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**

<table>
<tr><td colspan="2">COURSE CODE</td><td>XNT701A</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">COURSE NAME</td><td>MEMS AND NEMS fabrication</td><td>2</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td colspan="2">PREREQUISITES</td><td>Nanomaterials Fabrication Techniques I and II</td><td>L</td><td>T</td><td>P</td><td>H</td></tr>
<tr><td colspan="2">C:P:A</td><td>1.5:1.2:0.3</td><td>2</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="3">COURSE OUTCOMES</td><td colspan="2">DOMAIN</td><td colspan="2">LEVEL</td></tr>
<tr><td>CO1</td><td colspan="2">ExplainBasic concept of MEMS and NEMS</td><td colspan="2">Cognitive
Psychomotor</td><td colspan="2">Understand
Remember</td></tr>
<tr><td>CO2</td><td colspan="2">Explain andunderstandFabrication Process</td><td colspan="2">Cognitive
Psychomotor</td><td colspan="2">Understand,
Guided
Response</td></tr>
<tr><td>CO3</td><td colspan="2">Determine and Describe Mechanical and Thermal MEMS</td><td colspan="2">Cognitive
Psychomotor</td><td colspan="2">Understand,
Guided
Set</td></tr>
<tr><td>CO4</td><td colspan="2">Describe and Illustrate the Magnetic and RF MEMS</td><td colspan="2">Cognitive
Psychomotor</td><td colspan="2">Understand,
Mechanism</td></tr>
<tr><td>CO5</td><td colspan="2">Classify and Describe the MOEMS and Micro fluidic Systems</td><td colspan="2">Cognitive
Psychomotor</td><td colspan="2">Understand,
Mechanism</td></tr>
<tr><td>UNIT I</td><td colspan="5">Introduction to MEMS and NEMS</td><td>6+6</td></tr>
<tr><td colspan="7">MEMS and NEMS- Micro- and Nano electromechanical Systems:Scaling Laws-Mathematical Modelling- Microsensors and microactuators- Mechanical MEMS, Thermal MEMS- MOEMS, Magnetic MEMS, RF MEMS- Microfluidic systems, Bio-Chemo devices-MEMS Architectures- NEMS Architectures</td></tr>
<tr><td>UNIT II</td><td colspan="5">FABRICATION PROCESS</td><td>6+6</td></tr>
<tr><td colspan="7">Photolithography, structural and sacrificial materials- Thin film deposition- Impurity doping, etching-- Bulk and surface micromachining- Wafer bonding and LIGA-- MEMS Assembling and Packaging- Basic Modelling elements in mechanical, electrical systems- Basic Modelling elements in fluid systems, thermal systems- Translational and rotational pure mechanical systems</td></tr>
<tr><td>UNIT III</td><td colspan="5">Mechanical and Thermal MEMS</td><td>6+6</td></tr>
<tr><td colspan="7">Principles of sensing and actuation- Components: beam, cantilever, micro plates--Components: capacitive effects, piezo element-- Measurements: strain pressure, flow-MEMS Gyroscopes: shear mode-- MEMS Gyroscopes: gripping piezo actuators- Thermal sensors and actuators: thermal basics—Thermo devices, Thermal actuators, Bistable MEMS relays</td></tr>
<tr><td>UNIT IV</td><td colspan="5">Magnetic and RF MEMS</td><td>6+6</td></tr>
<tr><td colspan="7">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</td></tr>
<tr><td>UNIT V</td><td colspan="5">MOEMS and Microfluidic Systems</td><td>6+6</td></tr>
<tr><td colspan="7">Principles of MOEMS technology- Applications Light modulators , beam splitters- Micro lens, micro mirror, digital micromirror device- Optical switch, wave guide and tuning-</td></tr>
</table>

Properties of fluids, fluid actuation methods- Dilectrophoresis, electro thermal flow, thermo capillary effect- Micropumps, Micropumps: design consideration				
	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**30**	**0**	**30**	**60**
TEXT BOOK				
Book reference 1. MEMS and NEMS: Systems, Devices, and Structures-Sergey Edward Lyshevski 2. Modeling MEMS and NEMS-John A. Pelesko, David H. Bernstein				
REFERENCES				

Table 1 : COs versus POs mapping

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, 11-15 → 3

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

<table>
<tr><td>COURSE CODE</td><td colspan="2">XNT702</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>COURSE NAME</td><td colspan="2">HEALTH AND SAFETY ISSUES OF NANOTECHNOLOGY</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>C:P:A</td><td colspan="2">2:0:1</td><td>L</td><td>T</td><td>P</td><td>H</td></tr>
<tr><td>PREREQUISITE</td><td colspan="2">Physics,Chemistry and Material Science</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="2">COURSE OUTCOMES</td><td>DOMAIN</td><td colspan="4">LEVEL</td></tr>
<tr><td>CO1</td><td>Relate the toxic effects of nanotechnology on human health.</td><td>Cognitive

Affective</td><td colspan="4">Understand
Remember
Apply</td></tr>
<tr><td>CO2</td><td>Analyse the various issues on environmental effects.</td><td>Cognitive

Affective</td><td colspan="4">Understand
Remember
Apply</td></tr>
<tr><td>CO3</td><td>Identify suitable remedial measures</td><td>Cognitive

