Course list

This is the exhaustive collection of courses I have taken, during my time at the University of California, Berkeley (Master of Engineering in Materials Science and Engineering) and the Indian Institute of Science (Bachelor of Science in Materials Science). Descriptions and Textbooks are included where applicable.

Courses from UC Berkeley are listed in blue. Number of units for each course is listed in parentheses.

Courses from the Indian Institute of Science are listed in black. Credits for each course is enclosed in parentheses. The first digit is the number of hours of class per week, and the second digit is the number of lab sessions every week.

A leading U in the course number indicates that it is an undergraduate level course. The absence of such a U indicates that it is a graduate level course.

Materials Science courses

- MSE 204: Theory of Electron Microscopy and X-ray Diffraction (3 units)
- MSE 211: Mechanics of Solids (3 units)
- MSE 215: Introduction to Computational Materials Science (3 units)
- MSE C286: Modeling and Simulation of Advanced Manufacturing Processes (3 units)
- MSE 241: Electron Microscopy Laboratory (4 units)
- UE 202: Introduction to Materials Science (2:0)
- UMT 202: Structure of Materials (2:1)
- UMT 203: Materials Thermodynamics (3:0)
- UMT 204: Electronic Properties of Materials (3:0)
- UMT 301: Materials Kinetics (3:0)
- UMT 302: Introduction to Materials Processing (2:1)
- UMT 303: Mechanical Behaviour of Materials (3:0)
- UMT 306: Mechanical Processing Lab (0:1)
- UMT 304: Microstructures in Materials (3:0)
- UMT 305: Mechanical Properties Lab (0:1)
- UMT 307: Materials Characterization Lab (0:1)
- MT 201: Phase Transformations (3:0)
- MT 220: Microstructural Design and Development of Engineering Materials (3:0)
- MT 252: Science of Materials Processing (3:0)
- MT 255: Solidification Processing (3:0)
- MT 260: Polymer Science and Engineering 1 (3:0)
- MT 262: Concepts in Polymer Blends and Nanocomposites
- MT 271: Introduction to Biomaterials Science and Engineering (3:0)
- MT 233: Introduction to Electrochemical Engineering (3:0)

Other Engineering Courses

- BIOE 295: Bringing Biomedical Devices to Market (3 units)
- UE 101: Algorithms and Programming (2:1)
- UE 102: Introduction to Electrical and Electronics Engineering (2:1)
- UE200: Introduction to Earth and its Environment (2:0)
- UE 201: Introduction to Scientific Computing (2:1)
- UE204: Elements of solid mechanics (3:0)
- PD 212: Computer Aided Design (2:1)
- PD 205: Materials, Manufacturing, and Design (3:0)

Leadership and Business courses

- ENGIN 270A: Organizational Behavior and Negotiation for Engineers (1 unit)
- ENGIN 270B: R&D Technology Management and Ethics (1 unit)
- ENGIN 270C: Project management and teaming (1 unit)
- ENGIN 295: Communication for Engineering Leaders (1 unit)
- MBA 209F: Introduction to Business for Graduate Students (3 units)
- ENGIN 270E: Technology Strategy and Industry Analysis (1 unit)
- ENGIN 270F: Data Analytics (1 unit)
- ENGIN 270H: Accounting and Finance for Engineers (1 unit)
- MG 274: Management of Innovation and Intellectual Property

Math and Science Courses

- UM 101: Analysis and Linear Algebra I (3:0)
- UM 102: Analysis and Linear Algebra II (3:0)
- UM 201: Probability and Statistics (3:0)
- UP 101: Introductory Physics I – Mechanics, oscillations and waves (2:1)
- UP 102: Introductory Physics II – Electricity, Magnetism and Optics (2:1)
- UP 201: Introductory Physics Ill – Thermal and Modern Physics (2:1)
- UC 101: Physical Principles of Chemistry (2:1)
- UC 103: Basic Inorganic Chemistry (2:1)
- UC 206: Basic Organic Chemistry (2:1)
- UB 101: Introductory Biology I – Organismal Biology and the Molecular Basis of Life (2:1)
- UB 102: Introductory Biology II – Microbiology, Molecular Biology and Genetics (2:1)
- UB 201: Introductory Biology III – Cell Biology, Immunology and Neurobiology (2:1)
- NS 201: Fundamentals of Systems and Cognitive Neuroscience (3:0)

Humanities Courses

- UH 101: Ways of Knowing (2:0)
- UH 102: Ways of Seeing (2:0)
- UH 203: Ways of Doing (2:0)
- UH 204: Seminar Course: Mapping India through the Folk Arts (1:0)
- UH 301:Seminar Course: Journalism for Scientists (1:0)
- UH 302: Seminar Course: Introduction to Governance (1:0)

Materials Science courses

MSE 204: Theory of Electron Microscopy and X-ray Diffraction (3 units)

Basic principles of techniques used in the characterization of engineering materials by electron microscopy, diffraction, and spectroscopy; emphasis on detailed analysis of defects responsible for materials properties. Modern electrical, optical and particle beam techniques for the characterization of bulk single crystals and their crystalline and amorphous layers.

Transmission Electron Microscopy: A Textbook for Materials Science, 2nd ed., by D.B. Williams and C. B. Carter, Plenum Press, NY 1996

Physical Principles of Electron Microscopy, R. F. Egerton, Springer, 2010

Transmission Electron Microscopy and Diffractometry of Materials, 3rd Ed., by B. Fultz & J.M.Howe, Springer, 2008

MSE 211: Mechanics of Solids (3 units)

Mechanical response of materials: Simple tension in elastic, plastic and viscoelastic members. Continuum mechanics: The stress and strain tensors, equilibrium, compatability. Three-dimensional elastic, plastic and viscoelastic problems. Thermal, transformation, and dealloying stresses. Applications: Plane problems, stress concentrations at defects, metal forming problems.

