

Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development							
Metric	1.1.3	Average percentage of courses having focus on employability/							
		entrepreneurship/ skill development offered by the Nano technology							

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING (NANO TECHNOLOGY DIVISION)

SYLLABUS COPY OF THE COURSES HIGHLIGHTING THE FOCUS ON EMPLOYABILITY/ ENTREPRENEURSHIP/ SKILL DEVELOPMENT

1. List of courses for the programmes in order of

S. No.	Programme Name
i.	Master of Technology(Nano Technology)(Full Time)
ii.	Master of Technology (Nano Technology)(Part Time)

2. Syllabus of the courses as per the list.

Legend :	Words highlighted with Blue Color	-	Entrepreneurship
-	Words highlighted with Red Color	-	Employability
	Words highlighted with Purple Color	-	Skill Development

1. List of courses

Name of the Course	Course Code	Year of introduction	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
Encapsulation Techniques	XNT701A	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Health and safety issues of Nanotechnology	XNT702	2018-19	Entrepreneurship- Test,Assignment, Seminar
Nano composites	XNT703	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Nanoscaffold and Charecterization Techniques	XNT705D	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Cyber security	XUM706	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Project Theme – I	XNT707	2018-19	Entrepreneurship- Test,Assignment, Seminar
Project Work – Phase I	XNT901	2018-19	Skill Developement- Review,Publication
Open Elective – IV	OE-IV	2018-19	Skill Developement- Quiz, Test, Assignment Seminar, Group Discussion
Fullerene	XNT802C	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Career Development Skills	XNT803	2018-19	Entrepreneurship- Test,Assignment, Seminar
MEMS and NEMS	XNT804	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Surface Plasmon Resonance	XNT805	2018-19	Employability - Test, Assignment, Seminar, Poster Presentation
Mini Project	XNT806	2018-19	Skill Developement- Quiz, Test, Assignment Seminar, Group Discussion
Project Theme – II	XNT807	2018-19	Skill Developement- Quiz, Test, Assignment Seminar, Group Discussion
Project Work – Phase II	XNT1001	2018-19	Skill Developement- Review,Publication Seminar, Group Discussion
Nanomanipulation & Assembly	YNT301C	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Dissertation Phase - I	YNT303	2018-19	Skill Developement- Review,Publication Seminar, Group Discussion
Dissertation Phase - II	YNT401	2018-19	Skill Developement- Review,Publication Seminar, Group Discussion

Carbon Nanotube Electronics and Devices	QNT301C	2018-19	Employability - Test, Assignment, Seminar, Poster Presentation
English for Research Paper Writing	YEGOE1	2018-19	Skill Developement- Quiz, Test, Assignment Seminar, Group Discussion
Nanomaterials Characterization Techniques Lab	QNT304	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Spectroscopic Techniques for Nanomaterials	QNT401B	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Constitution of India	YPSOE1	2018-19	Entrepreneurship- Test, Assignment, Seminar
Computational Nanotechnology	QNT403	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Computational Nanotechnology Lab	QNT404	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Mini Project	QNT405	2018-19	Entrepreneurship- Test, Assignment, Seminar
Nanomanipulation & Assembly	QNT501C	2018-19	Employability - Test,Assignment, Seminar,Poster Presentation
Dissertation Phase - I	QNT502	2018-19	Skill Developement- Review,Publication Seminar, Group Discussion
Dissertation Phase - II	QNT601	2018-20	Skill Developement- Review,Publication Seminar, Group Discussion

2. Syllabus of Courses

COURSE C	CODE	XNT701A	L	Т	Р	С			
COURSE N	IAME	MEMS AND NEMS fabrication	2	0	1	3			
PREREQUISITES		Nanomaterials Fabrication Techniques I and II	L	Т	Р	Н			
C:P:A		1.5:1.2:0.3	2	0	2	4			
COURSE O	OUTCON	1ES	DOMA	IN	L	EVEL			
CO1	Explain	Basic concept of MEMS and NEMS	Cognitive Psychomo	otor		derstand member			
CO2	Explain	and <i>understand</i> Fabrication Process	Cognitive Psychomo	otor	Gu	derstand, ided sponse			
CO3		ine and Describe Mechanical and MEMS	Cognitive Psychomo			derstand, ided t			
CO4	<i>Describ</i> MEMS	e and Illustrate the Magnetic and RF	Cognitive Psychomo	otor		derstand, chanism			
CO5	Classify fluidic S	and <i>Describe the</i> MOEMS and Micro Systems	Cognitive Psychomo		Understand, Mechanism				
MEMS Arcl UNIT II Photolithogr etching Bu and Packag	FABRI FABRI raphy, str lk and su ging- Ba elements	agnetic MEMS, RF MEMS- Microfluid - NEMS Architectures CATION PROCESS uctural and sacrificial materials- Thin fi inface micromachining- Wafer bonding sic Modelling elements in mechani in fluid systems, thermal systems- Th	Im deposition and LIGA cal, electri	on- Imp MEMS	ourity S Ass	6+6 7 doping, 5- Basic			
UNIT III	Mechar	tical and Thermal MEMS and actuation- Components: bea	um. cantile	ver. m	icro	6+6 plates			
Components MEMS Gyr	s: capaci coscopes:	tive effects, piezo element Measur shear mode MEMS Gyroscopes: gri thermal basics—Thermo devices, The	ements: str pping piezo	ain pro actuat	essur ors-	e, flow- Thermal			
UNIT IV	Magnet	ic and RF MEMS				6+6			
MEMS mag Review of	Magnetic materials: properties- Magnetic materials for MEMS- Magneto resistive sensor- MEMS magnetic sensors and actuators Review of RF based communication system-I- Review of RF based communication system-II RF MEMS, varactors, tuner/filter- Resonators, Switches, Phase shifter								
UNIT V		S and Microfluidic Systems				6+6			
	Principles of MOEMS technology- Applications Light modulators, beam splitters- Micro lens, micro mirror, digital micromirror device- Optical switch, wave guide and tuning-								

Properties of fluids, fluid actuation methods- Dilectrophoresis, electro thermal flow, thermo capillary effect- Micropumps, Micropumps: design consideration

		-FF		
	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	30	0	30	60
TEXT BOOK				
Book reference				
1 MEMS and	INEMS System	ns Devices and Structure	s-Sergev Edward	Lysheyski

- MEMS and NEMS: Systems, Devices, and Structures-Sergey Edward Lyshevski 1.
- Modeling MEMS and NEMS-John A. Pelesko, David H. Bernstein 2.
- REFERENCES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2
CO1	1	1	1	1	2	2	2	1	1	1	1
CO2	1	1	1	1	2	2	2	1	1	1	1
CO3	1	1	1	1	2	2	2	1	1	1	1
CO4	1	1	1	1	2	2	2	1	1	1	1
CO5	1	1	1	1	2	2	2	1	1	1	1
Total	5	5	5	5	10	10	10	5	5	5	5
1-5 →	1,6-10	2, 1	1-15	3							

Table 1 : COs versus POs mapping

0 - No relation 1- Low relation 2- Medium relation 3- High relation

COURSE (CODE	XNT702		L	Т	P	C		
COURSE N	NAME	HEALTH AND SAFETY ISSUES	OF	3	0	0	3		
		NANOTECHNOLOGY							
C:P:A		2:0:1		L	Т	P	Η		
PREREQU	ISITE	Physics, Chemistry and Material Sci		3	0	0	3		
COURSE (DUTCO	MES	DOMAIN	LEV	EL				
CO1	Relate t	he toxic effects of nanotechnology on	Unde						
	human l	health.		Rem		er			
			Affective	Appl	-				
CO2	•	the various issues on environmental	Cognitive	Unde					
	effects.			Rem		er			
CO2	T1		Affective	Appl		1			
CO3	Identify	suitable remedial measures	Cognitive	Unde					
				Rem		er			
CO4	Suggest	start of the nine solution for	Affective	Appl Unde		ad			
004		start-of-the pipe solution for mental issues based on nanomaterials	Cognitive	Rem					
	environ	mental issues based on nanomaterials	Affective	Appl		51			
CO5	Work o	ut problems on nanomaterials related	Cognitive	Unde	-	nd			
005		ity. To frame a model policy on	Cognitive	Rem					
		ing health hazards.	Affective	Appl		01			
UNIT - I	_	f Nanomaterials			9		9		
		aterials: Identification of Nano, Spe	cific Risks F	Respon	dino	to	-		
		nealth hazard, Risk reduction, Standar							
Emergency			,,, , ,	1			. ,		
UNIT –	_	sessment					9		
II									
Risk assess	ment: Ri	sk assessment - Environmental Impac	t – Predicting	hazard	l – N	Aateı	ials		
Characteriz	ation. Ri	sk Assessment related to nanotechnol	logy – Enviror	nmenta	l an	d po	licy		
making									
UNIT - III	Ecotox	cicity of nanomaterials					9		
Ecotoxicity	of nanor	naterials: Ecotoxicity - Inhalation depo	sition and Puln	nonary	clea	ranc	e of		
		Bio –persistence of Inhaled solid ma							
inhaled Part	icles. Pu	lmonary effects of SWCNT							
UNIT –	Ecotox	cicological tests					9		
IV E i i i	• 1 4		1	• 1	•				
	-	ts: Terms and parameters frequently			-				
-		ons - ecotoxicological approaches in ment for polychlorinated biphenyls –				-	-		
Ames test	measure	ment for poryemornated orphenyls –	measurement	or ger	10107	licity	Uy		
UNIT – V	Legal a	spects and regulations on toxicity of					9		
	nanoma						,		
Legal aspec		gulations on toxicity of nanomaterials:	: The approach	es to a	SSes	smen	t of		
		anotechnology. Bioethics and legal							
-		•••					and		
environmental risks in nanotechnology, FDA regulation, cytotoxicity of n						anoparticies			
List of Exp	eriments								
List of Exp			course outcome	based	on tl	ne			

faculty will be taught and also feasibility.

TOTAL HOURS			
Lecture	Tutorial	Practical	Total
45	0	0	45

TEXT BOOK

- 1. P.P. Simeonova, N. Opopol and M.I. Luster, "Nanotechnology Toxicological Issues and Environmental Safety", Springer 2006.
- 2. Vinod Labhasetwar and Diandra L. Leslie, "Biomedical Applications of nanotechnology", A John Willy & son Inc,NJ, USA, 2007.
- Miyawaki, J.; et.al Toxicity of Single-Walled Carbon Nanohorns. ACS Nano 2 (213– 226) 2008.
- 4. Hutchison, J. E. Green Nanoscience: A Proactive Approach to Advancing Applications and Reducing Implications of Nanotechnology. ACS Nano 2, (395–402) 2008.
- 5. Mo-Tao Zhu et.al Comparative study of pulmonary responses to nano- and submicron-sized ferric oxide in rats Toxicology, 21 (102-111) 2008.
- 6. Dracy J. Gentleman, Nano and Environment: Boon or Bane? Environmental Science and technology, 43 (5), P 1239, 2009.