Affective</td><td colspan="4">Understand
Remember
Apply</td></tr>
<tr><td>CO4</td><td>Suggest start-of-the pipe solution for environmental issues based on nanomaterials</td><td>Cognitive

Affective</td><td colspan="4">Understand
Remember
Apply</td></tr>
<tr><td>CO5</td><td>Work out problems on nanomaterials related to toxicity. To frame a model policy on preventing health hazards.</td><td>Cognitive

Affective</td><td colspan="4">Understand
Remember
Apply</td></tr>
<tr><td>UNIT - I</td><td colspan="2">Risks of Nanomaterials</td><td colspan="4">9</td></tr>
<tr><td colspan="7">Risks with nanomaterials: Identification of Nano, Specific Risks, Responding to the Challenge, Human health hazard, Risk reduction, Standards, Safety, transportation of NP, Emergency responders</td></tr>
<tr><td>UNIT – II</td><td colspan="2">Risk assessment</td><td colspan="4">9</td></tr>
<tr><td colspan="7">Risk assessment: Risk assessment –Environmental Impact – Predicting hazard – Materials Characterization. Risk Assessment related to nanotechnology – Environmental and policy making</td></tr>
<tr><td>UNIT - III</td><td colspan="2">Ecotoxicity of nanomaterials</td><td colspan="4">9</td></tr>
<tr><td colspan="7">Ecotoxicity of nanomaterials: Ecotoxicity - Inhalation deposition and Pulmonary clearance of Insoluble Solids – Bio –persistence of Inhaled solid material. Systemic Trenslocation of inhaled Particles. Pulmonary effects of SWCNT</td></tr>
<tr><td>UNIT – IV</td><td colspan="2">Ecotoxicological tests</td><td colspan="4">9</td></tr>
<tr><td colspan="7">Ecotoxicological tests: Terms and parameters frequently used in ecotoxicological tests – endpoint classifications - ecotoxicological approaches in the evaluation of soil quality – ecotoxicity measurement for polychlorinated biphenyls – measurement of genotoxicity by Ames test</td></tr>
<tr><td>UNIT – V</td><td colspan="2">Legal aspects and regulations on toxicity of nanomaterials</td><td colspan="4">9</td></tr>
<tr><td colspan="7">Legal aspects and regulations on toxicity of nanomaterials: The approaches to assessment of exposure to the nanotechnology. Bioethics and legal aspects of potential health and environmental risks in nanotechnology, FDA regulation, cytotoxicity of nanoparticles</td></tr>
<tr><td colspan="7">List of Experiments</td></tr>
<tr><td colspan="7">10 to 12 Experiments will be provided relevant to the five course outcome based on the</td></tr>
</table>

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 .
3. 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.

Table 1 : COs versus POs mapping

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 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

1-5 → 1, 6-10 → 2, 11-15 → 3

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

COURSE CODE	**XNT703**	**L**	**T**	**P**	**C**
COURSE NAME	**NANOCOMPOSITES**	**3**	**1**	**1**	**5**
C:P:A	**2:0.5:0.5**	**L**	**T**	**P**	**H**
PREREQUISITE	**Physics, Chemistry and Material Science**	**3**	**2**	**2**	**7**

COURSE OUTCOMES		**Domain**	**Level**
CO1	***Define*** and ***explain*** nano ceramics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***Understand*** and ***describe*** the fabrication, properties and applications of metal based nano composites	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***List and understand*** the design of super hard materials	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Understand and explain*** the ***novel nano composites***	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Understand*** and ***describe*** the fabrication, properties and applications of polymer based nano composites	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	**Nano Ceramics**	**9+6+6**
Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniquesand their final properties and functionality		
UNIT – II	**Metal Based Nanocomposites**	**9+6+6**
Metal-metal nanocomposites, some simple preparation techniques and their new electricaland magnetic properties		
UNIT - III	**Design Of Super Hard Materials**	**9+6+6**
Super hard nano composites, its designing and improvements of mechanical properties.		
UNIT – IV	**New Kind Of Nanocomposites**	**9+6+6**
Fractal based glass-metal nano composites, its designing and fractal dimension analysis. Electrical property of fractal based nano composites. Core-Shell structured nano composites.		
UNIT – V	**Polymer Based Nanocomposites**	**9+6+6**
Preparation and characterization of diblock Copolymer based nanocomposites;		

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 Vepr¡ek (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,			

