Surigao City Campus

Bachelor of Science in Electrical Engineering

SURIGAO STATE COLLEGE OF TECHNOLOGY

SSCT

"For Nation's Greater Heights"

S.2.1. comprehensive enough to test the different levels of cognitive skills and knowledge of content; and

COLLEGE OF ENGINEERING AND INFORMATION TECHNOLOGY
First Semester, Academic Year 2020-2021

COURSE SYLLABUS in ES 242 – MATERIALS SCIENCE AND ENGINEERING

Institutional Vision, Mission, and Goals

Vision:

An innovative an d technologically-advanced State College in Caraga.

Mission:
To provide relevant,

a. high quality and sustainable instruction,
b. research, production and extension programs and
c. services within a culture of credible and responsive institutional governance.

Goals:

1. Foster application of the discipline and provide its learner with industry-based training and education particularly in engineering, technology and fisheries.
2. Conduct and utilize studies for the development of new products, systems and services relevant to Philippine life and of the global village.
3. Promote transfer of technology and spread useful technical skills, thus empowering its learners and their activities.

Institutional Intended Learning Outcomes

: SSCT graduates are expected to:

1. Demonstrate globally competitive skills;
2. Manifest positive work ethics and flexibility in various work condition;
3. Exhibit knowledge deemed essential towards work requirements.

Programs Goals:

The Electrical Engineering program aims to design and apply the generation, transmission, and distribution of electrical energy to produce competent engineers that exhibit positive work ethics and flexibility in work conditions for the development of Caraga.

Program Educational Objectives and Relationship to Institutional Mission

Program Educational Objectives	Mission		
	a	b	c
PEO 1 Innovative and knowledgeable in the latest trends in electrical engineering and demonstrate in their jobs as professional the technical expertise and practical skills.	✓	✓	✓
PEO 2 Flexible in working with multidisciplinary teams, responsible for providing solutions in electrical engineering showing attributes of professionalism and critical thinking.	✓	✓	✓
PEO 3 Engage in lifelong learning and are taking leadership roles in electrical engineering organization that are valuable to the advancement of the society.	✓	✓	✓

Program Outcomes and Relationship to Program Educational Objectives

Program Outcomes	Program Educational Objectives		
	1	2	3
a. Apply knowledge of mathematics and sciences to solve complex engineering problems	✓	✓	✓
b. Develop and conduct appropriate experimentation, analyze and interpret data;	✓	✓	✓
c. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability, in accordance with standards.	✓	✓	✓
d. Function effectively on multi-disciplinary and multi-cultural teams that establish goals, plan tasks, and meet deadlines;	✓	✓	✓
e. Identify, formulate, and solve complex problems in electrical engineering;	✓	✓	✓
f. Recognize ethical and professional responsibilities in engineering practice;	✓	✓	✓
g. Communicate effectively with a range of audiences;	✓	✓	✓
h. Understand the impact of engineering solutions in a global, economic, environmental, and societal context;	✓	✓	✓
i. Recognize the need for additional knowledge and engage in lifelong	✓	✓	✓

learning;			
j. Articulate and discuss the latest developments in the field of electrical engineering	✓	✓	✓
k. Apply techniques, skills, and modern engineering tools necessary for electrical engineering practice; and	✓	✓	✓
l. Demonstrate knowledge and understanding of engineering and management principles as a member and/or leader in a team to manage projects in multidisciplinary environments.	✓	✓	✓

Course Code ES 242
Course Title Materials Science and Engineering
Course Credit 3 units
Pre-requisites/Co-requisites Chemistry for Engineers, Fundamentals of Deformable Bodies

Course Description

The course deals with the properties of engineering materials including mechanical, acoustical, electrical, magnetic, chemical, optical and thermal properties.

Course Outcomes and Relationship to Program Outcomes

Course Outcomes: After completing this course, the students must be able to	**Program Outcomes**												
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
CO1. Describe the subject of materials science and engineering as a scientific discipline.						E	I	E		I			
CO2. Cite the primary classification of materials.						E	I	E		I			
CO3. Give distinctive features and characteristics of each group of materials.						E	I	E		I			
CO4. Name various materials from each group. Give some applications of different types of materials.						E	I	E		I			
CO5. Establish the importance of materials science and engineering in the selection of materials for various applications.						E	I	E		I			

