Nanotechnology Division
Department of ECE

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CURRICULUM & SYLLABUS

(Based on Outcome Based Education)

For

M.Tech. NANOTECHNOLOGY (Integrated)

(REGULAR – 5 Years)

Semester I to X

Regulation: 2015 , 2016, 2017

Head /Nanotech	HOD/ECE	Dean FET	Dean Academics
(Dr. D. Kumar)	(Dr. V. Violet Juli)	(Dr. R. Jayanthi)	(Dr. P.K. Srividhya)

PERIYAR MANIAMMAI UNIVERSITY

Vision		To be a University of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.
Mission	**UM1**	Offering well balanced programmes with scholarly faculty and state-of-art facilities to impart high level of knowledge.
	UM2	Providing student - centred education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.
	UM3	Involving progressive and meaningful research with concern for sustainable development.
	UM4	Enabling the students to acquire the skills for global competencies.
	UM5	Inculcating Universal values, Self respect, Gender equality, Dignity and Ethics.

Core Values

1. Student – centric vocation
2. Academic excellence
3. Social Justice, equity, equality, diversity, empowerment, sustainability
4. Skills and use of technology for global competency.
5. Continual improvement
6. Leadership qualities.
7. Societal needs
8. Learning, a life – long process
9. Team work
10. Entrepreneurship for men and women
11. Rural development
12. Basic, Societal, and applied research on Energy, Environment, and Empowerment.

NANOTECHNOLOGY DIVISION

Vision		To be a pioneer division in offering Nanotechnology education and research with special emphasis on Energy, Environment and Health which would help to serve industry and society for developing cost effective and useful means
Mission	**DM1**	To offer UG, PG and Research Programmes in Nano Technology
	DM2	To incorporate innovative teaching learning methods and teaching aids
	DM3	To nurture requirements of the emerging industrial needs to the students
	DM4	To cultivate the spirit of Entrepreneurship
	DM5	To explore solutions via Nano for the needs of society

Table: 1 Mapping of University Mission (UM) and Department Mission (DM)

	DM1	DM2	DM3	DM4	DM5	Total
UM1	3	2	2	2	2	11
UM2	2	2	2	2	2	10
UM3	2	2	2	2	2	10
UM4	2	1	1	1	1	6
UM5	1	0	1	0	0	2

1-Low 2- Medium 3 – High

PROGRAMME EDUCATIONAL OBJECTIVES

Based on the mission of the department, the programme educational objectives is formulated as

PEO1	To strengthen the application of fundamental knowledge in Mathematics, Science, Engineering and Technology for the benefit of mankind (GA – 1, 2).
PEO2	To enhance the technical competence of identifying, analyzing and creating appropriate engineering solutions. So that the graduates find opportunities in industries, research institutions, etc. including entrepreneurship (GA – 3, 4, 5, 9).
PEO3	To cultivate the habit of lifelong learning and working as a member of the team for successful career and life (GA – 9,10,11,12)
PEO4	To impart awareness of social responsibilities for becoming a responsible citizen. (GA – 6,7,8)

Mapping of Department Mission (DM) with Program Educational Objectives (PEOs)

	DM1	**DM2**	**DM3**	**DM4**	**DM5**
PEO1	3	0	1	1	
PEO2	3	1	2	2	2
PEO3	2	1	1	1	1
PEO4	-	-	1	2	2
	8	**2**	**5**	**6**	**5**
	3	**1**	**2**	**2**	**2**

1 - Low Relation 2 - Medium Relation 3 – High Relation

GRADUATE ATTRIBUTES

1. **Engineering knowledge: Apply** the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM OUTCOMES

PO 1	To provide knowledge and understanding of the key principles of nanotechnology including the relationship between Nano and various sciences, mathematics and Engineering sciences
PO 2	To expose analysis and design techniques and of details of new concepts and technologies relevant to the area of nano.
PO 3	To equip on methods and processes involved in the development and evaluation of different kinds of Nanomaterials and products
PO 4	To equip scientific and intellectual tools required to define and formulate research problems, and to detail the methodologies needed to address them
PO 5	To equip the scientific and intellectual tools required to design and analyze key physics/chemical/biological/engineering processes related to nanotechnology
PO 6	To provide a wide range of intellectual, practical and transferable skills that will allow students to develop careers in nanotechnology research, industry and other professional areas of the economy
PO 7	To develop deep knowledge of nanotechnology applications in society and especially in health/environment/energy
PO 8	To expose industrial designs and processes and to innovations in the nanotechnology industry
PO 9	To develop deep knowledge of standards and the nanotechnology commercial environments and standardisation processes and to be able to contribute to such processes through appreciation of their contexts, economic and regulatory drivers and limitations
PO 10	To provide knowledge and skills to allow for independent learning, individually and/or within a group.
PO 11	To equip on global understanding of the impacts and issues regarding nanotechnology and applications
PO 12	To become a responsible citizen of the society
	PROGRAM SPECIFIC OUTCOME
PSO 1	Knowledge and generation of intellectual capital (Paper, poster, presentation, patent etc) in the areas of Nano architecture, Nanomaterials, Nanosystems, and their encompassing applications
PSO 2	Ability to identify tailor made Nano applications for Local and Societal needs by (a) Improving efficiency of existing systems by developing innovative low cost solutions (b) New product development

Mapping of Program Outcomes (POs) with Graduate Attributes (GAs)

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PO1	3	1	0	0	1	0	0	0	0	0	0	0
PO2	1	3	1	1	1	0	0	0	0	0	0	0
PO3	1	1	3	1	1	0	0	0	0	0	0	0
PO4	1	1	1	3	1	0	0	0	0	0	0	0
PO5	1	1	1	1	3	0	0	0	0	0	0	0
PO6	1	1	1	1	1	3	0	0	0	0	0	0
PO7	1	1	1	1	1	1	3	1	0	0	0	0
PO8	0	0	0	0	0	1	1	3	1	0	0	0
PO9	0	0	0	0	0	0	0	0	3	1	0	0
PO10	0	0	0	0	0	0	0	0	1	3	1	0
PO11	1	1	1	0	1	0	0	0	0	0	3	0
PO12	1	1	1	1	1	0	0	0	0	0	0	3
PSO1	1	0	1	1	2	1	0	1	1	3	2	2
PSO2	0	0	3	0	0	3	3	0	0	0	2	1

1- Low Relation 2 - Medium Relation 3 – High Relation

CURRICULUM

REGULATIONS 2015- REVISION 2

(Applicable to the students admitted from the Academic year 2015– 2020)

SEMESTER I

Subject code	Subject Title	Credits				Hours				
		L	**T**	**P**	**Total**	**L**	**T**	**P**	**S.S**	**Total**
XMA101	Algebra, Differential Calculus and their applications	3	1	0	4	3	2	0	0	5
XEM102	Engineering Mechanics	3	1	0	4	3	2	0	0	5
XBE103	Electrical and Electronics Engineering Systems	3	1	1	5	3	2	2	0	7
XAP104	Applied Physics	3	1	1	5	3	2	2	0	7
XGS105	Study skills and Language Laboratory	1	0	0	1	1	0	2*	0	3
XUM106	Human Ethics, Values, Rights and Gender Equality	1	0	0	1	1	0	0	2*	3
	Total	**14**	**4**	**2**	**20**	**14**	**8**	**6**	**2**	**30**

***Non – credit hours** **Total Credits – 20**

SEMESTER II

Subject code	Subject Title	Credits				Hours			
		L	**T**	**P**	**Total**	**L**	**T**	**P**	**Total**
XMA201	Calculus and Laplace Transforms	3	1	0	4	3	2	0	5
XCP202	Computer Programming	3	0	1	4	3	0	2	5
XBW203	Mechanical and Civil Engineering Systems	3	1	1	5	3	2	2	7
XAC204	Applied Chemistry	3	1	1	5	3	2	2	7
XEG205	Engineering Graphics	2	0	1	3	2	0	2	4
XGS206	Speech Communication	1	0	0	1	1	0	2*	3
	Total	**15**	**3**	**4**	**22**	**15**	**6**	**10**	**31**

***Non – credit hours** **Total Credits – 22**

In-plant training during vocation for 15 days .Credits will be given only in third semester

SEMESTER III

course code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XMA301	Transforms and Partial Differential Equations /Discrete Mathematics	3	1	0	4	3	2	0	0	5
XNT302	Introduction to Nanotechnology	3	1	1	5	3	2	2	0	7
XNT303	Biology for Engineers	3	1	1	5	3	2	2	0	7
XNT304	Fluid Mechanics	3	1	0	4	3	2	0	0	5
OE-1	Open Elective- I	3	0	0	3	3	0	0	0	3
XEP306	Entrepreneurship Development and Management	2	0	0	2	2	0	0	0	2
XGS307	Interpersonal Communication	0	1	0	1	0	1	0	2*	3
XNT308	In Plant Training	0	0	0	1	0	0	0	0	0
	Total	**17**	**5**	**2**	**25**	**18**	**9**	**4**	**2**	**33**

***Non – credit hours** **Total Credits – 25**

SEMESTER IV

Course code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XRP401	Random Processes	2	1	0	3	2	2	0	0	4
XUM402	Environmental Science and Engineering	3	0	0	3	3	0	0	0	3
XNT403	Principles of Chemical Engineering	3	1	1	5	3	2	2	0	7
XNT404	Nano Applications	3	0	0	3	3	0	0	0	3
XMS405	Materials Science	3	1	0	4	3	1	0	0	4
XNT406	Nanosystems and their Design	3	1	1	5	3	2	2	0	7
XGS407	Technical Communication	0	1	0	1	0	1	0	2*	3
	Total	**17**	**5**	**2**	**24**	**17**	**8**	**4**	**2**	**31**

***Non – credit hours** **Total Credits – 24**

In-plant training during vocation for 30 days. Credits will be given only in Fifth semester.

SEMESTER V

Course Code	Course Name	Credits				Hours				
		L	**T**	**P**	**Total**	**L**	**T**	**P**	**S.S**	**Total**
XNT501	Quantum Mechanics for Engineers	3	1	0	4	3	2	0	0	5
XNT502	Nanomaterials Fabrication Techniques- I	3	0	1	4	3	0	2	0	5
OE – II	Open Elective –II	3	0	0	3	3	0	0	0	3
XNT504	Nanomaterials Characterization Techniques- I	3	0	1	4	3	0	2	0	5
XNT505	Engineering Thermodynamics	3	1	0	4	3	2	0	0	5
XNT506*	Elective (Core) –I	2	0	1	3	2	0	2	0	4
XGS507	Business Communication	1	0	0	1	1	0	2	0	3
XNT508	In Plant Training	0	0	0	1	0	0	0	0	0
	Total	**18**	**2**	**3**	**24**	**18**	**4**	**8**	**0**	**30**

Total Credits – 24

SEMESTER VI

Course code	Course Name	Credits				Hours				
		L	**T**	**P**	**Total**	**L**	**T**	**P**	**S.S**	**Total**
XNT601	Total Quality Management	3	0	0	3	3	0	0	0	3
XNT602	Colloids and surfaces Engineering	3	0	1	4	3	0	2	0	5
XNT603	Nanomaterials Fabrication Techniques- II	3	0	1	4	3	0	2	0	5
XNT604	Nanomaterials Characterization Techniques- II	3	1	1	5	3	2	2	0	7
XNT605*	Elective (Core) – II	2	0	1	3	2	0	2	0	4
XNT606*	Elective (Core) – III	2	0	1	3	2	0	2	0	4
XGS607	Academic Writing	0	0	0	0	0	0	0	2*	2*
	Total	**16**	**1**	**5**	**22**	**16**	**2**	**10**	**2**	**30**

Total Credits - 22

In-plant training during vocation for 45 days. Credits will be given only in Eighth semester.