Table 1 : COs versus POs mapping

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

1-5 → 1, 6-10 → 2, 11-15 → 3

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

<table>
<tr><td colspan="2">COURSE CODE</td><td colspan="2">XNT705D</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">COURSE NAME</td><td colspan="2">NANO IN WIRELESS COMMUNICATION</td><td>2</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td colspan="2">C:P:A</td><td colspan="2"></td><td>L</td><td>T</td><td>P</td><td>H</td></tr>
<tr><td colspan="2">PREREQUISITE</td><td colspan="2"></td><td>2</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="3">COURSE OUTCOMES</td><td>Domain</td><td colspan="4">Level</td></tr>
<tr><td>CO1</td><td colspan="2">Explainthe nanotechnology applications on wireless communication</td><td>Cognitive
Psychomotor</td><td colspan="4">Understand
Remember</td></tr>
<tr><td>CO2</td><td colspan="2">Explain andunderstandapplications of nanotechnology on fiber optics and microwave communications</td><td>Cognitive
Psychomotor</td><td colspan="4">Understand,
Guided Response</td></tr>
<tr><td>CO3</td><td colspan="2">Determine and Describe applications of CNT in telecommunications</td><td>Cognitive
Psychomotor</td><td colspan="4">Understand,
Guided
Set</td></tr>
<tr><td>CO4</td><td colspan="2">Describe and Illustrate MEMS based application on wireless communications</td><td>Cognitive
Psychomotor</td><td colspan="4">Understand,
Mechanism</td></tr>
<tr><td>CO5</td><td colspan="2">List , explain and practice the feasible experiments on nano wireless communication</td><td>Cognitive
Psychomotor</td><td colspan="4">Understand,
Mechanism</td></tr>
<tr><td>UNIT - I</td><td colspan="3">Impact of Nanotechnology on Telecommunications</td><td colspan="4">5</td></tr>
<tr><td colspan="8">Dimensions: A Snapshot- Global Standards-Impact and Promise of Nanotechnology for Telecommunications- Transparent Transaction: A Scenario- Ongoing Research and Nanotechnology: Some Samples - The Promise and Future of Nanotechnology- Concerns about Nanotechnology - Preparing Students for Nanotechnology</td></tr>
<tr><td>UNIT – II</td><td colspan="3">Nanotechnology in Fiber-Optic Telecommunications and Microwave</td><td colspan="4">10</td></tr>
<tr><td colspan="8">Nanostructures and Their Interaction with Light- Single Nanoparticle- Nanostructure- Nanostructure Construction-Nanostructures as Optical Power-Control Devices- Optical Fuses- Market Needs-Optical-Fuse Specifications - for Optical Communication Networks- Optical Fuse: State of the Art - How to Design and Produce a Fuse- Fuse Design and Compliance to Market Requirements- Optical Limiters - The Need -Optical Power Limiter Additional -Power Limiter Parameters-Applications of Graphene at Microwave Frequencies - RF Graphene Field Effect Transistor- Graphene Antenna - Graphene Microstrip Attenuator- Graphene Composites in EM Shielding</td></tr>
<tr><td>UNIT - III</td><td colspan="3">Carbon Nanotubes in Telecommunications</td><td colspan="4">5</td></tr>
<tr><td colspan="8">Resistivity of Nanotubes - Carbon Nanotubes as Neural Communicators - Nanotubes as Microwave Diodes in Spacecrafts and Satellites - Carbon Nanotubes in Fiber-Optics-Telecommunications - Carbon Nanotubes for Wireless Communications and Radio Transmission- CNT as Substrate Integrated Waveguide (SIW) and Modified SIW (MSIW)</td></tr>
</table>

UNIT – IV	**MEMS-Based Wireless Communications**	**10**

RF MEMS - MEMS-Based Inductors-Planar Spiral Inductor- Solenoid-Type Inductor-Toroidal-Meander-Type Inductor -Tunable Inductors - MEMS Variable Capacitor - Tuning of MEMS Variable Capacitor- Electrostatic Actuation- Comb Drive Actuators- RF MEMS Switch -Series Switch - Shunt Capacitive Switch- Electrostatic Actuation of the MEMS Switch -Problems and Solutions- Low Actuation Design-Problem of Stiction and Solutions-Reliability Issues of MEMS Switches - Packaging of RF MEMS -Wafer-Level Packaging-Fabrication of RF MEMS- Surface Micromachining - Bulk Micromachining-LIGA

UNIT – V	**Lab exercises**	**20**

1. Substrate Integrated Waveguide (SIW) and Modified SIW (MSIW) in CST
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

Table 1 : COs versus POs mapping

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, 11-15 → 3

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

COURSE CODE	**XUM706**	**L**	**T**	**P**	**C**
COURSE NAME	**CYBER SECURITY**	**0**	**0**	**0**	**0**
C:P:A	**2:0.5:0.5**	**L**	**T**	**P**	**H**
PREREQUISITE	**Physics,Chemistry and Material Science**	**0**	**0**	**0**	**3**

COURSE OUTCOMES		**Domain**	**Level**
CO1	***understand*** the Cyber Security Policy, Laws and Regulations	Cognitive	Understand Remember
CO2	***discuss*** the Cyber Security Management Concepts	Cognitive	Understand Remember
CO3	***understand*** the Cyber Crime and Cyber welfare	Cognitive	Understand Remember
CO4	***discuss*** on issues related to Information Security Concepts	Cognitive	Understand Remember
CO5	***understand***various security threats	Cognitive	Understand Remember

UNIT - I INTRODUCTION 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 POLICY CATALOG	9
Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising- Impersonation – Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectualproperty Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare		
UNIT – IV	**INFORMATION SECURITY CONCEPTS**	**9**
Information Security Overview: Background and Current Scenario - Types of Attacks - Goals for Security - E-commerce Security - Computer Forensics – Steganography		
UNIT – V	**SECURITY THREATS AND VULNERABILITIES**	**9**
Overview of Security threats -Weak / Strong Passwords and Password Cracking - Insecure Network connections - Malicious Code - Programming Bugs - Cyber crime and Cyber terrorism - Information Warfare and Surveillance		
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	**0**	**0**	**45**

TEXT BOOK

1.Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.