CO6. Name the two atomic models cited, and note the differences between them.						E	I	E		I			
CO7. Describe the important quantum-mechanical principle that relates to electron energies.						E	I	E		I			
CO8. Schematically plot attractive, repulsive, and net energies versus interatomic separation for two atoms or ions.						E	I	E		I			
CO9. Briefly describe ionic, covalent, metallic, hydrogen, and van der Waals bonds.						E	I	E		I			
CO10. Solve problems related to the atomic structure and atomic bonding.						E	I	E		I			
CO11. Describe the difference in atomic/molecular structure between crystalline and noncrystalline materials.						E	I	E		I			
CO12. Draw unit cells for face-centered cubic, body-centered cubic and hexagonal close-packed crystal structures.						E	I	E		I			
CO13. Derive the relationships between unit cell edge length and atomic radius for face-centered cubic and body-centered cubic crystal structures.						E	I	E		I			
CO14. Compute the densities for metals having face-centered cubic and body-centered cubic crystal structures given their unit cell dimensions.						E	I	E		I			
CO15. Distinguish between single crystals and polycrystalline materials.						E	I	E		I			
CO16. Define isotropy and anisotropy with respect to material properties.						E	I	E		I			
CO17. Describe both vacancy and self-interstitial crystalline defects.						E	I	E		I			
CO18. Calculate the equilibrium number of vacancies in a material at some specified temperature, given the relevant constants.						E	I	E		I			
CO19. Name the two types of solid solutions and provide a brief written definition and/or schematic sketch of each.						E	I	E		I			

CO20. Given the masses and atomic weights of two or more elements in a metal alloy, calculate the weight percent and atom percent for each element.						E	I	E		I			
CO21. Describe the edge, screw and mixed dislocations.						E	I	E		I			
CO22. Describe the atomic structure within the vicinity of (a) a grain boundary and (b) a twin boundary.						E	I	E		I			
CO23. Name and describe the two atomic mechanisms of diffusion.						E	I	E		I			
CO24. Distinguish between steady-state and nonsteady-state diffusion.						E	I	E		I			
CO25. Write Fick's first and second laws in equation form and define all parameters. Note the kind of diffusion for which each of these equations is normally applied.						E	I	E		I			
CO26. Write the solution to Fick's second law for diffusion into a semi-infinite solid when the concentration of diffusing species at the surface is held constant. Define all parameters in this equation.						E	I	E		I			
CO27. Calculate the diffusion coefficient for a material at a specified temperature, given the appropriate diffusion constants.						E	I	E		I			
CO28. Describe the four possible electron band structures for solid materials.						E	I	E		I			
CO29. Briefly describe electron excitation events that produce free electrons/holes in (a) metals, (b) semiconductors (intrinsic and extrinsic), and (c) insulators.						E	I	E		I			
CO30. Calculate the electrical conductivities of metals, semiconductors (intrinsic and extrinsic), and insulators given their charge carrier densities and mobilities.						E	I	E		I			
CO31. For a p–n junction, explain the rectification process in terms of electron and hole motions.						E	I	E		I			
CO32. Calculate the capacitance of a parallel-plate						E	I	E		I			

capacitor.													
CO33. Define dielectric constant in terms of permittivities.						E	I	E		I			
CO34. Briefly explain how the charge-storing capacity of a capacitor may be increased by the insertion and polarization of a dielectric material between its plates.						E	I	E		I			
CO35. Name and describe the three types of polarization.						E	I	E		I			
CO36. Briefly describe the phenomena of ferroelectricity and piezoelectricity.						E	I	E		I			
CO37. Define heat capacity and specific heat.						E	I	E		I			
CO38. Note the primary mechanism by which thermal energy is assimilated in solid materials.						E	I	E		I			
CO39. Determine the linear coefficient of thermal expansion, given the length alteration that accompanies a specified temperature change.						E	I	E		I			
CO40. Briefly explain the phenomenon of thermal expansion from an atomic perspective using a potential energy–versus–interatomic separation plot.						E	I	E		I			
CO41. Define thermal conductivity.						E	I	E		I			
CO42. Note the two principal mechanisms of heat conduction in solids, and compare the relative magnitudes of these contributions for each of metals, ceramics, and polymeric materials.						E	I	E		I			
CO43. Determine the magnetization of some material given its magnetic susceptibility and the applied magnetic field strength.						E	I	E		I			
CO44. From an electronic perspective, note and briefly explain the two sources of magnetic moments in materials.						E	I	E		I			
CO45. Briefly explain the nature and source of (a) diamagnetism, (b) paramagnetism, and (c) ferromagnetism.						E	I	E		I			
CO46. In terms of crystal structure, explain the source of ferrimagnetism for cubic ferrites.						E	I	E		I			

