Material Science Track:

Master of Physics by Thesis

Table of Contents

Common Course

Course Title: **Research methodology**

Course Code: **403643-3**

(C-0)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Course overview and introduction to the Study: Introduction (why the study was selected, background and setting), Statement of Problem, Purpose of the Study, Importance of the Study, Definition of Terms (if needed)	1	3
Review of Related Literature: This chapter should contain a concise presentation of literature and research (periodicals, dissertation abstracts, books, etc.) relevant to the problem.	2	6
Developing a bibliography and properly citing sources within text Online Reading: Citing Sources	2	6
SCIENCE GRAPHICS: Discussion and illustration of the importance of clear graphical presentation of data. Review basic guidelines and critically examine good and bad examples from the literature. Producing effective and publishable figures using a suitable software	2	6
WRITING AN IMRaD MANUSCRIPT: INTRODUCTION & METHODS. Review the functions, writing style, and content of Introduction and Methods sections.	2	6
Research Presentations: - Making scientific posters; Detailed instructions will be given on the design and development of a poster in class. - Making scientific papers; Detailed instructions will be given on the design and development of a paper in class. - students will present material to the class.	2	6
Library Research & Resources Practice (class in the library): Organization of Knowledge: Metadata and searching for information Online Reading: Library Catalog, Keyword Searching, and Subject Searching.	2	6
Evaluating Web Sites Online Reading: Evaluate Web Sites (reliable website with information related to your research topic.). Information ethics: Copyright, plagiarism Online Reading: Plagiarism	2	6
Total number	15 hrs	45 hrs

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Oral presentation (1)	6th week	10%
2	First Report (1)	6th week	15%
3	Oral presentation (2)	10th week	10%
4	Second Report (2)	10th week	15%
5	Scientific project report related to thesis	14th Week	50 %
	Total		100%

E Learning Resources

1. List Required Textbooks

1- John W. Creswell , J. David Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, SAGE Publications, Inc; Fifth Edition (2018) ISBN-13: 978-1506386706
2- Ron Iphofen, Martin Tolich Handbook of Qualitative Research. Sage, (2018) ISBN-13: 978-1473970977
3- Contemporary Field Research: Perspectives and Formulations. Prospect Heights, IL: Waveland Press (2001) ISBN-13: 978-1577661856
4- William Strunk Jr., Virginia Campbell , "The Elements of Style: Simplified and Illustrated for Busy People" (2018) ISBN-13: 978-1980205197.
5- William Badke, Research Strategies:6th edition (2018) ISBN-13: 978-1532018039

Elective Courses

Course Title: **Advanced programming**

Course Code: **403647-3**

(E-1)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Basics- Program construction, Output using "cout", Header files, when to use comments, Integer variables, variable names, integer constants the "endl" manipulator, exercises.	1	3
Basics- Character variables, character constants, escape sequence, input with "cin", floating point type, type bool, "setw" manipulator, the "iomanip" header file, arithmetic operation, library functions, exercises.	1	3
Loops and decisions – Relational operators, Loops, the "for" loop, the "while" loop, the "do" loop, Decisions, the "if" statement, the "if else" statement, the "switch" statement, the conditional operator	1	3
Loops and decisions- Logical operators, logical "AND" operator, logical "OR" operator, logical "Not" operator, the "break" statement, the "continue" statement, exercises	1	3
Structures- A simple structure, Defining the structure, accessing structure members, Structure within Structures, Structures and Classes, Enumeration, examples, exercises	1	3
Functions- Simple functions, the function declaration, calling the function, the function definition, passing arguments to functions, passing constants, passing variables, passing by value, Returning values from functions, the return statement, Returning structure variables	1	3
Functions- Reference arguments, Passing Data types by reference, Passing more complex pass by Reference, Passing Structures by Reference, Overloaded functions, inline functions, Returning by References.	1	3
Objects and Classes- A simple class, classes and objects, defining the class, using the class, calling member functions	1	3
Objects and Classes- Constructors, Destructors, objects as function arguments, overloaded constructors, Member functions defined outside the class, Static class data, const and classes.	1	3
Arrays- Array fundamentals, arrays as class member data, arrays of objects and exercises	1	3
Pointers– Addresses and pointers, Pointers and arrays, examples	1	3