CO/P O	PO 1	PO 2	PO 3	PO 4	РО 5	PO 6	PO 7	PO 8	PO 9	PO1 1	PO1 2	PSO 1	PSO 2
CO1	-	-	-	-	-	-	2	-	1	1	1	1	1
CO2	-	-	-	-	-	-	2	-	1	1	1	1	1
CO3	-	-	-	-	-	-	2	-	1	1	1	1	1
CO4	-	-	-	-	-	-	2	-	1	1	1	1	1
CO5	-	-	-	-	_	-	2	-	1	1	1	1	1
Total							10		5	5	5	5	5
							2		1	1	1	1	1

Table 1 : COs versus POs mapping

1-5 →1, 6-10 -2, 11-15 3 →

0 - No relation

1- Low relation

2- Medium relation

COURSE O	CODE	XNT703		L	Т	Р	C	
COURSE N	IAME	NANOCOMPOSITES		3	1	1	5	
C:P:A		2:0.5:0.5		L	Т	Р	Н	
PREREQU	ISITE	Physics, Chemistry and Material S	Science	3	2	2	7	
COURSE (COURSE OUTCOMES Domain							
CO1	Define	and <i>explain</i> nano ceramics	Cognitive Psychomotor	Unde Rem Appl Guid	emb ying	er	nse	
			Affective	Orga				
CO2	propert	stand and describe the fabrication, ties and applications of metal based composites	Cognitive Psychomotor	Unde Rem Appl Guid	emb ying	er	nse	
			Affective	Orga		-		
CO3		<i>d understand</i> the design of super aterials	Cognitive Psychomotor	Understand Remember Applying				
			Affective	Guided response Organizing				
CO4	Unders compo	stand and explain the novel nano sites	Cognitive Psychomotor Affective	Unde Rem Appl Guid	emb ying ed re	er espor	nse	
CO5	propert	stand and describe the fabrication, ties and applications of polymer	Cognitive	Organizing Understand Remember				
	based r	nano composites	Psychomotor Affective	Applying Guided response Organizing				
UNIT - I	Nano	Ceramics				9+	6+6	
		al-Ceramic composites, Different aspe final properties and functionality	ects of their prepa	ration				
UNIT – II	Metal	Based Nanocomposites				9+	6+6	
Metal-metal magnetic pro	nanocon	nposites, some simple preparation tec	hniques and their	r new o	elect	rical	and	
UNIT - III	Design	Of Super Hard Materials				<u>9</u> +	6+6	
		posites, its designing and improveme	ents of mechanica	l prop	ertie	s.		
UNIT – IV	New K	ind Of Nanocomposites				9+	6+6	
Fractal base	<u> </u>	netal nano composites, its designing a fractal based nano composites. Core					es.	
UNIT – V		er Based Nanocomposites					6+6	
Preparation	and char	acterization of diblock Copolymer bas	sed nanocomposi	ites;				

Polymercarbonnanotubes based composites, their mechanical properties, and industrial possibilities.

List of Experiments

10 to 12 Experiments will be provided relevant to the five course outcome based on the faculty will be taught and also feasibility.

Lecture	Tutorial	Practical	Total
45	30	30	105
TEXTBOOK			

1. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.

REFERENCE and E-REFERENCE

- 1. Physical Properties of Carbon Nanotubes- R. Saito 1998.
- 2. Carbon Nanotubes (Carbon , Vol 33) M. Endo, S. Iijima, M.S. Dresselhaus 1997.
- 3. The search for novel, superhard materials- Stan Veprjek (Review Article) JVST A, 1999
- 4. Electromagnetic and magnetic properties of multi component metal oxides, hetero
- 5. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal Ben, Youssef,

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	-	-	-	1			2	1
CO2	2	1	1	1	-	-	-	-	1			2	1
CO3	2	1	1	1	-	-	-	-	1			2	1
CO4	2	1	1	1	_	_	-	-	1			2	1
CO5	2	1	1	1	_	_	_	_	1			2	1
Total	10	5	5	5	-	-	-	-	5			10	5
	2	1	1	1	-	-	-	-	1			2	1

Table 1 : COs versus POs mapping

1-5 →1, 6-10 →, 11-15 3→

0 - No relation 1- Low relation

2- Medium relation

COURSE (CODE	XNT705D		L	Т	Р	С	
COURSE N		NANO IN WIRELESS COMMUN	ICATION	2	0	1	3	
C:P:A				L	Т	Р	Н	
PREREQU	ISITE			2	0	2	4	
COURSE O	OUTCO	MES	Domain	Level				
CO1	Cognitive	Understand						
	Psychomotor	Rem	embe	er				
CO2	Explai	<i>n</i> and <i>understand</i> applications of	Cognitive	Unde	ersta	nd,		
		chnology on fiber optics and vave communications	Psychomotor	Guid Resp		:		
CO3	Determine and Describe applications of Cognitive							
	CNT in telecommunications Psych							
				Set				
CO4		be and Illustrate MEMS based	Cognitive	Unde	ersta	nd,		
	applica	ation on wireless communications	Psychomotor	Mechanism				
CO5		xplain and practice the feasible	Cognitive	Understand,				
	-	ments on nano wireless unication	Psychomotor	Mechanism				
for Telecon Nanotechno	: A Snap nmunica logy: Sc	t of Nanotechnology on Telecommun oshot- Global Standards-Impact and Pro- ations- Transparent Transaction: A Some Samples - The Promise and Futu- gy - Preparing Students for Nanotechnology	omise of Nanote Scenario- Ongo ure of Nanotech	ing R	esea			
UNIT – II	Nanot	echnology in Fiber-Optic Telecomm					10	
MicrowaveNanostructures and Their Interaction with Light- Single Nanoparticle- NanostructureNanostructure Construction-Nanostructures as Optical Power-Control Devices- OpticalFuses- Market Needs-Optical-Fuse Specifications - for Optical Communication NetworksOptical Fuse: State of the Art - How to Design and Produce a Fuse- Fuse Design andCompliance to Market Requirements- Optical Limiters - The Need -Optical Power LimiterAdditional -Power Limiter Parameters-Applications of Graphene at Microwave FrequenciesRF Graphene Field Effect Transistor- Graphene Antenna - Graphene Microstrip AttenuatorGraphene Composites in EM Shielding								
		n Nanotubes in Telecommunications			[ov - 4		5	
Microwave and Satellite for Wireles	Diodes i es - Cart s Comi	otubes - Carbon Nanotubes as Neural n Spacecrafts oon Nanotubes in Fiber-Optics-Telecon munications and Radio Transmission nd Modified SIW (MSIW)	mmunications -	Carbo	n Na	notu	lbes	

UNIT – IV	MEMS-Based Wireless Communications	10
RF MEMS	- MEMS-Based Inductors-Planar Spiral Inductor- Soleno	id-Type Inductor-
Toroidal-Me	ander-Type Inductor -Tunable Inductors - MEMS Variable (Capacitor - Tuning
of MEMS V	Variable Capacitor- Electrostatic Actuation- Comb Drive Actu	uators- RF MEMS
Switch -Ser	ies Switch - Shunt Capacitive Switch- Electrostatic Actuati	on of the MEMS
Switch -Pro	blems and Solutions- Low Actuation Design-Problem of Stict	ion and Solutions-
Reliability I	ssues of MEMS Switches - Packaging of RF MEMS -Wafer	-Level Packaging-
Fabrication	of RF MEMS- Surface Micromachining - Bulk Micromachinin	g-LIGA
UNIT – V	Lab exercises	20
1. Substrate	Integrated Waveguide (SIW) and Modified SIW (MSIW) in CS	ST
	~ ~	

2. RF MEMS - Basic Switch design

3. RF MEMS - Capacitor and inductor design

4. Nano Antenna design in CST

List of Experiments

10 to 12 Experiments will be provided relevant to the five course outcome based on the faculty will be taught and also feasibility.

TOTAL HOURS			
Lecture	Tutorial	Practical	Total
30	0	20	50
TEXT BOOK	•	•	•

1. Sohail Anwar, et al., "Nanotechnology for telecommunications", CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

2. Maurizio BOZZI, Luca PIERANTONI, Stefano BELLUCCI, "Applications of Graphene at Microwave Frequencies", RADIOENGINEERING, VOL. 24, NO. 3, SEPTEMBER 2015

3. Parisa Moslemi1, Golamreza Askari, "Application of Nanotechnology in High Frequency and Microwave Devices

REFERENCES:

1. Sohail Anwar, et al., "Nanotechnology for telecommunications", CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300

Boca Raton, FL 33487-2742

2.Maurizio BOZZI, Luca PIERANTONI, Stefano BELLUCCI, "Applications of Graphene at Microwave Frequencies", RADIOENGINEERING, VOL. 24, NO. 3, SEPTEMBER 2015

3. Parisa Moslemi1, Golamreza Askari, "Application of Nanotechnology in High Frequency and Microwave Devices

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2
CO1	1	1	1	1	2	2	2	1	1	1	1
CO2	1	1	1	1	2	2	2	1	1	1	1
CO3	1	1	1	1	2	2	2	1	1	1	1
CO4	1	1	1	1	2	2	2	1	1	1	1
CO5	1	1	1	1	2	2	2	1	1	1	1
Total	5	5	5	5	10	10	10	5	5	5	5
	1, 6-10	<u>-</u> 2, 1	1-15	3→	•	1		I.	1	1	

 Table 1 : COs versus POs mapping

0 - No relation

1- Low relation

2- Medium relation

3- High relation

COURSE	COURSE CODE XUM706				Т	Р	С
COURSE	NAME	CYBER SECURITY		0	0	0	0
C:P:A 2:0.5:0.5				L	Т	Р	Н
PREREQ	UISITE	Physics, Chemistry and Material Sc	ience	0	0	0	3
COURSE	OUTCO	MES	Domain		Lev	vel	
C01		and the Cyber Security Policy, Laws gulations	Cognitive	Unde Reme			
CO2		the Cyber Security Management	Cognitive	Understand Remember			
CO3		and the Cyber Crime and Cyber	Cognitive	Understand Remember			
CO4		on issues related to Information 7 Concepts	Cognitive	Understand Remember			
CO5understandCognitiveCO5UnderstandCognitive				Unde Reme			
UNIT - I	INTRO	DUCTION					9

Cyber Security - Cyber Security policy - Domain of Cyber Security Policy - Laws and Regulations - Enterprise Policy - Technology Operations - Technology Configuration -Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges

UNIT – II CYBER SECURITY OBJECTIVES AND GUIDANCE 9

Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frameworks – E Commerce Systems – Industrial Control Systems – Personal Mobile Devices - Security Policy Objectives - Guidance for Decision Makers - Tone at the Top - Policy as a Project- Cyber Security Management - Arriving at Goals - Cyber Security Documentation -The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.