CO47. (a) Describe magnetic hysteresis; (b) explain why ferromagnetic and ferrimagnetic materials experience magnetic hysteresis; and (c) explain why these materials may become permanent magnets.						E	I	E		I			
CO48. Note the distinctive magnetic characteristics for both soft and hard magnetic materials.						E	I	E		I			
CO49. Describe the phenomenon of superconductivity.						E	I	E		I			
CO50. Diagram the total materials cycle and briefly discuss relevant issues that pertain to each stage of this cycle.						E	I	E		I			
CO51. List the two inputs and five outputs for the life cycle analysis/assessment scheme.						E	I	E		I			
CO52. Cite issues that are relevant to the "green design" philosophy of product design.						E	I	E		I			
CO53. Discuss recyclability/disposability issues relative to (a) metals, (b) glass, (c) plastics and rubber, and (d) composite materials.						E	I	E		I			
Level: I – Introductory E – Enabling D - Demonstrative													

Detailed Course Syllabus

Course Outcomes	Topics	Time Frame	Teaching and Learning Activities	Assessment Tasks	Resources	Values Integration	Remarks
Express understanding of the Vision and Mission statements of SSCT, including its Goals and Objectives; Analyze the syllabus by looking into the ILOs, Subject Matter, TLAs, Assessment Strategies, Values and References; and Design strategies that will help meet the requirements and obtain desired grades/marks for the course	**ORIENTATION ON THE COURSE** **VMGO** **Syllabus** **Grading System**	1 hr.	*Big Group Discussion* on VMGO *Documentary Analysis* of Syllabus and Grading System *Concept Mapping (Sunflower Map/Fishbone Map)* on strategies to meet course requirements		Computer/ Projector for PowerPoint presentation of the VMGO Syllabus	Obedience, Punctuality, Diligence	

CO1. Describe the subject of materials science and engineering as a scientific discipline. CO2. Cite the primary classification of materials. CO3. Give distinctive features and characteristics of each group of materials. CO4. Name various materials from each group. Give some applications of different types of materials. CO5. Establish the importance of materials science and engineering in the selection of materials for various applications.	**1. Introduction to Materials Science and Engineering** **1.1. Materials Science and Engineering** **1.2. Classification of Materials** **1.3. Advanced Materials** **1.4. Design and Selection**	3 hrs.	Instructor provides reading module for each subtopic 1.1. to 1.4. which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message	Objective quiz on the classifications of materials and advanced materials. Analysis quiz on design and selection of materials.	Module from Instructor Computer/laptop/cellular phone (optional) Online Resources (optional)	Appreciation, Diligence, self-reliance	
CO6. Name the two atomic models cited, and note the	**2. Atomic Structure and Interatomic Bonding** **2.1. Atomic Structure** **2.1.1. Fundamental Concepts**	6 hrs.	Instructor provides reading module for each subtopic 2.1.	Objective and problem solving quiz on the	Module from Instructor	Attentiveness, Diligence, and self-	

differences between them. CO7. Describe the important quantum-mechanical principle that relates to electron energies. CO8. Schematically plot attractive, repulsive, and net energies versus interatomic separation for two atoms or ions. CO9. Briefly describe ionic, covalent, metallic, hydrogen, and van der Waals bonds. CO10. Solve problems related to the atomic structure and atomic bonding.	**2.1.2. Electrons in Atoms** **2.1.3. he Periodic Table** **2.2. Atomic Bonding in Solids** **2.2.1. Bonding Forces and Energies** **2.2.2. Primary Interatomic Bonds** **2.2.3. Secondary Bonding or Van Der Waals Bonding** **2.2.4. Mixed Bonding** **2.2.5. Molecules** **2.2.6. Bonding Type-Material Classification Correlations**		to 2.2. which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message	atomic structure and interatomic bonding	Computer/laptop/cellular phone (optional) Online Resources (optional)	confidence	
CO11. Describe the difference in atomic/molecular structure between crystalline and noncrystalline materials. CO12. Draw unit cells for face-centered cubic, body-centered cubic and hexagonal close-packed	**3. The Structure of Crystalline Solids** **3.1. Crystal Structures** **3.1.1. Fundamental Concepts** **3.1.2. Unit Cells** **3.1.3. Metallic Crystal Structures** **3.1.4. Density Computations** **3.1.5. Polymorphism**	5 hrs.	Instructor provides reading module for each subtopic 3.1 to 3.2 which can be available online and offline/hardcopy (upon request).	Assignment and Analysis quiz on the structure of crystalline solids	Module from Instructor Computer/laptop/cellular phone (optional) Online	Diligence, perseverance, and retention	