2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.

3. Richard A. Clarke, Robert Knake "Cyberwar: The Next Threat to National Security & What to Do About It" Ecco 2010

4. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011

5. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.

E RESOURCES

1. https://www.coursera.org/specializations/cyber-security
2. www. nptel.ac.in
3. http://professional.mit.edu/programs/short-programs/applied-cybersecurity

Table 1 : COs versus POs mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO10	PO11	PO12	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	

1-5 → 1, 6-10 → 2, 11-15 3 →
0 - No relation 1- Low relation 2- Medium relation 3- High relation

COURSE CODE	**XNT901**		**L**	**T**	**P**	**C**
COURSE NAME	**Peroject Phase I**		**0**	**0**	**0**	**8**
COURSE OUTCOMES			**DOMAIN**		**LEVEL**	
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies		Cognitive Psychomotor		Understand Remember Guided 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					

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 CODE	**XNT802C**	**L**	**T**	**P**	**C**
COURSE NAME	**Fullerenes**	**2**	**0**	**1**	**3**
PREREQUISITES	**Introduction to nanotechnology** **Materials science**	**L**	**T**	**P**	**H**
C:P:A	**1.5:1.2:0.3**	**2**	**0**	**2**	**4**

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	***Explain***the **Structure of Fullerenes**	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and***understand***the **Symmetry Considerations of Fullerene Molecules**	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** the **Synthesis, Extraction, and Purification of Fullerenes**	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Fullerene Growth, Contraction, and Fragmentation	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** **Crystalline Structure of Fullerene Solids**	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Structure of Fullerenes**	**6+6**

Structure of C60 and Euler's Theorem; Structure of C70 and Higher Fullerenes; the Projection Method for Specifying Fullerenes

UNIT II	**Symmetry Considerations of Fullerene Molecules**	**6+6**

Icosahedra Symmetry Operations; Symmetry of Vibrational Modes; Symmetry for Electronic States; Going from Higher to Lower Symmetry: Symmetry Considerations for C70, Symmetry Considerations for Higher-Mass Fullerenes; Symmetry Considerations for Isotopic Effects

UNIT III	**Synthesis, Extraction, and Purification of Fullerenes**	**6+6**

Synthesis of Fullerenes: Historical Perspective, Synthesis Details; Fullerene Extraction: Solvent Methods, Sublimation Methods, Solubility of Fullerenes in Solvents; Fullerene Purification: Solvent Methods, Sublimation in a Temperature Gradient , Gas-Phase Separation and Purification , Vaporization Studies of C60; Endohedral Fullerene Synthesis; Health and Safety Issues

UNIT IV	**Fullerene Growth, Contraction, and Fragmentation**	**6+6**

Fullerene Growth Models: Stone-Wales Model ,Model for C 2 Absorption or Desorption , Fullerene Growth from a Corannulene Cluster , Transition from C60 to C70; Mass Spectrometry Characterization; Stability Issues; Fullerene Contraction and Fragmentation: Photo fragmentation, Collision of Fullerene Ion Projectiles , Collision of Fullerene Ions with Surfaces , Fragmentation of C60 by Energetic Ions; Molecular Dynamics Models

UNIT V	**Crystalline Structure of Fullerene Solids**	**6+6**

Crystalline C60: Ambient Structure , Group Theory for Crystalline Phases , Low-Temperature Phases ,Merohedral Disorder , Model for Phase Transitions in C60; Crystalline C70 and Higher-Mass Fullerenes; Effect of Pressure on Crystal Structure; Effect of Temperature on Crystal Structure; Polymerized Fullerenes: Photo polymerization of C60 , Electron Beam-Induced Polymerization of C60 ,Pressure-Induced Polymerization of C60, Plasma-Induced Polymerization of C6o ,Photo polymerization of C70 Films

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**

HOURS	30	0	30	60

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.

TEXT BOOK

1. TheFullerenes- Author(s):H.W.Kroto, J.E. Fischer and D.E. Cox
   ISBN: 978-0-08-042152-0
2. Science of Fullerenes and Carbon Nanotubes- M.S. Dresselhaus, G. Dresselhaus and P.C. Eklund

Table 1: COs versus POs mapping

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, 11-15 3 →

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

COURSE CODE	**XNT803**	**L**	**T**	**P**	**C**
COURSE NAME	**CAREER DEVELOPMENT SKILLS**	**0**	**0**	**1**	**0**
C:P:A	**1:1:1**	**L**	**T**	**P**	**H**
PREREQUISITE		**0**	**0**	**1**	**1**

COURSE OUTCOMES		**Domain**	**Level**
CO1	***Identify*** career related communication, and learning the different formats of CV / Resume.	Cognitive	Remember
CO2	***Prepare*** for an interview and to learn how to face for an interview	Psychomoto r	Set
CO3	***Perform /communicate*** effectively with a group of people in a group discussion	Affective	Respond

UNIT - I	OVERVIEW AND INTRODUCTION	10

CV Writing; difference between resume and CV; characteristics of resume and CV; basic elements of CV and resume, use of graphics in resume and CV; forms and functions of Cover Letters.