UNIT - III	CYBER SECURITY P	OLICY CAT	ALOG	9	
Cyber Gover	rnance Issues – Net Neutr	ality – Internet	t Names and N	Numbers – Co	pyright and
	– Email and Messaging -				
	Use – Cyber Crime –				
Intellectualp	roperty Theft – Cyber Esp	bionage – Cybe	er Sabotage –	Cyber Welfar	e
UNIT – IV	INFORMATION SEC	URITY CON	CEPTS	9	
Information	Security Overview: Back	ground and Cu	irrent Scenario	o - Types of A	Attacks - Goals
for Security	- E-commerce Security -	Computer Fore	ensics – Stega	nography	
UNIT – V	SECURITY THREAT	S AND VULN	ERABILITI	ES 9	
	f Security threats -Weak				
	nnections - Malicious C	-	nming Bugs	- Cyber crin	ne and Cyber
	nformation Warfare and S	urveillance			
List of Expe		I relevant to th	a five course	outooma haga	d on the
	beriments will be provided be taught and also feasibil		e five course (Jutcome based	u oli ule
idealty will b	be laught and also reasion	Lecture	Tutorial	Practical	Total
		45	0	0	45
TEXT BOC	K				
1.Jennifer L.	Bayuk, J. Healey, P. Roh	nmeyer, Marcu	s Sachs , Jeffi	ey Schmidt, J	oseph Weiss
"Cyber Se	curity Policy Guidebook"	John Wiley &	Sons 2012.		
2. Rick How	ard "Cyber Security Essen	ntials" Auerba	ch Publication	ns 2011.	
	. Clarke, Robert Knake "(ecurity &
What	,	5			5
to Do Abo	out It" Ecco 2010				
4. Dan Shoe	maker Cyber security The	Essential Bod	ly Of Knowle	dge, 1st ed. C	engage
Learning	2011		-	-	
5. Rhodes-O	usley, Mark, "Information	n Security: The	e Complete Re	eference", Sec	ond Edition,
	Hill, 2013.	2	1	,	, , , , , , , , , , , , , , , , , , ,
E RESOUR	CES				
1. <u>https</u>	s://www.coursera.org/spo	ecializations/c	yber-security	Y	
2. www	. nptel .ac.in				
3. http:/					

CO/P O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1		1	1	1	1	1	1	1	1			2	
CO2		1	1	1	1	1	1	1	1			2	
CO3		1	1	1	1	1	1	1	1			2	
CO4		1	1	1	1	1	1	1	1			2	
CO5		1	1	1	1	1	1	1	1			2	
Total		5	5	5	5	5	5	5	5			10	
		1	1	1	1	1	1	1	1			2	

Table 1 : COs versus POs mapping

1-5 →1, 6-10 -2, 11-15

11-15 3 →

0 - No relation 1- Low relation 2- Medium relation

COURSE C	CODE	XNT901	L	Т	Р	С	
COURSE N	AME	Peroject Phase I	0	0	0	8	
COURSE C	UTCOM	IES	DOMA	IN	L	LEVEL	
CO1	well as a	nd carry out scientific experiments as accurately record and analyze the of experiments and simulation studies	Cognitive Psychomo	tor	Understand Remember Guided Response		
CO2	and ana	n problem solving, critical thinking lytical reasoning as applied to c and Technical problems.	Cognitive Psychomo Affective	tor	Gu	derstand, ided sponse	
CO3	work in	communicate the results of scientific oral, written and electronic formats scientists and the public at large	Cognitive Psychomo Affective	tor	Understand, Guided Set		
CO4		new areas of research in physics and elds of nanoscience and hnology	Cognitive Psychomo Affective	tor	Understand, Mechanism		
CO5		te the central role of physics in our and use this as a basis for ethical r	Cognitive Psychomo Affective	tor		derstand, chanism	
	Syllabus						
Characteriza	tion of na nd submi	ends in Nanotechnology covering Synt anomaterials and their applications in d tted within the stipulated time in consu	evices. Note	e: Projec	ct is t	o be	