Pointers- Pointers and functions, the "new" and "delete" operators examples.	1	3
Inheritance- Derived class and base class, Derived class constructors, class inheritance, Public and private inheritance.	1	3
Virtual functions- Normal member functions accessed with pointers, virtual member functions accesses with pointers, friend functions, static functions, examples	2	6
Total number	15	45

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Exercises & Home works	All weeks	5%
2	Online quizzes	All weeks	5%
3	Oral exam	5^{th} Week	5%
4	Participation in activities lectures and labs	All weeks	5%
5	Test (1)	6^{th} week	10%
6	Test (2)	13^{th} week	10%
7	Scientific project	14^{th} Week	10 %
8	Final Exam	15^{th} week	50%
	Total		100%

E Learning Resources

1. List Required Textbooks

1- Object oriented programming in C++, Robert Lafore, fourth edition, Pearson and Sam Publishing (2002), ISBN 0-672-32308-7.
2- Object oriented programming using C++, Joyce Farrel, fourth edition, 2009, ISBN-13: 978-1-4239-0257-7.
3- Bjarne Stroustrup, The C++ Programming Language, 4th Edition (2013), ISBN-13: 978-0321563842.
4- -"Applied Computational Physics 1st Edition" Joseph F. Boudreau, Eric S. Swanson ISBN-13: 978-0198708643 (2018).

2. List Essential References Materials (Journals, Reports, etc.)

-Siddhartha Rao, "C++ in One Hour a Day, Sams Teach Yourself (8th Edition)", (2016) ISBN-13: 978-0789757746.

-Bjarne Stroustrup, "A Tour of C++ (C++ In-Depth Series)" , (2018), ISBN-13: 978-0134997834.

Course Title: Advanced Research lab.

Course Code: **403651-3.**

(E-2)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Introduction of material science laboratory.	1	3
Preparation of nanomaterial by chemical method and Preparation of nanomaterial by ball milling method and measurement it by UV-visible spectroscopy.	3	9
Preparation of thin films by spin coating and study their electrical conductivity by temperature-four probe method	2	6
Preparation of biopolymer material and study the morphology and crystal growth rate by polarized optical microscopy (POM).	2	6
Determination of the elongation at break and Young's modulus of polymer film by Tensile test.	1	3
Determination of dielectric constant, dielectric loss and Electrical conductivity of some material by impedance analyzers.	2	6
Preparation of thin film by vacuum thermal evaporation of and study the morphology by SEM.	1	3
Study of crystal size by using XRD and the cell Scherrer formula for some crystalline material.	1	3
Study the Surface morphology for some material by atomic force microscopy (AFM).	1	3
Study the I-V characteristics for solar cell temperature-two probe method	1	3
	15 weeks	**45 hrs.**

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	During the examination period following the module, an oral exam (duration: 30 min.) on "certain experimental" is held.	14th week	20 %

2	Experimental reports	Each week	40 %
3	Final exam	15th week	40%

E Learning Resources

1. List Required Textbooks

During the lab course, a set of references is given for each experiment. Manuals are available for all experiments; they contain individual literature references for all experiments.

