas-turbine (M Cr Al Y type); degradation mechanism; Performance evaluation of High temperature coatings.

References

1. Arthur W. adamson, Physical Chemistry of Surfaces; John Wiley & Sons
2. K.N. Stafford, Surface Engineering Practices

CHG7112: Electrochemical Interfaces (3-1-0)

Electrified interface; Basic concepts of electrochemistry, Potential difference across electrified interface; non-polarizable interfaces; Concept of surface excess. Fundamental treatment of polarizable interface; Lipmann equation;Pzc; determination of surface excess. Structure of electrified interface; Helmholtz-Perin parallel plate condenser model;Gouy-Chapman diffuse charge model of double layer; Stern model; Metal-water interaction; Contact adsorption; Lateral repulsion model of contact adsorption; Potential difference due to water dipole. **Electro kinetic phenomena**; Streaming current; Electrophoresis, Derivation of Butler-Volmer equation; High & low field over potential; Nernst thermodynamic treatment; Physical meaning of the symmetric factor (β). Multi step reaction; Butler-Volmerequation for multi-step reaction. Transient behaviour of interfaces; Experimental methods. Transport at charge transfer interface; Flux equality condition; Concept of transition time; Convection causing steady interfacial concentration; Concentration over potential; Diffusion layer, Limiting current density; Rotating disc electrode; Steady state condition for transport control; Transport controlled de-electronation reaction.

Determining step-wise mechanism of an electrode reaction. Hydrogen evolution reaction: Possible paths for hydrogen evolution reaction, Mechanism in hydrogen evolution reaction, Determination of reaction order with respect to hydrogen ion in solution. Introduction to various surface analytical methods.

References

1. John O'M. Bockris &Amulya K.N. Reddy, Modern ElectrochemitryVol II. Plenum Press
2. N.D. Tomashov, Corrosion, MIR Publication
3. V.S. Shastri, Corrosion inhibitors; John Wiley & Sons

CHG7113: Material Science and Engineering (3-1-0)

Crystal Structure: Space lattices, Bravais lattices and reciprocal lattice concept. Miller Indices of planes and directions; Bonding in solids: Ionic, covalent and Metallic bonding. Theory of alloy formation, solid solution, substitutional and interstitial solid solution, Hume Rothery Rules, Intermetallic compounds, Normal valency compounds, electron compounds, interstitial compounds; Imperfections: point defects: vacancies, Interstitialcies, Dislocations: edge and screw dislocations, Burgers vector; Binary phase diagrams: Isomorphous, Eutectic, Peritectic, Eutectoid, Monotectic and synthetic systems. Phase rule and Lever rule; Iron-Cementite equilibrium diagrams and its applications; Diffusion: Fick's first and second law of diffusion. Atomic model of diffusion. Grain boundary, surface and thermal diffusion. Kirkendall effect, Grube methode, Matano methode, Interstitial diffusion; Nucleation:

Homogeneous and Heterogeneous nucleation, Kinetics of nucleation. Growth and overall transformation kinetics.

References

1. L.H Van Vlack, Elements of materials science and engineering, Addison Wisley, New York (1985)
2. V. Raghavan, Material Science and Engineering, Prentice-Hall of India Private Limited (2003)
3. W.F Smith, Principles of Materials Science and Engineering, McGraw Hill, New York (1994)
4. W.D Callister, An Introduction Materials science & engineering, John Wiley & sons (2007)

CHG7114: Corrosion Science and Engineering (3-1-0)

Definition of Corrosion & Stability of Metals: Theories of corrosion of metals and alloys [Local cell theory (Role of NMI), Micro galvanic cell (Structural heterogeneity); Differential Oxygen-concentration cell etc.;Theory of ultra-pure metal, Mixed potential theory]; Forms of Corrosion: Uniform corrosion Localized corrosion, Pitting corrosion, Erosion corrosion, Fretting corrosion, Cavitational damages, Crevice corrosion; Selective leaching; Graphitisation; Dezincification; Ring worm attack; Galvanic corrosion;Filliform corrosion; Exfoliation;Intergranular attack; Weld decay; Knife line attack;Stress Corrosion Cracking (SCC); Caustic embrittlement;, Hydrogen Assessed Cracking (HAC); Corrosion fatigue; Fretting corrosion; Fretting fatigue; Liquid metal embrittlement (LME);Weldment corrosion; Marine & Underground corrosion; Stray current attack; In vivo corrosion; Metal matrix composite (MMC) corrosion; Microbial (S.R.B.) corrosion of steel in concrete. Corrosion under high temperature such as: Oxidation, Carburization, Metal dusting, Nitridation, Halogen corrosion, Sulphidation, Ash/Salt deposit attack, Fused (molten) salt corrosion & High temperature-High pressure conditions.