	CODE	XNT802C		L	Т	P	С
COURSE	NAME	Fullerenes	fullerenes 2		0	1	3
PREREQ	UISITES	Introduction	to nanotechnology	L	Т	Р	Н
		Materials sci	ience				
C:P:A		1.5:1.2:0.3		2	0	2	4
COURSE	COURSE OUTCOMES DOMAIN						
CO1	Explain the Structure of FullerenesCognitive						
	.	1 1 /		Psychomo			nember
CO2	-		nd the Symmetry	Cognitive			derstand,
	Conside	rations of Fulle	erene Molecules	Psychomo	otor		ided
CO3	Dotorm	ing and Docor	<i>ibe</i> the Synthesis,	Cognitive		-	sponse derstand,
005			ation of Fullerenes	Psychomo			ided
	Extracti	on, and i urne	ation of Functiones	rsycholic	101	Set	
CO4	Describ	e and Illustrat	e the Fullerene Growth,	Cognitive			derstand,
		ion, and Fragme	,	Psychomo			chanism
CO5	Classify	and <i>Describe</i>	the Crystalline	Cognitive		Une	derstand,
	Structur	e of Fullerene	Solids	Psychomo	otor	Me	chanism
UNIT I	Structur	e of Fullerenes	l .				6+6
Structure of	f C60 and	Euler's Theore	m; Structure of C70 and	Higher Full	erenes;	the P	rojection
M. d. 1.C	a .c.						
iviethod for	Specifying	Fullerenes					5
UNIT II			ons of Fullerene Molecule	s			6+6
UNIT II Icosahedra S	Symmetry (ry Considerations; Syn	ons of Fullerene Molecule nmetry of Vibrational Mod	es; Symmetry	for Ele	ectron	6+6 ic States;
UNIT II Icosahedra S Going fror	Symmetry on Higher	ry Considerations Operations; Synto Lower Synto	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con	es; Symmetry nsiderations	for Ele for C7	ectron 70, S	6+6 ic States;
UNIT II Icosahedra S Going fror	Symmetry on Higher	ry Considerations Operations; Synto Lower Synto	ons of Fullerene Molecule nmetry of Vibrational Mod	es; Symmetry nsiderations	for Ele for C7	ectron 70, S	6+6 ic States;
UNIT II Icosahedra S Going fror Consideratio UNIT III	Symmetry (n Higher ons for Higg Synthesi	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Consideration enes; Symmetry Consideration and Purification of Fullered	es; Symmetry nsiderations tions for Isoto enes	for Ele for C7 pic Effe	ectron 70, S ects	6+6 ic States; ymmetry 6+6
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o	Symmetry on N Higher Sons for High Synthesi f Fullerend	ry Considerations; Syn Dperations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical F	ons of Fullerene Molecule nmetry of Vibrational Mod mmetry: Symmetry Considerat enes; Symmetry Considerat and Purification of Fuller Perspective, Synthesis Details	es; Symmetry nsiderations tions for Isoto e nes ails; Fulleren	for Ele for C7 pic Effe e Extra	ectron 20, S ects ction:	6+6 ic States; ymmetry 6+6 Solvent
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, Su	Symmetry On Higher ons for Higher Synthesion f Fullerene ublimation	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical F Methods, Solub	ons of Fullerene Molecule ametry of Vibrational Mod ymmetry: Symmetry Con- enes; Symmetry Considerat and Purification of Fullerene Perspective, Synthesis Detaility of Fullerenes in Solve	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren	for Ele for C7 pic Effe e Extra e Purific	ectron 70, S ects ction: cation	6+6 ic States; ymmetry 6+6 Solvent : Solvent
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Methods, S	Symmetry (n Higher ons for Hig Synthesi of Fullerene ublimation	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Con- enes; Symmetry Considerat and Purification of Fullerenes Perspective, Synthesis Deta- ility of Fullerenes in Solve ature Gradient , Gas-Pha	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ase Separatio	for Ele for C7 pic Effe e Extra e Purific on and	ectron 70, S ects ction: cation Purif	6+6 ic States; ymmetry 6+6 Solvent : Solvent
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Methods, S Vaporizatio	Symmetry (n Higher ons for Hig Synthesi of Fullerene ublimation Sublimation	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohedr	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Con- enes; Symmetry Considerat and Purification of Fullerenes erspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatio alth and Safet	for Ele for C7 pic Effe e Extra e Purific on and	ectron 70, S ects ction: cation Purif	6+6 ic States; ymmetry 6+6 Solvent Solvent ication ,
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Vaporizatio UNIT IV	Symmetry On Higher ons for Higher Synthesi of Fullerene ublimation Sublimation n Studies of Fullerene	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed are Growth, Con	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con- enes; Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea- traction, and Fragmentat	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatio alth and Safet ion	for Ele for C7 pic Effe e Extra e Purific on and y Issues	ectron 70, S ects ction: cation Purif	6+6 ic States; ymmetry 6+6 Solvent ication , 6+6
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Vaporizatio UNIT IV Fullerene G	Symmetry Symmetry On Higher Ons for High Synthesi of Fullerene Sublimation Sublimation Studies of Fullerene rowth Mod	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con- enes; Symmetry Considerat and Purification of Fullerene respective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea- traction, and Fragmentat es Model , Model for C 2 A	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatio alth and Safet ion bsorption or	for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt	ectron 70, S ects ction: cation Purif	6+6 ic States; ymmetry 6+6 Solvent : Solvent ication , 6+6 Fullerene
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Vaporizatio UNIT IV Fullerene G Growth fro	Symmetry Symmetry on Higher ons for High Synthesi of Fullerend ublimation Sublimation Studies of Fullerend rowth Modom a Cor	ry Considerations; Syn to Lower Syn her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con- enes; Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea- traction, and Fragmentat	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatio alth and Safet ion bsorption or c60 to C70;	o for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass	ectron 70, S ects ction: cation Purif	6+6 ic States; ymmetry 6+6 Solvent ication , 6+6 Fullerene ctrometry
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of	Symmetry 0 Symmetry 0 m Higher ons for High Synthesi of Fullerene ublimation Sublimation Sublimation rowth Mode om a Corr ation; Stabi Fullerene	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ase Separatio alth and Safet ion bsorption or 260 to C70; agmentation:	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo	ectron 70, S ects ction: cation Purif ion , I Spec fragm	6+6 ic States; ymmetry 6+6 Solvent Solvent ication , 6+6 Fullerene ctrometry nentation,
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of	Symmetry 0 Symmetry 0 m Higher ons for High Synthesi of Fullerene ublimation Sublimation Sublimation rowth Mode om a Corr ation; Stabi Fullerene	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust ility Issues; Ful	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ase Separatio alth and Safet ion bsorption or 260 to C70; agmentation:	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo	ectron 70, S ects ction: cation Purif ion , I Spec fragm	6+6 ic States; ymmetry 6+6 Solvent Solvent ication , 6+6 Fullerene ctrometry nentation,
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V	Symmetry Symmetry Symmetry Symmetry In Higher Synthesi of Fullerene ublimation Sublimation Sublimation Studies or Fullerene rowth Modor Studies Fullerene rgetic Ions; Crystall	ry Consideration Operations; Syn to Lower Syn her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohedr the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con- enes; Symmetry Considerat and Purification of Fullerene Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea- traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior amics Models f Fullerene Solids	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatio alth and Safet ion bsorption or 260 to C70; agmentation: ns with Surfac	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra	ectron 70, S ects ction: cation Purif ion , 1 Spec fragm	6+6 ic States; ymmetry 6+6 Solvent : Solvent : Solvent : California fullerene ctrometry nentation, ntation of 6+6
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V Crystalline	Symmetry Symmetry Symmetry Image: Symmetry Image: Symmetry Symmetry Image: Symmetry Symmetry Image: Symmetry Symmetry Symmetry Symmetry Symmetry Symmetry Image: Symmetry Symmetry Symmetry Symmetry Symmetry Symmetry Symmetry Symmetry Symmetry Symthesi Symmetry Fulleren regetic Symmetry Ceo: Ambit	ry Consideration Operations; Syn to Lower Syn her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o ent Structure, G	ons of Fullerene Molecule metry of Vibrational Mod metry: Symmetry Con- enes; Symmetry Considerate and Purification of Fullerene erspective, Synthesis Deta- ility of Fullerenes in Solve ature Gradient , Gas-Pha- ral Fullerene Synthesis; Hea- traction, and Fragmentate es Model ,Model for C 2 A- ter , Transition from Co- lerene Contraction and Fr- , Collision of Fullerene Ion amics Models f Fullerene Solids froup Theory for Crystallin	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatic alth and Safet ion bsorption or 60 to C70; agmentation: as with Surfac	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp	ectron 70, S ects ction: cation Purif ion , I Spec fragm agmer	6+6 ic States; ymmetry $6+6$ Solvent : Solvent : Solvent : Content of the second s
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis of Methods, S Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V Crystalline (,Merohedra)	Symmetry 0 Symmetry 0 n Higher ons for High Synthesi of Fullerene ablimation Sublimation Sublimation <t< td=""><th>ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o , Model for P</th><th>ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60;</th><td>es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ase Separatio alth and Safet ion bsorption or 560 to C70; agmentation: ns with Surface e Phases , Lo Crystalline C</td><th>y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and</th><td>ectron 70, S ects ction: cation Purif ion , I Spec fragmer agmer</td><th>6+6 ic States; ymmetry 6+6 Solvent : Solvent ication , 6+6 Fullerene ctrometry nentation, ntation of 6+6 re Phases her-Mass</th></t<>	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o , Model for P	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60;	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ase Separatio alth and Safet ion bsorption or 560 to C70; agmentation: ns with Surface e Phases , Lo Crystalline C	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and	ectron 70, S ects ction: cation Purif ion , I Spec fragmer agmer	6+6 ic States; ymmetry 6+6 Solvent : Solvent ication , 6+6 Fullerene ctrometry nentation, ntation of 6+6 re Phases her-Mass
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis o Methods, S Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V Crystalline o ,Merohedral Fullerenes;	Symmetry 0 Symmetry 0 n Higher ons for High Synthesi of Fullerene ablimation Sublimation Sublimation <t< td=""><th>ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o ent Structure, C , Model for P Pressure on Cr</th><th>ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ion amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60; ystal Structure; Effect of</th><td>es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatic alth and Safet ion bsorption or :60 to C70; :agmentation: ns with Surfaction e Phases , Lo Crystalline C</td><th>y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and on Cry</th><td>ectron 70, S ects ction: cation Purif ion , I Spec fragm agmer</td><th>6+6 ic States; ymmetry 6+6 Solvent Solvent ication , 6+6 Fullerene ctrometry nentation of 6+6 re Phases her-Mass Structure;</th></t<>	ry Consideration Operations; Syn to Lower Sy her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o ent Structure, C , Model for P Pressure on Cr	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ion amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60; ystal Structure; Effect of	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatic alth and Safet ion bsorption or :60 to C70; :agmentation: ns with Surfaction e Phases , Lo Crystalline C	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and on Cry	ectron 70, S ects ction: cation Purif ion , I Spec fragm agmer	6+6 ic States; ymmetry 6+6 Solvent Solvent ication , 6+6 Fullerene ctrometry nentation of 6+6 re Phases her-Mass Structure;
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis of Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V Crystalline of ,Merohedral Fullerenes; Polymerized	Symmetry 0 Symmetry 0 n Higher ons for High Synthesi of Fullerene ublimation Sublimation Sublimation Sublimation Sublimation rowth Mode om a Corration; Stabil Fullerene rgetic Ions; Crystall C60: Ambid Disorder Effect of 1 Hullerene	ry Consideration Operations; Syn to Lower Syn her-Mass Fuller is, Extraction, a es: Historical P Methods, Solub in a Temper f C60; Endohed the Growth, Con els: Stone-Wale annulene Clust lity Issues; Ful Ion Projectiles Molecular Dyn ine Structure o ent Structure o ressure on Cry s: Photo polym	ons of Fullerene Molecule metry of Vibrational Mod ametry: Symmetry Con- enes; Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha- ral Fullerene Synthesis; Hea- traction, and Fragmentat es Model ,Model for C 2 A- ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ior amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60; ystal Structure; Effect of erization of C60 , Electron	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatic alth and Safet ion bsorption or 260 to C70; agmentation: ns with Surfact e Phases , Lo Crystalline C Temperature n Beam-Indu	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and on Cry ced Poly	ectron 70, S ects ction: cation Purif ion , I Spec fragm agmer operatur I Hig ymeri	6+6 ic States; ymmetry 6+6 Solvent Solvent ication , 6+6 Fullerene ctrometry nentation, ntation of 6+6 re Phases her-Mass Structure; zation of
UNIT II Icosahedra S Going fror Consideratio UNIT III Synthesis of Methods, S Vaporizatio UNIT IV Fullerene G Growth fro Characteriza Collision of C60 by Ene UNIT V Crystalline of ,Merohedral Fullerenes; Polymerized	Symmetry 0 Number on story 10 Symmetry 0 Number on story 10 Synthesi of Fullerene ublimation Sublimation Studies or Fullerene regetic Ions; Crystall C60: Ambid Disorder Effect of 10 Hendlerene ure-Induced	ry Consideration Operations; Syn to Lower Syn her-Mass Fuller is, Extraction, a es: Historical F Methods, Solub in a Temper f C60; Endohed te Growth, Con els: Stone-Wale annulene Clust ility Issues; Ful Ion Projectiles Molecular Dyn ine Structure o ent Structure, G , Model for P Pressure on Cry s: Photo polym il Polymerizatio	ons of Fullerene Molecule metry of Vibrational Mod ymmetry: Symmetry Considerat and Purification of Fuller Perspective, Synthesis Deta ility of Fullerenes in Solve ature Gradient , Gas-Pha ral Fullerene Synthesis; Hea traction, and Fragmentat es Model ,Model for C 2 A ter , Transition from C lerene Contraction and Fr , Collision of Fullerene Ion amics Models f Fullerene Solids froup Theory for Crystallin hase Transitions in C60; ystal Structure; Effect of	es; Symmetry nsiderations tions for Isoto enes ails; Fulleren ents; Fulleren ase Separatic alth and Safet ion bsorption or 260 to C70; agmentation: ns with Surfact e Phases , Lo Crystalline C Temperature n Beam-Indu	y for Ele for C7 pic Effe e Extra e Purific on and y Issues Desorpt Mass Photo ces , Fra w-Temp C70 and on Cry ced Poly	ectron 70, S ects ction: cation Purif ion , I Spec fragm agmer operatur I Hig ymeri	6+6 ic States; ymmetry 6+6 Solvent : Solvent : Solvent ication , 6+6 Fullerene ctrometry nentation, ntation of 6+6 re Phases her-Mass Structure; zation of

H	IOURS	30	0	30	60						
List of Experiments											
10 to 1	12 Experiment	s will be provided	l relevant to the five	course outcome bas	ed on the						
faculty	y will be taugh	t and also feasibil	lity.								
TEXT	BOOK										
 TheFullerenes- Author(s):H.W.Kroto, J.E. Fischer and D.E. Cox ISBN: 978-0-08-042152-0 											
2.	Science of Fu	llerenes and Carb	on Nanotubes- M.S. I	Dresselhaus, G. Dres	selhaus and P.C.						

Eklund

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2
CO1	1	1	1	1	2	2	2	1	1	1	1
CO2	1	1	1	1	2	2	2	1	1	1	1
CO3	1	1	1	1	2	2	2	1	1	1	1
CO4	1	1	1	1	2	2	2	1	1	1	1
CO5	1	1	1	1	2	2	2	1	1	1	1
Total	5	5	5	5	10	10	10	5	5	5	5

Table 1: COs versus POs mapping

1-5 →1, 6-10 →, 11-15 3→

0 - No relation 1- Low relation 2- Medium relation

COURSE C	CODE	XNT803		L	L T P (
COURSE N	IAME	CAREER DEVELOPMENT SKILLS		0	0	1	0			
C:P:A		1:1:1		L	L T P I					
PREREQU	ISITE			0	0 0 1					
COURSE C	OUTCON	ſES	Domain		Le	vel				
CO1		career related communication, and the different formats of CV /	Cognitive	Rem	nemt	ber				
CO2	-	e for an interview and to learn how to an interview	Psychomoto r	Set						
CO3	•	<i>a /communicate</i> effectively with a f people in a group discussion	Affective	Res	pond					

