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**

Nanoelectronics and Nanotechnology

College: Engineering

Department: Electrical Engineering

First: Course Definition

1- Course Code- EE614

2- Units (3)

3 – Semester (1)

4 -Prerequisite -None

5- Co-requisite- None

6- Location (if not on main Campus):

Second: Course Objectives

Upon completion of this course, the student will be able to:

1- Understand the underlying operating principles of nanodevices,
2- Explain how nanodevices are fabricated,
3- Demonstrate specialized practical and theoretical knowledge in the use of particular nanodevices in its context,
4- Understand the inter-relation between different technologies in the design of integrated devices operational principles of MOSFET's.

Third: Course Specifications

1- Topics to be covered

Subject	No of Weeks	Hours
- Introduction to course outlines - Introduction to Nano world	1	2 2
MOSFET and Logic functionality : - BULK MOSFET structure and theory of operation - Digital applications, - Short Channel Effects, SCEs on device performance - Threshold voltage models including SCEs	2	 2 2 2 2
(nano)MOSFET scaling: Transistors, Circuits, Architecture:	3	

- Proposed structures Current models, threshold voltage and other related parameters		**2** **10**
Schottky Barrier MOSFET and SpinFET: - Terminal contact effects on device performance - Ohmic and Schottky contacts effects on device performance	**3**	 **6** **6**
Carbon Nanotube: - Material and structures of CNT - Device modeling and their characteristics	**2**	 **4** **4**
Silicon Nanowire: - Material and Applications - Single Electron Transistor and Logic	**3**	 **6** **6**

2- Course components (Total hrs in the Semester)

Lecture	Lab	Exercise	Other
42	**8**	**6**	

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

a. *Knowledge*

i) Description of the knowledge to be acquired:

- Develop and apply knowledge of different microelectronic and nanoelectronic technologies for the different types of circuit-design devices, concepts and tools and their possible application to different fields of technology.
- Develop interdisciplinary knowledge of current and future trends in technologies, devices, circuits and systems in microelectronics and nanoelectronics and how they are merging with other, more-established or emerging areas of knowledge.
- Apply your knowledge to resolving problems in new or relatively unknown environments and in multidisciplinary contexts related to your nanodevices.
- Develop learning skills that enable you to continue studying autonomously

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.

b- Cognitive (Intellectual) Skills

i) Cognitive skills to be developed

- The ability to model the Short Channel Effects (SCEs).
- The ability to design an accurate/sensitive current models of nanodevices
- The ability to propose new materials for improving devices.

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

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

iii) Methods of assessment of students cognitive skills

- **Quizzes:** to asses the ability to solve quickly some problems.
- **Assignment reports:** to asses the ability to solve and analyze some comprehensive problems.
- **Midterm Exams:** to assess the ability to discuss, analyze, and solve the associated problems.
- **Final Exam**: to assess the intellectual skills such as analytical skills and ability to solve machine problems

c. Interpersonal Skills and Responsibility

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

- 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 students 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

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

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iii) Methods of assessment of student's psychomotor skills

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4- Student Assessment Schedule

Serial	*Assessment tool (test, group project, examination etc.)*	*Week due*	*Weight*
1	Quiz (1)	4	2%
2	Mid-Term(1)	6	15%
3	Quiz (2)	8	2%
4	Mid-Term Exam (2)	12	15%
5	Attendance		2%
6	Home work-Mini-project	13	14%
6	Final Exam	16	50%

5- Student Support

Four office hours per week are offered by the instructor to aid the students and support them.

6- Learning Resources

i) Essential Books (References)

1. **Nanoelectronics and Information Technology, Second, Corrected Edition (Edt R. Waser), 2005**
2. **Introduction to nanoelectronics: science, nanotechnology, engineering, and applications, by Vladimir Vasil'evichMitin, ViacheslavAleksandrovichKochelap, Michael A. Stroscio,Cambridge University Press, 2008 ،**
3. **Quantum nanoelectronics: an introduction to electronic nanotechnology and quantum computing, Edward L. Wolf, Wiley-VCH, 2009**
4. **Nanoelectronics and nanosystems: from transistors to molecular and quantum devices, K. Goser, Peter Glösekötter, Jan Dienstuhl, Springer, 2004-**

ii) Course Notes

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iii) Recommended Books

1- **Molecular and nano electronics: analysis, design and simulation, J. M. Seminario, Elsevier, Dec 11, 2006**
2- **Current at the nanoscale: an introduction to nanoelectronics, ColmDurkan, Imperial College Press, 2007**
3- **Nanoelectronics: Principles and Devices (Nanotechnology), Mircea Dragoman, Daniela Dragoman, ISBN-10: 1580536948 | ISBN-13: 978-1580536943**

iv) Electronic Books & Web Sites:

- ITRS web page,

- NanoHub web-page

v) Essential Tools

Laboratory space and equipment required:

1- **The E-CAD room or equivalent is required to teach the simulation software and to allow students to do the first piece of course work.**
2- **MATLAB with Applications to Engineering, Physics and Finance, David Baez-Lopez, CRC Press. This shows how to solve engineering and similar problems using Matlab and Simulink.**

Software requirements

1- Silvaco simulation package University license

MATLAB software license

7- Course Evaluation and Improvement Processes

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching

- Questionnaire,
- 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

- Periodical review of the teaching methods by both the department council and the education affairs vice dean.-
- Questionnaire,
- Observing the students opinions recorded in the college student site
- Appeal box

iii) Processes for Improvement of Teaching

- Evaluation of the course outlines by external staff member from outside the university
- Periodical contact with the different engineering authorities and industries for evaluating and getting their feedback and suggestions concerning the course outlines.

iv) Processes for Verifying Standards of Student Achievement

It is planned to:

- Check marking of a sample of student work by an independent faculty member.
- Exchange periodically, and remark a sample of assignments with a faculty member in King Saud University (KSU).

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

- 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.