Course Title: **Semiconductor device modeling**

Course Code: **403649**-3

(E-3)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
❖ **Semiconductor Carrier Transport Equations:** Semiconductor bandstructure, Simplified bandstructure models, Carrier dynamics, Semiconductor effective mass, Semiclassical transport theory, Boltzmann transport equation, Maxwell's equations, Drift-Diffusion Transport Model, equations, Boundary conditions, Generation-recombination, Scattering processes, Relaxation time approximation, Thermal Conductivity and Heat flow.	3	9
❖ **Analytical modeling and analysis of semiconductor Devices:** Techniques for solving Semiconductor equations, closed – form analysis, Mobility modeling, Analysis of pn Junction Diode, Analysis of Field Effect Transistor operation, , Analysis of MOSFET operation, limitation of the closed – form analysis.	2	6
❖ **Numerical solution of the Semiconductor equations:** Finite-Difference Schemes: Discretization of Semiconductor equations, methods for solving finite difference equations, Boundary Conditions, Simulation examples. Finite Element Method: Galerkin Method, Derivation of the Finite Element equations, Simulation examples. Modeling Heterojunction Devices: Semiconductor equations for Heterojunction, High Electron Mobility Transistors, Analytical solutions, Numerical Models, Heterojunction Bipolar Transistors, and Monte Carlo Simulations.	4	12
❖ **Monte Carlo Method:** Modeling carrier transport in Semiconductors, Equations of motion, Energy band structure, Application Monte Carlo Method for transport Characteristics and device modeling.	2	6
❖ **Introduction to Quantum transport theory:** Quantum theoretical foundations, state vectors, Schroedinger and Heisenberg picture, Band structure, Bloch theorem, one dimensional periodic potential, density of states, Pseudopotential theory, crystal symmetries, reciprocal lattice, Brillouin zone, Semiclassical transport theory, Quantum Transport Theory, limits of semiclassical transport theory, quantum mechanical derivation Boltzmann transport equation, Markov-Limes.	4	12
	15 weeks	**45 hrs**

E Learning Resources

1. List Required Textbooks

- D. Vasileska, S. M. Goodnick, G. Klimeck, "Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation 1st Edition", CRC Press, 2010.
- C. Snowden, "Introduction to Semiconductor Device Modeling", World Scientific, 1998.
- Fundamentals of Carrier Transport 2nd Edition, Cambridge University Press (2000).
- Carlo Jacoboni and Paolo Lugli, "The Monte Carlo Method for Semiconductor Device Simulation", Springer, 2002.

Material Science track

Course Title: **Solid State Physics**

Course Code: **403662-3**.

(M-1)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Lattice Vibrations and Thermal Properties:: Vibrations of monatomic and diatomic lattices - acoustic and optical modes - Quantization of lattice vibrations - Phonon Momentum - Inelastic scattering of neutrons by phonons. Lattice Heat Capacity - Einstein model, Density of modes in one and three dimensions -Debye model of lattice heat capacity – Debye's T3 law -Anharmonic crystal Interactions - Thermal Expansion - Thermal conductivity.	3	9
Band Theory: Energy levels and density of orbitals in one dimension - Free electron gas in three dimensions - Heat capacity of the electron gas - Electrical conductivity and Ohm's law - Motion in magnetic fields - Hall effect-Thermal conductivity of metals - Wiedemann-Franz law - Nearly free electron model- Wave equation of electron in a periodic potential - Number of orbitals in a band - Construction of Fermi Surfaces -Calculation of Energy Bands -Experimental methods in Fermi surface studies.	3	9
Transport Phenomena in solid materials: **DIFFUSION AND DRIFT:** Flux of particles. Fick's equation. -Time-dependent case. Solutions of the diffusion equation (or Fick's second law) . Thin layer or instantaneous source. The Boltzmann transformation. Relation between drift and diffusion. The Nernst-Einstein equation. Diffusion with phase change. Multiphase diffusion. The nature of the driving force. A variety of diffusion processes and generalization of Fick's law **DIFFUSION MECHANISMS AND CORRELATION EFFECTS** Mechanisms of diffusion. Direct interchange. Mechanisms involving point defects. Definition of the correlation factor. The encounter model. A simple simulation of self-diffusion and electro migration. Methods of calculating the correlation factor. Types of correlation factors. Dynamic correlations. Physical correlation. Meaning of the physical correlation factor. Compounds with a high concentration of defects. The potential-barrier model. Some simple applications of the potential-barrier model **SOLUTE DIFFUSION IN PURE MATERIALS. DIFFUSION IN ALLOYS** Solute diffusion at infinite dilution**.** Interstitial solid solutions Ionic crystals**.** Semiconductors Dilute alloys Diffusion in homogeneous concentrated alloys Superionic conductors Amorphous materials .	3	9