UNIT - I	OVERVI	EW AND INTRODUCT	TION	10
CV Writing;		between resume and C		ume and CV; basic
U .		ume, use of graphics in re		
Letters.			,	
UNIT – II	MEMS F	ABRICATION TECHN	OLOGIES	10
Interview sk	ills; tips t	for various types of int	erviews. Types of que	stions asked; body
	· .	dress code in interview,	• •	•
	-	uently asked questions. Pl		-
UNIT - III	MICRO	SENSORS		10
Mock intervie	ews - work	shop on CV writing – Gro	oup Discussion	1
List of Expe			1	
-				
-		ill be provided relevant to	the five course outcome	based on the
faculty will b	e taught ar	nd also feasibility.		
TOTAL HO	UKS			
TOTAL HO Lectu		Tutorial	Practical	Total
		Tutorial 0	Practical 30	Total 30
Lectu	re			
Lectu 0 TEXT BOO	re K	0	30	30
Lectu 0 TEXT BOO 1. Paul N	re K McGee Ha	0 chette, <i>How To Write a C</i>	30 CV That Really Works: A	30
Lectu 0 TEXT BOO 1. Paul M Comp	re K AcGee Ha rehensive	0 chette, <i>How To Write a C</i> Guide to Writing an Effec	30 CV That Really Works: A ctive CV UK, 2014	30 Concise, Clear and
Lectu 0 TEXT BOO 1. Paul M Comp 2. Mary	re K McGee Ha rehensive Ellen Gut	0 chette, <i>How To Write a C</i>	30 CV That Really Works: A ctive CV UK, 2014	30 Concise, Clear and
Lectu 0 TEXT BOO 1. Paul M Comp 2. Mary Learn	re K McGee Ha rehensive Ellen Guf ing, 2012	0 chette, <i>How To Write a C</i> Guide to Writing an Effec	30 CV That Really Works: A ctive CV UK, 2014	30 Concise, Clear and
Lectu 0 TEXT BOO 1. Paul M Comp 2. Mary	re K McGee Ha rehensive Ellen Guf ing, 2012	0 chette, <i>How To Write a C</i> Guide to Writing an Effec	30 CV That Really Works: A ctive CV UK, 2014	30 Concise, Clear and
Lectu 0 TEXT BOO 1. Paul M Comp 2. Mary Learn REFERENC	re K McGee Ha rehensive Ellen Guf ing, 2012 ES tel Spirop	0 chette, <i>How To Write a C</i> Guide to Writing an Effec fey, Dana Loewy, <i>Essen</i> poulos, <i>Interview Skills th</i>	30 IV That Really Works: A ctive CV UK, 2014 tials of Business Comm hat win the job: Simp	30 Concise, Clear and <i>unication</i> , Cengage
Lectu 0 TEXT BOO 1. Paul M Comp 2. Mary Learn REFERENC 1. Micha answe	re K McGee Ha rehensive Ellen Guf ing, 2012 ES tel Spirop tring all the	0 chette, <i>How To Write a C</i> Guide to Writing an Effec ffey, Dana Loewy, <i>Essen</i>	30 CV That Really Works: A ctive CV UK, 2014 ctials of Business Comm hat win the job: Simp & Unwin, 2005	30 Concise, Clear and <i>unication</i> , Cengage

Z .	william L.	Fleisner,	Nathan	J.	Gordon,	Effective	Interviewin
	Techniques,	, Academ	nic Press	, 2	010		

CO/P O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	1	1	1	1	2	2		1	1	1		1	1
CO2		1			2	2		1	1	1		1	1
CO3	1					2	2	1			1	1	1
CO4			1				2	1			1		
CO5	1	1	1	1	2				1	1	1	1	1
Total	3	3	3	2	6	6	4	4	3	3	3	4	4

Table 1 : COs versus POs mapping

 $1-5 \rightarrow 1, 6-10 \rightarrow 2, 11-15 \rightarrow 3$

- 0 No relation 1- Low relation 2- Medium relation

3- High relation

COURSE CODE XNT804

T P C L

COURSE	NAME	MEMS/NEMS		3	1	0	4
C:P:A		2:0.5:0.5		L	Т	Р	Н
PREREQU	UISITE	Physics, Chemistry and Material Sci	ience	3	2	0	5
COURSE	OUTCO	MES	Domain		Lev	vel	
CO1		to understand the operation of micro micro systems and their applications	Cognitive Psychomoto r Affective	Unde Reme Appl Guid Orga	embe ying ed re	er espon	ise
CO2	-	to design the micro devices, micro using the MEMS fabrication process.	Cognitive Psychomoto r Affective	Unde Reme Appl Guid Orga	embe ying ed re	er espon	ise
CO3		knowledge of basic approaches for sensor design	Cognitive Psychomoto r Affective	Unde Remo Appl Guid Orga	embe ying ed re	er espon	ise
CO4		knowledge of basic approaches for actuator design	Cognitive Psychomoto r Affective	Unde Reme Appl Guid Orga	embe ying ed re	er espon	ise
CO5	for phot Gain th compute and c	b experience on micro/nano systems onics. he technical knowledge required for er-aided design, fabrication, analysis haracterization of nano-structured ls, micro- and nano-scale devices.	Unde Remo Appl Guid Orga	embe ying ed re	er espon	ise	
UNIT - I	OVER	VIEW AND INTRODUCTION				(9+6
New trend Design of Application	s in Eng MEMS ans of Mi devices a	ineering and Science: Micro and Nar and NEMS, Overview of Nano and M cro and Nano electro mechanical sy and structures Definitions, Material	Aicro electromo stems, Micro	echani electr	cal S ome	ction Syste chan	n to ms, ical
UNIT – II	MEMS	FABRICATION TECHNOLOGIES	5			9	9+6
Microsyste Oxidation.7 techniques: Micromach	Thin film Dry a nining, S	cation processes: Photolithography, depositions: LPCVD, Sputtering, Eva nd wet etching, electrochemical e urface Micromachining, High Aspec ging: Microsystems packaging, Es	aporation, Elec etching; Micro et-Ratio (LIGA	troplat omach A and	ing; ining LIC	Etch g: B GA-li	ing Julk ike)

UNIT - III	MICRO S	SENSORS		9+6
Capacitive a	and Piezo		ensors, resonant sensor, nsors- engineering mec ure sensor	1
UNIT – IV	MICRO A	ACTUATORS		9+6
Actuation us	sing piezoe Comb driv	lectric crystals, Actuati	forces, Actuation using sl ion using Electrostatic f hanical Motors and pump	orces (Parallel plate
$\mathbf{UNIT} - \mathbf{V}$	NANOSY	STEMS AND QUANT	FUM MECHANICS	9+6
Shrodinger H and Molecul and Molecul	actures and Equation an lar Dynami ar Circuits.	l Quantum Mechanics d Wavefunction Theory	FUM MECHANICS s, Molecular and Nano y, Density Functional Th elds and their quantization	structure Dynamics eory, Nanostructures
Atomic Stru Shrodinger H and Molecul	actures and Equation an ar Dynami ar Circuits. DURS	l Quantum Mechanics d Wavefunction Theory	s, Molecular and Nano y, Density Functional Th	structure Dynamics eory, Nanostructures
Atomic Stru Shrodinger H and Molecul and Molecul TOTAL HC	actures and Equation an ar Dynami ar Circuits. DURS are	l Quantum Mechanics d Wavefunction Theory cs, Electromagnetic Fig	s, Molecular and Nano y, Density Functional Th elds and their quantizati	structure Dynamics eory, Nanostructures on, Molecular Wires
Atomic Stru Shrodinger H and Molecul and Molecul TOTAL HC Lectu 45 TEXT BOO 1. Marc M Senturia," M REFERENC	Actures and Equation and ar Dynami ar Circuits. DURS Ire K Madou, "Fun icro system CES:	l Quantum Mechanics d Wavefunction Theory cs, Electromagnetic Fie Tutorial 0 ndamentals of Micro fab a Design", Kluwer Acad	s, Molecular and Nano y, Density Functional Th elds and their quantization Practical 30 prication", CRC press 199	structure Dynamics eory, Nanostructures on, Molecular Wires Total 75 7.Stephen D.

CO/P O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	2	1	1	1	-	-	-	-	1			2	
CO2	2	1	1	1	-	-	-	-	1			2	
CO3	2	1	1	1	-	-	-	-	1			2	
CO4	2	1	1	1	-	-	-	-	1			2	
CO5	2	1	1	1	_	_	_	_	1			2	
Total	10	5	5	5	-	_	-	_	5			10	
	2	1	1	1	-	-	-	-	1			2	

Table 1 : COs versus POs mapping

1-5 →1, 6-10 →1, 11-15 3→

0 - No relation 1- Low relation 2- Medium relation 3- High relation

COURSE C	CODE	XNT805		L	Т	Р	С	
COURSE N	AME	SURFACE PLASMON RESONAN	CE	3	0	1	4	
C:P:A		2:0.5:0.5		L	Т	Р	Н	
PREREQU	ISITE	Physics, Chemistry and Material Sci	ience	3	0	2	5	
COURSE O			Domain		Lev	-		
CO1	Ability devices applica		Cognitive Psychomoto r Affective	Unde Remo Appl Guid Orga	embe ying ed re	er espon	ise	
CO2	Ability system process	e	Cognitive Psychomoto r Affective	Unde Remo Appl Guid Orga	embe ying ed re	er espon	ise	
CO3		knowledge of basic approaches for sensor design	Cognitive Psychomoto r Affective	Unde Reme Appl Guid Orga	embe ying ed re	er espon	ise	
CO4		knowledge of basic approaches for actuator design	Cognitive Psychomoto r Affective	Unde Reme Appl Guid Orga	embe ying ed re	er espon	ise	
CO5	for pho Gain t compu analysi	he technical knowledge required for ter-aided design, fabrication, sand characterization of nano- red materials, micro- and nano-scale	Cognitive Psychomoto r Affective	Unde Remo Appl Guid Orga	embe ying ed re	er espon	ise	
UNIT - I	ELEC	TROMAGNETICS OF METALS					9+6	
Maxwell's E Free Electro	quations on Gas,	s and Electromagnetic Wave Propagati The Dispersion of the Free Electron I Transitions, The Energy of the Electro	Gas and Volu	me Pl	asmo	on of on, F	the	
UNIT – II	SURF	ACEPLASMONPOLARITONSATM OR INTERFACES			9+6			
The Wave E	e Equation, Surface Plasmon Polaritons at a Single Interface, Multilayer Syst							

	CITATION OF S LARITONS AT PLANAR	URFACE PLASMO INTERFACES	N 9+6
Using Highly Foc	Charged Particle Impact, I used Optical Beams, Near-I conventional Photonic Eleme	Field Excitation, Coupling	
	AGING SURFACE PL DPAGATION	LASMON POLARITO	N 9+6
Near-Field Micro Imaging	oscopy, Fluorescence Ima	aging , Leakage Radiatio	on , Scattered Light
UNIT – V $ $ LOO	CALIZED SURFACE PLA	ASMONS	9+6
Plasmon and Gain	Medi	d Plasmon and Metallic N	Vanoshells, Localized
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau	Medi nts ents will be provided relevar ght and also feasibility.		
Plasmon and Gain List of Experime 10 to 12 Experime	Medi nts ents will be provided relevar ght and also feasibility.		
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau TOTAL HOURS	Medi nts ents will be provided relevar ght and also feasibility.	nt to the five course outcon	ne based on the
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau TOTAL HOURS Lecture 45 TEXT BOOK	Medi nts ents will be provided relevar ght and also feasibility. Tutorial 0	nt to the five course outcon Practical 30	ne based on the Total 75
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau TOTAL HOURS Lecture 45 TEXT BOOK 2. Marc Mad 3. Ste Publishers,2	Medi nts ents will be provided relevar ght and also feasibility. Tutorial 0 ou, "Fundamentals of Micro phen D. Senturia," Micro sy	nt to the five course outcon Practical 30 D fabrication", CRC press 1	ne based on the Total 75 997.
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau TOTAL HOURS Lecture 45 TEXT BOOK 2. Marc Mad 3. Ste Publishers,2 REFERENCES:	Medi nts ents will be provided relevan ght and also feasibility. Tutorial 0 ou, "Fundamentals of Micro phen D. Senturia," Micro sy 001	nt to the five course outcon Practical 30 b fabrication", CRC press 1 ystem Design", Kluwer Ac	Total 75 1997. ademic
Plasmon and Gain List of Experime 10 to 12 Experime faculty will be tau TOTAL HOURS Lecture 45 TEXT BOOK 2. Marc Mad 3. Ste Publishers,2 REFERENCES:	Medi nts ents will be provided relevan ght and also feasibility. Image: Tutorial 0 ou, "Fundamentals of Microsystem phen D. Senturia," Micro sy 001 1,"MEMS and Microsystem	nt to the five course outcon Practical 30 b fabrication", CRC press 1 ystem Design", Kluwer Ac	Total 75 1997. ademic