SEMESTER VII

Course Code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT701	Cyber security	3	0	0	3	3	0	0	0	3
XNT702	Health and safety issues of Nanotechnology	3	0	0	3	3	0	0	0	3
XNT703	Nano composites	3	1	1	5	3	2	2	0	7
OE –III	Open Elective – III	3	0	0	3	3	0	0	0	3
XNT705*	Elective (Core) – IV	2	0	1	3	2	0	2	0	4
XNT706*	Elective (Core) – V	2	0	1	3	2	0	2	0	4
XNT707	Project Theme – I	0	0	0	0	0	0	0	2	2
XNT708	In Plant Training	0	0	0	1	0	0	0	0	0
	Total	**16**	**1**	**3**	**21**	**16**	**2**	**6**	**2**	**26**

Total Credits- 21

SEMESTER VIII

Course Code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
OE-IV	Open Elective – IV	3	0	0	3	3	0	0	0	3
XNT802*	Elective (Core) – VI	2	0	1	3	2	0	2	0	4
XNT803	Career Development Skills	0	0	0	0	0	0	0	2*	2
XNT804	MEMS and NEMS	3	1	0	4	3	2	0	0	5
XNT805	Surface Plasmon Resonance	3	1	1	5	3	2	2	0	7
XNT806	Mini Project	0	0	0	4	0	0	4	0	4
XNT807	Project Theme – II	0	0	0	0	0	0	0	2	2
OE-V	Open Elective – V	3	0	0	3	3	0	0	0	3
	Total	**14**	**2**	**2**	**22**	**14**	**4**	**8**	**2**	**30**

Total Credits - 22

SEMESTER IX

Course code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT901	Project Work – Phase I	0	0	0	8	0	0	0	0	0
	Total	0	0	0	8	0	0	0	0	0

Total Credits - 8

SEMESTER X

Course code	Course Name	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT1001	Project Work – Phase II	0	0	0	12	0	0	0	0	0
	Total	0	0	0	12	0	0	0	0	0

Total Credits - 12

Grant Total Credits: 200

LIST OF CORE ELECTIVES

CORE ELECTIVES SET– I

Sub. Code	Name of the Course	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT506A	Emerging tools for Biology and Medicine	2	0	1	3	2	0	2	0	4
XNT506B	Enzyme Technology	2	0	1	3	2	0	2	0	4
XNT506C	Electric and Electronic Circuits	2	0	1	3	2	0	2	0	4
XNT506D	Mechanical Systems Design	2	0	1	3	2	0	2	0	4
XNT 507E	Mechanics of Materials	2	0	1	3	2	0	2	0	4

CORE ELECTIVES SET– II

Sub. Code	Name of the Course	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT605A	Nano-Physics	2	0	1	3	2	0	2	0	4
XNT605B	Molecular assembler –Molecular modelling	2	0	1	3	2	0	2	0	4
XNT605C	Nano-Sensors, Nano-actuators and Nano-probes	2	0	1	3	2	0	2	0	4
XNT605D	Nanorobotics	2	0	1	3	2	0	2	0	4
XNT605E	Nano-Optics and Nano-Photonics	2	0	1	3	2	0	2	0	4

CORE ELECTIVES SET– III

Sub. Code	Name of the Course	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT606A	Nanostructured Molecular Architectures	2	0	1	3	2	0	2	0	4
XNT606B	Nanophotonics for Biotechnology and Nanomedicine	2	0	1	3	2	0	2	0	4
XNT606C	Nano-Spintronics	2	0	1	3	2	0	2	0	4
XNT606D	Nanomaterials and photocatalytic nanoparticles for water/air detoxification	2	0	1	3	2	0	2	0	4

CORE ELECTIVES SET– IV

Sub. Code	Name of the Course	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT705A	Encapsulation Techniques	2	0	1	3	2	0	2	0	4
XNT705B	Lithographic techniques	2	0	1	3	2	0	2	0	4
XNT705C	Self Assembly Techniques	2	0	1	3	2	0	2	0	4
XNT705D	Nano in Wireless Communications	2	0	1	3	2	0	2	0	4
XNT705E	Optimization Techniques	2	0	1	3	2	0	2	0	4

CORE ELECTIVES SET– V

Sub. Code	Name of the Course	Credits				Hours				
		L	T	P	Total	L	T	P	S.S	Total
XNT706A	MEMS and NEMS Fabrication	2	0	1	3	2	0	2	0	4
XNT706B	Nanocoatings	2	0	1	3	2	0	2	0	4
XNT706C	Thin Film	2	0	1	3	2	0	2	0	4
XNT706D	Nanoscaffold and Characterization Techniques	2	0	1	3	2	0	2	0	4
XNT706E	Nano & Shockwaves	2	0	1	3	2	0	2	0	4

CORE ELECTIVES SET– VI

Sub. Code	Name of the Course	L	T	P	C
XNT803A	Graphene Nanotechnology	2	0	1	3
XNT803B	Carbon Nanotube	2	0	1	3
XNT803C	Fullerene	2	0	1	3
XNT803D	Quantom Dot	2	0	1	3
XNT803E	Polymeric Carrier	2	0	1	3
XNT803F	Lignocelluloses Biomass	2	0	1	3

OPEN ELECTIVES

Sub. Code	Name of the Course	L	T	P	C	H
XNTOE 1	Introduction to Nanotechnology	3	0	0	3	3
XNTOE 2	Nano Applications	3	0	0	3	3
XNTOE3	Nanomaterials	3	0	0	3	3

SYLLABUS
I SEMESTER

COURSE CODE		**XMA 101**	**L**	**T**	**P**	**C**
COURSE NAME		**ALGEBRA, DIFFERENTIAL CALCULUS AND THEIR APPLICATIONS**	**3**	**1**	**0**	**4**
PREREQUISITES		Basic concepts of Matrices, Numbers, Differentiation and Integration	**L**	**T**	**P**	**H**
C:P:A		**3:0:0**	**3**	**2**	**0**	**5**
COURSE OUTCOMES		**DOMAIN**	**LEVEL**			
CO1	***Explain*** the Properties of eigen values and eigen vectors of the matrices, ***Make Use of*** orthogonal and similarity transformation and ***Construct*** the quadratic form to Canonical form	Cognitive	Understanding Apply			
CO2	***Define*** and ***Find*** the radius and circle of curvature in cartesian and polar coordinates and to ***Explain*** evolutes and envelopes.	Cognitive	Remembering Understanding			
CO3	***Explain*** the convergence of series of positive terms, alternating series, and power series using tests of convergence.	Cognitive	Understanding			
CO4	***Find*** total and partial derivatives, Taylor series expansions of functions and the extremum of functions and their applications.	Cognitive	Remembering			
CO5	***Solve*** the linear equations of second and higher order with constant and variable coefficients and simultaneous first order differential equations and to ***Apply*** Method of variation of parameters to ***Solve*** the differential equation.	Cognitive	Apply			
UNIT I	**MATRICES**					**15**
Eigen values and Eigenvectors of a real matrix –Properties of Eigen values and Eigen vectors – Cayley-Hamilton theorem (excluding proof) - Similarity transformation (Concept only) – Orthogonal matrix - Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to Canonical form by Orthogonal transformation.						

UNIT II	GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS	15
Curvature – Cartesian and polar co-ordinates – Centre and radius of curvature – Circle of curvature – Involutes and evolutes – Envelopes – Properties of envelopes and evolutes.		
UNIT III	**INFINITE SERIES**	**15**
Sequences – Convergence of series – General properties – Series of positive terms – Tests of convergence (Comparison test, Integral test, Comparison of ratios and D'Alembert's ratio test – Statement of theorems and problems only) – Alternating series – Series of positive and negative terms – Absolute and conditional convergence – Power Series – Convergence of exponential, logarithmic and Binomial Series (Simple problems only)		
UNIT IV	**FUNCTIONS OF SEVERAL VARIABLES**	**15**
Functions of two variables – Partial derivatives – Total differentiation – Taylor's expansion – Maxima and Minima – Constrained maxima and minima – Lagrange's Multiplier method – Jacobian Determinants.		
UNIT V	**ORDINARY DIFFERENTIAL EQUATIONS AND APPLICATIONS**	**15**
Linear equations of second and higher order with constant and variable coefficients (Euler's and Legendre's equations) – Simultaneous first order linear equations with constant coefficients – Method of variation of parameters - Applications to electrical circuit problems.		

	LECTURE	TUTORIAL	TOTAL
	45	30	75

TEXT

1. Grewal, B.S. Higher Engineering Mathematics, 40th Edition, Khanna Publication, Delhi, 2007.
2. Kreyszig, E, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Son(Asia) Ltd, Singapore, 2001.

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1. Bali N.P and Narayana lyengar, Engineering Mathematics, Laxmi Publications (P) Ltd, New Delhi, 2003.
2. Veerarajan T, Engineering Mathematics Fourth Edition, Tata – McGraw Hill Publishing Company Ltd, New Delhi, 2005.
3. Kandasamy P., Thilagavathy K, and Gunavathy K, Engineering Mathematics Volume I, II and III, S. Chand & Co, New Delhi, 2005.
4. Venkataraman M. K, Engineering Mathematics, Volume I and II Revised enlarge Fourth Edition, The National Publishing Company, Chennai, 2004.

E REFERENCES

www.nptel.ac.in

Advanced Engineering Mathematics Prof. Pratima Panigrahi
Department of Mathematics Indian Institute of Technology, Kharagpur.

TABLE 1: CO VS PO Mapping

	PO1	PO2	PO3	PO4	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2			2						1		2
CO 2	3	1									1		1
CO 3	3	1									1		1
CO 4	3	2									1		1
CO 5	3	2			1						1		2
	15	8	0	0	3	0	0	0	0	0	5	0	7

COURSE CODE		XEM102	L	T	P	C
COURSE NAME		ENGINEERING MECHANICS	3	1	0	4
PREREQUISITES		Nil	L	T	P	H
C:P:A		2.6:0.2:0.2	3	2	0	5
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Identify*** and ***choose*** various types of loading and support conditions that act on structural and dynamic systems.	Cognitive	(Understand)			
CO2	***Apply*** pertinent mathematical, physical and engineering mechanics principles to the system to predict the problem.	Cognitive	Rem, Ap & Ev			
CO3	**Apply** knowledge on the concepts of centroid and moment of inertia of various sections and solids.	Cognitive& p	Rem, Ap&Ev			
CO4	***Model*** the problem using free-body diagrams and accurate equilibrium equations and finding the solution.	Cognitive	Analyze			
CO5	***Develop*** concepts of friction, rigid body kinematics and dynamics with an emphasis on the modeling and analysis and solving simple dynamic problems involving kinematics and momentum.	Cognitive& p	Rem, Ap&Ev			
UNIT I	**BASICS AND STATICS OF PARTICLES**					**15**
Eigen values and Eigenvectors of a real matrix –Properties of Eigen values and Eigen vectors – Cayley-Hamilton theorem (excluding proof) - Similarity transformation (Concept only) – Orthogonal matrix - Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to Canonical form by Orthogonal transformation.						
UNIT II	**EQUILIBRIUM OF RIGID BODIES**					**15**
Curvature – Cartesian and polar co-ordinates – Centre and radius of curvature – Circle of curvature – Involutes and evolutes – Envelopes – Properties of envelopes and evolutes.						
UNIT III	**PROPERTIES OF SURFACES AND SOLIDS**					**15**
Curvature – Cartesian and polar co-ordinates – Centre and radius of curvature – Circle of curvature – Involutes and evolutes – Envelopes – Properties of envelopes and evolutes.						
UNIT IV	**DYNAMICS OF PARTICLES**					**15**
Functions of two variables – Partial derivatives – Total differentiation – Taylor's expansion – Maxima and Minima – Constrained maxima and minima – Lagrange's Multiplier method – Jacobian Determinants.						

UNIT V	ELEMENTS OF RIGID BODY DYNAMICS AND FRICTION	15

Linear equations of second and higher order with constant and variable coefficients (Euler's and Legendre's equations) – Simultaneous first order linear equations with constant coefficients – Method of variation of parameters - Applications to electrical circuit problems.

	LECTURE	TUTORIAL	TOTAL
	45	30	75

TEXT

1. Grewal, B.S. Higher Engineering Mathematics, 40th Edition, Khanna Publishers, Delhi, 2007.
2. Kreyszig, E, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Sons(Asia) Ltd, Singapore, 2001.

REFERENCES

1. Bali N.P and Narayana lyengar, Engineering Mathematics, Laxmi Publications (P) Ltd, New Delhi, 2003.
2. Veerarajan T, Engineering Mathematics Fourth Edition, Tata – McGraw Hill Publishing Company Ltd, New Delhi, 2005.
3. Kandasamy P., Thilagavathy K, and Gunavathy K, Engineering Mathematics Volume I, II and III, S. Chand & Co, New Delhi, 2005.
4. Venkataraman M. K, Engineering Mathematics, Volume I and II Revised enlarge Fourth Edition, The National Publishing Company, Chennai, 2004.

E-References

1. Advanced Engineering Mathematics Prof. Pratima Panigrahi Department of

Mapping of CO's with PO's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3												
CO2	3	3												
CO3	3	3												
CO4	3	3												
CO5	3	3												

1 – Low relation, 2 – Medium relation, 3 – High relation 0- no relation

COURSE CODE		XBE103	L	T	P	C
COURSE NAME		ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS (BEE LAB INCLUDED)	3	1	1	5
PREREQUISITES			L	T	P	H
C:P:A		3:1:0	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Define, Relate,*** the fundamentals of electrical parameters and***build*** and ***explain***AC, DC circuits by Using measuring devices	Cognitive Psychomotor	Remember Understand Mechanism set			
CO2	***Define and Explain***the of operation of DCand AC machines.	Cognitive	Remember Understand			
CO3	***Recall, Illustrate,*** various semiconductor Devices and their applications and ***displays*** the input output characteristics of basic semiconductor devices.	Cognitive Psychomotor	Remember Understand Mechanism			
CO4	***Relate, Explain,*** the number systems and logic gates. ***Construc***t the different digital circuit.	Cognitive Psychomotor	Remember Understand Origination			
CO5	***Label, Outline*** different types of microprocessors and their applications.	Cognitive	Remember Understand			
UNIT I	**FUNDAMENTAL OF DC AND AC CIRCUITS, MEASUREMENTS**		**9+9+12**			
Fundamentals of DC– Ohm's Law – Kirchoff's Laws - Sources - Voltage and Current relations – Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities - Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter). Basic concepts of electrical wiring.						
UNIT II	**ELECTRICAL MACHINES**		**9 + 6+0**			
Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single Phase Transformer, Three phase transformers, Auto transformer.						
UNIT III	**SEMICONDUCTOR DEVICES**		**9 + 3+8**			
Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode – Zener Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications.						

