Kingdom of Saudi Arabia Ministry of Higher Education **Qassim University** College of Engineering	Qassim University جامعة القصيم	المملكة العربية السعودية وزارة التعليم العالي **جامعة القصيم** **كليه الهندسه**

Physics of Semiconductors and Devices

College:	**College of Engineering**
Department:	**Electrical Engineering Dept.**

First: Course Definition

1- Course Code: EE610

2- Units: 3 Credit Hrs

3 – Semester	**First semester of MSC program**
4 -Prerequisite	**-----**
5- Co-requisite	**-----**

6- Location (if not on main Campus):

Second: Course Objectives

- Developing a Solid foundation in the physics of semiconductors to appreciate the working principle of the current electronic devices
- Give students an appreciation of the role of semiconductors in novel applications, and solid foundation for new semiconductor devices as they materialize and evolve in future years.
- To give students an understanding of the concept of crystal structures, bonding properties, energy band theory, carrier distribution and recombination, theory of transport and scattering.
- To ensure that students know some characteristic properties of theory of p-n junction, and operation of majority carrier diodes and transistors.
- To make students familiar with a range of fast, low power and reliable electronics consists of superconducting electronics and its application will also be covered with modern electronic components in the field.

Third: Course Specifications

1- Topics to be covered

Subject	No of Weeks	Units

1. **Introduction to Materials:** Metal, Semiconductor, Insulator and Superconductors, Bonding in materials and their characteristics, Crystal Structures, Introduction to Crystal Growth Techniques	**1**	**3**
2. **Introduction to Quantum Mechanics:** Principles of Quantum Mechanics, Schrodinger's Wave Equation, Applications of Schrodinger's Wave Equation, Tunneling ,Allowed and Forbidden Energy Bands	**2**	**6**
3. **Homogeneous Semiconductors in Thermodynamic Equilibrium:** Charge Carriers in Semiconductors, Dopant Atoms and Energy Levels, The Extrinsic Semiconductor Statistics of Donors and Acceptors, Charge Neutrality, Position of Fermi Energy Level**.**	**2**	**6**
4. **Carrier Transport Phenomena in Semiconductors:** Carrier Drift, Carrier Diffusion, Graded Impurity Distribution.	**2**	**6**
5. **Principles of Semiconductor Devices:** Homo Junction, Metal Semiconductor Junctions, Hetero Junctions.	**2**	**6**
6. **Properties of interest for device applications:** Surface morphology, IV characteristics, Resistivity, conductivity, band gap, doping concentration, Type of doping etc.	**2**	**6**
7. **Introduction to superconductivity and superconducting devices:** Definition and critical quantities, Types of Superconductor, General Applications Areas, Superconducting Electronics : Josephson tunnel Junction , Superconducting Quantum Interference Devices (SQUID), Rapid Single-Flux-Quantum (RSFQ), Infrared detectors	**3**	**9**

2- Course components (Total hrs in the Semester): 42

Lecture	Exercises	Others
42	**-----**	**-----**

3- Intended Learning Outcomes of the Course (ILO's)

a. *Knowledge*

i) Description of the knowledge to be acquired-:

- To apply the fundamental knowledge from Quantum Mechanics and Solid State Physics to the technologically important and useful materials.
- To comprehensively understand the physics of semiconductors.
- To understand the physical basis and the use of typical semiconductor devices.
- To gain updated knowledge in the most advanced development of low dimensional semiconductor hetero structures and their applications.

ii) Teaching strategies to be used to develop that knowledge

- Lectures
- Assignments, at home
- Discussions in the Class

- Case study Report (data collection, internet search, and reporting)

iii) Methods of assessment of knowledge acquired

- **Quizzes:** to assess understanding of the course knowledge.
- **Assignment reports:** to assess ability to answer some comprehensive questions.
- **Midterm Exams:** to assess understanding of the course knowledge.
- **Final Exam:** to assess understanding of the course knowledge.

b- Cognitive (Intellectual) Skills

i) Cognitive skills to be developed

- The ability to analyze, and determine the micro Fabrication.
- The ability to select the suitable technology,
- The ability to control the synchronous machines.

ii) Teaching strategies to be used to develop these cognitive skills

- Lectures
- Assignments, at home
- Discussions in the Class
- Literature Survey Report (data collection, internet search, and reporting)

iii) Methods of assessment of student's cognitive skills

- **Quizzes:** to assess understanding of the course knowledge.
- **Assignment reports:** to assess ability to answer some comprehensive questions.
- **Midterm Exams:** to assess understanding of the course knowledge.
- **Final Exam:** to assess understanding of the course knowledge.

c. Interpersonal Skills and Responsibility

i) Description of the interpersonal skills and capacity to carry responsibility to be develope

- Team work
- Ideas development and sharing with others

ii) Teaching strategies to be used to develop these skills

- Assignments, at home
- Discussions in the Class
- Case study Report (data collection, Internet search, and reporting)

iii) Methods of assessment of student's interpersonal skills and capacity to carry responsibility

Unified reports and Seminars: to assess the integration done by the student in a - unified report and presentations.