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	-	-	-	-	1			2	
CO2	2	1	1	1	-	-	-	-	1			2	
CO3	2	1	1	1	-	-	-	-	1			2	
CO4	2	1	1	1	-	-	-	-	1			2	
CO5	2	1	1	1	-	-	-	-	1			2	
Total	10	5	5	5	-	-	-	-	5			10	

Table 1: COs versus POs mapping

2	1	1	1	_	_	_	_	1		2	
4	1	1	1	-	-	-		1		4	

1-5 →1, 6-10 -2, 11-15 3 →

0 - No relation 1- Low relation 2- Medium relation

COURSE C	CODE	XN	JT806				L	L T		Р	С	
COURSE NAME		Mi	Mini Project		0		0	0	12			
COURSE C	OUTCON	MES				DOMAIN		I	EVEL			
CO1	well as a	accura		ientific ex rd and ana	•		Psychomotor Rem			Understand Remember Guided		
CO2		al rea		ng, critical applied to			CognitiveUnderPsychomotorGuide				esponse nderstand, uided esponse	
CO3	work in oral, written and electronic formats to Psychomotor C			Psychomotor				derstand, ided t				
CO4				esearch in and techno		ind	CognitiveUnderstandPsychomotorMechanismAffectiveImage: Constraint of the second seco					
CO5		and u		role of phy a basis for	-	ur	Cogniti Psychon Affectiv	no	tor	Understand, Mechanism		
	Syllabu	us										
Characterizat	SyllabusMinor Project on Current Trends in Nanotechnology covering Synthesis Process, Fabrication and Characterization of nanomaterials and their applications in devices. Note: Minor Project work is to be carried out and submitted within the stipulated time in consultation with the concerned guide of the candidate.											

COURSE C	COURSE CODE XNT1001		L	Т	P	С
COURSE N	COURSE NAME Peroject Phase I		0	0	0	12
COURSE OUTCOMES			DOMA	IN	L	LEVEL
CO1				tor	Ren Gui	derstand nember ided sponse
CO2		n problem solving, critical thinking lytical reasoning as applied to	Cognitive Psychomore Affective	tor	Gui	derstand, ided sponse

	scientific and Technical problems.						
CO3	clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large	Cognitive Psychomotor Affective	Understand, Guided Set				
CO4	explore new areas of research in physics and allied fields of nanoscience and nanotechnology	Cognitive Psychomotor Affective	Understand, Mechanism				
CO5	appreciate the central role of physics in our society and use this as a basis for ethical behavior	Cognitive Psychomotor Affective	Understand, Mechanism				
	Syllabus						
Project on	Current Trends in Nanotechnology covering Sy	nthesis Process, Fa	brication and				
carried out	Project on Current Trends in Nanotechnology covering Synthesis Process, Fabrication and Characterization of nanomaterials and their applications in devices. Note: Project is to be carried out and submitted within the stipulated time in consultation with the concerned guide of the candidate						

COURSE O	CODE	YNT 303	L	L T		С	
COURSE NAME		Dissertation Phase -I	0	0	0	8	
COURSE (DUTCON	IES	DOMA	IN	LEVEL		
CO1	well as a	nd carry out scientific experiments as accurately record and analyze the of experiments and simulation studies	Cognitive Psychomo	Understand Remember Guided Response			
CO2	and ana	illed in problem solving, critical thinking ad analytical reasoning as applied to ientific and Technical problems.Cognitive Psychomotor AffectiveUnderstat Guided Response				ided	
CO3	work in	5		Psychomotor		derstand, ided t	
CO4	-	new areas of research in physics and elds of nanoscience and hnology	0		Understand, Mechanism		
CO5	apprecia	te the central role of physics in our and use this as a basis for ethical	Cognitive Unders		derstand, chanism		
	Syllabu	S					
Characteriza	ation of n and submi	rends in Nanotechnology covering Sy anomaterials and their applications in itted within the stipulated time in const	n devices. N	lote: Pr	oject	is to be	

YNI 303 L I P C

COURSE	CODE						
COURSE NAME		Dissertation Phase -II	0	0	0	12	
COURSE OUTCOMES		DOMA	IN	L	EVEL		
CO1	well as	and carry out scientific experiments as accurately record and analyze the of experiments and simulation studies	Psychomotor Rem Guid			Understand Remember Guided Response	
CO2	and ana	n problem solving, critical thinking lytical reasoning as applied to ic and Technical problems.	Cognitive Psychomo Affective	tor	Un Gu	derstand, ided sponse	
CO3	work in	clearly communicate the results of scientific work in oral, written and electronic formats o both scientists and the public at large		Cognitive Psychomotor Affective		derstand, ided t	
CO4	allied fi	explore new areas of research in physics and allied fields of nanoscience and nanotechnology		Cognitive Psychomotor Affective		derstand, chanism	
CO5		ate the central role of physics in our and use this as a basis for ethical r	Cognitive Psychomo Affective	Cognitive Understand Psychomotor Mechanism		,	
	Syllabu	S					
SyllabusProject on Current Trends in Nanotechnology covering Synthesis Process, Fabrication and Characterization of nanomaterials and their applications in devices. Note: Project is to be carried out and submitted within the stipulated time in consultation with the concerned guide							

of the candidate

COURSE CODE	QNT301C	L	Т	Р	С		
COURSE NAME CARBON NANOTUBE ELECTR		3	0	0	3		
	AND DEVICES						
PREREQUISITES		L	Т	Р	Η		
		3	0	0	3		
UNIT I Basics	of Carbon Nanotubes				9		
Carbon materials -	Allotropes of carbon – Structure of carbon nanote	ubes –	Types	of CN	Ts –		
Electronic propertie	s of CNTs – Band structure of Graphene – B	and st	ructure	e of SV	VNT		
from graphene – Electron transport properties of SWNTs – Scattering in SWNTs – Carrier							
mobility in SWNTs.							
UNIT II Synth	esis and Integration of SWNT Devices				9		
Introduction – CVD synthesis – Method – Direct incorporation with device fabrication							
process – SWNT synthesis on metal electrodes – Lowering the synthesis temperature –							
process – SWNT	•						
1	•	synthes	is tem	peratu	re –		
Controlling the SW	synthesis on metal electrodes - Lowering the s	synthes – Nar	is tem rowing	peratu g diar	re – neter		
Controlling the SW distributions – Ch	synthesis on metal electrodes – Lowering the s NT growth – Location, Orientation, Chirality	synthes – Nar	is tem rowing	peratu g diar	re – neter		
Controlling the SW distributions – Ch removal of the meta	synthesis on metal electrodes – Lowering the s NT growth – Location, Orientation, Chirality irality distribution analysis for different CVD	synthes – Nar	is tem rowing	peratu g diar	re – neter		
Controlling the SW distributions – Ch removal of the metaUNIT IIICarbo	synthesis on metal electrodes – Lowering the s NT growth – Location, Orientation, Chirality irality distribution analysis for different CVE llic nanotubes in FET devices – Integration	synthes – Nar) proce	is tem rowing esses	peratu g diar – Sele	re – neter ctive 9		

Metal-contaced MOSFETs – SWNT MOSFETs – SWNT band-to-band tunnelling FETs

UNIT IV AC Resp	onse and Device Simulat	ion OfSwntFets	9				
Assessing the AC response of Top gated SWNT FETs - Power measurement using a							
spectrum analyzer –Homodyne detection using SWNT FETs – RF characterization using a							
two tone measurement – AC gain from a SWNT FET common source amplifier – Device							
simulation of SWNT FETs – SWNT FET simulation using NEGF –Device characteristics at							
the Ballistic limit - Role of Phonon scattering - High frequency performance limits -							
Optoelectronic phenon	nena.						
UNIT V Carbon I	Nanotube Device Modelir	ng and Circuit Simulation	9				
Schottky barrier SW	NT-FET modeling – C	compact model for circuit	simulation –				
		– Full SWNT-FET model –					
of the SWNT-FET	compact model – P	erformance modeling for car	bon nanotube				
interconnects - Circui	it models for SWNTs – (Circuit models for SWNT bund	dles – Circuit				
models for MWNTs – C	Carbon nanotube interconn	ects – Applications.					
LECTURE							
LEUIUKE	TUTORIAL	PRACTICAL	TOTAL				
45	TUTORIAL 0	PRACTICAL 0	TOTAL 45				
45 TEXT	0	0	45				
45 TEXT	0		45				
45 TEXT	0	0	45				
45 TEXT 1. Ali Javey and Ji (2009).	0 ng Kong, —Carbon Nano	0	45 cience media,				
45 TEXT 1. Ali Javey and Ji (2009).	0 ng Kong, —Carbon Nano	0 otube Electronics Springer S	45 cience media,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com	0 ng Kong, —Carbon Nano	0 otube Electronics Springer S	45 cience media,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes:	0 otube Electronics Springer S	45 cience media, CRC/Taylor &				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES 1. Francois Leonard, (2009).	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon	0 otube Electronics Springer S Properties and Applications , C n Nanotube Devices , William	45 cience media, CRC/Taylor & Andrew Inc.,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES 1. Francois Leonard, (2009).	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon	0 otube Electronics Springer S Properties and Applications , C	45 cience media, CRC/Taylor & Andrew Inc.,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES 1. Francois Leonard, (2009).	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon S. Drbselmus, —Physical	0 otube Electronics Springer S Properties and Applications , C n Nanotube Devices , William	45 cience media, CRC/Taylor & Andrew Inc.,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES 1. Francois Leonard, (2009). 2. R. Saito and M.	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon S. Drbselmus, —Physical	0 otube Electronics Springer S Properties and Applications , C n Nanotube Devices , William	45 cience media, CRC/Taylor & Andrew Inc.,				
45 TEXT 1. Ali Javey and Ji (2009). 2. Michael J. O'Com Francis, (2006). REFERENCES 1. Francois Leonard, (2009). 2. R. Saito and M. College Press, (1998)	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon S. Drbselmus, —Physical	0 otube Electronics Springer S Properties and Applications , C n Nanotube Devices , William	45 cience media, CRC/Taylor & Andrew Inc.,				
 45 TEXT Ali Javey and Ji (2009). Michael J. O'Com Francis, (2006). REFERENCES Francois Leonard, (2009). R. Saito and M. College Press, (1998) E REFERENCES 	0 ng Kong, —Carbon Nano nell, —Carbon nanotubes: , —The Physics of Carbon S. Drbselmus, —Physical	0 otube Electronics Springer S Properties and Applications , C n Nanotube Devices , William	45 cience media, CRC/Taylor & Andrew Inc.,				

