Acropolis Technical Campus, Indore, 452020, (M.P.)
Department of Electronics & Communication

Course Plan

Nanoelectronics

Course Code	EC-6005	Session: 2017-18	Semester: VI
Tutor	Prof. Vishal Pawar	Revision date : 8/1/18	Branch: EC
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1. Scheme of the Semester Containing the Course

Rajiv Gandhi ProudhyogikiVishwavidyalaya, Bhopal

Semester VI

Credit Based Grading System (CBGS) w.e.f. July 2017

Scheme of Examination

Bachelor of Engineering B.E. (Electronics and Communication Engineering)

Subject wise distribution of marks and corresponding credits

Scheme of Examination w.e.f.July-2017 AcademicSession-2017-18

S. No.	Subject Code	Subject Name & Title	Maximum Marks Allotted							Hours / week			Total Credits	Remarks
			Theory			Practical			Total Marks					
			End Sem	Mid Sem MST	Quiz, Assignment	End Sem	Lab Work	Assignment /Quiz/Term paper		L	T	P		
1	EC-6001	Cellular mobile communication	70	20	10	-	-	-	100	3	1	-	4	One credit refers to one hour teaching in theory, Tutorial and in practical.
2	EC-6002	Digital signal Processing	70	20	10	30	10	10	150	3	1	2	6	
3	EC-6003	Antennas and wave Propagation	70	20	10	30	10	10	150	3	1	2	6	
4	EC-6004	VLSI circuits and systems	70	20	10	30	10	10	150	3	1	2	6	
5	EC-6005	Elective-II	70	20	10	-	-	-	100	3	1	-	4	
6	EC-6006	Workshop-II	-	-	-	30	10	10	50	-	-	2	2	
7	EC-6007	Creativity and Entrepreneurship Development** (Internal Assessment)	-	-	-	-	-	50	50	-	-	2	2	
8	EC-6008	Startup / Industrial Lectures ** (Internal Assessment)	-	-	-	-	-	50	50	-	-	2	2	Total Marks
			350	100	50	120	40	140	800	15	5	12	32	800

MST: Minimum of two mid semester tests to be conducted.
** OR any other subject as suggested by the respective BOS

L: Lecture T: Tutorial P: Practical

2. Course Overview

The course name Nano-electronics have total five units in which students learn the different types of materials used to design devices in nano size approach . They have also study the limitation of some devices in terms of advancement of the relevant technology. The major goals and objectives are to provide the fundamental principles of nanoelectronics with the present research front in applications and to be able to critically assess future trends.

3. Course Learning Objectives (CLO)

The Learning Objectives Nanoelectronics are such that the student will

CLO 1: Understand the limitations of silicon electronics and progress of nanoelectronics

CLO 2: Equip themselves about the significance of tunneling effect in nanoelectronic devices.

CLO 3: Understand the concepts of coulomb blockade and electron transport.

CLO 4: Improve their ability in knowing the electronic property of materials in mesoscopic level.

4. Course Outcomes (CO)

At the end of the course, student would be able to demonstrate the knowledge and ability to

CO1: The students will get basic knowledge on integrated circuit technology and how this technology is developing and can be applied for designing cost effective and ever increasingly compact systems to be used in future products.

CO2: The students should be able to design advanced electronic systems integrated on a miniaturized Silicon chip, thus master methods for designing, analyzing and testing such systems by using professional industry standard software and advanced laboratory instruments.

CO3: The Students should be able to reflect on central ethic and scientific problems related to your own work or the work of others.

Course Outcome (CO)	CO Statement
CO.6005.1	The students will get basic knowledge on integrated circuit technology and how this technology is developing and can be applied for designing cost effective and ever increasingly compact systems to be used in future products.
CO.6005.2	The students should be able to design advanced electronic systems integrated on a miniaturized Silicon chip, thus master methods for designing, analyzing and testing such systems by using professional industry standard software and advanced laboratory instruments.
CO.6005.3	The Students should be able to reflect on central ethic and scientific problems related to your own work or the work of others.

5. Mapping Course Outcomes (COs) leading to the achievement of Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

(Copy of programme related, PO and PSO are to be attached with this course plan)

S. No.	CO	PO												PSO				
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
1	C6005.1			H		H				M		M	L	L		L		L
2	C6005.2	H	H		M	M				M	H				L	L	M	L
3	C6005.3			H		H					M	M	M		M			

Enter correlation level 1, 2, 3 as defined below-

1: Slight (Low); 2: Moderate (Medium); 3: Substantial (High) and if there is no correlation, put "----".