UNIT – II	MEMS FABRICATION TECHNOLOGIES	10

Interview skills; tips for various types of interviews. Types of questions asked; body language, etiquette and dress code in interview, interview mistakes, telephonic interview , Video Conference, frequently asked questions. Planning for the interview.

UNIT - III	MICRO SENSORS	10

Mock interviews - workshop on CV writing – Group Discussion

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
0	0	30	30

TEXT BOOK

1. Paul McGee Hachette, *How To Write a CV That Really Works*: A Concise, Clear and Comprehensive Guide to Writing an Effective CV UK, 2014
2. Mary Ellen Guffey, Dana Loewy, *Essentials of Business Communication*, Cengage Learning, 2012

REFERENCES

1. Michael Spiropoulos,*Interview Skills that win the job:* Simple techniques for answering all the tough questions, , Allen & Unwin, 2005
2. William L. Fleisher, Nathan J. Gordon, *Effective Interviewing and Interrogation* Techniques, , Academic Press, 2010

Table 1 : COs versus POs mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO10	PO11	PO12	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

1-5 → 1, 6-10 → 2, 11-15 → 3

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

COURSE CODE	XNT804	L	T	P	C

COURSE NAME	**MEMS/NEMS**	**3**	**1**	**0**	**4**
C:P:A	**2:0.5:0.5**	**L**	**T**	**P**	**H**
PREREQUISITE	**Physics,Chemistry and Material Science**	**3**	**2**	**0**	**5**

COURSE OUTCOMES		**Domain**	**Level**
CO1	Ability to understand the operation of micro devices, micro systems and their applications	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	Ability to design the micro devices, micro systems using the MEMS fabrication process.	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	Gain a knowledge of basic approaches for various sensor design	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	Gain a knowledge of basic approaches for various actuator design	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	Develop experience on micro/nano systems for photonics. Gain the technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices.	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	**OVERVIEW AND INTRODUCTION**	**9+6**
New trends in Engineering and Science: Micro and Nano scale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals		
UNIT – II	**MEMS FABRICATION TECHNOLOGIES**	**9+6**
Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation.Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies,		

Selection of packaging materials

UNIT - III	**MICRO SENSORS**	**9+6**

MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor

UNIT – IV	**MICRO ACTUATORS**	**9+6**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators

UNIT – V	**NANOSYSTEMS AND QUANTUM MECHANICS**	**9+6**

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Shrodinger Equation and Wavefunction Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

TOTAL HOURS

Lecture	**Tutorial**	**Practical**	**Total**
45	**0**	**30**	**75**

TEXT BOOK

1. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001

REFERENCES:

1. Tai Ran Hsu ,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.
2. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006
3. www.tutorials point.com

Table 1 : COs versus POs mapping

CO/PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO10**	**PO11**	**PO12**	**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	

1-5 →1, 6-10 →2, 11-15 3 →

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

<table>
<tr><td>COURSE CODE</td><td colspan="2">XNT805</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>COURSE NAME</td><td colspan="2">SURFACE PLASMON RESONANCE</td><td>3</td><td>0</td><td>1</td><td>4</td></tr>
<tr><td>C:P:A</td><td colspan="2">2:0.5:0.5</td><td>L</td><td>T</td><td>P</td><td>H</td></tr>
<tr><td>PREREQUISITE</td><td colspan="2">Physics,Chemistry and Material Science</td><td>3</td><td>0</td><td>2</td><td>5</td></tr>
<tr><td colspan="2">COURSE OUTCOMES</td><td>Domain</td><td colspan="4">Level</td></tr>
<tr><td>CO1</td><td>Ability to understand the operation of micro devices, micro systems and their applications</td><td>Cognitive

Psychomotor

Affective</td><td colspan="4">Understand
Remember
Applying
Guided response
Organizing</td></tr>
<tr><td>CO2</td><td>Ability to design the micro devices, micro systems using the MEMS fabrication process.</td><td>Cognitive

Psychomotor

Affective</td><td colspan="4">Understand
Remember
Applying
Guided response
Organizing</td></tr>
<tr><td>CO3</td><td>Gain a knowledge of basic approaches for various sensor design</td><td>Cognitive

Psychomotor

Affective</td><td colspan="4">Understand
Remember
Applying
Guided response
Organizing</td></tr>
<tr><td>CO4</td><td>Gain a knowledge of basic approaches for various actuator design</td><td>Cognitive

Psychomotor

Affective</td><td colspan="4">Understand
Remember
Applying
Guided response
Organizing</td></tr>
<tr><td>CO5</td><td>Develop experience on micro/nano systems for photonics.
Gain the technical knowledge required for computer-aided design, fabrication, analysisand characterization of nano-structured materials, micro- and nano-scale devices.</td><td>Cognitive