UNIT IV	DIGITAL ELECTRONICS	9 + 6+10
Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.		
UNIT V	**MICROPROCESSORS**	**9+ 6+0**
Architecture, 8085, 8086 - Interfacing Basics: Data transfer concepts – Simple Programming concepts		

LIST OF EXPERIMENTS :

1.	Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.
2.	Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
3.	Verification of AC Voltage, Current and Power in Series and Parallel connection.
4.	Testing of DC Voltage and Current in series and parallel resistors which are connected in breadboard by using Voltmeter, Ammeter and Multimeter.
5.	Fluorescent lamp connection with choke.
6.	Staircase Wiring.
7.	Forward and Reverse bias characteristics of PN junction diode .
8.	Forward and Reverse bias characteristics of Zener diode.
9.	Input and Output Characteristics of NPN transistor.
10.	Construction and verification of simple Logic Gates
11.	Construction and verification of adders
12.	Construction and verification of and subtractions

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**30**	**30**	**105**

TEXT

1.Metha V.K., 2008. Principles of Electronics. S.Chand and Company .

2.Malvino, A. P., 2006. Electronics Principles. 7th ed. New Delhi: Tata McGraw-Hill.

3. A.K. Theraja, B.L.,TherajaA Text book of Electrical Technology Volume -II

3.Rajakamal, 2007. Digital System-Principle & Design. 2nd ed. Pearson education.

4.Moris Mano, 1999. Digital Design. Prentice Hall of India.

5.Ramesh, S. Gaonkar, 2000. Microprocessor Architecture, Programming and its Applications with the 8085. 4th ed. India: Penram International Publications.

REFERENCES

1.Corton,H.,2004. Electrical Technology. CBS Publishers & Distributors.

2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.

3. Jacob Millman and Christos, C. Halkias, 1967. Electronics Devices.New Delhi: McGraw-Hill.

4. Millman, J. andHalkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and Systems. Tokyo: McGraw-Hill, Kogakusha Ltd.

5.MohammedRafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E REFERENCES

1.NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya and Prof. G. D. Roy, IIT Kharagpur.

2. Prof.L.Umanand ,http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.

3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura , IIT Madras.

4. Dr.LUmanand , http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Bangalore

Table: 1 Mapping of COs with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3		2	1				1			1		
CO 2	2	3		1	1							1		
CO 3	2	3		2	1				1			1		
CO 4	3	3		3	1				1			1		
CO 5	2	3		1	1							1		
Total	12	15		13	5				3			5		
Scaled value	3	3		3	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		XAP104 / XAP204	L	T	P	C
COURSE NAME		APPLIED PHYSICS	3	1	1	5
PREREQUISITES		2.8:0.8:0.4	L	T	P	H
C:P:A		Basic Physics in HSC level	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Identify*** the basics of mechanics, explain the principles of elasticity, viscosity and ***determine*** its significance in engineering systems and technological advances.	Cognitive: Psychomotor:	Remember, Understand Mechanism			
CO2	***Describe*** the production, propagation, perception & analysis of acoustical wave and ***locate*** basic acoustical problem encountered in constructed buildings.	Cognitive: Affective:	Remember, Analyze, Respond			
CO3	***Understand*** the fundamental phenomena in optics by measurement and ***describe*** the working principle and application of various lasers and fibre optics.	Cognitive: Psychomotor: Affective:	Understand, Apply Mechanism Receive			
CO4	***Analyse*** different crystal structures, ***discuss*** and ***use*** physics principles of latest technology by visualizing.	Cognitive: Psychomotor: Affective:	Understand, Analyze Mechanism Receive			
CO5	***Develop*** Knowledge on engineering materials, its properties and application.	Cognitive:	U, App			
UNIT I	**MECHANICS ANDPROPERTIES OF MATTER**		**9+6+12**			

Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction.

Elasticity: Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending - I shape girders.

Viscosity: Coefficient of viscosity - Laminar flow - streamline flow - turbulent flow - Reynold's number - Poiseuille's method.

UNIT II	**ACOUSTICS, ULTRASONICS AND SHOCK WAVES**	**9+6+0**

Acoustics: Classification of sound - Characteristics of musical sound - Loudness - Weber Fechner law - Decibel - Absorption coefficient - Reverberation - Reverberation time - Sabin's formula (growth and decay) - Factors affecting acoustics of buildings (reverberation time, loudness, focussing, echo, echelon effect - resonance and noise) and their remedies.

Ultrasonics: Production: Magnetostriction and Piezoelectric methods - NDT: Ultrasonic flaw detector.

Shock waves: Definition of Mach number - Description of a shock wave - Characteristics - Methods of creating shock waves.

UNIT III	**OPTICS, LASERS AND FIBRE OPTICS**	**9+6+12**

Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating.

LASER: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser -

Semiconductor Laser (homojunction) - Applications

Fibre Optics: Principle and propagation of light in optical fibre - Numerical aperture and acceptance angle - Types of optical fibre - Fibre optic communication system

UNIT IV	SOLID STATE PHYSICS	9+6+6

Crystal Physics: Lattice - Unit cell - Lattice planes - Bravais lattice - Miller indices - Sketching a plane in a cubic lattice - Calculation of number of atoms per unit cell - Atomic radius - Coordination number - Packing density for SC, BCC, FCC and HCP structures.

Semiconductors: Semiconductor properties - Types of semiconductor - Intrinsic - Extrinsic: P-type and N-type semiconductor - PN junction diode - Biasing - Junction diode characteristics.

UNIT V	NOVEL ENGINEERING MATERIALS AND BIOMETRICS	9+6+0

Novel Engineering Materials: Introduction - Metallic glasses: Melt spinning technique, properties, applications - Shape Memory Alloys: Transformation temperature, working of SMA, characteristics - Biomaterials: Properties, interaction of biomaterials with tissues, applications - Nano phase materials: Production, properties and applications.

Biometrics: Introduction - definition - instrumentation - devices -advantages

TEXT

1. Avadhanulu M. N. and Kshirsagar P. G., "A Text Book of Engineering Physics", 7th Enlarged Revised Edition. S. Chand & Company Ltd., New Delhi, 2005.
2. Senthil Kumar G., “Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers, Chennai, 2003.
3. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2005.
4. Prabu P. and Gayathri P., " Applied Physics", PMU Press, Thanjavur, 2013

REFERENCES

1. Gaur R.K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publishers, New Delhi, 2001.
2. Pillai S.O., "Solid State Physics", 5th Edition, New Age International Publication, New Delhi, 2003.

E RESOURCES

NPTEL, Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

LABORATORY

1.	Torsional Pendulum - determination of moment of inertia and rigidity modulus of the given material of the wire.
2.	Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3.	Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4.	Poiseuille's flow - Determination of coefficient of viscosity of the given liquid.
5.	Spectrometer - Determination of dispersive power of the give prism.
6.	Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7.	Air wedge - Determination of thickness of a given thin wire.
8.	Laser - Determination of wavelength of given laser source and size of the given micro particle using Laser grating.
9.	Post office Box - Determination of band gap of a given semiconductor.
10.	PN Junction Diode - Determination of V-I characteristics of the given diode.

REFERENCE BOOKS

1. Srinivasan M. & others, "A text book of Practical Physics", Sultan Chand & Sons, 2001.
2. Shukla R.K., "Practical Physics", New Age International Publication, New Delhi, 2011.
3. Umayal Sundari AR., "Applied Physics Laboratory Manual", PMU Press, Thanjavur, 2012.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
	45	**30**	**30**	**105**

Mapping of CO's with PO:

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS1	PS2
CO1	3	2	2	2	1	-	-	-	1	-	-	1		
CO2	3		1		1	-	-	-		-	-	1		
CO3	3	2	2	2	1	-	-	-	1	-	-	1		
CO4	3	2	2	2	1	-	-	-	1	-	-	1		
CO5	3		2			-	-	-		-	-	1		
Total	15	6	9	6	4				3			5		
Scaled to 0,1,2,3 scale	3	2	2	2	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		XGS105	L	T	P	SS	C
COURSE NAME		STUDY SKILLS	1	0	0	2	1
PREREQUISITES			L	T	P	SS	H
C:P:A		1.8:0.6:0.6	1	0	0	2	3
COURSE OUTCOMES		DOMAIN		LEVEL			
CO1	***Identify*** different strategies of reading and writing skills.	Cognitive		Remember			
CO2	***Revise*** the library skills in their learning process.	Affective		Internalizing Values			
CO3	***Apply*** different techniques to various types of material such as a novel, newspaper, poem, drama and other reading papers.	Cognitive		Apply			
CO4	***Use*** visual aids to support verbal matters into language discourse.	Cognitive		Understanding			
CO5	***Prepare*** to face the written exam with confidence and without any fear or tension.	Cognitive Psychomotor		Understanding Guided Response			
UNIT I	**INTRODUCTION TO STUDY SKILLS**						5
Learning Skills and Strategies of Learning - Cognitive Study skills and physical study skills, Library skills (How to use Library), familiarization of library facilities by the librarian - familiarization of basic cataloguing techniques, how to ransack the library etc.							
UNIT II	**REFERENCE SKILLS**						5
How to use the library facilities for research and to write assignments - how to find out reference books, articles, journals and other e- learning materials - how to use a dictionary and thesaurus**.**							
UNIT III	**READING RELATED STUDY SKILLS**						
Process of reading, various types of reading materials and varied reading techniques - familiarization to materials written by various authors - features of scientific writing and familiarization to scientific writing by renowned authors - note making skills.							
UNIT IV	**WRITING RELATED STUDY SKILLS**						5
Process of writing - characteristics of writing - discourse analysis - use of visual aids, and note making and note taking skills.							
UNIT V	**EXAM PREPARATION SKILLS**						5
Anxiety reduction skills - familiarization with various types of exam / evaluation techniques etc							
TEXT							
Appropriate Chapters/Units from the following textbooks 1. Narayanaswamy. Strengthen Your Writing. Orient Longman. New Delhi, 2006 2. Sasikumar, Writing with A Purpose, Champa Tickoo, Oxford University Press.2009 3. Freeman, Sarah: *Study Strategies*. New Delhi: Oxford University Press, New Delhi *1979.* 4. Peter Viney. *Streamline English: Destinations*, Oxford University Press, 1992.							
REFERENCES							
1. Susan Fawcett Evergreen: A Guide to Writing with Readings Paperback – 2013 *2.* Raymond Murphy. English. Grammar in Use A reference and practice book *for* Intermediate, Third Edition, OUP, New Delhi, 2010							

3. Kiranmai Dutt and Geetha Rajeevan. *A Course in Listening and Speaking* I & II. New Delhi: Foundation Books, Cambridge House, 2006.
4. David Bolton, English Grammar in Steps, Richmond Publishing, New Delhi,2000

Table 1: Mapping of Cos with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO1	0	0	0	0	0	3	0	0	0	0	0	0	0	0
CO2	0	0	0	0	0	0	3	0	0	3	0	0	0	0
CO3	0	0	0	0	0	0	0	0	0	1	0	1	0	0
CO4	0	2	0	0	0	3	0	0	2	1	0	0	0	0
CO5	0	0	0	0	0	0	0	0	0	3	2	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaled Value	0	2	0	0	0	6	3	0	2	8	0	1	0	0
	0	1	0	0	0	2	1	0	1	2	0	1	0	0

1-5= 1, 6-10 = 2, 11-15= 3

0-No Relation, 1- Low Relation, 2 – Medium Relation, 3- High Relation

COURSE CODE		XUM 106	L	T	P	SS	C
COURSE NAME		HUMAN ETHICS,VALUES,RIGHTS AND GENDER EQUALITY	1	0	0	0	1
PREREQUISITES		Not Required	L	T	P	SS	H
C:P:A		2.7:0:0.3	1	0	0	2	3
COURSE OUTCOMES		DOMAIN	LEVEL				
CO1	***Relate*** and ***Interpret*** the human ethics and human relationships	Cognitive	Remember, Understanding				
CO2	***Explain*** and ***Apply*** gender issues, equality and violence against women	Cognitive	Understanding, Applying				
CO3	***Classify*** and ***Develop*** the identify of women issues and challenges	Cognitive & Affective	Analyzing Receiving				
CO4	***Classify*** and ***Dissect***human rights and report on violations.	Cognitive	Understanding, Analyze				
CO5	***List*** and **respond** to family values, universal brotherhood, fight against corruption by common man and good governance.	Cognitive & Affective	Remember, (Respond)				

UNIT I	HUMAN ETHICS AND VALUES	7

HUMAN ETHICS AND VALUES

Human Ethics and values - Understanding of oneself and others- motives and needs- Social service, Social Justice, Dignity and worth, Harmony in human relationship: Family and Society, Integrity and Competence, Caring and Sharing, Honesty and Courage, WHO's holistic development - Valuing Time, Co-operation, Commitment, Sympathy and Empathy, Self respect, Self-Confidence, character building and Personality.