Non-crystalline solid materials Introduction to non-crystalline and amorphous materials (polymers, glasses, etc.) -Structure and chemistry of amorphous and non-crystalline materials: molecular structure of polymers; polarization and defects; thermoplastic and thermosetting polymers; crystallinity and elastomers -Glass: formation, structure and transition temperature, -Thermodynamics of glass formation; kinetics of glass formation -Properties of amorphous and non-crystalline materials: mechanical, electrical, thermal, dielectric, and optical	3	9
Phase diagrams: Basic concept. Phase and phase equilibrium Phase structures in solids Phase transitions and classification Single component phase diagram and solidification of pure crystals. Phase rule and phase equilibrium conditions Liquid structure, cooling curve Pure metal crystallization conditions Binary phase diagram and solidification of its alloy The conditions of phase equilibrium, the application of the phase rule. Lever law and its application Crystallization and nucleation conditions of solid solution alloys Types of phase diagram. Phase change kinetics Phase transformation process Phase change kinetics. Ternary phase diagrams Basis of ternary phase diagrams. Types of ternary phase diagrams Method for determination of phase diagram	3	9
	15 weeks	45 hrs

E Learning Resources

1. List Required Textbooks
-Kittel, C., Introduction to Solid State Physics, John Willey, (2007).
-H. Ibach, H. Luth “Solid-state physics : an introduction to theory and experiment” spring verlag 1991
-J.R. Hook, H.E. Hall “Solid state physics” 2nd edition 1995 Kindle Edition.
-Atom Movements—Diffusion and Mass Transport in Solids .J.Philibert , 2012 Publisher: EDP Sciences

Course Title: **Advanced Crystallography**

Course Code: **403664-3**

(M-2)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
1 - Symmetry operations : **1.1.** Direct and reciprocal lattice, **1.2.** Rotation axis, inversion axis, glide planes, centrum of symmetry, **1.3.** International tables for Crystallography.	1	3
2 - Diffraction from Polycrystalline Samples and Determination of Crystal Structure : **2.1**. X-ray Diffractometer Essentials, Bragg's law, **2.2.** Estimation of X-ray Diffraction Intensity from a Polycrystalline Sample, **2.2.1**. Ewald construction, **2.2.2.** Structure Factor, **2.2.3.** Polarization Factor, **2.2.4.** Multiplicity Factor, **2.2.5.** Lorentz Factor, **2.2.6.** Absorption Factor, **2.2.7.** Temperature Factor.	2	6
3 - Factors affecting the intensity of diffraction: **3.1.** Absorption correction, **3.2.** Lorentz polarization correction, **3.3.** secondary extinction.	1	3
4 - Structure determination methods: **4.1.** Fourier transformation, **4.2.** Phase problem methods, **4.3.** Patterson synthesis, **4.4**. Direct methods.	1	3
5 - Crystal structure refinement: **5.1.** Model refinement of the crystal structure. **5.2.** Crystallographic software, disorder, modulated structure, error analysis **5.3.** Examples of structure refinement software (Rieldvelt , shelix ….)	2	6
6 - Crystallographic databases: **6.1** Cambridge structural database, statistical treatment of structural data.	1	3

7 - Analysis methods for powder: **7.1.** Quality, quantity, crystal structure from powder data **7.2.** Identification of an Unknown Sample by X-ray Diffraction (Hana Walt Method **7.3.** Determination of Lattice Parameter of a Polycrystalline Sample **7.4.** Quantitative Analysis of Powder Mixtures and determination of Crystalline Size and Lattice Strain **7.5.** Quantitative Determination of a Crystalline Substance in a Mixture **7.6.** Measurement of the Size of Crystal Grains and Heterogeneous Distortion	3	9
8. Reciprocal Lattice and Integrated Intensities of Crystals: **8.1.** Mathematical Definition of Reciprocal Lattice **8.2.** Intensity from Scattering by Electrons and Atoms **8.3** Neutron diffraction concept	1	3
9. Interpretation of the structural results: **9.1.** Interpretation and visualization of the crystal structure, **9.2.** Interpretation of publishes structural results.	1	3
10. single crystal structure refinement: **10.1.** Data collection of accurate structure factors for multipolar refinement. **10.2.** Quality of single crystal, data collection at low temperature, error analysis	1	3
11. Charge density analysis. AIM analysis: Relation of the experimental and theoretical electronic structure and their correlation to chemical and physico-chemical properties.	1	3
Total	15 weeks	45 h