crystal structures. CO13. Derive the relationships between unit cell edge length and atomic radius for face-centered cubic and body-centered cubic crystal structures. CO14. Compute the densities for metals having face-centered cubic and body-centered cubic crystal structures given their unit cell dimensions. CO15. Distinguish between single crystals and polycrystalline materials. CO16. Define isotropy and anisotropy with respect to material properties.	**and Allotropy** **3.1.6. Crystal Systems** **3.2. Crystalline and Noncrystalline Materials** **3.2.1. Single Crystals** **3.2.2. Polycrystalline Materials** **3.2.3. Anisotropy** **3.2.4. X-Ray Diffraction: Determination of Crystal Structures** **3.2.5. Noncrystalline Solids**		Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message.		Resources (optional)		
CO17. Describe both vacancy and self-interstitial crystalline defects. CO18. Calculate the equilibrium number of vacancies in a material at some specified temperature, given the relevant constants.	**4. Imperfections in Solids** **4.1. Point Defects** **4.1.1. Vacancies and Self-Interstitials** **4.1.2. Impurities in Solids** **4.1.3. Specification of Composition** **4.2. Miscellaneous Imperfections**	5 hrs.	Instructor provides reading module for each subtopic 4.1 to 4.3 which can be available online and offline/hardcopy (upon request).	Problem solving and assignment on the topic of imperfections in solids.	Module from Instructor Computer/laptop/cellular phone (optional)	Diligence and analytical thinking.	

CO19. Name the two types of solid solutions and provide a brief written definition and/or schematic sketch of each. CO20. Given the masses and atomic weights of two or more elements in a metal alloy, calculate the weight percent and atom percent for each element. CO21. Describe the edge, screw and mixed dislocations. CO22. Describe the atomic structure within the vicinity of (a) a grain boundary and (b) a twin boundary.	**4.2.1. Dislocations—Linear Defects** **4.2.2. Interfacial Defects** **4.2.3. Bulk or Volume Defects** **4.2.4. Atomic Vibrations** **4.3. Microscopic Examination** **4.3.1. Basic Concepts of Microscopy** **4.3.2. Microscopic Techniques** **4.3.3. Grain-Size Determination**		Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message.		Online Resources (optional)		
CO23. Name and describe the two atomic mechanisms of diffusion. CO24. Distinguish between steady-state and nonsteady-state diffusion. CO25. Write Fick's first and second laws in equation form and define all parameters.	**5. Diffusion** **5.1. Diffusion Mechanisms** **5.2. Fick's First Law** **5.3. Fick's Second Law—Nonsteady-State Diffusion** **5.4. Factors That Influence Diffusion** **5.5. Diffusion in Semiconducting Materials**	5 hrs.	Instructor provides reading module for each subtopic 5.1 to 5.6 which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions	Written quiz and assignment on diffusion	Module from Instructor Computer/laptop/cellular phone (optional) Online Resources (optional)	Diligence and appreciation	

Note the kind of diffusion for which each of these equations is normally applied. CO26. Write the solution to Fick's second law for diffusion into a semi-infinite solid when the concentration of diffusing species at the surface is held constant. Define all parameters in this equation. CO27. Calculate the diffusion coefficient for a material at a specified temperature, given the appropriate diffusion constants.	**5.6. Other Diffusion Paths**		through Google Classroom, Messenger Group Chat, or text message.				
MIDTERM EXAMINATION (2 hours)							
CO28. Describe the four possible electron band structures for solid materials. CO29. Briefly describe electron excitation events that produce free electrons/holes in (a) metals, (b) semiconductors (intrinsic and extrinsic), and (c)	**6. Electrical Properties of Materials** **6.1. Electrical Conduction** **6.2. Semiconductivity** **6.3. Electrical Conduction in Ionic Ceramics and in Polymers** **6.4. Dielectric Behavior** **6.5. Other Electrical**	6 hrs.	Instructor provides reading module for each subtopic 6.1 to 6.5 which can be available online and offline/hardcopy (upon request). Students can ask	Problem solving quiz on the electrical properties of materials.	Module from Instructor Computer/laptop/cellular phone (optional) Online	Perseverance and analytical thinking	

insulators. CO30. Calculate the electrical conductivities of metals, semiconductors (intrinsic and extrinsic), and insulators given their charge carrier densities and mobilities. CO31. For a p–n junction, explain the rectification process in terms of electron and hole motions. CO32. Calculate the capacitance of a parallel-plate capacitor. CO33. Define dielectric constant in terms of permittivities. CO34. Briefly explain how the charge-storing capacity of a capacitor may be increased by the insertion and polarization of a dielectric material between its plates. CO35. Name and describe the three types of polarization. CO36. Briefly describe the	**Characteristics of Materials**		the clarifications and questions through Google Classroom, Messenger Group Chat, or text message.		Resources (optional)		