Psychomotor

Affective</td><td colspan="4">Understand
Remember
Applying
Guided response
Organizing</td></tr>
<tr><td>UNIT - I</td><td colspan="2">ELECTROMAGNETICS OF METALS</td><td colspan="4">9+6</td></tr>
<tr><td colspan="7">Maxwell’s Equations and Electromagnetic Wave Propagation, The Dielectric Function of the Free Electron Gas, The Dispersion of the Free Electron Gas and Volume Plasmon, Real Metals and Interband Transitions, The Energy of the Electromagnetic Field in Metals.</td></tr>
<tr><td>UNIT – II</td><td colspan="2">SURFACEPLASMONPOLARITONSATMETAL/INSULATOR INTERFACES</td><td colspan="4">9+6</td></tr>
<tr><td colspan="7">The Wave Equation, Surface Plasmon Polaritons at a Single Interface, Multilayer Systems,</td></tr>
</table>

Energy Confinement and the Effective Mode Length		
UNIT - III	**EXCITATION OF SURFACE PLASMON POLARITONS AT PLANAR INTERFACES**	**9+6**
Excitation upon Charged Particle Impact, Prism Coupling, Grating Coupling, Excitation Using Highly Focused Optical Beams, Near-Field Excitation, Coupling Schemes Suitable for Integration with Conventional Photonic Elements		
UNIT – IV	**IMAGING SURFACE PLASMON POLARITON PROPAGATION**	**9+6**
Near-Field Microscopy , Fluorescence Imaging , Leakage Radiation , Scattered Light Imaging		
UNIT – V	**LOCALIZED SURFACE PLASMONS**	**9+6**
Normal Modes of Sub-Wavelength Metal Particles, Mie Theory, Beyond the Quasi-Static Approximation and Plasmon Lifetime, Real Particles: Observations of Particle Plasmon, Coupling Between Localized Plasmon, Void Plasmon and Metallic Nanoshells, Localized Plasmon and Gain Medi		
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
45	**0**	**30**	**75**

TEXT BOOK

2. Marc Madou, “Fundamentals of Micro fabrication”, CRC press 1997.
3. Stephen D. Senturia,” Micro system Design”, Kluwer Academic Publishers,2001

REFERENCES:

4. Tai Ran Hsu ,”MEMS and Microsystems Design and Manufacture” ,Tata Mcraw Hill, 2002.
5. Chang Liu, “Foundations of MEMS”, Pearson education India limited, 2006
6. www.tutorials point.com

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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	

1-5 → 1, 6-10 → 2, 11-15 3 →

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

COURSE CODE	XNT806	L	T	P	C
COURSE NAME	Mini Project	0	0	0	12
COURSE OUTCOMES		DOMAIN		LEVEL	
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments/theory	Cognitive Psychomotor		Understand Remember Guided Response	
CO2	skilled in problem solving, critical thinking and analytical reasoning as applied to scientific 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 science and technology.	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				
Minor 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 CODE	XNT1001	L	T	P	C
COURSE NAME	Peroject Phase I	0	0	0	12
COURSE OUTCOMES		DOMAIN		LEVEL	
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies	Cognitive Psychomotor		Understand Remember Guided Response	
CO2	skilled in problem solving, critical thinking and analytical reasoning as applied to	Cognitive Psychomotor Affective		Understand, Guided Response	

	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 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	**YNT 303**	**L**	**T**	**P**	**C**
COURSE NAME	**Dissertation Phase -I**	**0**	**0**	**0**	**8**

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies	Cognitive Psychomotor	Understand Remember Guided 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		
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			

	YNT 303	**L**	**T**	**P**	**C**

COURSE CODE					
COURSE NAME	**Dissertation Phase -II**	**0**	**0**	**0**	**12**

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies	Cognitive Psychomotor	Understand Remember Guided 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		
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 CODE	**QNT301C**	**L**	**T**	**P**	**C**
COURSE NAME	**CARBON NANOTUBE ELECTRONICS AND DEVICES**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		3	**0**	**0**	**3**

UNIT I	**Basics of Carbon Nanotubes**	**9**
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 graphene – Electron transport properties of SWNTs – Scattering in SWNTs – Carrier mobility in SWNTs.		
UNIT II	**Synthesis 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 – Controlling the SWNT growth – Location, Orientation, Chirality – Narrowing diameter distributions – Chirality distribution analysis for different CVD processes – Selective removal of the metallic nanotubes in FET devices – Integration		
UNIT III	**Carbon Nanotube Field-Effect Transistors**	**9**
Schottky barrier heights of metal S/D contacts – High k-gate dielectric integration – Quantum capacitance – Chemical doping – Hysteresis and device passivation – Near ideal,		

Metal-contaced MOSFETs – SWNT MOSFETs – SWNT band-to-band tunnelling FETs		
UNIT IV	**AC Response and Device Simulation 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 phenomena.		
UNIT V	**Carbon Nanotube Device Modeling and Circuit Simulation**	**9**
Schottky barrier SWNT-FET modeling – Compact model for circuit simulation – Model of the intrinsic SWNT channel region – Full SWNT-FET model – Applications of the SWNT-FET compact model – Performance modeling for carbon nanotube interconnects – Circuit models for SWNTs – Circuit models for SWNT bundles – Circuit models for MWNTs – Carbon nanotube interconnects – Applications.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**0**	**0**	**45**

TEXT

1. Ali Javey and Jing Kong, ―Carbon Nanotube Electronics‖ Springer Science media, (2009).
2. Michael J. O'Connell, ―Carbon nanotubes: Properties and Applications‖, CRC/Taylor & Francis, (2006).