L. Anand, Introduction to Mechanics of Solid Materials (2016)

MSE 215: Introduction to Computational Materials Science (3 units)

Introduction to computational materials science. Development of atomic scale simulations for materials science applications. Application of kinetic Monte Carlo, molecular dynamics, and total energy techniques to the modeling of surface diffusion processes, elastic constants, ideal shear strengths, and defect properties. Introduction to simple numerical methods for solving coupled differential equations and for studying correlations.

Relevant reading

MSE C286: Modeling and Simulation of Advanced Manufacturing Processes (3 units)

This course provides the student with a modern introduction to the basic industrial practices, modeling techniques, theoretical background, and computational methods to treat classical and cutting edge manufacturing processes in a coherent and self-consistent manner. Also listed as Mechanical Engineering C201. Topics: overview of manufacturing processes, mechanical behavior of materials, surfaces and tribology, casting and heat treatment, analytical treatment of cold working, continuum formulations in three dimensions, elasto-plastic analysis of forming with thermal effects, finite element methods for forming at finite deformations, surface treatments, simulation of surface treatments with finite element methods, composite material design and optimization of materials using numerical methods.

Course reader and class notes

MSE 241: Electron Microscopy Laboratory (4 units)

This course covers the basic principles of techniques used in the characterization of engineering materials by electron microscopy, diffraction, and spectroscopy. In addition to lectures on the theory of electron diffraction and microscopy, there is a hands-on laboratory that offers detailed practical training in the operation of the transmission electron microscope (TEM) in all of its major functional diffraction and imaging modes. (Includes 4 hours on a dedicated TEM each week)

Instructor-prepared slide decks.

UE 202: Introduction to Materials Science (2:0)

Bonding, types of materials, basics of crystal structures and crystallography. Thermodynamics, thermochemistry, unary systems, methods of structural characterization. Thermodynamics of solid solutions, phase diagrams, defects, diffusion. Solidification. Solid-solid phase transformations. Mechanical behaviour: elasticity, plasticity, fracture. Electrochemistry and corrosion. Band structure, electrical, magnetic and optical materials. Classes of practical materials systems: metallic alloys, ceramics, semiconductors, composites.

W.D. Callister: Materials Science and Engineering, Wiley India (2007)

UMT 202: Structure of Materials (2:1)

Elements of bonding, structures of simple metallic, ionic and covalent solids; Coordination polyhedra, projections of structures, stacking; Lattices, symmetry operations, stereographic projection; Structure and thermodynamics of point defects and solid solutions, non-stoichiometry, ordered structures; Dislocations and slip, twinning and interfaces.

A. Kelly and G.W.Groves: Crystallography & Crystal Defects, Addison Wesley C.S.Barrett and T.B.Massalski, Structure of Metals, Pergamon

A.R. West,: Introduction to solid state chemistry, John Wiley

UMT 203: Materials Thermodynamics (3:0)

First Law, Enthalpy, Thermochemistry; Second Law, Entropy, Statistical Interpretation; Helmholtz and Gibbs Free Energies, Chemical Potential; Solution Thermodynamics; Conditions for Equilibrium, Phase Rule, Phase Diagrams; Chemical Reactions and Equilibria; Surfaces and Interfaces.

R.T. DeHoff: Thermodynamics in Materials Science, Taylor & Francis (2006)

D.R. Gaskell: Introduction to the Thermodynamics of Materials (4th Ed), Taylor & Francis (2003).

UMT 204: Electronic Properties of Materials (3:0)

Brief review of the fundamentals of quantum mechanics, statistical mechanics, electrostatics and electrodynamics. Energy bands in crystals, density of states, Electric conduction in metals and alloys, Thermoelectric phenomenon and applications, Semiconductors and devices, Electrical properties of polymers, ceramics, dielectric and amorphous materials, classical and quantum mechanical description of optical properties, Lasers, LEDs, photonics,Magnetic phenomenon and applications, Thermal properties of materials.

C. Kittel: Introduction to Solid State Physics, McGraw-Hill.

L. Solymar and D. Walsh, Lectures on Electrical Properties of Materials

M. Ali Omar: Elementary Solid State Physics

R.E. Hummel: Electronic Properties of Materials

UMT 301: Materials Kinetics (3:0)

Point defects, Fick's laws of diffusion, concept of jump frequency, activation energy, Kirkendall effect, solidification, nucleation, constitutional supercooling, sintering, interfaces, grain growth, solid state transformations, JMA theory, GP zone, Spinodal decomposition, ordering and martensitic transformations, effect of stress and electric current.

R.E. Reed-Hill and R. Abbaschian, Physical Metallurgy Principles

D.A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys, Taylor and Francis (2009)

UMT 302: Introduction to Materials Processing (2:1)

Metals: Principles of extraction of metals, hydrometallurgy, electrometallurgy, pyrometallurgy. Solidification Processing. Ceramics: Synthesis of ceramic powders, consolidation, sintering. Polymer synthesis. Growth and processing of thin films.

C.B. Alcock: Principles of pyrometallurgy, Academic Press, London (1976)

S. Venkatachalam: Hydrometallurgy, Narosa, New Delhi (1998).

W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, Wiley (1976)

D. Braun, H. Cherdron, M. Rehahn, H. Ritter and B. Voit, Polymer Synthesis: Theory and Practice: Fundamentals, Methods, Experiments, Springer (2010)

UMT 303: Mechanical Behaviour of Materials (3:0)

Introduction to basic concepts of Stress and Strain; Engineering stress-strain response vs. True stress-strain response, Elastic and viscoelastic behavior, dislocations, plastic flow in single crystals, strengthening mechanisms, composites, noncrystalline materials, fracture and toughening mechanisms of ceramics and polymers, creep and fatigue, environmental effects.