phenomena of ferroelectricity and piezoelectricity.							
CO37. Define heat capacity and specific heat. CO38. Note the primary mechanism by which thermal energy is assimilated in solid materials. CO39. Determine the linear coefficient of thermal expansion, given the length alteration that accompanies a specified temperature change. CO40. Briefly explain the phenomenon of thermal expansion from an atomic perspective using a potential energy–versus–interatomic separation plot. CO41. Define thermal conductivity. CO42. Note the two principal mechanisms of heat conduction in solids, and compare the relative magnitudes of these contributions for each of	**7. Thermal Properties** **7.1. Heat Capacity** **7.2. Thermal Expansion** **7.3. Thermal Conductivity** **7.4. Thermal Stress**	6 hrs.	Instructor provides reading module for each subtopic 7.1 to 7.4 which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message	Assignment and objective quiz on the thermal properties of materials	Module from Instructor Computer/laptop/cellular phone (optional) Online Resources (optional)	Appreciation and perseverance	

metals, ceramics, and polymeric materials.							
CO43. Determine the magnetization of some material given its magnetic susceptibility and the applied magnetic field strength. CO44. From an electronic perspective, note and briefly explain the two sources of magnetic moments in materials. CO45. Briefly explain the nature and source of (a) diamagnetism, (b) paramagnetism, and (c) ferromagnetism. CO46. In terms of crystal structure, explain the source of ferrimagnetism for cubic ferrites. CO47. (a) Describe magnetic hysteresis; (b) explain why ferromagnetic and ferrimagnetic materials experience magnetic hysteresis; and (c) explain	**8. Magnetic Properties** **8.1. Basic Concepts** **8.2. Diamagnetism and Paramagnetism** **8.3. Ferromagnetism** **8.4. Antiferromagnetism and Ferrimagnetism** **8.5. The Influence of Temperature on Magnetic Behavior** **8.6. Domains and Hysteresis** **8.7. Magnetic Anisotropy** **8.8. Soft Magnetic Materials** **8.9. Hard Magnetic Materials** **8.10. Magnetic Storage** **8.11. Superconductivity**	7 hrs.	Instructor provides reading module for each subtopic 8.1 to 8.11 which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message.	Multiple choice quiz on the magnetic properties of materials.	Module from Instructor Computer/laptop/cellular phone (optional) Online Resources (optional)	Diligence and perseverance	

why these materials may become permanent magnets. CO48. Note the distinctive magnetic characteristics for both soft and hard magnetic materials. CO49. Describe the phenomenon of superconductivity.	**9. Environmental and Societal Issues in Materials Science and Engineering** **9.1. Environmental And Societal Considerations** **9.2. Recycling Issues In Materials Science And Engineering**	3 hrs.	Instructor provides reading module for each subtopic 9.1 to 9.2 which can be available online and offline/hardcopy (upon request). Students can ask the clarifications and questions through Google Classroom, Messenger Group Chat, or text message	Written essay on the environmental and societal issues in materials science and engineering.	Module from Instructor Computer/laptop/cellular phone (optional) Online Resources (optional)	Appreciation, perseverance and optimism	
CO50. Diagram the total materials cycle and briefly discuss relevant issues that pertain to each stage of this cycle. CO51. List the two inputs and five outputs for the life cycle analysis/assessment scheme. CO52. Cite issues that are relevant to the "green design" philosophy of product design.							

CO53. Discuss recyclability/disposability issues relative to (a) metals, (b) glass, (c) plastics and rubber, and (d) composite materials.							
FINAL EXAMINATION (2 hours)							

References:

- William F. Smith, et. al. FOUNDATIONS OF MATERIALS SCIENCE AND ENGINEERING. McGraw-Hill Education; 6th ed. 2019
- William D. Callister & Jr., David G. Rethwisch. MATERIALS SCIENCE AND ENGINEERING AN INTRODUCTION. John Wiley & Sons, Inc.; 10th ed. 2018

Course Requirements:

- Assignment and Quizzes
- Problems Sets and Activities
- Midterm & Final Examination

Course Evaluation:

Criteria	Lecture Grade
Quizzes and Online outputs/interaction	25%
Performance Tasks (project/ assignment)	35%
Major Exams (Midterm & Finals)	40%
TOTAL	**100%**

Grade Point	Description
1.0	Excellent
1.5 – 1.1	Very Good
2.0 – 1.6	Highly Satisfactory
2.5 – 2.1	Good
2.9 – 2.6	Satisfactory
3.0	Passing
5.0	Failed due to poor performance, absences, withdrawal without notice
DRP	Dropped with approved dropping slip
INC	Incomplete requirements but w/ passing class standing. INC is for non-graduating students only

Source: *SSCT Student Handbook*

Course Policies:

1. Attendance will be checked in every class sessions to prove the students' presence in the class. This is to monitor whether absences incurred by the student is still within the allowed number of absences for a course as stipulated in the Student Handbook.
2. Excuse from the class will only be honoured if a Memo from the school is issued before the absence or valid excuse letter from parents/guardians is presented after the absence. No other excuses will be entertained.
3. The use of multiple choice questionnaires is used during the midterm and final examination. However, for problem solving, a detailed solution is required written legibly in a separate long size bond paper or newsprint.
4. Cheating in midterm and final examination will entail a zero score. Cheating is defined to include an attempt to defraud, deceive, or mislead the instructor in arriving at honest grade assessment.
5. Plagiarism in papers and other works will entail zero score. Plagiarism is a form of cheating that involves presenting as one's own work the ideas or work of another.
6. Students who fail to take the midterm and final examination as scheduled shall be required to write an explanation letter address to the Program Chair, noted by the parents/guardian, and approved by the Dean. After that, he/she can take the missed examination.
7. Clearance is required when the student take the final examination based on No Clearance No Examination Policy.
8. Project shall be submitted on the set deadline by the instructor. Unsatisfactory project will not be accepted. However, the student will be given a chance to improve their project. Non-submission of the project on the set deadline means a zero score.

Revision History:

Revision No.	Date of Revision	Date of Implementation	Highlight of Revision
1	August 2019	1st Sem, AY 2019-2020	Followed school OBTL Format as per CMO #101 S. 2017
2	December 5, 2020	1st Sem, AY 2020-2021	Followed suggestion from ChED COPC.

Preparation, Review, and Approval:

Prepared by:

ENGR. VERNON V. LIZA
Guest Lecturer
Date: Aug 11, 2020

Checked and Reviewed by:

ENGR. VICENTE Z. DELANTE, MEng'g
Program Chair, BSEE
Date: Aug. 11, 2020

Noted:

ENGR. ROBERT R. BACARRO, MECE, MBA
Dean, CEIT
Date: Aug 13, 2020

Recommending Approval:

DR. RONITA E. TALINGTING
Campus Director
Date: Aug 14, 2020

Approved by:

DR. EMMYLOU A. BORJA
VP for Academic Affairs
Date: Aug 14, 2020

COLLEGE OF ENGINEERING & INFORMATION TECHNOLOGY
First Semester, AY 2020-2021

TEST QUESTIONNAIRE
Midterm Examination in **ES 242 – Materials Science and Engineering**

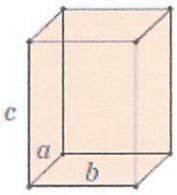
Instruction:
1. Read the questions carefully. You are not permitted to share calculators or any other materials during the examination;
2. Show the detailed solution of the problem in a separate sheet of paper;
3. Shade the bubble in the answer sheet that corresponds to the correct answer of the given test question.

Multiple Choice:

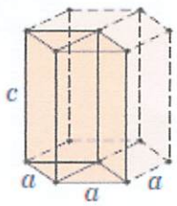
1. The _____ of a material usually relates to the arrangement of its internal components.
   a. Structure
   b. Microstructure
   c. Property
   d. mechanical property
2. These are compounds between metallic and nonmetallic elements.
   a. Metals
   b. Ceramics
   c. Polymers
   d. Composites
3. These have electrical properties that are intermediate between those of electrical conductors and insulators.
   a. Biomaterials
   b. Semiconductors
   c. smart materials
   d. nanomaterials
4. These are metals that, after having been deformed, revert to their original shape when the temperature is changed.
   a. piezoelectric ceramics
   b. biomaterials
   c. shape-memory alloys
   d. nanomaterials
5. These materials expand and contract in response to an applied electric field.
   a. piezoelectric ceramics
   b. biomaterials
   c. shape-memory alloys
   d. nanomaterials
6. In this model, an electron is no longer treated as a particle moving in a discrete orbital; rather, the position is considered to be the probability of an electron being at various locations around the nucleus.
   a. atomic model
   b. Bohr Atomic Model
   c. Wave-mechanical Model
   d. electron configuration model
7. This quantum-mechanical concept stipulates that each electron state can hold no more than two electrons that must have opposite spins.
   a. electron configuration
   b. Pauli exclusion principle
   c. wave-mechanical model
   d. Bohr atomic model
8. The _____ or structure of an atom represents how electron states are occupied.
   a. electron configuration
   b. electron states
   c. property
   d. atomic model
9. What type(s) of bonding would be expected for a rubber?
   a. ionic bonding
   b. metallic bonding
   c. covalent bonding with some van der Waals bonding
   d. van der Waals bonding
10. What type(s) of bonding would be expected for bronze (a copper-tin alloy)?
    a. ionic bonding
    b. metallic bonding