UNIT II	IIGENDER EQUALITY	9

Gender Equality - Gender Vs Sex, Concepts, definition, Gender equity, equality, and empowerment. Status of Women in India Social, Economical, Education, Health, Employment, HDI, GDI, GEM. Contributions of Dr.B.R. Ambethkar, ThanthaiPeriyar and Phule to Women Empowerment.

UNIT III	WOMEN ISSUES AND CHALLENGES	9

Women Issues and Challenges- Female Infanticide, Female feticide, Violence against women, Domestic violence, Sexual Harassment, Trafficking, Access to education, Marriage. Remedial Measures – Acts related to women: Political Right, Property Rights, and Rights to Education, Medical Termination of Pregnancy Act, and Dowry Prohibition Act.

UNIT IV	HUMAN RIGHTS	9

Human Rights Movement in India – The preamble to the Constitution of India, Human Rights and Duties, Universal Declaration of Human Rights (UDHR), Civil, Political, Economical, Social and Cultural Rights, Rights against torture, Discrimination and forced Labour, Rights and protection of children and elderly. National Human Rights Commission and other statutory Commissions, Creation of Human Rights Literacy and Awareness. - Intellectual Property Rights (IPR). National Policy on occupational safety, occupational health and working environment.

UNIT V	GOOD GOVERNANCE AND ADDRESSING SOCIAL ISSUES	11

Good Governance - Democracy, People's Participation, Transparency in governance and audit,Corruption, Impact of corruption on society, whom to make corruption complaints, fight against corruption and related issues, Fairness in criminal justice administration, Government system of Redressal. Creation of People friendly environment and universal brotherhood.

LECTURE	SELF STUDY	TOTAL
15	30	45

REFERENCES

1. Aftab A, (Ed.), Human Rights in India: Issues and Challenges, (New Delhi: RajPublications, 2012).
2. Bajwa, G.S. and Bajwa, D.K. Human Rights in India: Implementation and Violations (New Delhi: D.K. Publications, 1996).
3. Chatrath, K. J. S., (ed.), Education for Human Rights and Democracy (Shimala: Indian Institute of Advanced Studies, 1998).
4. Jagadeesan. P. Marriage and Social legislations in Tamil Nadu, Chennai: Elachiapen Publications, 1990).
5. Kaushal, Rachna, Women and Human Rights in India (New Delhi: Kaveri Books, 2000)
6. Mani. V. S., Human Rights in India: An Overview (New Delhi: Institute for the World Congress on Human Rights, 1998).
7. Singh, B. P. Sehgal, (ed) Human Rights in India: Problems and Perspectives (New Delhi: Deep and Deep, 1999).
8. Veeramani, K. (ed) Periyar on Women Right, (Chennai: Emerald Publishers, 1996)
9. Veeramani, K. (ed) Periyar Feminism, (PeriyarManiammai University, Vallam, Thanjavur: 2010).
10. Planning Commission report on Occupational Health and Safety http://planningcommission.nic.in/aboutus/committee/wrkgrp12/wg_occup_safety.p
11. Central Vigilance Commission (Gov. of India) website: http://cvc.nic.in/welcome.html.
12. Weblink of Transparency International: https://www.transparency.org/
13. Weblink Status report: https://www.hrw.org/world-report/2015/country-chapters/india

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								2						
CO2								3	1					
CO3								2						
CO4								3		2				
CO5								3	2	2		2		
Total		2						13	3	4		2		
Scaled Value		1						3	1	1		1		

1 – 5 → 1, 6-10 → 2, 11 – 15→ 3

0 – No relation, 1 – Low relation, 2 – Medium relation, 3 – High relation

SYLLABUS

II SEMESTER

COURSE CODE		**XMA201**	**L**	**T**	**P**	**C**
COURSE NAME		**CALCULUS AND LAPLACE TRANSFORMS**	**3**	**1**	**0**	**4**
PREREQUISITES		Basic concepts of Differentiation, Integration, Vectors and Complex numbers.	**L**	**T**	**P**	**H**
C:P:A		**3:0:0**	**3**	**2**	**0**	**5**
COURSE OUTCOMES		**DOMAIN**	**LEVEL**			
CO1	***Make Use of*** standard results to ***Find*** the Laplace transforms of derivatives and integrals and to ***solve*** differential equations.	Cognitive	Receiving, Apply			
CO2	***Apply*** *multiple integral concepts to* ***Find*** the area, volume and to understand the order of integration.	Cognitive	Receiving, Apply			
CO3	***Define*** the gradient, divergent curl of vectors. ***Find*** directional derivative, unit vector normal to the surface. ***Apply*** corresponding theorems to ***Find*** the line, surface and Volume integrals.	Cognitive	Receiving, Apply			
CO4	***Construct*** and examine the analytic functions, and their the complex Conjugate and to ***Explain*** the concept of conformal mapping and to ***Construct*** the bilinear transformation.	Cognitive	Understanding, Apply			
CO5	***Explain*** the poles , singularities and residues of functions and to ***solve*** the problems using contour integration	Cognitive	Understanding, Apply			
UNIT I	**LAPLACE TRANSFORMS**					**15**
Transforms of elementary functions – properties – derivatives and integrals of transforms-Transforms of derivatives and integrals - Transforms of unit step function and impulse function - Transform of periodic functions – Convolution Theorem – Inverse transforms – Solutions of differential and integral equations.						
UNIT II	**MULTIPLE INTEGRALS**					**15**
Double integration – Cartesian and polar coordinates – change of order of integration - area as a double integral – change of variables between Cartesian and polar coordinates - triple integration–- Simple applications (Finding area & volume of a certain region).						

UNIT III	VECTOR CALCULUS	15

Gradient, divergence and curl - directional derivative – normal and tangent to a given surface – angle between two surfaces – irrotational and solenoidal vector fields - Line, Surface and Volume Integral – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (excluding proof).

UNIT IV	ANALYTIC FUNCTIONS	15

Function of a complex variable – analytic function – necessary and sufficient condition (excluding proof) – Cauchy Riemann equations – properties of analytic functions - harmonic conjugate - construction of an analytic function – Conformal mapping: w= z + c, cz, $\frac{1}{z}$, sinz, coshz, $z+\frac{k^2}{z}$ - Bilinear transformation.

UNIT V	COMPLEX INTEGRATION	15

Statement and application of Cauchy's integral theorem and integral formula - Taylor's and Laurent's expansion - Residues – Cauchy's Residue Theorem - Contour integration over unit circle.

	LECTURE	TUTORIAL	TOTAL
	45	30	75

TEXT

1. Grewal, B.S. Higher Engineering Mathematics, 41st Edition, Khanna Publication, Delhi, 2011.
2. Kreyszig, E, Advanced Engineering Mathematics, Eighth Edition, John Wiley and Son(Asia) Ltd, Singapore, 2001.

REFERENCES

1. Bali N.P and Narayana lyengar, Engineering Mathematics, Laxmi Publications (P) Ltd, New Delhi, 2003.
2. Veerarajan T, Engineering Mathematics Fourth Edition, Tata – McGraw Hill Publishing Company Ltd, New Delhi, 2005.
3. Kandasamy P., Thilagavathy K, and Gunavathy K, Engineering Mathematics Volume I, II and III, S. Chand & Co, New Delhi, 2005.
4. Venkataraman M. K, Engineering Mathematics, Volume I and II Revised enlarge Fourth Edition, The National Publishing Company, Chennai, 2004.

E REFERENCES

www.nptel.ac.in

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Department of Mathematics Indian Institute of Technology, Kharagpur

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3											1
CO 2	3											1
CO 3	3	2								1	1	2
CO 4	3	2			1					1	1	1
CO 5	3	2			1					1	1	1
	15	6	0	0	2	0	0	0	0	3	3	6

1 - Low , 2 – Medium , 3- high

COURSE CODE		XCP202	L	T	P	C
COURSE NAME		COMPUTER PROGRAMMING	3	1	0	4
PREREQUISITES			L	T	P	H
C:P:A		3:1:0	3	2	0	5
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Define*** programming fundamentals and ***Solve*** simple programs using I/O statements.	Cognitive Psychomotor	Remember Guided Response			
CO2	***Define*** syntax and ***write simple programs*** using control structures and arrays	Cognitive Psychomotor	Remember Guided Response			
CO3	***Explain*** and ***write simple programs*** using functions and pointers	Cognitive Psychomotor	Understand Guided Response			
CO4	***Explain*** and ***write simple programs*** using structures and unions	Cognitive Psychomotor	Understand Guided Response			
CO5	***Explain*** and ***write simple programs*** using files and ***Build*** simple projects	Cognitive Psychomotor	Understand Guided Response			
UNIT I	**PROGRAMMING FUNDAMENTALS AND INPUT /OUTPUT STATEMENTS**					**15**

Theory

Program – Flowchart – Pseudo code – Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, and Operators – sample program structure -Header files – Data Types - Output statements – Input statements.

Practical

Program to display a simple picture using dots.
Program for addition of two numbers
Program to swap two numbers
Program to solve any mathematical formula.

UNIT II	**CONTROL STRUCTURE AND ARRAYS**	**15**

Theory

Control Structures – Conditional Control statements: Branching, Looping – Unconditional control structures: switch, break, continue, goto statements – Arrays: One Dimensional Array Declaration – Initialization – Accessing Array Elements – Searching – Sorting – Two Dimensional arrays - Declaration – Initialization – Matrix Operations – Multi Dimensional Arrays - Declaration – Initialization. Storage classes: auto – extern – static. Strings: Basic operations on strings.

Practical

Program to find greatest of 3 numbers using Branching Statements
Program to display divisible numbers between n1 and n2 using Looping Statement
Program to remove duplicate element in an array.
Program to perform string operations.

UNIT III	FUNCTIONS AND POINTERS	15

Theory

Functions: Built in functions – User Defined Functions - Parameter passing methods - Passing arrays to functions – Recursion - Programs using arrays and functions. Pointers – Pointer declaration - Address operator - Pointer expressions & pointer arithmetic - Pointers and function - Call by value - Call by Reference - Pointer to arrays - Pointers and structures - Pointers on pointer.

Practical

Program to find factorial of a given number using four function types.
Programs using Recursion
Programs using Pointers

UNIT IV	STRUCTURES AND UNIONS	9+7

Theory

Structures and Unions - Giving values to members - Initializing structure - Functions and structures - Passing structure to elements to functions - Passing entire function to functions- Arrays of structure - Structure within a structure and Union.

Practical

Program to read and display student mark sheet Structures with variables
Program to read and display student marks of a class using Structures with arrays
Program to create linked list using Structures with pointers

UNIT V	FILES	15

Theory

File management in C - File operation functions in C - Defining and opening a file - Closing a file - The getw and putw functions - The fprintf & fscanf functions - fseek function – Files and Structures.

Practical

Program for copying contents of one file to another file.
Program using files using structure with pointer

	LECTURE	PRACTICAL	TOTAL
	45	30	75

TEXT BOOKS

1. Byron Gottfried, "Programming with C", III Edition, (Indian Adapted Edition), TMH publications, 2010
2. Yeshwant Kanethker, “Let us C”, BPB Publications, 2008

REFERENCES

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education Inc. (2005).
2. Behrouz A. Forouzan and Richard. F. Gilberg, "A Structured Programming Approach Using C", II Edition, Brooks–Cole Thomson Learning Publications, 2001.
3. Johnsonbaugh R. and Kalin M., “Applications Programming in ANSI C”, III Edition, Pearson Education India, 2003.
https://iitbombayx.in/courses/IITBombayX/BMWCS101.1x/2015_T1/courseware

Mapping of COs with Pos

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1								2						
CO2								3	1					
CO3								2						
CO4								3		2				
CO5								3	2	2		2		
Total		2						13	3	4		2		
Scaled Value		1						3	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		XBW203	L	T	P	C
COURSE NAME		MECHANICAL AND CIVIL ENGINEERING SYSTEMS (WORKSHOP PRACTICE INCLUDED)	3	1	1	5
PREREQUISITES			L	T	P	H
C:P:A		1.5:1.5:0	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Define and visualize*** the working principles of the various boilers, turbines and engines	Cognitive Psychomotor	Knowledge			
CO2	***Differentiate and auscultate*** the measurements by using various metrology instruments	Cognitive Psychomotor	Comprehension			
CO3	***Categorise and palpate*** the various metal forming, joining and cutting processes	Cognitive Psychomotor	Synthesis			
CO4	***Characterize and diagonose*** the quality of the good Building materials; and measure linear and angular dimensions	Cognitive Psychomotor	Knowledge			
CO5	***Summarize and palpate*** the components of a substructures and super structures.	Cognitive Psychomotor	Evaluation			

UNIT I	Basics of Thermal and Energy Systems	21

Introduction to Mechanical Engineering – Streams – Thermal, Design, and Manufacturing Conventional and non conventional sources of energy – Heat energy – Modes of heat transfer – Working principles of Boilers and Turbines – Classification of IC Engines – 4 stroke and 2 stroke engines – Petrol and diesel engines – Performance and heat balance – Working principles of hydel, steam and nuclear power plants.