Dieter, Mechanical Metallurgy

T.H. Courtney, Mechanical Behavior of Materials

UMT 306: Mechanical Processing Lab (0:1)

Solidification, Mechanical working of materials: Rolling, Extrusion; Powder processing: Sintering; Materials Joining: Welding, Soldering.

UMT 304: Microstructures in Materials (3:0)

Structure and properties of grain boundaries, interface boundaries, and surfaces; Solidification microstructures; Phase transformations: precipitation, eutectoid, martensitic transformations; Sintering.

D.A. Porter and K. E. Easterling, Phase Transformations in Metals and Alloys, Taylor and Francis (2009)

J.W. Martin, R.D. Doherty and B. Cantor, Stability of Microstructures in Metallic Systems, Cambridge University Press

UMT 305: Mechanical Properties Lab (0:1)

Tensile and compression testing. Hardness tests. Fatigue. Impact testing. Creep, Dynamic properties of materials.

UMT 307: Materials Characterization Lab (0:1)

Lab course covering characterization of functional materials, such as magnetic materials, solar cells, piezoelectric crystals, etc.

MT 201: Phase Transformations (3:0)

Overview of phase transformations, nucleation and growth theories, coarsening, precipitation, spinodal decomposition, eutectoid, massive, disorder-to-order, martensitic transformations. crystal interfaces and microstructure. topics in the theory of phase transformations: linear stability analysis, elastic stress effects, sharp interface and diffuse interface models of microstructural evolution.

D.A. Porter. and K.E. Easterling: Phase Transformations in Metal and Alloys, Van Nostrand, 1981. A.K. Jena, and M. Chaturvedi: Phase Transformations in Materials, Prentice-Hall, 1993.

A.G. Khachaturyan: Theory of Structural Transformation in Solids, John Wiley, 1983.

R.E. Reed-Hill and R. Abbaschian: Physical Metallurgy Principles, P.W.S-Kent, 1992.

MT 220: Microstructural Design and Development of Engineering Materials (3:0)

This course builds on the fundamentals of phase stability, transformations, processing, solid state physics, and mechanical behavior to describe how engineering materials can be tailored to achieve desired properties through the control of composition, processing and microstructure. Two broad classes of materials were covered. Thermo-structural materials including aluminium and magnesium alloys, titanium and nickel base alloys, steels, composites, shape memory alloys and amorphous alloys. Functional materials include hard and soft magnetic materials, families of semiconductors, optical materials and electronic ceramics. Common applications for these materials and current technological challenges and trends were also highlighted.

G. Lutjering and J.C. Williams: Titanium, Springer, New York

R.C. Reed: The Superalloys: Fundamentals and Applications, Cambridge University Press, UK.

H.K.D.H. Bhadeshia and R. Honeycombe: Steels: Microstructure and Properties, Butterworth-Heinemann, UK.

I.J. Polmear: Light Alloys: From Traditional Alloys to Nanocrystals, 4th ed, Butterworth-Heinemann, UK.

R.E. Hummel: Electronic Properties of Materials, Springer, New York.

D. Hull and T.W. Clyne: An Introduction to Composite Materials, Cambridge University Press.

MT 252: Science of Materials Processing (3:0)

Fundamentals of Materials Processing: Deformation processing. Fundamentals and applications of plasticity, yielding, flow instability, drawability, anisotropy. Temperature and strain rate dependence. Thermally activated deformation, dynamic recovery and recrystallization. Modeling of materials processing-processing maps. Applications of deformation processing. Casting and Joining, Powder processing.

W.A. Backofen: Deformation processing: Addision Wesley.

R.W. Cahn and P. Haasan (Editors): Processing of Metals and Alloys: Materials Science and Technology series,, Wiley VCH. B.H. Amstead, P.F. Oswald. and M. Begeman: Manufacturing Processes, John Wiley, 1987.

MT 255: Solidification Processing (3:0)

Theoretical approach to the physics of solidification. Covers Nucleation, Gibbs Thomson effect (capillary effect), transport processes in solidification, Stefan boundary condition, one-dimensional freezing approximation, Neumann Solution (Semi-infinite freezing), segregation, Scheil solidification, Brody-Fleming's model. Zone refining (single and multi pass). The Mullins-Sekerka instability, Directional solidification. The physics of Dendritic growth: The paraboloid approximation, Ivantsov solution, Lipton-Glicksman-Kurz (LGK) theory, Primary and secondary dendritic arm spacing. Multiphase solidification: Eutectic growth, Jackson-hunt analysis, Long wavelength perturbation theory, instabilities, peritectic growth.

Class notes

Dantzig and Rappaz, Solidification, EPFL Press

MT 260: Polymer Science and Engineering 1 (3:0)

Fundamentals of polymer science. Polymer nomenclature and classification. Current theories for describing molecular weight, molecular weight distributions. Synthesis of monomers and polymers. Mechanisms of polymerization reactions. Introduction to polymer processing (thermoplastic and thermoset). Structure, property relationships of polymers: crystalline and amorphous states, the degree of crystallinity, cross-linking, and branching. Stereochemistry of polymers. Instrumental methods for the elucidation of polymer structure and properties; basic principles and unique problems encountered when techniques such as thermal (DSC, TGA, DMA, TMA, TOA), electrical, and spectroscopic (IR, Raman, NMR, ESCA, SIMS) analysis GPC, GC-MS, applied to polymeric materials. Polymer Processing - Injection Molding, Extrusion, Compression Molding, Blow Molding, Casting and Spin Coat, Calendaring.