Factors affecting corrosion: Environments; Temperature, Turbulence, Concentration-gradient, pH; Once-through & closed re-circulating cooling water system; State of stress, etc.

Metallurgical variables: Effect of Non-Metallic Inclusions (NMI) & Role of alloying additions and micro structures etc.;On corrosion resistance of metals with particular reference to cast iron, steel, stainless steel (Austentic, Ferritic, Mertistic), Aluminium, Copper, Nickel & their alloys.

Evans Diagram: Anodic and Cathodic control, Role of Inhibitors, Oxidizers, Temperature, Velocity etc; Diagram of multi electrode system.

Pourbaix Diagram: EH-pH Diagram for system like Fe-H_2O, Cu-H_2O, Pb-H_2O, Al-H_2O, Zn-H_2O, Ni-H_2O, etc.

Iso-corrosion Diagram: Characteristics of different metals: Environment systems; such as steel, Lead, Duriron, Chlorimet, Hestelloy, Inconel, Aluminium & Bronze in Sulphuric acid, Stainless steel, High Si iron, Durimet, Aluminium in Nitric acid & Mixed acid; Materials for handling Hydrofluoric acid, Phosphoric acid & Hydrochloric acid.

Corrosion resistant Materials: (a) Mechanical/Metallurgical properties of selected alloys [Iron Steel, Low alloy steels, Stainless steels, Cast iron (including high Si variety), Aluminium alloys, Copper alloys, Nickel alloys, Zinc alloys, Titanium alloys, etc.].(b) Performance of the alloys with respect to natural environment such as atmosphere, underground seawater, etc.

References

1. M.G. Fontana & Greene, Corrosion Engineering; Tata McGraw Hill
2. L.L. Shrier (Vol. I & II), Corrosion & corrosion control.

Semester II

CHG7121: Mechanistic Models of Corrosion (3-1-0)

Passivity: (a) Development of theory,(b) passivation processes, Passivation kinetics, Passive-film characteristics,(c) Theories and models: (i) Metal-modification theory; (ii) Electron-configuration theory,(iii) Reaction rate theory,(iv) oxide film theory,(v) Adsorption theory,(d) Ionic space-charge induced passivity, Bipolar fixed charge induced passivity, Ion-transport models, Hopping motion and place-exchange mechanism.

Pitting: Various models of pitting (a) Adsorption theory, (b) Anion penetration and migration theories.Mechano-Chemical model; Point-defect model of pit-initiation; Localized acidification theories, Thermodynamic theory; Depassivation-Repassivation theory.

Mechanism of stress corrosion cracking: (a) Dissolution controlled mechanism,(b) Film-rupture model,(c) Slip dissolution theory,(d) Adsorption theory, (e) Strain-enhanced corrosion mechanism,(f) Mass transport-kinetic model,(g) Ligament instability model,(f) Constant charge criteria,(g) Hydrogen controlled mechanism.

Mechanism and theories of hydrogen embrittlement: (a) Pressure theory of Zapffe and recent development, Pressure mechanism by Bockris, by Troiano,(b) Surface energy concept,(c) Cohesive energy concept (Unified model of hydrogen-embrittlement, Liquid metal embrittlement),(d) Decohesion theory (Oriani), (e) Crack-tip plasticity concept,(f) Concept of brittle fracture in ductile material,(g) Dislocation locking (Transport) model,(h) Hydride theory,(i) Reaction model.