REFERENCES

1. Francois Leonard, ―The Physics of Carbon Nanotube Devices‖, William Andrew Inc., (2009).
2. R. Saito and M. S. Drbselmus, ―Physical properties of Carbon Nanotubes‖ Imperial College Press, (1998).

E REFERENCES

1. www.nptel.ac.in
2. www.mit.co.in

COURSE CODE	**YNT301C**	**L**	**T**	**P**	**C**
COURSE NAME	**NANOMANIPULATION & ASSEMBLY**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		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 & combined microscopy tools; nano manipulation for mechanical properties		
UNIT III	**Nano Particle Manipulation by Electrostatic Forces**	9
Theoretical aspects of AC electro kinetics; applications of dielectrophoresis on the nanoscale; limitations of nanoscale dielectrophoresis		
UNIT IV	**Biologically Mediated Assembly of Artificial Nanostructures**	9
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 Architectures from Molecular Building Blocks				9
Bonding & connectivity; molecular building block approaches					
		LECTURE	TUTORIAL	PRACTICAL	TOTAL
		45	0	0	45
TEXT					
1. Electrochemical Nanotechnology by W.J. Lorenz and W.Pleith, IUPAC, Wiley Publications. 2. Handbook of Microscopy for nanotechnology by Nanyo, Zhong Lin Wang. Kluwer academic publish- 2005.					
REFERENCES					
1.“Handbook of Nanostructured Materials & Nanotechnology,” Hari Singh Nalwa (Ed.), Academic Press, 2000. 2.“Scanning Probe Microscopy & Spectroscopy: Theory, Techniques & Applications,” Dawn A Bonnell, Wiley-VCH, 2001. 3.“Micro/Nanotechnology and its Applications,” B. Bhushan, Kluwer Publishers. 4. Robot Hands & Mechanics of Manipulation,” Matthew T. Mason & J. Kenneth Salisbury, MIT Press, 1985. 5. Micro & Nano manipulation tools by Yu Son, Xinyu Liu. Wiley Publications.					
E REFERENCES					
1. www.nptel.ac.in **2.** www.mit.co.in					

COURSE CODE	QNT304	L	T	P	C
COURSE NAME	**NANOMATERIALS CHARACTERIZATION TECHNIQUES**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		3	**0**	**0**	**3**
UNIT I	**Introduction to spectroscopy**				**9**
Basic principles and applications of UV-Vis-NIR, FTIR, FT-Raman, Photoluminescence, NMR, ESR and Light Scattering methods.					
UNIT II	**X – ray techniques**				**9**
X-ray powder diffraction –Quantitative determination of phases; Structure analysis, single crystal diffraction techniques - Determination of accurate lattice parameters - structure analysis-profile analysis - particle size analysis using Scherer formula- Particle Size Analyzer- Ellipsometry- thickness measurements					
UNIT III	**Electron Spectroscopy**				**9**
X-Ray Photoelectron Spectroscopy, Auger Electron Spectroscopy, X-Ray Characterization of Nanomaterials – EDAX and WDA analysis – EPMA - Applications to nanomaterials characterization					

UNIT IV	Mechanical, Magnetic and electrical properties measurement	9
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**	**9**
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

1. "Handbook of Nanostructured Materials and Nanotechnology," vols. 1-5, H. S. Nalwa (Ed.), Academic Press, 2000.
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. www.nptel.ac.in
2. www.mit.co.in

COURSE CODE	QNT401B	L	T	P	C
COURSE NAME	SPECTROSCOPIC TECHNIQUES FOR NANOMATERIALS	3	0	0	3
PREREQUISITES		L	T	P	H

	3	0	0	3

UNIT I	**Nano Optics**	**9**
Basic Concepts-Spontaneous Emission- Classical Bound- Radiating Electron-Quantum Mechanical Radiative Decay-Absorption and Emission - Absorption Coefficient and Absorption Cross-Section,Absorption and Induced Emission-Nano-optics and local spectroscopy -Scanning plasmon near-field optical spectroscopy (SPNM)-near-field optical spectroscopy- nearfield nonlinear optics		
UNIT II	**Molecular Spectroscopies OfNanoassemblies**	**9**
Simplified model for vibrational interactions-Characteristic 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**	**9**
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		
UNIT IV	**Luminescence Spectroscopies**	**9**
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**	**9**
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

1. www.nptel.ac.in
2. www.mit.co.in

COURSE CODE	**YNT403**	**L**	**T**	**P**	**C**
COURSE NAME	**COMPUTATIONAL NANOTECHNOLOGY**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		3	**0**	**0**	**3**