COURSE CODE	YNT301C	L	Τ	Р	С			
COURSE NAME	NANOMANIPULATION & ASSEMBLY	3	0	0	3			
PREREQUISITES		L	Τ	Р	Η			
		3	0	0	3			
UNIT I Introduction				9				
Concept of manipulation in nanostructures &nanoassembly, experimental realization,								
limitation of present-day instrumentation, future out look								
UNIT II Nanomanipulation				9				
Buckling, Transport & Rolling at the nano scale. Instrumentation Systems: the nano								
manipulator & com	bined microscopy tools; nano manipulation for mechan	ical p	rope	ertie	S			
UNIT III Nano Particle Manipulation by Electrostatic Forces 9					9			
Theoretical aspects	Theoretical aspects of AC electro kinetics; applications of dielectrophoresis on the nanoscale;							
limitations of nanos	cale dielectrophoresis							
UNIT IV Biologically Mediated Assembly of Artificial Nanostructures				9				
Bio-inspired self-as	Bio-inspired self-assembly; the forces & interactions of self-assembly; biological linkers;							
state-of- the-art in bio-inspired self-assembly; future directions								

UNIT V	Nanostructural Ar	chitectures fro	om Molecular H	Building Blocks	9				
Bonding & connectivity; molecular building block approaches									
		LECTURE	TUTORIAL	PRACTICAL	TOTAL				
45 0 0 45									
TEXT									
1. Electro	chemical Nanotechno	logy by W.J. L	orenz and W.Ple	eith, IUPAC, Wil	ey				
Publica					-				
2. Handbook of Microscopy for nanotechnology by Nanyo, Zhong Lin Wang. Kluwer									
academic									
publish- 2005.									
REFERENCES									
1."Handbo	ok of Nanostructured	Materials & Na	anotechnology,"	'Hari Singh Nal	wa (Ed.),				
Academ	ic Press, 2000.			-					
2."Scannin	g Probe Microscopy	& Spectroscopy	: Theory, Tech	niques & Applica	tions," Dawn				
A Bonr	nell, Wiley-VCH, 200	1.							
3."Micro/N	Vanotechnology and it	s Applications,	" B. Bhushan, K	Cluwer Publishers					
4. Robot H	lands & Mechanics of	Manipulation,	" Matthew T. M	ason & J. Kennet	h Salisbury,				
MIT Press, 1985.									
5. Micro &	Nano manipulation t	ools by Yu Son	, Xinyu Liu. Wi	iley Publications.					
E REFER	ENCES								
1. <u>www.n</u>	ptel.ac.in								
2. www.mit.co.in									

COURSE	CODE	QNT304	L	Τ	Р	С
COURSE NAME		NANOMATERIALS CHARACTERIZATION	3	0	0	3
		TECHNIQUES				
PREREQU	PREREQUISITES		L	Τ	Р	Η
			3	0	0	3
UNIT I	Introdu	ction to spectroscopy				9
Basic princ	iples and	applications of UV-Vis-NIR, FTIR, FT-Raman, Pho	tolu	nine	esce	nce,
NMR, ESR	and Light	t Scattering methods.				
UNIT II X – ray techniques				9		
X-ray powe	ler diffrac	tion -Quantitative determination of phases; Structure	ana	lysis	s, si	ngle
crystal diff	raction te	chniques - Determination of accurate lattice parameter	eters	- s	truc	ture
analysis-pro	analysis-profile analysis - particle size analysis using Scherer formula- Particle Size					
Analyzer- H	Ellipsomet	ry- thickness measurements				
UNIT	Electron	1 Spectroscopy				9
III						
X-Ray Pho	X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, X-Ray Characterizati					
of Nanomaterials - EDAX and WDA analysis - EPMA - Applications to nanomater					rials	
characteriza	ation					

UNIT IV | Mechanical, Magnetic and electrical properties measurement

Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions- models for interpretation of Nan indentation load displacement curves- Nan indentation data analysis methods-Hardness testing of thin films and coatings- MD simulation of nanoindentation. Vibration Sample Magnetometer, Impedance Spectroscopy- PPMS, - Measurement of Magnetic and electrical properties of nanomaterials.

UNIT V Electrometric Methods of Analysis

Types of electrochemical cells; electrode potentials. Hall measurement; Quantum Hall Measurement; Dynamic and static Current-Voltage (I-V) characteristics; capacitance; voltage measurements; I-V analysis by AFM and STM (STS); electron beam induced current measurement (EBIC)

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT

- 1. Skoog, Holler, Nieman "Principles of Instrumental Analysis"
- 2. Rainer Waser" NanoscaleCalibratinStandards" Wiley-VCH
- 3. Rainer Waser" Nanometrology" Wiley-VCH

REFERENCES

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- 2. "Electron Microscopy and Analysis," P. J. Goodhews& F. J. Humphreys, Taylor and Francis.
- 3. "Modern Techniques of Surface Science," D. P. Woodruff & T. A. Delchar, Cambridge Solid State Science.
- 4. "Electronic Structure of Materials," A. P. Sutton, Oxford University Press, 1993.
- 5. "Semiconductor Materials & Device Characterization," D. K. Schroder,

John Willy & Sons

E REFERENCES

- 1. <u>www.nptel.ac.in</u>
- 2. www.mit.co.in

COURSE CODE	QNT401B	L	Т	Р	С
COURSE NAME	SPECTROSCOPIC TECHNIQUES	3	0	0	3
	FOR NANOMATERIALS				
PREREQUISITES		L	Т	Р	Н

9

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				3	0	0	3
UNIT I	Nano Op	tics					9
	- <u>-</u>	neous Emission- Class		<u> </u>			-
Mechanical	Radiative	Decay-Absorption and	Emission - Abso	orption	n Co	efficie	ent an
Absorption	Cross-Sec	ction, Absorption and	Induced Emission	-Nano	o-opti	cs an	id loca
spectroscopy	-Scanning	g plasmon near-field opti	cal spectroscopy (S	PNM)-near	-field	l optica
spectroscopy	- nearfield	nonlinear optics					
UNIT II	Molecula	r Spectroscopies OfNa	noassemblies				9
Simplified	model fo	or vibrational interac	tions-Characteristic	baı	nds	for	organi
compounds	- Atten	uated-total reflection	(ATR) and graz	zing	incid	lence	angl
techniques-F	teflection-a	bsorption IR spectrosc	copy (RAIRS)-Th	e Ran	nan E	ffect-	Latera
and in-depth	n Resolutio	n of Conventional µRS	S- Resonant Ramar	Spec	ctrosc	opy ((RRS)
Nanospecific	: Modes-	Surface-Enhanced Ran	nan Spectroscopy	(SER	S)- N	Vano-	Raman
Phase Iden	tification	and Phase Transitions	s in Nanoparticles-	Char	acteri	izing	Carbo
Materials wi	th Raman S	Spectroscopy					
UNIT III	Nonlinea	r Spectroscopies					9
Absorption	saturation	and harmonic genera	ation,Second-harmo	nic g	genera	ation	(SHG
and sum		spectroscopy (SFG)-					
		ods to obtain infrared s	-				
surfaces			1				
UNIT IV	Lumines	cence Spectroscopies					9
		assembled nanostruc	ctures-interaction	betwe	en n	anopa	articles
	-	gap transitions-, -Sing				-	
		light scattering spectro	-		-	-	
	-	ectrometry- Atomic emi					
UNIT V		Spectroscopies for Nan					9
X-Ray Bea	mEffects,S	pectral Analysis -Core	e Level Splitting	Linev	vidths	s- El	ementa
Analysis: Q	ualitative	and Quantitative -Seco	ondary Structure,	XPS	Imag	ging	-Angle
Resolved -	Basic	Principles of AES-I	Instrumentation Ex	perim	ental	Pro	cedure
Including S	ample Pre	eparation - AES Mod	lifications and Co	mbina	ations	with	n othe
Techniques	-Auger Sp	pectra: Direct and Der	rivative Forms and	i Apj	olicati	ions-E	Electro
energy loss	spectrosco	py of nanomaterial					
LECT	'URE	TUTORIAL	PRACTIC	4L		TO	TAL
4	5	0	0				45
TEXT							
1. Vladimir	G. Bordo a	and Horst-Günter Rubal	nn; —Optics and S	pectro	oscop	y at S	Surface
and Inter	faces" John	-Wiley and Sons, Inc., (2005).				
2. William V	W. Parson,	Modern Optical Spectro	scopy, Springer, (20	007).			
		c Cash, Fundamentals			opy, N	McGra	aw Hil
(1994).			1		10,		
4. Harvey E	lliot White	, Introduction to Atomic	Spectra, McGraw I	Hill, (1	1934)	•	
			- '		,		
REFEREN	LES						
REFEREN		d Annick Rouessac. C	hemical Analysis-	Mode	n Ins	strume	entatio
REFEREN 1.Francis R	ouessac an	d Annick Rouessac, C es.(2000)	hemical Analysis-l	Mode	m Ins	strume	entatio
REFEREN 1.Francis Ro Methods an	ouessac an d Techniqu						entatio

- 3. Pavia, Lampman, Kriz, Vyvyan, Introduction to spectroscopy, Cengage learning, (2009).
- 4. JinJhongJhang, Optical properties and spectroscopies of Nanomaterials, World Scientific Publishing (2009).