5. Assessment Task Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Exercises & Home works	All weeks	% 5
2	Participation	All weeks	% 5
3	In-Class Problem Solving	13th,7th week	10 %
4	Midterm 1	6th week	15 %
5	Midterm 2	12th week	15 %
6	Final Exam	16th week	50 %

E Learning Resources

1. List Required Textbooks:

1.1 C. Giacovazzo et al. : Fundamentals of Crystallography, latest edition, Oxford University Press. ISBN-13: 978-0198509585

2. List Essential References Materials (Journals, Reports, etc.) :

1. Edited by R. A. Young, (1995) The Rietveld method, IUCr monographs on Crystallography, Oxford University Press, Oxford.
2. Bish, D. L., Post J. E. (Eds.), (1989) Modern Powder Diffraction, Reviews in Mineralogy, Vol. 20, 145 p, Mineral. Soc. America, Michigan.

3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.

http://www.monash.edu/pubs/handbooks/units/MTE6881.html

https://www.ch.cam.ac.uk/analytical/crystallography/

http://www.rgf.bg.ac.rs/predmet.php?menu=about&id=6939&lang=en

Course Title: **Characterization techniques**

Course Code: **403666-3**

(M-3)

1 Topics to be Covered

Topic	No of Weeks	Contact hours
1- Ultraviolet visible spectroscopy (UV-VIS): It is including basic principle, instrumentation configuration, data interpretation, analysis and studying of the optical properties	**2**	**6**
2- Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy: It is including basic principle, instrumentation configuration, data interpretation and analysis, and special techniques such as attenuated total reflection (ATR), diffuse reflectance, and Polarization modulation-infrared reflection-adsorption spectroscopy (PM-IRRAS)	**2**	**6**
3- Scanning electron microscope (SEM): It is including introduction the basic principle and instrumentation configuration and their strengths and weaknesses	**1**	**3**
4- The transmission electron microscope (TEM): It is including the basic principle and instrumentation configuration, the introduction of the electron diffraction and various imaging techniques including high-resolution imaging as well as chemical analysis as performed by both transmission and scanning electron microscopy.	**2**	**6**
5- Atomic force microscope (AFM): It is including contact-mode, tapping-mode and lateral-force AFM, scanning tunneling microscope (STM), electrostatic force microscope (EFM), magnetic force microscope (MFM), AFM-based nano-lithography, surface force and adhesion measurement, as well as molecular recognition. Understanding of the required instrumentation and the underlying mechanism of image formation.	**1.5**	**4.5**
6- X-ray diffraction: It is used to describe the types of structural information that can be obtained from X-ray scattering: crystallinity, phase identification, crystallite size, orientation, cell parameters for strain and/or chemical information, the thickness of films and multilayers.	**2**	**6**
7- X-ray photon spectroscopy (XPS): It is including basic principle, instrumentation configuration, data interpretation and analysis, chemical shift, quantification, and depth-profiling	**1.5**	**4.5**
1.		
8- The I-V Characteristic Curves: It is including, basic principle, instrumentation configuration, measuring of data and interpretation of a new materials which operated within an electrical circuit.	**1**	**3**
LCR Meter: It is including, basic principle, instrumentation configuration, measuring the inductance (L), capacitance (C), and resistance (R), impedance (Z), phase angle (θ), dissipation factor (D), quality factor (Q), and equivalent series resistance (ESR) at various frequencies and data interpretation of a new materials which operated within LCR circuit.	**2**	**6**
	15 weeks	**45 hrs**

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Midterm 1	5th week	15 %
2	Midterm 2	10th week	15 %
3	quizzes	During the semester	10%
4	Home works	During the semester	10%
5	Final exam	End of the semester	50%
	Total		100 %