Practical:

Petrol engine performance – BHP

Diesel engine performance – BHP

Demonstration of refrigeration and air conditioning units

UNIT II	Fundamentals of Machine Elements and Measurements	15

Engineering materials – Machine elements – fasteners and support systems – Belt drives – Types – Velocity ratio and Length of belt – Gear drives – Types – Velocity ratio.

Principle of measurements – Accuracy – Precision – Errors – Measuring instruments – Scale – Vernier Caliper – Micrometer – Slip gauges – Spirit level.

Practical:

Measurements using Vernier Caliper, Micrometer, Slip gauges and Spirit level.

Demonstration of transmission system in machines and suspension system in automobiles.

UNIT III	Elements of Manufacturing	15

Manufacturing processes – Classification – Principles of metal forming – forging, moulding, casting – Principles of metal joining – welding, soldering and brazing.

Machining – turning, drilling, milling and grinding – Machining time and material removal rate.

Practical:

Exposure to workshop tools

Fitting exercises: Square and triangle

Simple turning and drilling

Demonstration of welding and mould preparation

UNIT IV	**Surveying and Construction Materials**	**15**

Surveying: Definition – Survey Instruments – Classification of Survey – Linear and Angular Measurements – Measurement of area – Illustrative Examples.

Construction Materials: Bricks – Stones – Timber – Steel – Cement – Sand – Aggregates – Concrete

Practical: Surveying

UNIT V	**Components and of Construction of Civil Structures**	**15**

Substructure: Bearing capacity **-** Types of Foundation – Application – Requirement of good foundations.

Superstructure: Brick masonry – Types of bond – Flooring – Beams – Columns – Lintels – Roofing – Doors and windows fittings – Introduction to bridges and dams – Building drawing

Practical: Building drawing, Carpentry, Plumbing.

	LECTURE	**PRACTICAL**	**TOTAL**
	45	**30**	**75**

TEXT BOOKS

Dr. P.K. Srividhya, P. Pandiyaraj, S. Balamurugan, "Basic Civil and Mechanical Engineering", PMU Publications, Vallam, 2013.

Dr. B.C.Punmia, Ashok Kumar Jain, "Basic Civil Engineering", Laxmi Publications, New Delhi, 2003.

Dr. B.C.Punmia, "Surveying – Volume I", Laxmi Publications, New Delhi, 2005

REFERENCES

Venugopal K., Basic Mechanical Engineering, Anuradha Publications, Kumbakonam, 2007.

Shanmugam G. and Palanichamy M. S.,"Basic Civil and Mechanical Engineering", Tata Mc Graw Hill Publishing Co., New Delhi, 3rd Edition, 2009.

Mapping of CO's with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	-	-	2	-	-	-	-	-	-	-	-
CO2	2			2		1	-	-	-	-	-	-
CO3		2			2	-	-	-	-	-	-	-
CO4		3		1		-	-	-	-	-	-	-
CO5	1	1			3	-	-	-	-	-	-	-
Total	5	6	-	5	5	1	-	-	-	-	-	-

1 - Low, 2 – Medium, 3 – High

COURSE CODE		XAC204	L	T	P	C
COURSE NAME		APPLIED CHEMISTRY	3	1	1	5
PREREQUISITES		Nil	L	T	P	H
C:P:A		2.8:0.8:0.4	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Identify*** and describe the various water quality parameters and methods to purify water in contest with boilers and domestics usage.	Cognitive Psycomotor	Remember Perception			
CO2	***Explain*** the fundamental principles of electrochemical reactions, its applications in redox reactions and calculate the different electrochemical processes.	Cognitive Psycomotor	Understand Set			
CO3	***Interpret*** the types of corrosion, ***use*** *and* ***measure*** its control by various methods including protective techniques.	Cognitive Psycomotor Affective	Apply Mechanism Receive			
CO4	***Describe***, ***Illustrate*** and ***Discuss*** the generation of energy in batteries, nuclear reactors, solar cells, fuel cells and anaerobic digestion.	Cognitive Affective	Remember Analyse Respond			
CO5	***Apply*** and ***measure*** the different types of spectral techniques for quantitative chemical analysis and ***list*** nanomaterials for various engineering processes.	Cognitive Psycomotor	Remember Apply Mechanism			
UNIT I	**WATER TECHNOLOGY**		**7 + 8 +9**			
Sources and types of water – water quality parameters – BIS and ISO specifications- hardness: types and estimation of hardness (problems) – alkalinity: types and estimation (problems) – boiler feed water – requirements – disadvantages of using hard water in boilers – internal treatment, external treatment – demineralization process – desalination using reverse osmosis – domestic water treatment – Effluent treatment processes in industries						
UNIT II	**ELECTROCHEMISTRY**		**8+5 +15**			
Basic concepts of conductance – Kohlraush's law and conductometric titrations –electrode potentials– Nernst equation: derivation and problems – reversible and irreversible cells – electrolytic and electrochemical cells – emf and its measurements – types of electrodes-reference electrodes – primary and secondary – glass electrode – determination of pH using quinhydrone and glass electrodes – electrochemical series and its applications – Galvanic cells and concentration cells – potentiometric titrations - redox titrations.						
UNIT III	**CORROSION AND PROTECTIVE COATINGS**		**9 + 4 +3**			
Corrosion- causes- types-chemical, electrochemical corrosion (galvanic, differential aeration), corrosion in electronic devices, corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method.						

Protective coatings: paints- constituents and functions - electroplating of copper and gold, Electro less plating - Distinction between electroplating and electro less plating,
Advantages of electroless plating, electro less plating of nickel and copper on PCB.

UNIT IV	ENERGY STORAGE DEVICES AND NUCLEAR ENERGY	12 + 7+0

Energy storage devices – Batteries: Types – primary (dry cell, alkaline cells) and secondary (lead acid, Ni-Cd and Lithium ion batteries) - Super capacitors – Fuel cells-Hydrogen-Oxygen fuel cell- Solar cells .

Nuclear energy: nuclear fission and fusion –chain reaction and its characteristics – nuclear energy and calculations (problems) – atom bomb –Nuclear reactor- light water nuclear power plant – breeder reactor- Weapon of mass destruction- nuclear, radiological, chemical and biological weapons. Disarmament - National and International Cooperation- Chemical Weapon Convention (CWC), Peaceful Uses of Chemistry. Bio fuels: biomethanation- anaerobic digestion process, biomass: sources and harness of energy.

UNIT V	SPECTROSCOPY AND NANOCHEMISTRY	9 +6 +3

Electromagnetic spectrum - Lambert law and Beer-Lambert's law (derivation and problems) – molecular spectroscopy -UV- visible spectroscopy: electronic transitions - chromophores and auxochromes – instrumentation (block diagram) - applications – IR spectroscopy: principle – fundamental modes of vibrations – calculations of vibrational frequency – IR spectrophotometer instrumentation (block diagram) – applications of IR spectroscopy.

Nanochemistry - Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: Nanocluster, nanorod, nanotube and nanowire. Synthesis; properties and applications of nano materials-Buckminister fullerenes, CNT"S(Single walled carbon nano tubes and Multi-walled carbon tubes)-Graphene- advantages and applications.

	LECTURE	TUTORIAL	TOTAL
	45	30	75

TEXT BOOKS

1. Jain and Jain , "A Text book of Engineering Chemistry", Dhanapatrai Publications,New Delhi, 2011.
2. Gadag and NityanandaShetty , "Engineering Chemistry", I.K International publishing House Pvt. Ltd, 2010.
3. P. Atkins, J.D. Paula , "Physical Chemistry" , Oxford University Press, 2009.
4. S. S. Dara, S. S. Umare, "A Text Book of Engineering Chemistry", S. Chand Publishing, 2011
5. C.P. Poole and F.J. Owens, "Introduction to Nanotechnology", , Wiley, New Delhi ,2007.

REFERENCES

1. Puri B R Sharma L R and Madan S Pathania, " Principles of Physical Chemistry", Vishal publishing Co., Edition 2004
2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000

E REFERENCES

E Resources ***-*** *MOOCs:*

1. *http://www.mooc-list.com/course/chemistry-minor-saylororg*
2. *https://www.canvas.net/courses/exploring-chemistry*
3. *http://freevideolectures.com/Course/2263/Engineering-Chemistry-I*
4. *http://freevideolectures.com/Course/3001/Chemistry-I*
5. *http://freevideolectures.com/Course/3167/Chemistry-II*
6. *http://ocw.mit.edu/courses/chemistry/*

Laboratory Part **30 hrs**

1. Determination of total hardness, temporary and permanent hardness of water by EDTA method.
2. Determination of alkalinity of water sample.
3. Determination of chloride content of water sample by Argentometric method.
4. Conductometric titration of a strong acid with a strong base.
5. Determination of strength of hydrochloric acid by pH metric method.
6. Conductometric precipitation titration using barium chloride and sodiumsulphate.
7. Determination of strength of iron by potentiometric method using dichromate.
8. Potentiometric acid-base titration using quinhydrone electrode.
9. Corrosion inhibition efficiency by weight loss method.
10. Estimation of iron by colorimetric method.

REFERENCE BOOKS

1. Mendham, Denney R.C,. Barnes J.D and Thomas N.J.K., "Vogel's Textbook of Quantitative Chemical Analysis", 6th Edition, Pearson Education, 2004.
2. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. "Experiments in Physical Chemistry", 8th Ed.; McGraw-Hill: New York, 2003.
3. Sirajunnisa.A., Sundaranayagi.S.,Krishna.,Rajangam.R.,Gomathi.S., "Applied Chemistry Lab Manual", Department of Chemistry, PMU Press, Thanjavur, 2016.

E Resources **-** MOOCs:

1.http://freevideolectures.com/Course/2380/Chemistry-Laboratory-Techniques
2. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Chemistry-Fall-2011
3.http://ocw.mit.edu/courses/chemistry/5-301-chemistry-laboratory-techniques

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL HOURS**
HOURS	**45**	**30**	**30**	**105**

Mapping of CO's with PO's:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	3	3	1	2	3	1	3	1	1	2	1
CO2	3	2	3	3	3	2	3	3	1	3		1	2	1
CO3	3	3	3	3	3	1	3	3	1	2	1	1	2	2
CO4	3		3	3	3	3	3	3	1	1		1	3	2
CO5	1	3		2	2	1	2		1	1		1	2	2
Total	13	11	12	14	14	8	13	12	5	10	2	5	11	8
Scaled Value	3	3	3	3	3	2	3	3	1	2	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		XEG205	L	T	P	C
COURSE NAME		ENGINEERING GRAPHICS	2	1	0	3
PREREQUISITES		Nil	L	T	P	H
C:P:A		1:1:1	2	2	0	4
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Apply*** the national and international standards, ***construct*** and ***practice*** various curves	C(Ap), P(GR) and A(Res)				
CO2	***Interpret***, ***construct*** and ***practice*** orthographic projections of points, st. lines and planes.	C(Under) ,P(Mech) and A(Res)				
CO3	***Construct Sketch*** and ***Practice*** projection of solids in various positions and true shape of sectioned solids.	C(Apply) ,P(CoR) and A(Res)				
CO4	***Interpret***, ***Sketch*** and ***Practice*** the development of lateral surfaces of simple and truncated solids, intersection of solids.	C(Under) ,P(CoR) and A(Res)				
CO5	***Construct***, ***sketch*** and ***practice*** isometric and perspective views of simple and truncated solids.	C(Apply) ,P(CoR) and A(Res)				
UNIT I	**INTRODUCTION, FREE HAND SKETCHING OF ENGG OBJECTS AND CONSTRUCTION OF PLANE CURVE**		**6+6**			

Importance of graphics in engineering applications – use of drafting instruments – BIS specifications and conventions as per SP 46-2003.

Pictorial representation of engineering objects – representation of three dimensional objects in two dimensional media – need for multiple views – developing visualization skills through free hand sketching of three dimensional objects.

Polygons & curves used in engineering practice – methods of construction – construction of ellipse, parabola and hyperbola by eccentricity method – cycloidal and involute curves – construction – drawing of tangents to the above curves.

UNIT II	**PROJECTION OF POINTS, LINES AND PLANE SURFACES**	**6+6**

General principles of orthographic projection – first angle projection – layout of views – projections of pints, straight lines located in the first quadrant – determination of true lengths of lines and their inclinations to the planes of projection – traces – projection of polygonal surfaces and circular lamina inclined to both the planes of projection.

UNIT III	**PROJECTION OF SOLIDS AND SECTIONS OF SOLIDS**	**6+6**

Projection of simple solids like prism, pyramid, cylinder and cone when the axis is inclined to one plane

of projection – change of position & auxiliary projection methods – sectioning of above solids in simple vertical positions by cutting plane inclined to one reference plane and perpendicular to the other and above solids in inclined position with cutting planes parallel to one reference plane – true shapes of sections.

UNIT IV	DEVELOPMENT OF SURFACES AND INTERSECTION OF SOLIDS	6+6

Need for development of surfaces – development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones – development of lateral surfaces of the above solids with square and circular cutouts perpendicular to their axes – intersection of solids and curves of intersection –prism with cylinder, cylinder & cylinder, cone & cylinder with normal intersection of axes and with no offset.