F.W. Billmeyer: Textbook of Polymer Science, Wiley. 1984.

Other sources including class notes

MT 262: Concepts in Polymer Blends and Nanocomposites

Introduction to polymer blends and composites, nanostructured materials and nanocomposites, Polymer- polymer miscibility, factors governing miscibility, immiscible systems and phase separation, Importance of interface on the property development, compatibilizers and compatibilization, Blends of amorphous & semi-crystalline polymers, rubber toughened polymers, particulate, fiber reinforced composites. Nanostructured materials like nano clay, carbon nanotubes, graphene etc. and polymer nanocomposites. Surface treatment of the reinforcing materials and interface/interphase structures of composites / nanocomposites. Various processing techniques like solution mixing, melt processing. Unique properties of blends, composites/nanocomposites in rheological, mechanical, and physical properties and applications

D.R. Paul and S. Newman: Polymer Blends, Vol 1&2 , Academic Press, 2000

L.A. Utracki: Polymer Alloys and Blends, Hanser, 2000

C. Chung: Introduction to Composites, Technomic, Lancaster, PA. 1998.

T.J. Pinnavia and G.W. Beall (Editors): Polymer-Clay Nanocomposites, Wiley, New York 2000.

P.M. Ajayan, L.S. Schadler and P.V. Braun: Nanocomposite Science &Technology, Wiley-VCH, Weinheim, 2003.

MT 271: Introduction to Biomaterials Science and Engineering (3:0)

This course introduces basic concepts of biomaterials research and development including discussion on different types of materials used for biomedical applications and their relevant properties. Contents: Surface engineering for biocompatibility; Protein adsorption to materials surfaces; Blood compatibility of materials; Immune response to materials; Corrosion and wear of implanted medical devices; Scaffolds for tissue engineering and regenerative medicine; Concepts in drug delivery; Regulatory issues and ethics.

Ratner et al: Biomaterials science: An introduction to materials in medicine, 2nd edition, Elsevier Academic Press Current Research Literature

MT 233: Introduction to Electrochemical Engineering (3:0)

Introduction to Electrochemical Systems, Designing Electrochemical Systems with emphasis on Thermodynamics, Kinetic-, and Mass-Transport-Limitations. Electrochemical Systems include the following: Lithium-ion Batteries, Proton Exchange Membrane Fuel Cells, Electrochemical Double Layer Capacitors (Symmetric and Asymmetric), Corrosion Mitigation, Electrolyzers, and Biosensors.

Electrochemical Systems, 3rd Edition, J. Newman and K.E. Thomas-Alyea, Wiley, 2004. ISBN: 0471477567

Electrochemical Methods: Fundamental and Application, 2nd Edition, A.J. Bard and L.R. Faulkner, Wiley India 2006. ISBN:

8126508078

Modern Electrochemistry, Volume 1: Ionics, 2nd Edition, J.O'M. Bockris and A.K.N. Reddy, Springer 2006. ISBN:

8181284755

Modern Electrochemistry, Volume 2A: Fundamentals of Electrodics, 2nd Edition

Modern Electrochemistry, Volume 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science, 2nd Edition,

Other Engineering Courses

BIOE 295: Bringing Biomedical Devices to Market (3 units)

Provide students with a fundamental understanding of the biomedical device R&D pathway including: design proof-of-concept, design input/output, design verification and validation, and regulatory approval. This course highlights the context and value of product development: the formalized process bridging the gap between device proof-of-concept and an FDA approved biomedical product in the marketplace.

Instructor led lectures and student led case studies and exercises.

UE 101: Algorithms and Programming (2:1)

Notions of algorithms and data structures. Introduction to C programming. Importance of algorithms and data structures in programming. Notion of complexity of algorithms and the big Oh notation. Iteration and Recursion. Algorithm analysis techniques. Arrays and common algorithms with arrays. Linked lists and common algorithms with linked lists. Searching with hash tables and binary search trees. Pattern search algorithms. Sorting algorithms including quick-sort, heap-sort, and merge-sort. Graphs: shortest path algorithms, minimal spanning tree algorithms, depth first and breadth first search. Algorithm design techniques including greedy, divide and conquer, and dynamic programming.

Brian W. Kerninghan and Dennis M. Ritchie, The C Programming Language. Prentice Hall of India, New Delhi, 2009. R.G. Dromey, How to Solve it by Computer. Pearson Education India. 2006.

Robert L. Kruse, Data Structures and Program Design in C. Prentice Hall of India, New Delhi, 2006.

Steven S. Skiena, The Algorithm Design Manual. Springer, Second Edition, 2008.