E Learning Resources

1. List Required Textbooks

1- "Surface Analysis: The Principal Techniques", John C. Vickerman, Ian Gilmore, 2nd Edition, John Wiley & Sons, Inc., (2009), ISBN: 978-0470017647
2- "Organic Structural Spectroscopy" by Joseph B. Lambert, Herbert F. Shurvell, David A Lightner, Robert Graham Cooks, Prentice Hall; 1st edition, (1997), ISBN: 0132586908
3- 'Fundamentals of light microscopy and electronic imaging' Douglas B. Murphy, 2001, Wiley-Liss, Inc. USA
4- 'Encyclopedia of Materials Characterization, Surfaces, Interfaces, Thin Films,' Editors C. Richard Brundle, Charles A. Evans, Jr., Shaun Wilson, Butterworth-Heinemann, Boston, US
5- Elements of X-ray diffraction' B.D. Cullity and S.R. Stock, 2001, Prentice Hall, Inc. USA
6- 'Transmission electron microscopy" D.B. Williams and C. Barry Carter, 4 volumes, Springer, 1996. USA
7- 'Handbook of low and high dielectric constant materials and their applications' Hari Singh Nalwa (ed.), 1999, London, Academic Press, ISBN 0 12 5139071 and ISBN 0 12 5139063
8- Electrical Properties of Materials, by L. Solymar, D. Walsh, , (2004) Oxford University Press, Seven edition, ISBN-13: 978-0199267934

2. List Essential References Materials (Journals, Reports, etc.)

1- "Surface Analysis Methods in Materials Science" by D.J. O'Connor, Brett A. Sexton, Roger S. C. Smart, Springer; 2 edition, (2003), ISBN: 3540413308
2- Organic Spectroscopy, by Lal Dhar Singh Yadav, Springer; 1 edition, (2005), ISBN: 1402025742
1. (Surface and Thin Film Analysis: A Compendium of Principles, Instrumentation, and Applications" by Henning Bubert, Holger Jenett, Wiley-VCH, (2002), ISBN: 3527304584
2. "Scanning Probe Microscopy: The Lab on a Tip" by Ernst Meyer, Hans J. Hug, Roland Bennewitz, Springer, (2003), ISBN: 3540431802.

3. "Handbook of Surface and Interface Analysis, by John C. Riviere, CRC; 1 edition, (1998), ISBN: 0824700805
4. "Structure Determination of Organic Compounds: Tables of Spectral Data", by E. Pretsch, P. Bühlmann, C. Affolter, Springer; 3 edition, (2004), ISBN: 3540678158
5. Practical Guide to Surface Science and Spectroscopy by Yip-Wah Chung, Academic Press, (2001), ISBN: 0121746100

3. List Electronic Materials, Web Sites, Facebook, Twitter, etc.

1. http://www.nanotech-america.com/dmdocuments/mironov_book_en.pdf

Course Title :

Physical Properties of Solid Materials

Course code : **403663-3**

(M-4)

1 Topics to be Covered :		
List of topics :	**No of Weeks**	**Contac t hours**
INTRODUCTION TO PHYSICAL PROPERTIES.	2	6
ELECTRICAL PROPERTIES: 1- Electrical conduction in solids 2- Breakdown of the classical theory of conduction & introduction to the quantum theory and its predictions. 3- Quantum model of electrical conduction in metals; alloying effects; effect of temperature on conductivity. 4- Transport theory in solid materials. 5- Electrical conduction in non-crystalline materials. 6- The combined role of the band gap and temperature on conductivity. - Simple intrinsic semiconductor devices - Extrinsic semiconductors: doping - donor and acceptor atoms; - conductivity equations; - effect of temperature on conductivity - freeze-out curves. 7- Introduction to band-gap engineering 8- Defects theory in solid materials	3	9