Fatigue growth mechanism, Liquid metal embrittlement, Recent models on atmospheric corrosion

De-alloying/ Selective leaching: (a) Volume-diffusion model,(b) Enhanced diffusion models,(c) Surface diffusion,(d) Oxide formation, (e) Percolation model, (f) Dissolution-re-precipitation model. Fracture mechanics applied to stress corrosion creacking, Hydrogen assisted cracking and corrosion fatigue

References

1. R.P. Frankenthal& J. Kruger, Corrosion Monograph Series, The Electrochemical Society, Inc., New Jersey.
2. S. Szklarska-Smialowska, Pitting Corrosion, NACE.
3. Proceedings of International conference on Stress corrosion cracking (Ohio State University) 1962;
4. Proceedings of Stress corrosion cracking and hydrogen embrittlement of iron based alloys (University of Finniny, Italy);
5. H. Buhl, Stress corrosion cracking, DFVIR.

CHG7122: Corrosion Test & Pollution Aspects (3-1-0)

1. Introduction

(a) Planning and design of tests. (b) Types of data: Electrochemical test data, Metallographic analysis, Surface analysis, Statistical treatment of data, Data interpretation and reliability and computerization Types of test: laboratory tests: Electrochemical, Cabinet, Immersion, High temperature-high pressure, Field test: Atmospheric, Sea water, Fresh water, Soil service test: Industrial applications.

2. Electrochemical Methods

Corrosion rates from electrochemical data, Electrochemical methods for uniform corrosion, Polarization methods & complications due to concentration polarization, Polarization resistance methods. Electrochemical impedance (EIS), Electrochemical method for passivity & localized corrosion. Cyclic, Potentiostatic&Galvanostatic methods for localized corrosion, The scratch re-passivation method for localized corrosion, Electrochemical noise method, Electrochemical methods for environmentally assisted cracking, Scratch repassivation, Tribo-ellipsometric method, Evaluation of alloy sensitization (ERP) Evaluation of protective coatings & films, Ford anodized aluminium corrosion test (FACT), The electrolytic corrosion test, Paint adhesion on a scribed Surface (PASS), Single frequency test, Electrochemical impedance spectroscopy (EIS).

Cabinet Test: (a) Types of test: Controlled humidity test, Corrodekote test, Test for solder fluxes, Water resistance of coating up to RH = 100. Preventive properties of greases and cyclic

humidity test, (b) Corrosive gas tests: Combined controlled humidity & controlled gases, Test with nitric acid vapour. Test with sulphuric acid/sulphur dioxide vapour, The moist sulphur dioxide test (Mixed Flowing Gas Test), (c) Salt spray tests: Acetic acid salt fog test, Copper accelerated acetic acid salt spray test (CASS); Acidified synthetic sea water test for exfoliation testing of aluminium alloys, Prohesion test for paints i.e., Periodic spray & exposure for preparing, Cleaning, Evaluation & recording data of corrosive tests.

3. Immersion test

Basic principles,Test conditions, Physical parameters, Test durations type of test, Simple immersion test, Alternate immersion test, Simulation & acceptance testing, Specimen preparations, Evaluation of results, Standard test procedures.

High temperature & high pressure (aqueous): Basic principle of high temperature & high pressure corrosion test & typical test condition, Types of tests: Static tests, Agitated tests, Refreshed & recirculating test, Factors affecting test conditions, Particular test of dissolved oxygen, Hydrogen & other gases, other types of tests safety, Standards.

4. Atmospheric corrosion test

Basic principle: Types of exposures, Atmospheric variables, Classification of atmosphere, Test Programmes and standards: Practice for conducting atmospheric corrosion test on metals Practice for recording data, Practice for measurement of time for wetness, Practice for monitoring atmosphere Sulfur dioxide, Practice for characterizing test sites, ISO and NACE standard.

5. Sea water corrosion tests

Basic principle, Specimen configuration, Duration of exposure, Tests for specific types of corrosion, Specimen exposure & retrieval, Corrosion evaluation Standards.

6. Fresh water corrosion

Basic principle, Factors affecting water chemistry & others (Temperature, Pressure Metallurgy redox potential, Biological, Velocity & galvanic effect). Basic testing technique & standards: Practice for laboratory immersion tests, practice for preparing etc. for test specimen, Practice for electrochemical tests, practice for potentiodynamic polarization resistance measurements, Practice for online monitoring of corrosion in plant equipments etc.