UE 102: Introduction to Electrical and Electronics Engineering (2:1)

Ohms law, KVL, KCL, Resistors and their characteristics, Categories of resistors, series parallel resistor networks. Capacitors and their characteristics, Simple capacitor networks, Simple RC Circuit and differential equation analysis, Frequency domain analysis and concepts of transfer function, magnitude and phase response, poles. Inductors and their characteristics, a simple LR circuit and differential equation analysis, frequency domain transfer function and time constant, LRC circuit and second order differential equation, frequency domain analysis, resonance and Quality factor. Introduction to Faraday's and Lenz's laws, magnetic coupling and transformer action for step up and step down. Steady State AC analysis and introduction to phasor concept, lead and lag of phases in inductors and capacitors, Concept of single phase and three phase circuits. Semiconductor concepts, electrons & holes, PN junction concept, built-in potential, forward and reverse current equations, diode operation and rectification, Zener diodes, Simple Diode circuits like half wave rectifier and full-wave rectifier. NPN and PNP bipolar transistor action, current equations, common emitter amplifier design, biasing and theory of operation. MOSFET as a switch, introduction to PMOS and NMOS. Introduction to Opamp concept, Characterisitics of an ideal opamp a simple realisation of opamp using transistors, Various OPAMP based circuits for basic operations like summing, a mplification, integration and differentiation, Introduction to feedback concept LAB: Design of 3 transistor opamp and its characterisation. Simple OPAMP applications using 741. MOSFET circuits for some simple gates, simple combinational functions. Basic flip-flop operation and clocks in digital design, Introduction to A/D conversion, Introduction to 8051 microcontroller and assembly language programming.

Art of Electronics, Second Edition, by Horowitz and Hill.

Floyd, Electronic Devices

UE200: Introduction to Earth and its Environment (2:0)

Evolution of earth as habitable planet; evolution of continents, oceans and landforms; evolution of life through geological times. Exploring the earth's interior; thermal and chemical structure; origin of gravitational and magnetic fields. Plate tectonics; how it works and shapes the earth. Internal Geosystems; earthquakes; volcanoes; climatic excursions through time. Basic Geological processes; igneous, sedimentation and metamorphic processes. Geology of groundwater occurrence.

Groundwater occurrence and recharge process, Groundwater movement, Groundwater discharge and catchment hydrology, Groundwater as a resource, Natural groundwater quality and contamination, Modeling and managing groundwater systems.

Engineering and sustainable development; population and urbanization, toxic chemicals and finite resources, water scarcity and conflict. Environmental risk; risk assessment and characterization, hazard assessment, exposure assessment. Water chemistry; chemistry in aqueous media, environmental chemistry of some important elements. Air resources engineering; introduction to atmospheric composition and behavior, atmospheric photochemistry. Solid waste management; Solids waste characterization, management concepts.

John Grotzinger and Thomas H. Jordan (2010) Understanding Earth, Sixth Edition, W. H. Freeman

Younger, P L (2007) Groundwater in the environment: An introduction, Blackwell Publishing

Mihelcic, J. R., Zimmerman, J. B. (2010) Environmental Engineering: Fundamentals, Sustainability & Design, Wiley

UE 201: Introduction to Scientific Computing (2:1)

Number representation, stability and convergence and error analysis; Interpolation: Lagrange, Newton's Divided Difference, Neville; Root finding: Bisection, Newton-Raphson, Secant, Regula falsi, Ridders, Steffensen; Data analysis and fitting: Goodness of fit, Chi-Square test; Numerical integration and differentiation: Newton- Cotes, Gaussian quadrature, Romberg integration, Importance sampling; Numerical solution of ODEs: Euler and Runge-Kutta methods; Fourier Series and Fourier Transforms, Basics of Sampling Theory, DFT and FFT; Simple computer implementation exercises.

Erwin Kreyszig, Advanced Engineering Mathematics

Class Notes

UE204: Elements of solid mechanics (3:0)

Elastic bodies. Axial and shear stresses. Hookes law. Stress resultants. Axially loaded members. Torsion of circular bars. Shear force, bending moment, and axial thrust. Theory of simple bending. Bending and shear stress distribution in beams. Two dimensional state of stress. Principal stresses and strains. Mohrs diagram. Pressure vessels. Combined states of stress and failure theories. De.ection of beams. Statically indeterminate beams. Unsymmetrical bending. Shear centre. Buckling of columns. Energy methods. Principle of virtual work. Castiglianos theorems and applications.

S H Crandall, and N C Dahl, An Introduction to mechanics of solids, McGraw-Hill, New York.

PD 212: Computer Aided Design (2:1)

CAD – modeling of curves, surfaces and solids manipulation of CAD models, features based modeling, parametric/ variational modeling, product data exchange standards. Introduction to CAID, surfaces. Interfacing for production and tool design, photo rendering and scanning, 3D animation and morphing, studio exercise in virtual products and systems.

Piegl and Tiller, the NURBS book

PD 205: Materials, Manufacturing, and Design (3:0)

Engineering materials, metals and their properties, uses, processing methods, design data and applications, selection criteria, manufacturing and processing limitations, comparative studies. Plastics and composites, types, classification, properties, processing techniques and limitation, selection of plastics for specific applications, finishing and surface coating for different materials.

Ashby, M.F., Materials selection in Mechanical Design

Class notes

Leadership and Business courses

ENGIN 270A: Organizational Behavior and Negotiation for Engineers (1 unit)

Designed for professionally-oriented engineering graduate students, this course explores key topics in organizational behavior, including negotiations, power and conflict.

Relevant reading

ENGIN 270B: R&D Technology Management and Ethics (1 unit)

Designed for professionally-oriented engineering graduate students, this course explores key topics in R&D technology management and ethics through faculty-led case analysis and discussion. Covers IP management, non-competes and non-disclosures, managing 'superstars', networking within and outside the workplace, university tech transfer, ethical decisions, team dynamics, etc.

Case studies from Harvard Business School

ENGIN 270C: Project management and teaming (1 unit)

Designed for professionally-oriented engineering graduate students, this course applies key topics in project management and team dynamics to students' concurrent capstone projects.

Relevant reading

ENGIN 295: Communication for Engineering Leaders (1 unit)

Engineering leadership principles integrated with concurrent technical capstone projects for Master of Engineering students. Students enroll in this supplementary course while working on their capstone projects, with their technical department capstone advisor. This project-based course will apply communication skills to the capstone project with a focus on presentations and writing in a professional context.