ELECTROMAGNETIC PROPERTIES: 1- Basic concepts of magnetism: dipole moment and the Bohr magneton; magnetic susceptibility; magnetic induction; saturation magnetization. 2- Types of magnetic behaviour: diamagnetism; paramagnetism; ferromagnetism; anti ferromagnetism; ferrimagnetism 3- Modern theories of ferri/ferromagnetism; exchange interaction; effect of temperature on saturation magnetization (Curie and Neel temperatures) 4- Magnetic domains and Bloch walls. Generation of hysteresis loops and the definition of soft/hard ferri/ferromagnets. Magnetic anisotropy and magnetostriction. 5- Basic ferromagnetic and ferromagnetic devices such as memory devices; electrical motors, computer hard disks, transformers etc. 6- Superconductivity: Type I and II superconductors; concept of the critical temperature; high-temperature superconductors. 7- Types of superconducting materials (metals and alloys, intermetallics, polymers & ceramics). 8- BCS theory of superconductivity; effects of electrical and magnetic fields on superconductivity; Meissner effect. 9- Superconducting devices.	4	12
THERMAL AND OPTICAL PROPERTIES: 1- Thermal properties of materials: classical and quantum theories of heat capacity. 2- Thermal expansion. Thermoelectricity and the Seebeck effect.. 3- Optical properties of materials: interaction of radiation with matter; reflectivity. 4- Optical devices (lasers, modulators, switches, waveguides, optical fibres, blue ray disks) 5- Optical properties of nanomaterials	3	9
MECHANICAL PROPERTIES**:** 1- Stress-strain diagram ,Young modulus, Poisson ratio, Shear modulus 2- Plastic tensile test 3- Dislocation **4-** Hardness and roughness	3	9
Total :	15 weeks	45 hrs

2 Course components (total contact hours per semester):			
Lecture : 45 hrs	**Tutorial : 15 hrs**	**Lab :**	**Total : 60 hrs**

5. Assessment Tasks Schedule for Students During the Semester

	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	Week Due	Proportion of Total Assessment
1	Midterm 1	5th week	15%
2	Midterm 2	10th week	15%
3	Online quizzes	every week	10%
4	Homework	Every week	5%
5	Interactive discussions	Every week	5%
6	Final exam	End of semester	50%
	Total		100 %

D. Student Academic AND Counselling Support

E. Learning Resources

List Required Textbooks:

Text book :

1) Physical Properties of Materials, Second Edition Mary Anne White (2011) Publisher: CRC Press (1642) ASIN: B01K0TTZ3I
2) W. D. Callister, Jr., "Materials Science and Engineering, An Introduction" Wiley - 8th Edition (2013) ISBN-13: 978-1118324578
3) S. O. Kasap, "Principles of Electronic Materials and Devices," McGraw Hill, 3rd edition (2017) ISBN-13: 978-0078028182
4) Electronic Properties of Materials Hummel, Rolf E. 4th ed. Springer. (2011) ISBN: 978-1441981639

Recommended Reading List :

1) The Structure and Properties of Materials: Volume IV – Electronic Properties: R. M. Rose, L. A. Shepard and J. Wulff, John Wiley and Sons, 1966.
2) • Lectures on the Electrical Properties of Materials: L. Soymar and D. Walsh, Oxford, 1988.
3) An Introduction to the Electron Theory of Solids: J. Stringer, Pergamon, 1967.

4) Introduction to the Modern Theory of Metals: A. Cottrell, Institute of Metals, London, 1988.
5) Physics of Solids: C. A. Wert and R. M. Thompson, McGraw-Hill, 1964.
6) Introduction to solid State Physics: C. Kittel, John Wiley and Sons, 1986.
7) Electronic Properties of Crystalline Solids: R. H. Bube, Academic Press, New York, 1974.
8) Solid State Theory in Metallurgy: P. Wilkes, Cambridge University Press, 1973.
9) Solid State Electronic Devices: B.G. Streetman, Prentice-Hall, 1980.
10) Magnetic Materials: R. S. Tebble and D.J. Craik, Wiley Interscience, 1969.
11) Electronic process in Non-crystalline Materials, N.E Mott and E.A.Davis , Oxford classic texts in physical sciences , 2012

Electronic Materials, Web Sites

http://www.physicalpropertiesofmaterials.com/student

Other learning material such as computer-based programs/CD, professional standards / regulations

- Youtube videos (use e-learning gate of Umm Al-Qura university)

Course Title: **Renewable energy**

Course Code: **403665-3**

(M-5)