Oral Group Exams: to assess interactive and communication abilities.-

d. Communication, Information Technology and Numerical Skills

i) Description of the skills to be developed in this domain

- Use of the internet search
- Technical report writing

ii) Teaching strategies to be used to develop these skills

- Assignments, at home
- Assignment Reports (data collection, Internet search, and reporting)

iii) Methods of assessment of students numerical and communication skills

- Assignment Reports: to assess technical report writing abilities.

Discussion Groups: to assess interactive and communication abilities.-

e. Psychomotor (if applicable) & Other Non-cognitive Skills

i) Description of the psychomotor or other skills to be developed and the level of performance required

Not Applicable

ii) Teaching strategies to be used to develop these skills-

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iii) Methods of assessment of student's psychomotor skills

4- Student Assessment Schedule

Serial	*Assessment tool (test, group project, examination etc.)*	*Week due*	*Weight*
1	Quiz 1 on **Introduction to Materials**	2	1%
2	Short Quiz 2	3	1%
3	HW 1		2%
4	Extended QUIZ on **Introduction to Quantum Mechanics**	4	3%
5	Short Quiz 3	5	1%
	HW 2		2%
6	Extended QUIZ on **Homogeneous Semiconductors** in Thermodynamic Equilibrium	6	**3%**
7	**Midterm Exam I**	7	**15%**

8	Short Quiz 4	8	**1%**
	HW3		2%
9	Extended QUIZ on **Carrier Transport Phenomena** in Semiconductors	9	3%
10	Quiz 5 **on Principles of Semiconductor Devices**	10	**1%**
11	**Midterm Exam II**	11	**15%**
12	**Presentation** on **Properties of interest for device** applications	12	**5%**
	HW4		2%
13	Extended QUIZ on **Introduction to superconductivity and superconducting devices**	14	3%
14	**Final**	15	40%

5- Student Support

1. Office hours per week are offered by the instructor to aid the students and support them.
2. Tutorial arranged to help in understanding the course material

6- Learning Resources

i) Essential Books (References)

- S.O. Kasap, "Principles of electronics materials and devices", 3rd Edition Mc Graw Hill, 2006
- Donald A. Neamen, "Semiconductor Physics and devices", 3rd Edition Mc Graw Hill, 2003
- Ben G. Streetman, "Solid State Devices", 4th Edition, Prentice Hall, 1995
- S. M. Sze, "Physics of Semiconductor Device", Wiley Inter science.
- Charles kittel, "Introduction to soild state physics", 8th Edition, John Wiley and Son Inc., 2005.
- J.B. Ketterson and S. N. Song, "Superconductivity", Cambridge University, 1999.
- Robert F. Pierret, "Advanced Semiconductor Fundamentals", Prentice Hall.

ii) Course Notes

Lecture notes on semiconductor material physics, providing a deeper treatment than that available in Taur, will be distributed in class.

iii) Recommended Books

- K. Seeger, Semiconductor physics, Springer (Berlin, 1999) QC611.S43 1999
- H. T. Grahn, Introduction to semiconductor physics, World Scientific (Singapore, 1999) QC611.G73 1999
- R. Enderlein, N. J. M. Horing, Fundamentals of semiconductor physics and devices, World Scientific (Singapore, 1997) QC611.E655 1997

- Peter Y. Yu, M. Cardona, Fundamentals of semiconductors, Springer (Berlin, 2005) QC611 .Y88 2005
- S. M. Sze (ed.), Modern semiconductor device physics, John Wiley & Sons, Inc. (New York, 1998) QC611.M674 1998
- C. Weisbuch, B. Vinter, Quantum semiconductor structures, Academic Press, Inc. (Boston, 1991) QC611.W38

iv) Electronic Books & Web Sites:

- http://www.optique-ingenieur.org/en/courses/OPI_ang_M05_C02/co/Grain_OPI_ang_M05_C02_2.html
- http://jas.eng.buffalo.edu SUNY, Buffalo offers great graphics for SC physics and devices
- http://www.britneyspears.ac/lasers.htm Britney Spears (Essex Univ. Physics Grads) provide a succinct summary of SC physics
- http://phet.colorado.edu/simulations/index.php?cat=Quantum_Phenomena
- http://video.google.com/videoplay?docid=1005391949403496551

v) Periodicals

- IEEE transaction on Applied superconductivity
- IEEE transaction on Quantum Electronics
- IEEE transaction on semiconductor manufacturing
- Solid State electronics IEEE

7- Course Evaluation and Improvement Processes

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching

- Course related discussions with students at the end of each section
- Introduction of class representative who convey feed backs to the teacher which helps teacher to build an appropriate strategy to improve the teaching and learning process.
- Course evaluation and suggestions form filled after first midterm exam for teacher feedback
- Official course evaluation forms should be compiled and results should be shared with the professor.
- Observing the students opinions recorded in the college student site
- Appeal box
- Carrying out extensive questioners by a sample of the distinguished students just after the graduation from the college.

ii) Other Strategies for Evaluation of Teaching by the Instructor or by the Department

A key to effective teaching evaluation is to collect data from multiple sources (triangulation), making sure that all education-related activities are rated by the people best qualified to rate them.

Peer Ratings: A far more effective procedure is for two or more reviewers to use standardized checklists to rate instructional materials and at least two class observations independently and then to reconcile their ratings.[1-3]

Student Ratings: Faculty performance evaluations should take into account student ratings collected over a period of several years, with relatively little weight being attached to ratings of someone's first semester of teaching.

The Teaching Portfolio: Just as some performance assessment data can best be provided by students and some by peers, certain important information can only be supplied by the faculty member being reviewed. Instructors should assemble materials summarizing all of their education-related activities, including developing new courses and redesigning old ones, developing and evaluating innovative instructional methods, advising and mentoring students, writing new texts and courseware, providing instructional development to faculty colleagues and graduate students, and carrying out educational research. All of these materials except those related to educational research should be incorporated into a teaching portfolio, along with summaries of student ratings over the past two or three years, peer ratings, and reference letters from alumni and colleagues at other institutions who are familiar with the instructor's educational activities. The portfolio provides a solid basis for evaluating the faculty member's teaching performance and contributions to education.[4–6] [7]

1. Brent, R., and R.M. Felder, "A Protocol for Peer Review of Teaching," Proc. 2004 An. ASEE Meet., ASEE, June (2004),
2. Chism, N. Van Note, Peer Review of Teaching, Anker Publishing, Bolton, MA (1999)
6. Weimer, M., J.L. Parrett, and M. Kerns, How am I Teaching? Magna Publications, Madison, WI (1988)
4. Seldin, P., The Teaching Portfolio: A Practical Guide to Improved Performance and Promotion/Tenure Decisions, 2nd ed., Anker Publishing
Co., Bolton, MA (1997)
5. Edgerton, R., P. Hutchings, and K. Quinlan, The Teaching Portfolio: Capturing the Scholarship in Teaching, American Association for
Higher Education, Washington, DC (1991)
6. Felder, R.M., "If You've Got It, Flaunt It: Uses and Abuses of Teaching Portfolios," Chem. Eng. Ed., 30(3), 188 (1996)
7. http://www.crlt.umich.edu/tstrategies/tseot.php

iii) Processes for Improvement of Teaching

- The following framework is one that you could use to document strategies you use and assess how they work. The framework follows the familiar "plan, do, check, act cycle" which is a continuous improvement process used in business, industry, government, and higher education.

Plan: Concept - The concept that you plan to teach
Strategy - The teaching strategy that you plan to use
Date - The day you plan to use the strategy
Materials Needed - The teaching materials that you will need

Time Needed - Plan your teaching activity so that you can accomplish all your goals

Feedback - Decide on a strategy to obtain student feedback. Consider fast feedback, written reports and observing students' reactions

Do: Execute your plan

Check: Review student evaluations

Act: Decide on what you would do next time. Stick with the strategy? Change?

iv) Processes for verifying standards of student achievement (e.g. check marking by an independent faculty member of a sample of student work, periodic exchange and remarking of a sample of assignments with a faculty member in another institution)

- Not required

v) Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

As per procedure of academic council

- Assessment and evaluation of the level of achieving the course outcomes through a continuous improvement process (part of a quality assurance system established by the university),
- Consequently, actions are to be taken to improve the course delivery when necessary.
- Review of the course objectives, outcomes and curriculum each 2 years.