Relevant reading

MBA 209F: Introduction to Business for Graduate Students (3 units)

An introduction to business methods of analysis and terminology for nonbusiness graduate students. The course is taught in three five-week modules: (1) organizational behavior and management, (2) accounting and finance, and (3) marketing and strategy. Taught by faculty from the Haas School of Business at UC Berkeley.

Kotler, Marketing Management

Droms and Wright, Finance and Accounting for non-financial managers

Hill, Being the Boss

ENGIN 270E: Technology Strategy and Industry Analysis (1 unit)

Designed for professionally-oriented engineering graduate students, this course explores key topics in technology strategy and industry analysis.

Relevant reading

ENGIN 270F: Data Analytics (1 unit)

Designed for professionally-oriented engineering graduate students, this course explores key topics in data analytics. Covers basics of using Python for Data Analytics.

Relevant reading

ENGIN 270H: Accounting and Finance for Engineers (1 unit)

This bootcamp course is designed to introduce students to accounting and finance, including the concepts and techniques necessary to analyze and implement optimal investment decisions by firms. Topics include basic discounting techniques, and capital budgeting under certainty and uncertainty, asset pricing models. This course will combine the theoretical underpinnings of finance with some real world examples.

Relevant reading

MG 274: Management of Innovation and Intellectual Property

Organizational and technological innovation – definition of innovation vs inventions, role of organizational design and processes – strategic role of intellectual property protection in case studies, the R&D value chain, stage gates, differences in priority with the R&D value chain, NPD - international, national, organizational, individual actors, organizations and vehicles to manage intellectual property, critical steps in managing R&D, process management during stage gates for patent searches, technology landscaping, specification writing, timeline management, rights and responsibilities in competitive technology environments, innovative inventions, commercial potential, processes to enhance technological know-how transfer, open source approach, incubators, assessing patent value, information technology support systems in managing innovation and intellectual property, prior art laboratories sessions and working with a client.

Trott, P., Innovation Management and New Product Development, Financial Times, Pitman Publishing, GB, 1998.

Petrusson, U., Intellectual Property and Entrepreneurship, Creating Wealth in an Intellectual Value Chain, CIP Working Paper Series, Centre for Intellectual Property Studies, Gotenburg, Sweden, 2004.

Rivette, K.G. & Kline, D., Rembrandts in the Attic, Unlocking the Hidden Value of Patents, Harvard Business School Press, Boston, Massachusetts, 2000.

Math and Science Courses

UM 101: Analysis and Linear Algebra I (3:0)

One-variable calculus: Real and Complex numbers; Convergence of sequences and series; Continuity, intermediate value theorem, existence of maxima and minima; Differentiation, mean value theorem, Taylor series; Integration, fundamental theorem of Calculus, improper integrals. Linear Algebra: Vector spaces (over real and complex numbers), basis and dimension; Linear transformations and matrices.

T M Apostol, Calculus, Volume I, 2nd. Edition, Wiley, India, 2007.

G. Strang, Linear Algebra And Its Applications, 4th Edition, Brooks/Cole, 2006.

UM 102: Analysis and Linear Algebra II (3:0)

Linear Algebra continued: Inner products and Orthogonality; Determinants; Eigenvalues and Eigenvectors; Diagonalisation of Symmetric matrices. Multivariable calculus: Functions on Rn Partial and Total derivatives; Chain rule; Maxima, minima and saddles; Lagrange multipliers; Integration in Rn, change of variables, Fubini's theorem; Gradient, Divergence and Curl; Line and Surface integrals in R2 and R3; Stokes, Green's and Divergence theorems.

Introduction to Ordinary Differential Equations; Linear ODEs and Canonical forms for linear transformations.

T. M. Apostol, Calculus, Volume II, 2nd. Edition, Wiley Wiley India, 2007.

G. Strang, Linear Algebra And Its Applications, 4th Edition, Brooks/Cole, 2006

UM 201: Probability and Statistics (3:0)

Basic notions of probability, conditional probability and independence, Bayes' theorem, random variables and distributions, expectation and variance, conditional expectation, moment generating functions, limit theorems. Samples and sampling distributions, estimations of parameters, testing of hypotheses, regression, correlation and analysis of variance.

Sheldon Ross, A First Course in Probability, 2005, Pearson Education Inc

Sheldon Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, 2010, Fourth edition.

UP 101: Introductory Physics I – Mechanics, oscillations and waves (2:1)

Kinematics, laws of motion. Circular motion, Work. Kinetic and potential energy. Line integrals. Conservative forces. Friction, terminal velocity in air. Systems of particles. Conservation of linear momentum. Scattering in one and two dimensions. Angular momentum. Moment of inertia. Rotation about one axis. Precession of gyroscope. Central force. Reduction of two-body problem to one-body problem and effective one-body potential. Planetary motion and Kepler's laws. Simple pendulum, damped and forced, resonance. Coupled oscillators, normal modes. Small oscillations. Transverse waves on a string. Linear superposition, interference, beats. Fourier series. Sound waves in air. Doppler effect.

Kleppner D and Kolenkow R J, An Introduction To Mechanics (Special Indian Edition) (2007)

UP 102: Introductory Physics II – Electricity, Magnetism and Optics (2:1)

Introduction, Review of vector algebra, Vector calculus: gradient, divergence, curl, Gauss's theorem and Stokes' theorem, Laplacian etc. Coulomb's law, electric field, Electrostatic potential, Uniqueness theorem, Conductors, capacitance, Method of images, Bound charges and dipole moment density, Energy stored in electric fields. Magnetostatics: Electric currents, Biot-savart law, Ampere's law, magnetic fields of straight wires, circular loops and infinite solenoids, Vector potential, Magnetic dipole moment and bound currents. Lorentz force and Faraday's law, Inductance, Energy stored in a magnetic field. Linear dielectric and magnetic materials, Charge conservation, displacement current, Maxwell's equations and gauge invariance, Classical wave equation and plane monochromatic waves, Energy of EM waves and Poynting's theorem.