7. Soil corrosion testing

Basic principle; Design speciemen emplacement; Specimen retneval; Cleaning & evaluation; Physical measurements; Electrochemical measurements; Polarizatio;, Galvanic corrosion; Potential mapping standards.

8. Indutraial in palnt testing

Basic principle, Measurement technique, Installation & monitoring devices, Specimen types, Types of tests: Electrical resistance probes (SATMG 96), Electrochemical probes (G96), Other methods, Safety.

9. High temperature corrosion tests (dry)

Basic principle of high temperature corrosion chemical thermpodynamics& physical principles, Basic modes (Oxidation, Carorization, Nitridation, Sulfadation, etc

10. Pollution aspects

(a) Concept and scope of Environmental Chemistry and Natural Cycles, (b) Metallic corrosion causing Atmospheric, Water, Air Pollution,(c) Chemical and Biological analysis of pollutants

References

1. R.P. Frankenthal& J. Kruger, Corrosion Monograph Series, The Electrochemical Society, Inc., New Jersey.
2. S. Szklarska-Smialowska, Pitting Corrosion, NACE.
3. Proceedings of International conference on Stress corrosion cracking (Ohio State University) 1962;
4. Proceedings of Stress corrosion cracking and hydrogen embrittlement of iron based alloys (University of Finniny, Italy);
5. H. Buhl, Stress corrosion cracking, DFVLR.
6. L.L. shrier (Vol. II), Corrosion & corrosion control.
7. Robert Baboien, Corrosion test & standards.
8. A.K. Dey, Environmental Chemistry, New Age, International Pulications. (New Delhi).

CHG7123: Design of Corrosion Protection (3-1-0)

Principles of Cathodic Protection: Electrochemical principl; Protection criteria, current requirement, Potential distribution for finite & infinite length pipe line, Sacrificial anode types, Back fills, Resistivity, Capacity, Efficiency & life of anodes, Design parameters. Power impressed anode: Types: Ferrous & non-ferrous materials, Lead, Carbonaceous materials & rare buried structure, Cathodic protection instruments.

Anodic Protection: Principles, Passivity criteria, Practical aspects. Conditioning the environment: Corrosion inhibitors, Principles and practice, Classifications, Types, inhibitors for aqueous solution and steam, Oil industry, Mechanism of inhibitive action: Diffusion barrier, Blocking reaction, Alteration of electrical double layer; Inhibitors for neutral and acid solutions, Boiler-feed water treatment, Vapour phase inhibitors (VPI). Pre-treatment, prior to applying coating, Pickling in acids, Chemical and electro chemical polishing, Design parameters.

Electroplating: Principles, Pre-treatment, Plating processes, Aqueous electrolytes, Adhesive agents, Anode strike baths, Factors influencing; Substrate effects (Epitoxy and Psudomorphism), Electrolyte effects; Properties of electro deposits, Thickness, Throwing power, Current path geometry, Internal stress, Ductility, Hardness, Water strength, Inter-diffusion and porosity.

Metallic coatings: Immersion coating, Chemical reduction, Vacuum evaporation, Gas plating, Cathodic sputtering, Plasma spraying, Properties of sprayed products of aluminium, Cadmium, nickel, Chromium and Copper, Electroless coating; Hot Dip Coating: Principles, Tinning, Terne coating, Galvanizing and aluminizing diffusion coating: Theory, Methods, Gas phase deposition, Chromizing, Aluminizing and properties of coatings. Corrosion problems in industry: In chemicals, Fertilizers, Petrochemicals, Steel and automobile industries, etc. Effective design for corrosion prevention.

References

1. L.L. Shrier, Corrosion Vol.II, Newnes-Butterworths (1979)
2. V.S. Sastri, Corrosion Inhibitors: Principles and Applications, John-Wiley and Sons
3. J.H. Morgan, Cathodic Protection, Leonard Hills Ltd., London (1959)
4. V.R. Pludek, Cathodic protection by Peabody: Design and Corrosion Control, McMillan Press Ltd., London (1977).