c. covalent bonding with some van der Waals bonding
d. van der Waals bonding

11. The electron configuration for $1s^2 2s^2 2p^6 3s^2 3p^6$ is
    a. inert gas
    b. halogen
    c. alkali metal
    d. alkaline earth metal
12. The atomic radii of $Mg2^+$ and F^- ions are 0.072 and 0.133 nm, respectively. What is the force of repulsion at this same separation distance?
    a. -1.10×10^{-8} N
    b. -1.10×10^{-6} N
    c. 2.15×10^{-8} N
    d. -2.15×10^{-7} N
13. This type of bonding is found in materials whose atoms have small differences in electronegativity.
    a. ionic bonding
    b. metallic bonding
    c. covalent bonding
    d. van der Waals bonding
14. This bonding is found in metals and their alloys.
    a. ionic bonding
    b. metallic bonding
    c. covalent bonding
    d. van der Waals bonding
15. Is proper selection important in the design and application of materials?
    a. Yes
    b. No
    c. Maybe
    d. It depends
16. Which of the following is the correct order?
    I. Processing-Structure-Properties-Performance
    II. Properties-Structure-Processing-Performance
    III. Structure-Properties-Performance-Processing
    IV. Processing-Properties-Structure-Performance
    a. II
    b. I
    c. IV
    d. III
17. The sum of the sphere volumes of all atoms within a unit cell divided by the unit cell volume.
    a. Avogadro's number
    b. Fick's law
    c. atomic packing factor
    d. coordination number
18. A common metallic crystal structure that has a cubic unit cell with atoms located at all eight corners and a single atom at the cube center.
    a. body-centered cubic (BCC)
    b. face-centered cubic (BCC)
    c. hexagonal closed-packed
    d. trigonal closed-packed
19. What kind of crystal system is the figure shown below?



    a. Cubic
    b. Hexagonal
    c. Tetragonal
    d. Orthorhombic
20. What kind of crystal system is shown below?



a. Cubic
b. Hexagonal
c. Trigonal
d. Orthorhombic

21. Substances in which measured properties of a material are independent of the direction of measurement.
a. Polymorphic
b. Isotropic
c. Anisotropy
d. none of the above

22. It is a special type of secondary bonding found to exist between some molecules that have hydrogen as one of the constituents.
a. Hydrogen Bonding
b. Oxygen Bonding
c. Van Der Waals Bonding
d. none of the above

23. If the atomic radius of lead is 0.175 nm, calculate the volume of its unit cell in cubic meters.
a. 3.65 m^3
b. 0.015 m^3
c. 4.97 m^3
d. none of the above

24. Calculate the volume of an FCC unit cell in terms of the atomic radius R.
a. $16\sqrt{2}(R^3)$
b. $\sqrt{2}\ R^3$
c. $\sqrt{2}\ R^3$
d. none of the above

25. The magnitude and direction of lattice distortion associated with a dislocation are specified by its _____.
a. Vectors
b. Burgers vectors
c. interfacial defect
d. none of the above

26. This electron microscope employs an electron beam that raster-scans the specimen surface and an image is produced from back-scattered or reflected electrons.
a. Transmission electron microscope (TEM)
b. Scanning probe microscope
c. Scanning electron microscope (SEM)
d. None of the above

27. A _____ is a linear or one-dimensional defect around which some of the atoms are misaligned.
a. Dislocation
b. Defect
c. Vacancy
d. point defect

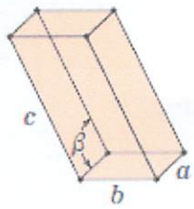
28. Determine the composition, in atom percent, of an alloy that consists of 97 wt% aluminum and 3 wt% copper.
a. 1.30 at%
b. 2.10 at%
c. 0.67 at%
d. 1.45 at%

29. A _____ forms when the solute atoms are added to the host material, the crystal structure is maintained and no new structures are formed.
a. interstitial solid solution
b. substitutional solid solution
c. solid solution
d. none of the above