E REFERENCES

- 1. www.nptel.ac.in
- 2. <u>www.mit.co.in</u>

COURSE C	ODE	YNT4	03			L	Т	Р	С
COURSE N	COURSE NAME COMPUTATIONAL NANOTECHNOLOGY				HNOLOGY	3	0	0	3
PREREQU	PREREQUISITES					L	Т	Р	Η
3						3	0	0	3
UNIT I	Physical N	Aodeli	ng						9
Basics of sir	nulation an	id mod	eling - Role o	f simulation in	model evaluati	on a	and s	studi	es -
			-	tem and enviror					
system - line	ear and nor	nlinear	system - stoc	hastic activities	- static and dy	nan	nic r	node	els -
Advantages a	and Disadv	antage	s of simulatior	1.					
UNIT II	Computat	tion Ba	sed Simulatio	n					9
Technique of	f simulation	n - calu	imnious syster	n models - expe	erimental natur	e of	sim	ulati	on -
numerical co	mputation	technie	ques - Monte	Carlo method -	analog and hyl	orid	sim	ulati	on -
feedback sys	-		-						
UNIT III	Probabilit	y Con	cepts in Simu	Ilation					9
Stochastic v	ariables - o	liscrete	e and continue	ous probability	functions - rar	don	n nu	mbe	rs -
generation of	of random	numbe	ers - variance	reduction tech	niques - deter	min	atior	n of	the
length of sim	nulation rur	ns - Out	tput analysis.						
UNIT IV	Molecular	·Mode	ling						9
Introduction	to molecu	ılar mo	odeling – mol	ecular mechani	cs- molecular	dyn	ami	cs b	asic
principles -	Computing	g trans	port in mater	rials - Simulati	ion of crystals	wi	th c	hem	ical
disorder at	lattice site	s – De	esign of comp	pound semicon	ductor alloys	lsin	g m	olec	ular
simulations -	- Optical,	electric	al and structur	al property by f	ïrst principle ca	lcu	latio	ns.	
UNIT V	Micro and	l Nano	structure Mo	deling					9
Studies on m	nicrostructu	re syste	ems using ator	nistic and meso	scale simulatio	ns –	Sol	id lic	Juid
phase transi	tion under	confi	nement – M	odeling of me	tals - Simula	ion	pro	otoco	1 –
Semiemprica	al methods	- Der	nsity functiona	al theory meho	ds (DFT) - V	isua	lizat	ion	and
analysis.									
			LECTURE	TUTORIAL	PRACTICAL		T()TA	L
			45	0	0			45	
TEXT 1. Erwin Kreyzig, "Advanced Engineering Mathematics", John Wiley & Sons, 2004									
		vanced	Engineering	Mathematics",	John Wiley & S	ons	, 200)4	
REFERENC									
				oori "Computat		y an	d m	olec	ular
				Springer, 2008.		1		1	1
			-	design of Nov	ei performance	e ch	emi	cais	and
materials", Taylor & Francis group, 2012.3. Chistopher.J. Cramer "Essentials of Computational Chemistry- Theories and models".									
3. Chistopher.J. Cramer "Essentials of Computational Chemistry- Theories and models".									

John wiley& sons	2004.				
E REFERENCES					
1. www.nptel.ac.in					
2. <u>www.mit.co.in</u>					
COURSE CODE	QNT 404	L	Т	Р	C
COURSE NAME	COMPUTATIONAL NANOTECHNOLOGY	0	0	2	2
	LAB				
PREREQUISITES	Applied Physics, Applied Chemistry, Introduction	L	Т	Р	Н
	to nanotechnology and Materials Science				
		0	0	4	4

List of Experiments

- 1. Simulation and modeling of simple molecular structures.
- 2. Prediction of crystals structure and properties using nanomaterials modeling methods.
- 3. Simulation and modeling of various nanostructures.
- 4. Simulation and modeling of metals nanoparticles and their studies.
- 5. Development of simulation protocols for the study of nanofilms and nanosurfaces.
- 6. Simulation and modeling study of nanomaterials and their optical property studies.
- 7. Simulation and modeling of nanomaterials and their electronic property studies.
- 8. Modeling of nanomaterials and their interaction studies with other molecules.

COURSE C	ODE	QNT401B	L	Т	Р	С
COURSE N	AME	SPECTROSCOPIC TECHNIQUES FOR	3	0	0	3
		NANOMATERIALS				
PREREQU	ISITES		L	Т	Р	Н
			3	0	0	3
UNIT I	Nano ()ptics				9
Basic Conc	epts-Spo	ntaneous Emission- Classical Bound- Radi	ating	Elect	ron-Q	uantum
Mechanical	Radiativ	ve Decay-Absorption and Emission - Absorption	orption	n Co	efficie	ent and
Absorption	Cross-	Section, Absorption and Induced Emission	n-Nan	o-opti	cs an	d local
spectroscopy	-Scanni	ng plasmon near-field optical spectroscopy (S	SPNM)-nea	r-field	optical
spectroscopy	- nearfie	ld nonlinear optics				
UNIT II	Molecu	lar Spectroscopies OfNanoassemblies				9

Simplified model vibrational interactions-Characteristic for bands for organic compounds - Attenuated-total reflection (ATR) and grazing incidence angle techniques-Reflection-absorption IR spectroscopy (RAIRS)-The Raman Effect- Lateral and in-depth Resolution of Conventional µRS- Resonant Raman Spectroscopy (RRS) - Nanospecific Modes-Surface-Enhanced Raman Spectroscopy (SERS)-Nano-Raman-Phase Identification and Phase Transitions in Nanoparticles- Characterizing Carbon Materials with Raman Spectroscopy

UNIT III Nonlinear Spectroscopies

Absorption saturation and harmonic generation, Second-harmonic generation (SHG) and sum frequency spectroscopy (SFG)- Luminescence up conversion-The use of nonlinear optical methods to obtain infrared spectra of ultra-thin assemblies confined to surfaces

9

9

UNIT IV Luminescence Spectroscopies

Optical properties of assembled nanostructures-interaction between nanoparticles-Direct and indirect gap transitions-, -Single molecule and single nanoparticles spectroscopy-Dynamic light scattering spectroscopy Fluorimetry and chemiluminescence - X-ray fluorescence spectrometry- Atomic emission spectroscopy.

UNIT V Electron Spectroscopies for Nanomaterials

X-Ray BeamEffects,Spectral Analysis -Core Level Splitting Linewidths- Elemental Analysis: Qualitative and Quantitative -Secondary Structure ,XPS Imaging -Angle-Resolved - Basic Principles of AES-Instrumentation Experimental Procedures Including Sample Preparation - AES Modifications and Combinations with other Techniques -Auger Spectra: Direct and Derivative Forms and Applications-Electron energy loss spectroscopy of nanomaterial

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT

1. Vladimir G. Bordo and Horst-Günter Rubahn; —Optics and Spectroscopy at Surfaces and Interfaces" John-Wiley and Sons, Inc., (2005).

- 2. William W. Parson, Modern Optical Spectroscopy, Springer, (2007).
- 3. Collin Banwell, Mc Cash, Fundamentals of Molecular Spectroscopy, McGraw Hill (1994).

4. Harvey Elliot White, Introduction to Atomic Spectra, McGraw Hill, (1934).

REFERENCES

1.Francis Rouessac and Annick Rouessac, Chemical Analysis-Modern Instrumentation Methods and Techniques,(2000)

- 2. Joseph. R. Lakowicz Principles of fluorescence spectroscopy, Springer, (2010).
- 3. Pavia, Lampman, Kriz, Vyvyan, Introduction to spectroscopy, Cengage learning, (2009).
- 4. JinJhongJhang, Optical properties and spectroscopies of Nanomaterials, World Scientific Publishing (2009).

E REFERENCES

3. <u>www.nptel.ac.in</u>

4. <u>www.mit.co.in</u>

COUNDE	CODE	QNT5010	C			L	Τ	Р	С
COURSE	NAME	NANOM	ANIPULATIO	ON & ASSEME	SLY	3	0	0	3
PREREQU	JISITES					L T P			Η
						3	0	0	3
UNIT I	Introdu	ction							9
Concept o	f manipu	lation in	nanostructures	&nanoassemb	ly, expe	eriment	al r	ealiz	zatior
limitation of	of present-	day instrun	nentation, future	e out look					
UNIT II	Nanoma	nipulation	l						9
Buckling,	Transport	& Rollin	g at the nand	scale. Instru	nentatior	n Syste	ms:	the	nan
manipulato	r & combi	ned micros	copy tools; nar	o manipulation	for mech	nanical	prop	ertie	S
UNIT III	Nano Pa	article Mar	nipulation by H	Electrostatic Fo	rces				9
Theoretical	aspects of	f AC electr	o kinetics; appl	ications of diele	ectrophor	esis on	the 1	nanc	oscale
limitations	of nanosca	ale dielectro	ophoresis						
UNIT IV	Biologic	ally Media	ted Assembly	of Artificial Na	nostruc	tures			9
Bio-inspire	d self-ass	embly; the	forces & inte	ractions of self	-assembl	ly; biol	ogic	al li	nker
state-of- the	e-art in bio	o-inspired s	elf-assembly; f	uture directions					
UNIT V	Nanostr	uctural Ar	chitectures fro	om Molecular I	Building	Blocks			9
Bonding &	connectiv	vity: molecu	lor building bl	ock approaches					•
			nai bununig bio	JCK approaches					
		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		TUTORIAL	PRAC'	TICAL	, '	ГОТ	ΓAL
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TEXT 1. Electroo Publica 2. Handbo	tions. ook of M - 2005.	Nanotechno	LECTURE 45 logy by W.J. L	TUTORIAL 0	eith, IUP	0 PAC, W	iley	4	5
TEXT 1. Electroo Publica 2. Handbo academic publish REFEREN 1."Handboo Academi	tions. ook of Mi - 2005. ICES ok of Nand c Press, 20	Nanotechno icroscopy d ostructured 000.	LECTURE 45 logy by W.J. L for nanotechno Materials & Na	TUTORIAL 0	eith, IUP o, Zhong ' Hari S	0 PAC, W g Lin V ingh Na	iley Wang alwa	4 g. K	5 (luwe .),
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COURSE C	CODE	QNT 502	L	Т	Р	С	
COURSE N	AME	Dissertation Phase -I	0	0	0	8	
COURSE C	COURSE OUTCOMES		DOMA	IN	LEVEL		
CO1	well as a	nd carry out scientific experiments as accurately record and analyze the f experiments and simulation studies	Cognitive Psychomo	Understand Remember Guided Response			
CO2	and ana	n problem solving, critical thinking ytical reasoning as applied to c and Technical problems.	Cognitive Psychomo Affective	Gu	derstand, ided sponse		
CO3	work in	communicate the results of scientific oral, written and electronic formats scientists and the public at large	Cognitive Psychomo Affective	Understand, Guided Set			
CO4		new areas of research in physics and elds of nanoscience and nnology	Cognitive Psychomo Affective	tor	Understand, Mechanism		
CO5		te the central role of physics in our and use this as a basis for ethical r	Cognitive Psychomotor Affective			derstand, chanism	
	Syllabu	S					
Characteriza	tion of n nd submi	rends in Nanotechnology covering Sy anomaterials and their applications in tted within the stipulated time in consu	n devices. N	lote: Pr	oject	is to be	

COURSE O	CODE	QNT 601	L	Т	Р	С
COURSE N	NAME	Dissertation Phase -I	0	0	0	12
COURSE C	DUTCOM	IES	DOMA	IN	L	EVEL
CO1	design a	nd carry out scientific experiments as	Cognitive		Un	derstand
	ccurately record and analyze the	Psychomotor		Rei	nember	
	results o	f experiments and simulation studies			Gui	ided

			Response
CO2	skilled in problem solving, critical thinking and analytical reasoning as applied to scientific and Technical problems.	Cognitive Psychomotor Affective	Understand, Guided Response
CO3	clearly communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large	Cognitive Psychomotor Affective	Understand, Guided Set
CO4	explore new areas of research in physics and allied fields of nanoscience and nanotechnology	Cognitive Psychomotor Affective	Understand, Mechanism
CO5	appreciate the central role of physics in our society and use this as a basis for ethical behavior	Cognitive Psychomotor Affective	Understand, Mechanism
	Syllabus		
•	Current Trends in Nanotechnology covering Sy		
	zation of nanomaterials and their applications in t and submitted within the stipulated time in cons didate		•