CHG7124: Paint Technology (3-1-0)

Principles and Paint Film Formation: Cohesive & Adhesive forces, Film formation by evaporation of solvent plus polymerization.

Ingradients of paints: (a) Drying oils: The chemistry and properties of drying oils, Types of polymers & physical properties, (b) Pigments: Inorganic Pigments & Organic pigments, Types & uses of pigments in industrial finishing, (c) Extenders: Chemical constitution and composition. (d) Solvents: Characteristics of Solvent groups, properties, (e) Plasticisers: Types, Mechanism & uses, (f) Additives: Dryers, Extenders (Oxides, Hydroxides, Carbonates, Silicates, Sulphates), Anti skinning agents, Anti setting Agents, Anti floating and flooding agents, Anti foaming agents, (g) Surface active agents: Types, Physical Properties.

Surface Preparation before painting, Film properties and defects, Application Techniques of paint. Test of paint: (A)Test of Ingradients: (a) Drying of oils (Softening point, Iodine value, Gel time, Acetone number) (b) Solvents (Aniline point, Kauri-Butanol value, Flash point), (c) Pigments (Oil adsorption value, Daniel flow point for pigment composition), (d) Dryers (Hydrophilic-Liophilic Balance number), (e) Liquid Paint (Skinning test, thixotropic test, Solid content, Sagging test, Gel time, Hiding power, Drying time etc.). **(B)Test for Coated Sample:**Distensibility (Conical mandrel Test), Abrasion resistance (Taber and wheel abrasion test), Impact Testing (Bell lab glacing type test),

Hardness (Swordrocker hardness, Pencil hardness), Adhesion (Scrape method, Snatch pull, Scratch method).etc.

Modern Paint Technology: (a) Water borne coating, (b) Radiation curable coating: Important types (UV curing, Electron beam, Radio frequency, Gamma rays, Microwaves etc.), (c) Powder coatings: Thermo plastic, Thermosetting powder coatings, Applications techniques of powder coatings (Electrostatic spraying, Corona charging, Tribo charging, Fluidized bed technique, Flame spray techniques, etc.,), (d) High solid liquid coating, (e) Cathodic electro deposition, (f) Anodic electro deposition.

References

1. Ed-Swaraj Paul, Surface Coatings; John Wiley Sons, New York (1996).
2. H.F. Payne (Vol-1,2), Organic Coatings
3. W.M. Morgan, Outlines of Paint Technology (Vol-1), Edward Arnold Publication (1990).
4. Charles R. Martens, Water Borne Coating Emulsion and Water soluble Paints; Van NastandRainhold company Network (1964).
5. Paint Calculations; OCCAA Publications.
6. Ed-T.A. Misev, Powder Coatings Chemistry and Technology; John Wiley and sons, New York (1961).

List of Electives

CHG7131: Characterization of Materials (3-1-0)

Scope of Characterization of materials; Materials beam interaction Optical Microscopy: Techniques, Polarised and interferomery phase contrast. In-situ metallography, colour metallorgaphy, inclusion characterization. Quantitative Microscopy: Techniques Diffraction Techniques: X-ray diffraction technique for phase identification, strain & particle size, phase diagram and Texture determinations, synchrotron radiation, Neutron diffraction. Scanning electron microscopy and Electron probe micro analysis: Principles of image formation in SEM and application. Energy dispersive X-ray analysis and wavelength dispersive X-ray analysis. Electron probe micro analysis and its application for chemical analysis. Scanning Transmission electron microscopy. Transmission and analytical electron microscopy. Formation of image and selection area diffraction patterns. Theories of image contrast and their application to perfect and imperfect crystalline specimens. High resolution electron microscopy, analytical electron microscopy, convergent beam electron diffraction, micro diffraction, composition analysis by EELS. Surface probe microscopy: Scanning Tunneling microscopy, Atomic Force microscopy. X-ray fluorescence; EDXRF, WDXRF; optical

absorption spectroscopy, emission spectroscopy, Auger spectroscopy. Thermal analysis: DTA, DSC and TGA, working principle and applications. Types and applications of strain gauges.