UNIT V	ISOMETRIC AND PERSPECTIVE PROJECTIONS	6+6

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones – principles of perspective projections – projection of prisms, pyramids and cylinders by visual ray and vanishing point methods.

	LECTURE	TUTORIAL	TOTAL
	30	30	60

TEXT

1. Natarajan,K.V, " A Textbook of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2006 .
2. Dr. P.K. Srividhya, P. Pandiyaraj, "Engineering Graphics", PMU Publications, Vallam, 2013

REFERENCES

1. Luzadder and Duff, "Fundamentals of Engineering Drawing" Prentice Hall of India PvtLtd, XI Edition - 2001.
2. Venugopal,K. and Prabhu Raja, V., "Engineering Graphics", New Age International(P) Ltd., 2008.
3. Gopalakrishnan.K.R,. "Engineering Drawing I & II", Subhas Publications, 1998.
4. Shah,M.B and Rana,B.C.,"Engineering Drawing", Pearson Education,2005.

E REFERENCES

1. http://periyarnet/Econtent
2. http://nptel.ac.in/courses/112103019/

Mapping of CO's with PO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1							1
CO2	3	2	1	1	1							1
CO3	3	2	1	1	1							1
CO4	3	2	1	1	1							1
CO5	3	2	1	1	1							1
Total	15	10	7	5	5							5
Scaled	3	2	2	1	1							1

1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE		XGS206	L	T	P	C
COURSE NAME		SPEECH COMMUNICATION	1	0	2	2
PREREQUISITES			L	T	P	H
C:P:A		3:0:0	1	0	2	3
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	I***dentify*** different styles to various forms of public speaking skills and presentation skills	Cognitive	Remember			
CO2	***Understand*** and identify the proper tone of language required in writing and speaking	Cognitive	Understanding			
CO3	***Adapt*** the speech structures and develop the speech outline according to the audience.	Cognitive Psychomotor	Apply			
CO4	***Ability*** to communicate and develop presentation skills	Cognitive Affective	Response			
CO5	***Equip*** the speaker to face the audience without any anxiety.	Psychomotor	Guided Response			
UNIT I	INTRODUCTION TO PUBLIC SPEAKING					9
Functions of oral communication; skills and competencies needed for successful speech making; importance of public speaking skills in everyday life and in the area of business, social, political and all other places of group work.						
UNIT II	TYPES OF SPEECH					9
Manuscript, impromptu, rememorized and extemporaneous speeches; analyzing the audience and occasion; developing ideas; finding and using supporting materials.						
UNIT III	ORGANIZATION OF SPEECH					9
Introduction, development and conclusion; language used in various types of speeches; Adapting the speech structures to the Audience; paralinguistic features.						
UNIT IV	USE OF VISUAL AIDS					
How to present a paper/assignment etc; using visual aids to the speeches; using body language to communicate						
UNIT V	SPEECH ANXIETY					9
Public speaking and speech anxiety, public speaking and critical listening Speech practice (4-6 speeches per student)						

	LECTURE	TUTORIAL	TOTAL
	45		45

TEXT BOOKS

1. **Principles and Types of Public Speaking - 2002** by Raymie E. McKerrow (Author), Bruce E. Gronbeck ,Douglas Ehninger , Alan H. Monroe
2. **Communication : Principles for a lifetime,** portable Edition- volume 2 Interpersonal Communication, Stevan A. Beebe, Texas State Universtiy- San Marcos, 2008.
3. **Writing and Speaking** Author: John Sealy, Oxford University Press, New Delhi Third Edition 2009. **Communicating in Business** (8th Edition) Paperback – 2012 by Williams K S , Engage Learning India Pvt. Ltd.

Mapping of Cos with POs:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	0	0	0	0	3	0	0	2	0	2	0	0
CO2	0	1	0	0	0	1	0	2	0	1	0	0
CO3	0	0	0	0	0	0	0	0	0	2	0	0
CO4	0	0	0	2	0	2	0	0	0	1	0	0
CO5	0	0	0	0	0	3	0	0	0	3	0	0
Total	0	1	0	2	3	6	0	4	0	9	0	0
Scaled Value	0	1	0	1	1	2	0	1	0	2	0	0

1-5= 1, 6-10 = 2, 11-15= 3

0-No Relation, 1- Low Relation, 2 – Medium Relation, 3- High Relation

SYLLABUS
III SEMESTER

COURSE CODE		**XMA301**	**L**	**T**	**P**	**C**
COURSE NAME		**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**	**3**	**1**	**0**	**4**
PREREQUISITES		**XMA101, XMA201**	**L**	**T**	**P**	**H**
C:P:A		**3:0:0**	**3**	**2**	**0**	**5**
COURSE OUTCOMES		**DOMAIN**	**LEVEL**			
CO1	***Explain*** and ***Demonstrate*** the basic concepts in partial differential equations and to solve linear, nonlinear, homogeneous and nonhomogeneous Partial Differential equations.	Cognitive	Remembering Understanding			
CO2	***Demonstrate*** the basic concept and properties of Fourier series and to ***State*** Parseval's identity and Diritchlet's condition.	Cognitive	Remembering Understanding			
CO3	***Solve*** the standard Partial Differential Equations, arising in Engineering Problems, like Wave equation and Heat flow equation by Fourier series method.	Cognitive	Apply			
CO4	***Explain*** and ***Apply*** the concept of Fourier transform and its properties.	Cognitive	Understanding Apply			
CO5	**CO5** ***State*** and ***Apply*** the properties of Z transform and to ***Find*** the Z transform and inverse Z transform.	Cognitive	Remembering Apply			
UNIT I	**PARTIAL DIFFERENTIAL EQUATIONS**					**15**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.						
UNIT II	**FOURIER SERIES**					**15**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series –Parseval's identity – Harmonic Analysis. Fourier series of rectangular pulses. Fourier series for various line codes and comparison in terms of spectrum						
UNIT III	**APPLICATIONS OF BOUNDARY VALUE PROBLEMS**					**15**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.						

UNIT IV	FOURIER TRANSFORM	15

+-Fourier integral theorem (without proof) – Fourier transform pairs – Fourier Sine and Cosine transforms – properties – Transforms of simple functions – Convolution theorem – Parseval's identity. Application to convolution of signals in frequency domain. Fourier transform as tool for estimating spectrum of the signals. Simple examples of Frequency domain equalization – Zero forcing only.

UNIT V	Z – TRANSFORM AND DIFFERENCE EQUATIONS	15

Z-transform – Elementary properties – Inverse Z – transform – Convolution theorem – Initial and Final value theorems - Formation of difference equations – Solution of difference equations using Z-transform. Discrete system and their solutions and analysis by Z – transform.

	LECTURE	TUTORIAL	TOTAL
	45	30	75

TEXT

1. Grewal, B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, New Delhi (2012).
2. Narayanan, S., ManicavachagomPillay, T.K. and Ramaniah, G., "Advanced Mathematics for Engineering Students", Volumes II and III, S.Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai (2002).
3. Veerarajan. T., "Transforms and Partial Differential Equations", Second reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

REFERENCES

1. Churchill, R.V. and Brown, J.W., "Fourier Series and Boundary Value Problems", Fourth Edition, McGraw Hill Book Co., Singapore (1987).
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., " Engineering Mathematics Volume III", S. Chand & Company Ltd., New Delhi (1996).
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics" 7th Edition Lakshmi Publications (P) Limited, New Delhi (2007).
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8 th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

E REFERENCES

1. **www.nptel.ac.in**
2. Advanced Engineering Mathematics, Prof.Jitendra Kumar,
3. Department of Mathematics, Indian Institute of Technology, Kharagpur, India.

CO vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3									1	1	
CO 2	3									1	1	
CO 3	3			2					1	1	2	
CO 4	3	1		2					1	1	1	
CO 5	3	1		2					1	1	1	
	15	2		6					3	5	6	

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

1-5 → 1, 6-10 → 2, 11-15 → 3

COURSE CODE		XNT302	L	T	P	C
COURSE NAME		INTRODUCTION TO NANOTECHNOLOGY	3	1	1	5
PREREQUISITES		Physics and Chemistry	L	T	P	H
C:P:A		3:1:0	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Outline*** the role of nano in civilization and ***explain*** methods to show various features	Cognitive Psychomotor	Remember Set			
CO2	***Identify*** and ***relate*** the forces and states	Cognitive Psychomotor	Remember Perception			
CO3	***List*** and ***describe*** various Nano materials	Cognitive Psychomotor	Remember Perception			
CO4	***Explain*** nanomaterial fabrication and characterization methods	Cognitive Psychomotor	Understand Set			
CO5	***Appraise*** the real world applications of Nano and ***build*** their design	Cognitive Psychomotor	Evaluate Origination			
UNIT I	**NANO EVOLUTION**					**15**
Introduction to Macro Micro and Nano Scale – Large to small, Scale, Natural and Manmade things, Nanotechnology in ancient history, Rise of Nanotechnology with special reference to Feynman, Definition of Nanostructure; insight and intervention into the nanoworld; building blocks of nanotechnology. Scientific revolutions in Nanotechnology						
UNIT II	**NANOSCALE PHENOMENA**					**15**
Chemical bonds (types & strength); Intermolecular & inter-particle forces; Density of states; Discrete energy levels, Molecular & crystalline structures; particles & grain boundaries; Super-Hydro-Phobicity, Mesosopic phenomena; Amorphous, crystalline, semi-crystalline; crystals, polycrystals.						
UNIT III	**NANOMATERIALS**					**15**
Fullerenes, carbon nanotube, graphene. Monomers & polymers, block copolymers, Composite materials; ceramics, alloys, silicates. Quantum hetero-structures: quantum well, quantum wire, quantum dot, nanofossils, smart dust, porous & nonporous inorganic materials, hydrogel & aerosols. Bionanomaterials: biomimetic systems, bioceramics, dendrimers, micelles, liposomes, block copolymers.						
UNIT IV	**NANOMATERIAL FABRICATION AND CHARACTERIZATION**					**15**
Fabrication: Top Down and Bottom up Approaches, Chemical Methods, Physical Methods and biological methods. **Characterization:** SPM, AFM, STM, SEM, TGA, DSC, Optical Characterization – UV Vis Spectroscopy, X-ray diffraction, Raman Spectroscopy, FTIR, and Fluorescent Spectroscopy						
UNIT V	**APPLICATIONS**					**15**

Applications of nanomaterials in Electronics & communication, Healthcare, sensors, Textile, paints, Building materials, Energy & Environment, Aerospace and other industrial as well as consumer products

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
	45	30	30	105

TEXT

1. "Principles of Nanoscience & Nanotechnology," M. A. Shah & T. Ahmad, Narosa Publishing House, New Delhi, 2010

REFERENCES

1. "Nanotechnology: Basic Science & Emerging Technologies," Mick Wilson, Kamali Kannangara & Geoff Smith, Overseas Press India Private Limited, 2005.
2. "Amorphous and Nanocrystalline Materials: Preparation, Properties and Applications," A. Inoue & K. Hashimoto (Eds.), Springer, 2001.
3. "Understanding Nanotechnology," Scientific American (Eds.), Warner Books, 2002.
4. "Introduction to Nanotechnology," Charles P. Poole & Frank J. Owens, Wiley-Interscience, 2003.
5. Nanotechnology: A Crash Course, Raúl J. Martín-Palma; Akhlesh Lakhtakia, SPIE Press 2010

e-resources

http://nupex.eu/index.php?g=textcontent/materialuniverse/sizeofthings&lang=en
http://www.slideshare.net/niraliakabari3/ppt-of-phynanophysics
http://www.nanoscienceworks.org/publications/books/4/9781420048056/instructors/ITNS-Lecture-1.pdf

http://ipn2.epfl.ch/lns/lectures/nanoscience/lecturenotes/cour-1.pdf
www.uniroma2.it/didattica/NANOSCIENZE/deposito/L1.ppt
mp.misis.ru/docs/courses/17/Mats_Moscow_2.ppt
http://uw.physics.wisc.edu/~himpsel/Nano/lectures.htm
http://ipn2.epfl.ch/lns/lectures/nanoscience/
http://uw.physics.wisc.edu/~himpsel/Nano/Nanofabrication.pdf omicsonline.org/editor-ppt/Sungsoo_Na.pptx http://uw.physics.wisc.edu/~himpsel/Nano/Microscopy.pdf
www.nano.gov/nanotech-101/special http://www.ifb.ethz.ch/woodmaterialsscience/people/emilt
http://ec.europa.eu/consumers/archive/safety/int_coop/docs/pres_Freeman.pdf
http://ocw.mit.edu/courses/mechanical-engineering/2-57-nano-to-macro-transport-processes-spring-2012/video-lectures/lecture-1-intro-to-nanotechnology-nanoscale-transport-phenomena

LABORATORY

1.	Calculate the band structure of a crystal
2.	Transport calculations with ATK
3.	Phonon Band structure, Electrical and Heat Transport of a Graphene Nanoribbon
4.	Electron-phonon coupling properties of a Graphene Nanoribbon
5.	Optical Properties of Silicon
6.	Study of $NiSi_2$–Si interface
7.	Study of Bi_2Se_3 topological insulator
8.	Study of Effective band structure of random alloy InGaAs
9.	Study of Li-air battery interface
10.	Study of Li-ion diffusion in $LiFePO_4$ for battery applications