Purcell E.M., Electricity and Magnetism, Berkeley Physics Course - Volume 2, 2nd edn (Tata McGraw Hill, 2011)

Griffiths D.J., Introduction to Electrodynamics, 3rd edn (Prentice-Hall of India, 2003)

UP 201: Introductory Physics III – Thermal and Modern Physics (2:1)

Temperature, The First Law of Thermodynamics, Kinetic Theory of Gases and Maxwell -Boltzmann Statistics, Heat Engines, Entropy and the Second Law of Thermodynamics, Relativity, Introduction to Quantum Physics, Basics of Quantum Mechanics, Atomic , Molecular and Solid state Physics, Nuclear Physics, Particle Physics and Cosmology.

Serway and Jewitt, Physics for Scientists and Engineers (7th Edition)

Young and Friedman, University Physics (12th Edition)

UC 101: Physical Principles of Chemistry (2:1)

Bohr theory, Wave Particle Duality, Uncertainty principle, Schrödinger equation, H-atom and atomic orbitals, electron spin, Pauli principle and many electron atoms. Chemical bonding: covalent and ionic bonding, valance bond theory, hybridization and resonance; molecular orbital theory. Homonuclear and heteronuclear diatomics, potential energy curves and intermolecular interactions; elements of spectroscopy, van der Waals equation of state; theory of chemical reactions.

D.A. McQuarrie and J.D. Simon, Physical Chemistry, Viva Books.

Elements of Physical Chemistry by Peter Atkins & Julio De Paula, 5/E, Oxford University Press, Indian Edition.

UC 103: Basic Inorganic Chemistry (2:1)

Multi-electron atoms–periodic trends; chemical bonding: ionic solids, CFT: d-orbital splitting, tetrahedral, square planar, cubic and octahedral crystal fields, covalent bonding; Lewis model (2 Dim); VSEPR (3 Dim) hybridization; molecular orbital theory: heteronuclear diatomics, triatomics; shapes of main group compounds; acid-base chemistry: concepts, measures of acid-base strength, HSAB.

Concise Inorganic Chemistry by J. D. Lee, 5/E, Oxford University Press

Inorganic Chemistry by Duward F. Shriver, P.W. Atkins, C.H. Langford, Oxford University Press.

Inorganic Chemistry by J. E. Huheey, E. A. Keiter, R. L. Keiter, 4/E, Pearson Education Asia.

UC 206: Basic Organic Chemistry (2:1)

Nomenclature of organic compounds: alkanes, alkenes and alkynes; structure and reactivity. Concept of aromaticity; organic reactions – Addition reactions; Elimination reactions; substitution reactions and rearrangements. Organic reaction mechanisms; reaction intermediates and their characterization. Introduction to stereochemistry.

Organic Chemistry by Solomons, T. W. G. and Fryhle, C., John Wiley & Sons, (2009).

Organic Chemistry by Paula Y. Bruice, 6th Edition, Pearson.

UB 101: Introductory Biology I – Organismal Biology and the Molecular Basis of Life (2:1)

Introduction to the world of living organisms; levels of biological organisation; diversity of life on earth; history and evolution of life on earth; mechanisms of evolution; genetic basis of natural selection; measuring the rate of natural selection; organisms and their environment; adaptation; behaviour and ecology; biological species diversity; environmental degradation, conservation and management; the future of life on earth.

Concepts of pH/pKa, structures of water, amino acids, peptides and proteins; chemistry of DNA, RNA, proteins, lipids and carbohydrates; elementary enzymology and molecular biology; Introduction to various model organisms. Cell as a unit of living organisms, cellular organelles: Structure and function, organization of cytoskeleton and nuclei, ER-Golgi modifications, Vesicle-mediated protein transport, endocytosis and exocytosis, mitochondria and respiration.

Lab: Methods of describing, observing, counting and estimating the abundance, diversity and behaviour of living organisms. Light Microscopy, sample preparation and examination, identification of microorganisms, staining techniques, fluorescence microscopy to examine intracellular compartments, Cell fractionation and centrifugation methods, isolation of intracellular compartments by differential centrifugation techniques, nuclei, mitochondria, RER etc. Basics of cell culture methods: cell counting, culture media preparation. Titration of amino acids, estimations of reducing non-reducing sugars, proteins, DNA, RNA, lipids, paper chromatography/ TLC, SDS-PAGE, isoelectric focusing, DNA melting curves.

D. Sadava, D. M. Hillis, H. Craig Heller, M. Berenbaum, Life, the science of biology, W. H. Freeman, 9th edition, 2009.

H. Lodish, A. Berk, C. A. Kreiger, M. P. Scott, A. Bretscher, H. Ploegh, P. Matsudaira, Molecular cell biology, W.H. Freeman

UB 102: Introductory Biology II – Microbiology, Molecular Biology and Genetics (2:1)

Introduction to the microbial world and its diversity; importance of microbes in exploration of basic principles of biology; bacterial growth and its modulation by nutrient availability in the medium; structure and function of a bacterial cell; structure of cell wall; isolation of auxotrophs; life cycles of temperate and lytic bacteriophages, structure and function of extra-chromosomal elements and their applications in molecular microbiology. Molecular biology (central dogma, replication, transcription, genetic code and translation); examples of post-transcriptional and post-translational modifications; genetic methods of gene transfer in bacteria; Mendelian genetics (segregation and independent assortment); introduction to polytene and lampbrush chromosomes; sex determination and sex linkage in diploids; cytoplasmic inheritance; pedigrees, markers, mapping and genetic disorders; gene frequencies and Hardy-Weinberg principle, and introduction to various model organisms.