Reference Books:

1. Cullity, B.D., Elements of X- Ray diffraction, Addison Wesley
2. Sridhar, G., Ghosh Choudhary, S., and Goswami, N. G., Materials characterization techniques (ed) NML, Jamshedpur.
3. Williams, D.B., and Carter, C.B., Transmission electron microscopy: A Text Book of Materials Science.
4. Krishna, R., Anantraman, T.R., Pande, C.S., Arora, O.P., Advanced techniques for microstrutural characterization (ed), Trans Tech Publication

CHG7132: Tribology (3-1-0)

Introduction tribology, surface degradation, wear and corrosion, types of wear, roles of friction and lubrication- overview of different forms of corrosion, introduction to surface engineering, importance of substrate Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, thermochemical processes -industrial practices Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electrocomposite plating, electroless plating of copper, nickel-phosphorous, nickel-boron; electroless composite plating; application areas, properties, test standards (ASTM) for assessment of quality deposits.

Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities,chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD, specific industrial applications Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, D-Gun and high velocity oxy-fuel processes, laser surface alloying and cladding, specific industrial applications, tests for assessment of wear and corrosion behaviour.

Refernce Books:

1.Sudarshan T S, ‘Surface modification technologies- An Engineer’s guide’, Marcel Dekker, Newyork, 1989

2.Varghese C.D, ‘Electroplating and Other Surface Treatments - A Practical Guide’, TMH, 1993

CHG7133: Composite Materials (3-1-0)

Introduction: classifications, terminologies, manufacturing processes. Macro-mechanical analysis of lamina: Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina – Strength theories of lamina. Micro-mechanical analysis of lamina: Volume and mass fraction, density and void content – Evaluation of Elastic module, Ultimate strength of unidirectional lamina. Macro-mechanical analysis of laminates: Laminate code, Stress strain relations – In-plane and Flexural modulus, Hydrothermal effects. Failure Analysis and Design: Special cases of laminates, symmetric, cross ply, angle ply and antisymmetric laminates, failure criteria and failure modes

Reference Books:

1. R. M. Jones, Mechanics of Composite Materials, Scripta Book Co., ISBN: 781560327127.

2. B. D. Agarwal, and J. D. Broutman, Analysis and Performance of Fiber Composites, New York, John Willey and Sons, 1990.

3. P. K. Mallick, Fiber Reinforced Composites: Materials, Manufacturing and Design (2ndedition), New York- Marcel and Dekker, 1993, ISBN: 9780824790318.

4. Autar, K. Kaw, Mechanics of Composite Materials, CRC Press, 1997, ISBN: 9780849313431.

5. J. N. Reddy, Mechanics of Laminated Composite Plates, CRC Press, ISBN: 9780849315923.

6. P. K. Mallick, Composite Engineering Hand Book (2nd edition), Marcel and Dekker, New York, 1997, ISBN: 9780824793043.

CHG7134: Corrosion in Oil and Gas Industries (3-1-0)

Household corrosion vs Industrial corrosion, example of corrosion in various industries: power plants, refineries, chemical and petrochemical plants, fertilizers plants, sugar and pulp & paper industry. Corrosion in electrical and electronics industries. Corrosion in concrete and RCC structures. Failure case histories and analysis. How to make industry free from

corrosion, better material selection based upon requirement of various industries, corrosion control method, use of corrosion monitoring to monitor the health of an industries, corrosion management approach and KPI concept. Definition of highly aggressive environment, sour and sweet environments, materials requirements for offshore structures, refineries, petrochemical plants, X-40 to X80 steels for pipelines, high corrosion resistant materials such as superaustenitic, superferritic, Duplex stainless steels and special supe alloys, design of corrosion resistant storage tanks, tank linings and cathodic protection, transportation of crude and gas, underground cross country pipelines, phenomena of corrosion in crude gas pipelines, complex combination of pH, water cut, oil, carbon dioxide and H_2S, external corrosion prevention by coatings and cathodic protection, methods of corrosion monitoring of pipelines, PSP surveys, Pearson surveys, intelligent pigging, ultrasonic and other NDT methods, SCADA system.