30. It is the element or compound that is present in the greatest amount in an alloy.
a. Solute
b. Solution

c. Solvent
d. none of the above

31. This boundary is a special type of grain boundary across which there is a specific mirror lattice symmetry.
    a. phase boundary
    b. twin boundary
    c. grain boundary
    d. stacking faults
32. These are boundaries that have two dimensions and normally separate regions of the materials that have different crystal structures.
    a. phase boundary
    b. twin boundary
    c. interfacial defects
    d. volume defects
33. Calculate the number of vacancies per cubic meter in iron at 855 degrees celsius. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm^3 and 55.85 g/mol, respectively.
    a. $1.2x10^{24}$ m^{-3}
    b. $1.2x10^{24}$ m^{-3}
    c. $2.1x10^{24}$ m^{-3}
    d. $2.1x10^{21}$ m^{-3}
34. The process by which atoms of one metal diffuse into another.
    a. Diffusion
    b. vacancy diffusion
    c. interstitial diffusion
    d. interdiffusion
35. This type of diffusion involves atoms which migrate from an interstitial position to a neighboring one that is empty.
    a. Diffusion
    b. vacancy diffusion
    c. interstitial diffusion
    d. interdiffusion
36. The diffusion coefficients for copper in aluminum at 500- and 600-degree Celsius are 4.8×10^{-14} and 5.3×10^{-13} m^2/s, respectively. Determine the approximate time at 500-degree Celsius that will produce the same diffusion result (in terms of concentration of Cu at some specific point in Al) as a 10-h heat treatment at 600-degree celsius.
    a. 100.3 hours
    b. 110.4 hours
    c. 97 hours
    d. 125 hours
37. The equation below is known as
    $J = -D\frac{dC}{dx}$
    a. Diffusion flux
    b. Fick's second law
    c. Fick's first law
    d. None of the above
38. For a steel alloy, it has been determined that carburizing heat treatment of 10-h duration will raise the carbon concentration to 0.45 wt% at a point 2.5 mm from the surface. Estimate the time necessary to achieve the same concentration at a 5.0 mm position for an identical steel and at the same carburizing temperature.
    a. 40 hrs
    b. 30 hrs
    c. 25 hrs
    d. 65 hrs
39. Calculate the radius of an iridium atom, given that Ir has an FCC crystal structure, a density of 22.4 g/cm^3, and an atomic weight of 192.2 g/mol.
    a. 0.136 nm
    b. 1.32 nm
    c. 0.211 nm
    d. none of the above
40. What kind of crystal system is shown below?



a. Cubic
b. Triclinic
c. Monoclinic
d. Tetragonal

41. The following configuration is _____.
$1s^2 2s^2 2p^6 3s^2 3p^5$
a. Inert
b. Transition metal
c. Halogen
d. Alkaline earth metal

42. This atomic diffusion heat treatment is used to transport impurity atoms farther into the silicon of semiconducting material in order to provide a more suitable concentration distribution without increasing the overall impurity content.
a. drive-in diffusion
b. predeposition
c. predeposition
d. none of the above

43. Copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Compute its theoretical density in g/m^3.
a. 6.89 g/m^3
b. 8.89 g/m^3
c. 9.86 g/m^3
d. 8.66 g/m^3

44. Compute the number of kilograms of hydrogen that pass per hour through a 5-mm-thick sheet of palladium having an area of 0.25 m2 at 500 C. Assume a diffusion coefficient of 1.0 x 10-8 m2/s, that the concentrations at the high- and low-pressure sides of the plate are 2.4 and 0.6 kg of hydrogen per cubic meter of palladium, and that steady-state conditions have been attained.
a. 3.2 $x10^{-5}$ kg/h
b. 2.3 $x10^{-3}$ kg/h
c. 2.2 $x10^{-2}$ kg/h
d. 3.2 $x10^{-3}$ kg/h

45. What happens during the predeposition treatment of diffusion in semiconducting materials?
a. impurity atoms are diffused into the silicon, often from a gas phase, the partial pressure of which is maintained constant.
b. impurity atoms are transported nearer into the silicon in order to provide a more suitable concentration distribution without increasing the overall impurity content.
c. impurity atoms are diffused into the silicon, often from a liquid phase, the partial pressure of which is doubled.
d. impurity atoms are transported farther into the silicon in order to provide a more suitable concentration distribution without increasing the overall impurity content.

46. What is the variable called in the equation of temperature dependence of the diffusion coefficient?
a. Diffusion energy
b. Heat energy
c. Activation energy
d. Energy quotient

47. This rate is defined as the mass (or, equivalently, the number of atoms) M diffusing through and perpendicular to a unit cross-sectional area of solid per unit of time.
a. Interdiffusion flux
b. Diffusion flux
c. Energy flux
d. Magnetic flux

48. Is it possible for three or more elements to form a solid solution?
a. Yes
b. No
c. It depends
d. Maybe

49. Zinc has five naturally occurring isotopes: 48.63% of ^{64}Zn with an atomic weight of 63.929 amu; 27.90% of 66Zn with an atomic weight of 65.926 amu; 4.10% of ^{67}Zn with an atomic weight of 66.927 amu; 18.75% of ^{68}Zn with an atomic weight of 67.925 amu; and 0.62% of ^{70}Zn with an atomic weight of 69.925 amu. Calculate the average atomic weight of Zn.
    a. 56.300 amu
    b. 45.600 amu
    c. 35.400 amu
    d. 65.400 amu
50. The following configuration is _____.
    $1s^2 2s^2 2p^6 3s^2$
    a. Alkaline earth metal
    b. Halogen
    c. Inert gas
    d. Transition metal

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