6. Topic delivery details of "Content beyond the Syllabus" for the attainment of POs and PSOs.

Sr. No.	Content Beyond syllabus to be taught	Satisfying PO	Satisfying PSO
1.	Introduction Course.		
2.	Material Science		
3.	IC Technology		

7. Distribution of Course Work as per University Scheme

(Copy of scheme is to be attached with this course plan)

Slot / Contact Type	Ingredients (per student)	Distribution of periods @ 1hr		Distribution of Marks Max. Marks As per University scheme		
		Number of hours per week	Per Sem (12 weeks)	End Sem	Internal	
					MST / LWS	Q/A
Theory Slot	Lecture (L)	3	36	70	20	20
	Tutorial (T)	1	12			
Practical Slot	Practical Work (P)	2	24	30	10	10

Internal Assessments are based on scheme provided by the university.

(3.a) No. of Theory Lectures Necessary for the course: 48

(3.b) No. of Theory Lectures Unit wise:

UNIT	I	II	III	IV	V	TOTAL
Assigned No. of Lectures per Unit →	7	15	7	9	10	48
Actual Taken						

8. Time Schedules: Total expected periods from <*Start of session*> to <*End of session*> as per Academic Calendar, excluding sports week, holidays etc.

<write the no. of periods available as per academic calendar >

Ingredients	Mon day	Tues day	Wednes day	Thurs day	Fri day	Satur day	Max. Available	Needed	Excess / Short
Available									
Theory (L)									
Tutorials (T)									
Practicals (P)									
Batch (for T & P)									

9. Prerequisite(s)

Students should have desire to learn and scientific approach in laboratory.
Students should have knowledge of Material Science.

10. Post Requisites

The Students able to design and moderate software tool & Boards useful in implement business application.

11. University Syllabus

Theory

Unit I : Introduction	**
Nanoscale technology: Consequences of the nanoscale for technology and society. Molecular building blocks for nanostructure systems, Nano-scale 1D to 3D structures, Band structure and density of states at low dimensional structure. Size dependent properties (Elelctrical, mechanical, optical, thermal etc).top down and bottom up technique, lithographic, nanolithographic and nonlithographictechniques:plused laser depositon,plasma arc discharge, e-beam sputtering, ball milling , solgel, electrodeposition, chemical vapour deposition.	07
Unit II : Characterization technique	**
Scanning probe microscopy: (Principle, construction and working;) Scanning tunnelling microscope, Atomic force microscope, scanning electron microscope, Transmission electron microscope, Carbon materials :Allotropes of carbon, Structure of Carbon Nanotubes, types of CNTs-, Electronic properties of CNTs, Band structure of Graphene ,Band structure of SWNT from grapbene ,electron transport properties of SWNTs ,	15
Unit III : :Introduction to magnetism and superconductivity	**
Basic magnetic phenomena: paramagnetism, ferromagnetism, ferrimagnetism, anti-ferromagnetism;nano-magnetism; giant and colossal magnetoresistance; ferrofluids. Basic superconductivity phenomena; flux quantisation and Josephsoneffects.	07
Unit IV : Fundamental of nanoeletronics	**
Charging of quantum dots, Coulomb blockade, Quantum mechanical treatment of quantum wells, wires and dots, Widening of bandgap in quantum dots, Strong and weak confinement, spin field effect transistor. single electron transistors, other SET and FET structure.	09
Unit V : Silicon MOSFETs	**
fundamental of MOSFET devices, scaling rules, silicon dioxide based gate dielectrics, metal gates , junction and contacts, advanced MOSFET concepts	10

Tutorials For smooth conduction of tutorials we implements following steps

- Doubt Clearing session.
- Quiz Test.
- Discussed about related topics

12. Books prescribed by the University

1.G. W. Hanson: Fundamentals of Nanoelectronics, Pearson Education.

2. K. K. Chattopadhyay and A. N. Banerjee: Introduction to Nanoscience and Nanotechnology, PHI Learning. 3. John H. Davis: Physics of low dimension semiconductor, Cambridge Press.

4.KTu, JW Mayer, LC Feldman, "Electronic Thin Film Science", Macmillan, New York, 1992.