C. Course Description (Note: General description in the form used in the program's bulletin or handbook)

1. Topics to be Covered		
List of Topics	**No. of Weeks**	**Contact hours**
Introduction to Renewable Energy Technology	1	3
Energy Shortage and Fossil Fuel - Coal . Petroleum. Natural Gas . Hydrocarbon Conversion . Fossil Fuel Summary	1	3
Basics on Solar Energy -Description of the solar Spectrum **.** Black body **.** Wien Law Stefan Effect and energy lost**.** Existing Energy Technologies	1	3
Global Worming and Greenhouse Effect - Albedo and the Greenhouse Effect . Atmospheric Physics . Global Energy Flow . CO2 and the Carbon Cycle. Feedbacks and Climate Modeling	1	3
Solar Radiation Distribution over the world	1	3
Solar Energy **Photovoltaics .** Introduction to solar energy, solar geometry, photovoltaic effect, Solar cell technology**,** photovoltaic generators technologies, photovoltaic systems autonomous/interconnected. **Solar thermal applications.** Solar thermal power systems (household, centralized), Energy generating systems, thermal energy storage. Photovoltaic Energy**.** Thermal Energy**.** Solar Concentrators	2	6
Wind Energy Introduction to wind energy**.** The Nature of the Wind **.** Characterization of a Wind Resource **.** The Potential of Wind Energy**.** Wind Turbines**.** Wind characteristics, Wind energy potential, Types of wind turbines, wind farms.	1	3
Biomass Introduction to biomass, biomass potential, exploitation possibility, cogeneration.	1	3
Hydropower Introduction to hydropower, Small hydropower systems, system resources, hydroelectric power plants technologies. Fuel cell technology	2	6
Geothermal Energy Introduction to geothermal energy, geothermal fields, space heating, electricity generation, shallow geothermal energy systems	1	3
Other form of renewable energy Tidal power, wave power.	1	3

Energy storage -Performance Criteria for Energy Storage , Grid-scale Storage -Mobile Energy Storage . Other Energy Storage Systems	1	3
Efficient Energy Use and Thermal Building Optimization -First Law Efficiency , Second Law Efficiency , Example: The Efficiency of Space Heating , Exergy , Efficiency and Conservation Case Studies Energy Systems: Scales and Transformations	1	3
Total	15	45

5. Assessment Task Schedule for Students During the Semester			
	Assessment task (i.e., essay, test, quizzes, group project, examination, speech, oral presentation, etc.)	**Week Due**	**Proportion of Total Assessment**
1	Midterm 1	5th week	15 %
2	Midterm 2	10th week	15 %
3	quizzes	During the semester	10%
4	Home works	During the semester	10%
5	Final exam	15th week	50%
	Total		100%

E Learning Resources

1. List Required Textbooks
1. Renewable and Efficient Electric Power Systems. Masters, G. (2004). Wiley Interscience.
2. The Physics of Energy . Robert L Jaffe and Washington Taylor Cambridge University Press, 2018 ISBN 978-1-107-01665-1 Hardback
3. Physics of Energy Sources. Manchester physics series. George C. King, 1st edition
   a. Editor Wiley 2014
4. Energy for a sustainable world: from the oil age to a sun-powered future, Armaroli N. and Balzani V Wiley-VCH.
5. Energy and the Environment, Ristinen R.A. , Kraushaar J.J. Wiley.
6. Messenger, R., & Ventre, J. (2010). Photovoltaic Systems Engineering. CRC Press.
7. Patel, M. (2006). Wind and Solar Power Systems. Taylor and Francis.
8. Yildiz, F., & Coogler, K. (2010). Development of a Renewable Energy Course for a Technology Program. ASEE Annual Conference and Exposition.

2. List Essential References Materials (Journals, Reports, etc.)

- Renewable and Efficient Electric Power Systems, Master G. M., John Wiley & Sons, Inc.

- Energy: Physical, Environmental and Social Impact, Aubrecht G. J., Pearson Prentice Hall. - Emissions Trading: Principles and Practice, Tietenberg T. H. Washington D.C.: Resources for the Future Press.
3.List Electronic Materials, Web Sites, Facebook, Twitter, etc. http://www.microbot-ed.com/ExpRenewNRG1_0.pdf
4. Other learning material such as computer-based programs/CD, professional standards or regulations and software.