Mapping of CO's with PO's

CO /PO	1	2	3	4	5	6	7	8	9	10	11	12
1	3											
2	3	2										
3	3			2			1					
4	3			2								
5	3						1			2		
Total	15	2		4			2			2		
Scaled	3	2		2			1			2		

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

1-5 → 1, 6-10 → 2, 11-15 → 3

COURSE CODE		XNT303	L	T	P	C
COURSE NAME		Biology for Engineers	3	1	1	5
PREREQUISITES		Chemistry and Biology	L	T	P	H
C:P:A		3:1:0	3	2	2	7
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	***Identify*** different structural components of cells and its functions and **describe** and **relates** the functions of different types of bio-molecules	Cognitive: Psychomotor:	Remember Perception			
CO2	***Remember and apply*** *the* mechanisms underlying molecular biological processes on signal transduction and various tissues.	Cognitive: Psychomotor:	Understand and apply			
CO3	***Understand the immune*** system and construct the experiment on Agglutination	Cognitive: Psychomotor:	Remember Understand and Apply			
CO4	***Understand*** Molecular structure and function of genes and ***adapts*** the DNA for the selected sample	Cognitive: Psychomotor:	Understand and apply			
CO5	***Understand*** the principles of bioinformatics tools and simulate the moleculaFr structure	Cognitive: Psychomotor:	Remember Understand and apply			
UNIT I	**Cell & Cell Function**		**12**			
Types of eukaryotic and prokaryotic cells –Cell division – Mitosis and Meiosis – Cell cycle and cell cycle genes. -Molecular organization of cell – Endocytosis and exocytosis – Passive and active transport –Sodium and potassium pumps – Ca2+ATPase pumps – ATP dependent proton pumps – Co transport– Symport and antiport.						
UNIT II	**Cell – Cell interaction and Tissue**		**12**			
Receptor Proteins and Signaling between Cells - Types of Cell Signaling -- Intracellular Receptors - Cell Surface Receptors. - Initiating the Intracellular Signal. - Amplifying the Signal - Expression of Cell Identity-Intercellular Adhesion - Tight Junctions-Anchoring Junctions-Communicating Junctions. Tissues - classification, general structure and function. Connective tissue – general characterization. Extracellular matrix - its synthesis and composition. Cartilage - structure and function.						
UNIT III	**Immunology**		**7**			
Cellular Immunology, antigen, antibody, major histocompatability complexes (MHC), autoimmune processes, transplantation immunity, Tumor immunology, immunological tolerance and immuno suppression						
UNIT IV	**Molecular structure and function of genes**		**6**			

Structure of nucleic acids - Gene, genomes, and chromosomes - DNA replication - Transcription of protein-coding genes - Formation of functional mRNA - The decoding of mRNA by tRNA - Viruses: parasites of the cellular genetic system ,HIV life cycle		
UNIT V	**Computational Biology**	**8**
Bioinformatics Examples of related tools (FASTA, BLAST, BLAT, RASMOL), Databases: DNA Databases - Protein Databases - DNA Sequencing and Assembly (GENBANK, Pubmed, PDB) – Protein folding – Population biology – Ethics in biology and bioengineering		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
	45	**15**	**30**	**90**

TEXT

S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.

REFERENCES

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, "Biochemistry," W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Robert Weaver, "Molecular Biology," MCGraw-Hill, 5th Edition, 2012.
3. Jon Cooper, "Biosensors A Practical Approach" Bellwether Books, 2004

LABORATORY

1.	Microscopic Measurements
2.	Cellular Carbohydrates
3.	Mitosis And Cytokinesis
4.	Preparation Of Epithelial Cells And Microscopy Analysis
5.	Staining and Histochemistry
6.	Agglutination Reaction
7.	Extraction Of DNA
8.	Genbank.
9.	Protein Data Bank
10.	Use of BLAST, FASTA (Nucleic Acids & Protiens)

Mapping of CO's with PO:

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS1	PS2
CO1	1	1	1	1	1	-	1	-	-	-	-	-	-	-
CO2	1	1	1	2	1	-	1	-	-	-	-	-	-	-
CO3	2	3	1	1	2	-	1	-	-	-	-	-	-	-
CO4		3	1	2			3	-	-	-	-	-	-	-
CO5	3	3	1	2	1		2	-	-	-	-	-	-	-
Total	7	11	5	8	5		8		-	-	-	-	-	-
Scaled to 0,1,2,3 scale	2	3	1	2	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		XNT304	L	T	P	C
COURSE NAME		FLUID MECHANICS	3	1	0	4
PREREQUISITES		XBW103	L	T	P	H
C:P:A		3:0:0	3	2	0	5
COURSE OUTCOMES		DOMAIN	LEVEL			
CO1	An ***understanding*** of fluid Mechanics fundamentals, including concepts of mass and momentum conservation.	Cognitive	Remembering, Understanding			
CO2	An ***ability*** to apply the Bernoulli equation to solve problems in fluid mechanics.	Cognitive	Applying, Remembering, Understanding			
CO3	An ***ability*** to apply control volume analysis to problems in fluid mechanics	Cognitive	Applying, Remembering, Understanding			
CO4	An ***ability*** to use potential flow theory to solve problems in fluid mechanics	Cognitive	Applying, Remembering, Understanding			
CO5	An ***ability*** to perform Dimensional analysis for problems in fluid mechanics.	Cognitive	Applying, Remembering, Understanding			
UNIT I	**INTRODUCTION**		**8**			
Fluids, Properties of fluids, Classification of fluids, Newton's law of viscosity, Rheological classification of fluids, Pressure and temperature dependence, Types of flow, Lines to describe the flow, Application of fluid flow in Chemical Engineering**.**						
UNIT II	**FLUID STATISTICS AND ITS APPLICATIONS**		**8**			
Hydrostatic equilibrium, Parametric equation, Hydrostatic equilibrium in centrifugal field; Concept of atmospheric, gauge and absolute pressure, manometers, pressure measurement by simple and differential manometer.						
UNIT III	**BASIC EQUATIONS OF FLUID FLOW AND FLOW MEASURING DEVICES**		**6**			
Basic equations of fluid flow: Continuity equation, equation of motion, Flow measurement using Venturimeter, Orificemeter, Rotameter & Pitot Tube						
UNIT IV	**FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS**		**8**			
Shear stress distribution, Relation between skin friction and wall shear, The friction factor; Laminar flow through circular pipe, on inclined plane, through annular space; Relation between average and maximum velocity, Major and Minor Loses, Darcy Weisbach equation, Friction factor chart, Micro and						

nano fluidics -Active control of flow patterns, Carbon nano pipette and Cellular probe, Electrokinetics and Dielectrophoresis, Liquid Cell Electron Microscopy (the Nanoaquarium), Magneto-Hydrodynamics (MHD), Microfluidic Pumps, Stirrers, Microswimmers (C. elegans), Nanowalkers (Molecular Motors), Point of Care Diagnostics (Lab on Chip), Energy Storage and Desalination		
UNIT V	**BOUNDARY LAYER , DIMENSIONAL ANALYSIS, FLOW PAST IMMERSED BODIES AND TRANSPORTATION OF FLUIDS**	**15**
Concept of hydrodynamic boundary layer, Growth over a flat plate, Different thickness of boundary layer, Fundamental dimensions of quantities, Dimensional homogeneity, Dimensional analysis by Rayleigh's method and Buckingham's method, Dimensionless numbers. Drag and drag coefficient, Flow through beds of solids, Motion of particles through fluids, fluidization, pipes and tubings, Joints and fittings, Major and minor losses, Different types of valves, Pumps: Centrifugal pump, Performance of centrifugal pumps		

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT

1. Noel. D. Nevers, "*Fluid Mechanics for Chemical Engineers*", McGraw Hill, 3rd International Edition, 2005
2. McCabe and Smith. *Unit operations in Chemical Engineering*, McGraw Hill, Co.2005.
3. R K Bansal, "*A Textbook of Fluid Mechanics and Hydraulic Machines*", 9th ed. Laxmi Publications, New Delhi, 2004
4. R.W. Fox, A.T. MacDonald and P.J. Pritchard, *Introduction to Fluid Mechanics* Wiley, 2008

REFERENCES

1. M. Coulson, J.F. Richardson, with J.R. Backhurst and J.H. Harker, Coulson "Richardson, *Chemical Engineering*, Volume-1" , 6th ed., Butterworth-Heinemann, 1999

TABLE 1: Mapping of CO's with PO'S:

COs	**PO_1**	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**	**PSO_1**	**PSO_2**
CO_1	2	2	3	3	1	1	-	2	-	3	1	3	2	2
CO_2	3	3	1	1	1	-	-	1	-	2	3	2	3	1
CO_3	3	2	1	1	1	-	-	1	-	3	1	3	3	1
CO_4	2	3	1	3	1	-	-	1	-	2	3	2	3	2
CO_5	3	2	3	3	1	1	-	1	-	3	2	1	2	2
Total	13	12	9	11	5	2	-	6	-	13	10	11	13	8
Scaled	3	3	2	3	1	1	-	2	-	3	2	3	3	2

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

1-5 → 1, 6-10 → 2, 11-15 → 3

COURSE CODE	XCHOE1	L	T	P	C
COURSE NAME	MASS TRANSFER FUNDAMENTALS	3	0	0	3
PREREQUISITE		L	T	P	H
C:P:A		3	0	0	3

Course Outcomes At the end of this course, the students should be able to		DOMAIN	LEVEL
CO1	***Explain*** the basic principles in diffusional mass transfer and ***calculate*** the rate of the mass transfer under one dimensional steady state diffusion	Cognitive	Comprehension and apply
CO2	***Describe*** the operations of Distillation and absorption and ***calculate*** number trays for distillation tower	Cognitive	Comprehension and apply
CO3	***Discuss*** the salient features of Separation by adsorption, chromatographic separation and Extraction/ leaching	Cognitive	Comprehension
CO4	***Describe*** the salient features and mechanism involved in Drying and crystallization	Cognitive	Comprehension

COURSE CONTENT

UNIT I	**Mass Transfer and Diffusion**	9

Steady state molecular diffusion in fluids and solids. One dimensional steady state and unsteady state molecular diffusion through stationary media – molecular diffusion in laminar flow – diffusivity measurements – mass transfer analogies – inter phase mass transfer, models of mass transfer at fluid – fluid interface – two film theory and overall mass transfer coefficients – simple problem.

UNIT II	**Distillation and Absorption**	9

Vapour liquid equilibrium – methods of distillation – simple, steam, flash distillation, azeotropic, Extractive and molecular distillation – Continuous distillation – McCabe - Thiele method. Principles – Simple problems. Gas absorption: single and multi-component absorption, absorption with chemical reaction: design principles of absorbers – simple problems.

UNIT III	**Extraction and Leaching**	9

L-L equilibrium – staged and continuous extraction concepts, Equipments for extraction – general design considerations. Solid – liquid equilibria, leaching principles – Equipments for leaching – equilibrium stage model for leaching and washing - simple problems.

UNIT IV	**Adsorption, Ion Exchange and Chromatography**	9

Adsorption and its types -sorbents – equilibrium consideration- kinetic and transport considerations – sorption systems. Ion Exchange cycle – Chromatographic separations.	
UNIT V	**Drying And Crystallization** **9**
Theory and mechanism of drying – drying characteristics of materials -batch and continuous drying – drying equipment – design and performance of various drying equipments – simple problem. Nuclei formation and crystal growth – theory of crystallization – Growth co efficient and factors affecting these in crystallization – batch and continuous industrial crystallizers.	
	L=45 hrs

Text books

1. Seader and Henley, "Separation Process Principles", John Wiley and Sons Inc.2006.
2. Treybal R.E., "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.

References

1. Geankoplis C.J., "Transport Processes and unit Operations" 3rd Edition, Prentice Hall 2003.
2. Coulson and Richardson, "Chemical Engineering" Vol. I & II, Asian Books Pvt.ltd., 1998.
3. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering" 5th Edition , McGraw Hill, 1993.