1. A. S. Khanna, Introduction to High Temperature Corrosion, ASM Publication, 2002, ISBN: 978-0871707628.

2. Evans, R. Ulick, An Introduction to Metallic Corrosion, Edward Arnold, London, UK, 1948, ISBN: 9780713120530.

3. Fontana, G. Mars, Greene and D. Norbert, Corrosion Engineering, McGraw-Hill, New York, 1967, ISBN: 0070214611.

4. D. Stephen, Cramer, S. Bernard and Jr. Covino, ASM Corrosion Fundamentals and Testing, ASM International, Edited, ISBN: 0 87170-705-5.

CHG7135: Nanoscience and Engineering (3-1-0)

Concept of nano materials, scale/dimensional aspects, top down and bottom up approaches for preparing nano materials. Advantages and limitations at the nano level, thermodynamic aspects at the nano level, health and environmental issues. Long range and short range order forces, vander waal forces, solvation forces, electrostatic forces, hydrophobic forces, electric double layer forces, steric forces; Relevant theories, advantages and limitations, applications in colloidal stability. Thermodynamics of surfaces; surface and interfacial energy, uses of Wulff plot, binding energy, surface roughness, adhesion and wetting. Principles of photo and nano lithography, steps involved and applications. Synthesis routes of nano particles: mechanical alloying, sol- gel process, dispersed phase and dispersion medium and their

interactions; gaseous reduction, Chemical vapor deposition, hydrogen plasma arc method, laser ablation, radiolysis, photolysis; Applications.

Reference Books:

1. Pradeep, T., Nano: The essentials, McGraw Hill
2. Wilson, M et al, Nano Technology, Overseas Press
3. Poole, C.P and Owens, J.F, Introduction to Nano Technology, Wiley
4. Schmid, G., Nano particles: From theory to applications, Wiley VCH Verlag GmBH and Co.

CHG7136: Thermodynamics and kinetics of Materials (3-1-0)

Introduction to thermodynamics and kinetics- different approaches, emphasis on metallurgical thermodynamics. Law of thermodynamics and related applications, Concepts of free energy and entropy, criteria for spontaneity. Introduction to solutions, Partial molar quantities, Gibbs- Duhem relations, thermodynamic aspects of metallic solutions and salt melts, Raoult's and Henry's Law, Regular and quasi chemical models. Thermodynamic aspects of phase diagrams, Similarity in thermodynamic approach towards different classes of materials, thermodynamic aspect of defect formation in metals and ceramics. Principles of metallurgical kinetics, reaction rates and reaction mechanism.

Reference Books:

1. Gaskell, David, R., Introduction to Metallurgical Thermodynamics, McGraw Hill.
2. Mohanty, A. K., Rate processes in metallurgy, Prentice Hall of India.
3. Upadhayaya, G.S., and Dube, R.K., Problems in metallurgical thermodynamics and kinetics, Pergamon
4. Darken, L.S., and Gurry, R.W., Physical chemistry of Metals, McGraw Hill

M.Tech in Surface Science & Engineering- Corrosion & Coating Science (NIT, Jamshedpur) with 1 year internship in R&D lab of Kansai Nerolac Paints Ltd, Mumbai. Along with M.Tech, I have qualified GATE-2013 (Graduate Aptitude Test of Engineering) with 91.4 percentile. I have also qualified M.Sc. (organic chemistry) with 71% in 2012. I believe that the combination of my qualifications and 1 year experience of internship offers me the unique opportunity of making a positive contribution to your organization. Here I attached my updated resume. Thanking You, Bhupendra Daharwal. Experienc B.Tech in Surface Coating Technology is a relatively new course in the field of engineering, and hence only 2 institutes offer this program in India: College/University. City.Â The science of Surface Coating involves plastics and materials science aspects such as scientific principles of fabrication. Some of the professional avenues open to such postgraduates are listed below with the corresponding salaries offered for the respective positions. Job Position. Because of the multiscale nature of surface science and engineering, IJSURFSE will provide a forum for cross-scale investigations into the property, integrity and durability of surfaces and subsurfaces of advanced elements. Readership. Disciplines: Academics; materials researchers; materials, manufacturing and mechanical engineers; physicists in surface analysis; professionals in tribology and surface engineering and related industries. Scales: From nanoscopic (e.g. nanoscience and nanotechnology) to macroscopic. Contents.