Lab: Light microscopy, identification of microorganisms, staining techniques (Gram's, acid fast), bacterial plating, tests for antibiotic resistance, M13 infection, plaque assay, preparation of bacterial competent cells, transformation, transduction, conjugation, β-galactosidase assay, Drosophila crosses using red eye and white eyemutants,observationofBarrbodyinbuccalmucosacells,preparationofmitotic/polytene chromosomes from Drosophila larvae, and karyotyping using human metaphase plate photos.

J. M. Berg, J. L. Tymoczko, L. Styrer, Biochemistry, W. H. Freeman & Co., 6th edition, 2006.

R. Y. Stanier, E. A. Adelberg, J. L. Ingraham, General Microbiology, MacMillan Press, 5th edition, 2007.

M.W. Strickberger, Genetics, Prentice-Hall, India, 3rd edition, 2008.

Daniel Hartl, Essential Genetics: A genomics perspective, Jones & Bartlett 3rd edition, 2002

UB 201: Introductory Biology III – Cell Biology, Immunology and Neurobiology (2:1)

Eukaryotic cells and organelles, cell membranes and cell function. Introduction to animal viruses with examples, life cycle and host-virus interactions. Introduction to the immune system – the players and mechanisms, innate immunity, adaptive responses, B cell receptor and immunoglobulins, T cell activation and differentiation and Major Histocompatibility Complex encoded molecules. Overview of the nervous system (from neuron to brain), ionic basis of resting membrane potential and action potentials, neurotransmitters, neuromodulators and second messengers, motor systems, neural basis of cognition: attention, and language and disorders of the brain.

Lab: Animal cell culture and microscopy, Immune organs and isolation of cells from lymph node, spleen and thymus. Lymphocyte and macrophage activation studies, nitrite detection, ELISA and cell cycle analysis. Gross anatomy of the human brain; staining of mouse brain sections; generation of action-potential; psychophysical and cognitive neurobiology experiments.

Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Molecular Cell Biology, W. H. Freeman; 6th edition, 2007.

Bruce Alberts, Molecular Biology of the Cell, Garland Science, 5th edition, 2008

T. Kindt, R. Goldsby, B. A. Osborne, Kuby Immunology, W. H. Freeman, 6th edition, 2006.

David M. Knipe, Peter Howley, Fields Virology, Lippincott Williams & Wilkins, 6th edition, 2013.

M. Bear, B. Connors, M. Paradiso, Neuroscience: exploring the brain, Lippincott Williams & Wilkins, 3rd edition, 2006.

NS 201: Fundamentals of Systems and Cognitive Neuroscience (3:0)

Biophysics of action potentials, brain imaging, sensation and perception, attention, motor systems and executive control, insect and animal behavior

Kandel ER, Schwartz JH and Jessell TM, Principles of Neural Science, Fourth Edition, Mc-Graw Hill, 2000.

Humanities Courses

UH 101: Ways of Knowing (2:0)

Ethnographic methods, historical analysis, textual analysis, Writing workshop

Relevant readings

UH 102: Ways of Seeing (2:0)

Literature, Visual Arts, Film, Theatre

Relevant readings

UH 203: Ways of Doing (2:0)

The digital subject, Brain-mind divide, People and Nature, Sustainable development

Relevant readings

UH 204: Seminar Course: Mapping India through the Folk Arts (1:0)

The objective of this course is to understand the seven regions of India—North, West, East South, Central, North-East and the Islands a little better—through their folk arts. The course considers the art forms, as viewed in the discipline of Folkloristics, as means of knowing the regional cultures from "inside-out rather than outside- in".

Dorson, M Richard. Folklore and Folklife. Chicago. University of Chicago Press. 1972.

Dundes, Alan. Interpreting Folklore. Indiana University. 1980.

and other Relevant readings

UH 301:Seminar Course: Journalism for Scientists (1:0)

The Course will be useful in acquainting students with journalistic skills which they may apply in their own work to observe and communicate better for instance or to their field as future science reporters, perhaps or as individuals who might have to explain science to the lay person.

It also seeks to provoke thought on the practice of journalism, its tenets, its limitations and its influence with a view to encouraging a more critical engagement with media but also to position science within the media.

Shah, Amrita. Hype, Hypocrisy & Television in Urban India, Vikas, New Delhi 1997.

Wolfe, Tom. "Selections". In E W Johnson; Picador (ed.) The New Journalism, 1990, pp.40-42.

Shah, Amrita. Vikram Sarabhai-A Life. Viking-Penguin, 2007.

UH 302: Seminar Course: Introduction to Governance (1:0)

The Semester long programme on Introduction to Governance is to enable the participants to develop an appreciation of key issues and challenges to governance in India while gaining an insight into how the Government of India works and relates to the people. The Semester- long programme will be largely interactive and to facilitate this (i) Select reading material will be given ahead of each session (a) additionally a selection of books will be available for consultation in the library of the Centre for Contemporary Studies –IISc. Some if not all of the sessions are expected to be supplemented by experts drawn from the top echelons of public administration, the judiciary and politics. Evaluation is based on group projects and individual assignments emerging from each covering a range of contemporary issues that engage us as concerned citizens of our country.

Relevant readings