UNIT I	**Physical Modeling**	**9**
Basics of simulation and modeling - Role of simulation in model evaluation and studies - principles used in modeling - Concept of system and environment - continuous and discrete system - linear and nonlinear system - stochastic activities - static and dynamic models - Advantages and Disadvantages of simulation.		
UNIT II	**Computation Based Simulation**	**9**
Technique of simulation - calumnious system models - experimental nature of simulation - numerical computation techniques - Monte Carlo method - analog and hybrid simulation - feedback systems.		
UNIT III	**Probability Concepts in Simulation**	**9**
Stochastic variables - discrete and continuous probability functions - random numbers - generation of random numbers - variance reduction techniques - determination of the length of simulation runs - Output analysis.		
UNIT IV	**Molecular Modeling**	**9**
Introduction to molecular modeling – molecular mechanics- molecular dynamics basic principles - Computing transport in materials - Simulation of crystals with chemical disorder at lattice sites – Design of compound semiconductor alloys using molecular simulations – Optical , electrical and structural property by first principle calculations.		
UNIT V	**Micro and Nanostructure Modeling**	**9**
Studies on microstructure systems using atomistic and mesoscale simulations – Solid liquid phase transition under confinement – Modeling of metals - Simulation protocol – Semiemprical methods - Density functional theory mehods (DFT) - Visualization and analysis.		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
	45	**0**	**0**	**45**

TEXT

1. Erwin Kreyzig, “Advanced Engineering Mathematics”, John Wiley & Sons, 2004

REFERENCES

1. Ramachandran K.I., G. Deepa, K.Namboori “Computational chemistry and molecular modeling – Principles and applications”, Springer, 2008.
2. BeenaRai, “Molecular modeling for the design of Novel performance chemicals and materials”, Taylor & Francis group, 2012.
3. Chistopher.J. Cramer “Essentials of Computational Chemistry- Theories and models”.

John wiley& sons 2004.
E REFERENCES
1. www.nptel.ac.in **2.** www.mit.co.in

COURSE CODE	**QNT 404**	**L**	**T**	**P**	**C**
COURSE NAME	**COMPUTATIONAL NANOTECHNOLOGY LAB**	**0**	**0**	**2**	**2**
PREREQUISITES	Applied Physics , Applied Chemistry, Introduction to nanotechnology and Materials Science	**L**	**T**	**P**	**H**
		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 CODE	**QNT401B**	**L**	**T**	**P**	**C**
COURSE NAME	**SPECTROSCOPIC TECHNIQUES FOR NANOMATERIALS**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		3	**0**	**0**	**3**

UNIT I	**Nano Optics**	**9**
Basic Concepts-Spontaneous Emission- Classical Bound- Radiating Electron-Quantum Mechanical Radiative Decay-Absorption and Emission - Absorption Coefficient and Absorption Cross-Section,Absorption and Induced Emission-Nano-optics and local spectroscopy -Scanning plasmon near-field optical spectroscopy (SPNM)-near-field optical spectroscopy- nearfield nonlinear optics		
UNIT II	**Molecular Spectroscopies OfNanoassemblies**	**9**

Simplified model for vibrational interactions-Characteristic 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**	**9**
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		
UNIT IV	**Luminescence Spectroscopies**	**9**
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**	**9**
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).
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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. www.nptel.ac.in
4. www.mit.co.in

COURSE CODE	**QNT501C**	**L**	**T**	**P**	**C**
COURSE NAME	**NANOMANIPULATION & ASSEMBLY**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
		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 & combined microscopy tools; nano manipulation for mechanical properties		
UNIT III	**Nano Particle Manipulation by Electrostatic Forces**	9
Theoretical aspects of AC electro kinetics; applications of dielectrophoresis on the nanoscale; limitations of nanoscale dielectrophoresis		
UNIT IV	**Biologically Mediated Assembly of Artificial Nanostructures**	9
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 Architectures from Molecular Building Blocks**	9
Bonding & connectivity; molecular building block approaches		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
	45	**0**	**0**	**45**

TEXT

1. Electrochemical Nanotechnology by W.J. Lorenz and W.Pleith, IUPAC, Wiley Publications.
2. Handbook of Microscopy for nanotechnology by Nanyo, Zhong Lin Wang. Kluwer academic publish- 2005.

REFERENCES

1.“Handbook of Nanostructured Materials & Nanotechnology,” Hari Singh Nalwa (Ed.), Academic Press, 2000.
2.“Scanning Probe Microscopy & Spectroscopy: Theory, Techniques & Applications,” Dawn A Bonnell, Wiley-VCH, 2001.
3.“Micro/Nanotechnology and its Applications,” B. Bhushan, Kluwer Publishers.
4. Robot Hands & Mechanics of Manipulation,” Matthew T. Mason & J. Kenneth Salisbury, MIT Press, 1985.
5. Micro & Nano manipulation tools by Yu Son, Xinyu Liu. Wiley Publications.

E REFERENCES

1. www.nptel.ac.in
2. **www.mit.co.in**

COURSE CODE	QNT 502		L	T	P	C
COURSE NAME	**Dissertation Phase -I**		**0**	**0**	**0**	**8**
COURSE OUTCOMES			**DOMAIN**		**LEVEL**	
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies		Cognitive Psychomotor		Understand Remember Guided 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					
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 CODE	QNT 601		L	T	P	C
COURSE NAME	**Dissertation Phase -I**		**0**	**0**	**0**	**12**
COURSE OUTCOMES			**DOMAIN**		**LEVEL**	
CO1	design and carry out scientific experiments as well as accurately record and analyze the results of experiments and simulation studies		Cognitive Psychomotor		Understand Remember Guided	

			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	

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