5. Z Cui , "Mico-Nanofabrication", Higher Education press, Springer, 2005.

6.Brian Cantor, "Novel Nanocrystalline Alloys and Magnetic Nanomaterials," Institute of Physics Publications, 2005.
7. S.Chikazumi and S.H. Charap," Physics of Magnetism", Springer-verlag berlin Heideberg, 2005
8.CaoGuozhong, "Nanostructures and Nanomaterials - Synthesis, Properties and Applications", Imperial College Press, 2004.
9. SadamichiMaekawa, "Concepts in Spintronics", Oxford University Press, 2006

13. Course / Lecture and Tutorial Schedule

Unit	Topic	Objective	Ref No. [Page no.]	Hrs	Date	Students Present
1	**Unit – I** **Introduction:**					
	Consequences of the nanoscale for technology and society. Molecular building blocks for nanostructure systems	CLO1	R.G.P.V. NOTES.	2	8/1/18 12/1/18	1 3
	Nano-scale 1D to 3D structures	CLO1	R.G.P.V. NOTES	1	12/1/18	3
	Band structure and density of states at low dimensional structure	CLO1	R.G.P.V. NOTES.	1	12/1/18	3
	Size dependent properties (Elelctrical, mechanical, optical, thermal etc)	CLO1	R.G.P.V. NOTES.	1	15/1/18	15
	top down and bottom up technique	CLO1	2: [5, 11]	1	15/1/18	15
	plused laser depositon, plasma arc discharge	CLO1, 2	1: [134]	2	22/1/18	21
	e-beam sputtering, ball milling	CLO1, 2	1: [113, 142]	1	22/1/18	18
	solgel, electrodeposition, chemical vapour deposition.	CLO1, 2	1: [127, 155]	2	29/1/18 18/1/18	18 22
2	**Unit – II** **Characterization technique**					
	Scanning probe microscopy: (Principle, construction and working;)	CLO2	1: [177]	2	19/1/18 29/1/18	
	Scanning tunnelling microscope	CLO2	1: [177]	1	1/2/18	29
	Atomic force microscope	CLO2	1: [188]	1	1/2/18	29.
	scanning electron microscope	CLO2	1: [199]	1	2/2/18	27.
	Transmission electron microscope	CLO2	1: [208]	2	24/1/18	33
	Carbon materials :Allotropes of carbon, Structure of Carbon Nanotubes	CLO2	1: [223]	1	2/2/18	27
	types of CNTs-, Electronic properties of CNTs	CLO3		1	9/2/18	11
	Band structure of Graphene	CLO3	1: [232]	1	9/2/18	25
	Band structure of SWNT from grapbene	CLO3	2: [172]	1	12/2/18	41
	electron transport properties of SWNTs ,	CLO3	2: [172]	2	16/2/18	10
3	**Unit – III** **Introduction to magnetism and superconductivity**					
	paramagnetism, ferromagnetism,	CLO3	2: [347]	1	19/2/18	52
	ferrimagnetism, anti-ferromagnetism;	CLO3	2: [347-348]	1	21/2/18	15

	nano-magnetism; giant and colossal magnetoresistance;	CLO3	R.G.P.V. NOTES.	1	23/2/18	50
	Ferrofluids , Basic superconductivity phenomena;	CLO3	R.G.P.V. Notes.	1	28/2/18	45.
	flux quantisation	CLO3	R.G.P.V. NOTES.	1	9/3/18	05
	Josephsoneffects	CLO3	R.G.P.V. NOTES.	1	9/3/18	05
4	**Unit – IV** **Fundamental of nanoeletronics**					
	Charging of quantum dots, Coulomb blockade,	CLO3	2: [181].	2	12/3/18 14/3/18	34. 28
	Quantum mechanical treatment of quantum wells,	CLO3	2: [122, 151]	2	14/3/18 16/3/18	28 29
	wires and dots, Widening of bandgap in quantum dots,	CLO4	2: [124, 281]	2	19/3/18 28/3/18	23. 21
	Strong and weak confinement,	CLO4	2: [201]	1		
	spin field effect transistor.	CLO4, 1	2: [251].	1	9/4/18	24
	single electron transistors,	CLO4, 1	2: [184, 235]	1	9/4/18	24.
	other SET and FET structure.	CLO4, 1	2: [184, 235]	1	11/4/18	57.
5	**Unit – V** **Silicon MOSFETs**	~~CLO4~~		~~1~~		
	fundamental of MOSFET devices,	CLO4, 1	R.G.P.V. NOTES.	1	14/4/18	57
	scaling rules,	CLO4, 1	R.G.P.V. NOTES.	1	16/4/18	44.
	Silicon dioxide based gate dielectrics	CLO4, 1	R.G.P.V. NOTES.	1	18/4/18	14
	metal gates ,	CLO4, 1	R.G.P.V. NOTES.	1	19/4/18	10
	junction and contacts,	CLO4, 1	R.G.P.V. NOTES.	1	25/4/18	20
	advanced MOSFET concepts	CLO4, 1	R.G.P.V. NOTES.	1	25/4/18	20.
			Total	48		

14. Evaluation and Assessment scheme: As per format no.....

Approved by:

HEAD

Director
Shri G.S. Institute of Tech. & Science
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Director