Mapping of Course Outcomes with Program Outcomes (Course Articulation Matrix)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	3	0	0	0	0	0	0	-	-
CO2	-	2	2	2	1	0	0	0	0	0	0	0
CO3	0	1	2	2	1				1	0	0	0
CO4	-	2	2	1	1	0	0	0	0	0	0	0
0 – No relation 1 - Low, 2 – Medium, 3 – High												

COURSE CODE		XEP 306		L	T	P	C
COURSE NAME		ENTREPRENEURSHIP DEVELOPMENT		2	0	0	2
PREREQUISITES		NIL	L	T	P	SS	H
C:P:A		2.7 : 0 : 0.3	2	0	0	1	3
COURSE OUTCOMES		DOMAIN		LEVEL			
CO1	***Recognise*** and ***describe*** the personal traits of an entrepreneur.	Affective Cognitive		Receiving Understanding			
CO2	***Determine*** the new venture ideas and ***analyse*** the feasibility report.	Cognitive		Understanding Analysing			
CO3	***Develop*** the business plan and ***analyse*** the plan as an individual or in team.	Affective Cognitive		Receiving Analysing			
CO4	***Describe*** various parameters to be taken into consideration for launching and managing small business.	Cognitive		Understanding			
CO5	***Explain the*** technological management and Intellectual Property Rights	Cognitive		Understanding			
UNIT I	**ENTREPRENEURIAL TRAITS AND FUNCTIONS**						**9**
Definition of Entrepreneurship; competencies and traits of an entrepreneur; factors affecting Entrepreneurship Development; Role of Family and Society ; Achievement Motivation; Entrepreneurship as a career and national development;							
UNIT II	**NEW PRODUCT DEVELOPMENT AND VENTURE CREATION**						**9**
Ideation to Concept development; Sources and Criteria for Selection of Product; market assessment ; Feasibility Report ;Project Profile; processes involved in starting a new venture; legal formalities; Ownership; Case Study.							
UNIT III	**ENTREPRENEURIAL FINANCE**						**9**
Financial forecasting for a new venture; Finance mobilization; Business plan preparation; Sources of Financing, Angel Investors and Venture Capital; Government support in startup promotion.							
UNIT IV	**LAUNCHING OF SMALL BUSINESS AND ITS MANGEMENT**						**9**
Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units.							
UNIT V	**TECHNOLOGY MANAGEMENT, IPR PORTFOLIO FOR**						**9**

	NEW PRODUCT VENTURE	

Technology management; Impact of technology on society and business; Role of Government in supporting Technology Development and IPR protection; Entrepreneurship Development Training and Other Support Services.

LECTURE	TUTORIAL	TOTAL
45	0	45

TEXT BOOKS

1. Hisrich, 2016, *Entrepreneurship*, Tata McGraw Hill, New Delhi.
2. S.S.Khanka, 2013, *Entrepreneurial Development*, S.Chand and Company Limited, New Delhi.

REFERENCES

1. Mathew Manimala, 2005, *Entrepreneurship Theory at the Crossroads, Paradigms & Praxis*, Biztrantra ,2nd Edition.
2. Prasanna Chandra, 2009, *Projects – Planning, Analysis, Selection, Implementation and Reviews*, Tata McGraw-Hill.
3. P.Saravanavel, 1997, *Entrepreneurial Development*, Ess Pee kay Publishing House, Chennai.
4. Arya Kumar,2012, *Entrepreneurship: Creating and Leading an Entrepreneurial Organisation*, Pearson Education India.
5. Donald F Kuratko, T.V Rao, 2012, *Entrepreneurship: A South Asian perspective*, Cengage Learning India.
6. Dinesh Awasthi, Raman Jaggi, V.Padmanand, *Suggested Reading / Reference Material for Entrepreneurship Development Programmes* (EDP/WEDP/TEDP), EDI Publication, Entrepreneurship Development Institute of India, Ahmedabad. Available from: http://www.ediindia.org/doc/EDP-TEDP.pdf

E REFERENCES

1. Jeff Hawkins, " Characteristics of a successful entrepreneur", ALISON Online entrepreneurship courses, "https://alison.com/learn/entrepreneurial-skills
2. Jeff Cornwall, "Entrepreneurship -- From Idea to Launch", Udemy online Education, https://www.udemy.com/entrepreneurship-from-idea-to-launch/

Mapping of COs with POs

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2
1	-	-	1	1	1	0	2	1	1	1	2	1	0	0
2	-	-	1	1	-	1	1	1	0	1	1	1	0	0
3	-	-	2	2	3	3	2	3	3	3	3	3	0	1
4	-	1	1	3	0	0	0	0	0	1	2	0	0	0
5	1	1	1	3	0	2	0	0	1	2	2	1	0	0
Total	1	2	6	10	4	6	5	4	5	8	10	6	0	0
Scaled to 0,1,2,	1	1	1	2	1	1	1	1	1	2	2	2	0	1

3														

1-5 →1, 6-10 →2, 11-15 →3

0 – No Relation, 1- Low Relation, 2- Medium Relation, 3- High Relation

COURSE CODE		**XGS307**	**L**	**T**	**P**	**SS**	**C**
COURSE NAME		**INTERPERSONAL COMMUNICATION**	**0**	**0**	**0**	**2**	**0**
PREREQUISITES		**Nil**	**L**	**T**	**P**	**SS**	**H**
C:P:A		**2:0:0**	**0**	**0**	**0**	**2**	**2**
COURSE OUTCOMES		**DOMAIN**		**LEVEL**			
CO1	***Recognize*** culture and a need for interpersonal communication.	Cognitive		Remember			
CO2	***Demonstrate*** the need for effective communication between two people.	Cognitive		Understand			
CO3	***Explain*** family and social relationships and need for socialization.	Cognitive		Understand			
CO4	***Justify*** the IP principles as to how to reduce and repair conflict in interpersonal relationships.	Cognitive		Evaluate			
CO5	***Make use*** of effective and appropriate language at various interpersonal situations to avoid conflict.	Cognitive		Apply			
UNIT I	**UNIVERSALS OF INTERPERSONAL COMMUNICATIONS**						**5**
Axioms of interpersonal Communication - culture in interpersonal communication and the self in interpersonal communication.							
UNIT II	**APPREHENSION AND ASSERTIVENESS**						**5**
Aggressiveness and assertiveness - perception in interpersonal communication - listening in interpersonal communication**.**							
UNIT III	**VERBAL AND NON VERBAL MESSAGES**						**5**
Relationship and involvement - relationship maintenance and repair.							
UNIT IV	**POWER IN INTERPERSONAL RELATIONSHIP**						**5**
Conflict in interpersonal relationship - friends and relatives - primary and family relationships.							
UNIT V	**SOCIALIZATION**						**10**
Need for socialization and benefits of socialization among students.							

	Self-Study	TOTAL
	30	30

TEXT BOOKS

1. *DeVito, Joseph,* The *Interpersonal Communication* Book, 13th Edition -, Published by *Longman* Pub Group, Updated in its *13th edition,*2000
2. Kathleen S. Verderber, Inter-Act: Interpersonal Communication Concepts, Skills and Contexts, Rudolph F. Verderber, 2000

REFERENCES

1. Clifford Whitcomb, Effective Interpersonal and Task Communication Skills for Engineers, Atlantic Publishers. 2010

CO vs PO mapping

	PO										PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**
CO1	0	0	0	0	2	0	0	0	0	0	0	0
CO2	1	0	0	0	0	0	0	0	0	0	0	0
CO3	0	0	0	0	0	0	0	0	0	0	0	0
CO4	0	0	0	0	0	0	0	0	0	2	0	0
CO5	0	0	0	0	0	0	0	0	1	0	0	0
Total	1	0	0	0	2	0	0	0	1	2	0	0
Scaled Value	1	0	0	0	1	0	0	0	1	1	0	0

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

1-5 → 1, 6-10 → 2, 11-15 → 3

SYLLABUS

SEMESTER - IV

COURSE CODE			**XRP401**	**L**	**T**	**P**	**C**
COURSE NAME			**RANDOM PROCESSES**	**2**	**1**	**0**	**3**
C	**P**	**A**	**2.5 : 0.25 : 0.25**	**L**	**T**	**P**	**H**
				2	**2**	**0**	**4**

PREREQUISITE: Basic concepts of Probability theory , Differentiation and Integration

COURSE OUTCOMES		**Domain**	**Level**
CO1	***Define*** basic concepts of probability theory and to ***Find*** their Statistics of one Dimensional distribution functions.	Cognitive	Remembering
CO2	**Find** the marginal and conditional distribution and to **Find** correlation Coefficients and regression equation. **Participates** in the class discussion On two dimensional random variable.	Cognitive Affective	Remembering Responds to phenomena
CO3	***Demonstrate*** the concepts and properties of Stationary, Markov, Poisson and Random telegraph process. **Reproduce** the Markov model.	Cognitive Psychomotor	Understanding Guided Response
CO4	***State*** and ***Explain*** the concepts of auto correlation and cross correlation and to ***Find*** power and cross spectral density.	Cognitive	Remembering Understanding
CO5	***State*** the principles of continuous and discrete-time signals and to ***Find*** the response of linear & time-invariant Systems.	Cognitive	Remembering

UNIT I	**RANDOM VARIABLES**	**12**
Discrete and Continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions.		
UNIT II	**TWO-DIMENSIONAL RANDOM VARIABLES**	**12**
Joint distributions – Marginal and Conditional distributions – Covariance – Correlation and Linear regression .Central limit theorem (for independent and identically distributed random variables).		
UNIT III	**RANDOM PROCESSES**	**12**
Classification – Stationary process – Markov process - Poisson process – Random telegraph process.		
UNIT IV	**CORRELATION AND SPECTRAL DENSITIES**	**12**
Auto-correlation functions – Cross-correlation functions – Properties – Power spectral density – Cross-spectral density – Properties – Wiener-Khinchine relation, theorem.		
UNIT V	**LINEAR SYSTEMS WITH RANDOM INPUTS**	**12**
Linear time invariant system – System transfer function – Linear systems with random inputs – Auto-correlation and Cross-correlation functions of input and output – White noise.		

	LECTURE	TUTORIAL	TOTAL
	30	30	60

TEXT

1. Veerarajan .T, Probability, "Statistics and Random Processes", Tata McGraw Hill, 3rd edition, (2008).

REFERENCES

1. Yates, R.D. and Goodman, D.J., "Probability and Stochastic Processes", John Wiley and Sons, 2nd edition, (2005).
2. Stark, H. and Woods, J.W., "Probability and Random Processes with Applications to Signal Processing", Pearson Education, Asia, 3rd edition, (2002).
3. Miller,S.L. and Childers, D.G.,"Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, (2004).
4. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill edition, New Delhi, (2004).
5. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th edition, New Delhi, (2002).
6. Kandasamy.P, Thilagavathy.K,Gunavathy.K, " Probability, Random Variables and Random Processes", S.Chand & Company Ltd, (2008).

E REFERENCES

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1. Advanced Engineering Mathematics , Prof. Somesh Kumar

   Department of Mathematics, Indian Institute of Technology, Kharagpur.

TABLE 1: CO VS PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3									1		1
CO 2	3									1		1
CO 3	3			2	2					1		2
CO 4	3			2						1		1
CO 5	3			2						1		2
Total	15	1	0	6	0	0	0	0	0	5	0	7
Scaled Value	3	1	0	2	2	0	0	0	0	1	0	2

1-5 →1, 6-10 →2, 11 and above →3.
0 – No relation, 2 – medium relation, 3 – high relation

COURSE CODE	XUM402	L	T	P	C
COURSE NAME	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3
PRE REQUISITE	Basic concepts of engineering, quality management and ethics	L	T	P	H
C:P:A	2:0.5:0.5	3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Understand*** the natural environment and its relationships with human activities.	Cognitive	Remembering
CO2	***Characterize*** and ***analyze*** human impacts on the environment.	Cognitive Affective	Understanding
CO3	***Integrate facts***, concepts, and methods from multiple disciplines and ***apply*** to environmental problems.	Cognitive Psychomotor	Understanding
CO4	***Acquire*** practical skills for scientific problem-solving, including familiarity with laboratory and field instrumentation, computer applications, statistical and modelling techniques.	Cognitive	Understanding Apply
CO5	***Understand*** and ***implement*** scientific research strategies, including collection, management, evaluation, and interpretation of environmental data. ***Design*** and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.	Cognitive	Understanding, apply

UNIT I	INTRODUCTION TO ENVIRONMENTAL STUDIES AND ENERGY	12

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT II	ECOSYSTEMS AND BIODIVERSITY	12

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT III	**ENVIRONMENTAL POLLUTION**	**8**

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Soil waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**7**

Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation – Consumerism and waste products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

UNIT V	**HUMAN POPULATION AND THE ENVIRONMENT**	**6**

Population growth, variation among nations – Population explosion – Family Welfare Programme – Environment and human health – Human Rights – Value Education - HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies.

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
	45	**00**	**00**	**45**

TEXT

1. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
2. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co.
3. Townsend C., HarperJ and Michael Begon, Essentials of Ecology, Blackwell Science.
4. Trivedi R.K. and P.K. Goel, Introduction to Air Pollution, Techno-Science Publications.

REFERENCES

1. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media.
2. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
3. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.
4. S.K.Dhameja, Environmental Engineering and Management, S. K. Kataria and Sons, New Delhi, 1999.

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TABLE 1: CO VS PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3									1		1
CO 2	3									1		1
CO 3	3	1	1				1	0	1	2		2
CO 4	1	1	1	1	1		2	0	1	2	1	1
CO 5	2									1		2
Total	12	2	2	1	1	0	3	0	2	7	0	7
Scaled Value	3	1	1	1	1	0	1	0	1	2	1	2

1-5 $\rightarrow$1, 6-10 $\rightarrow$2, 11 and above $\rightarrow$3.
0 – No relation, 2 – medium relation, 3 – high relation

COURSE CODE	XNT403	L	T	P	C
COURSE NAME	PRINCIPLES OF CHEMICAL ENGINEERING	3	1	1	5
PREREQUISITES	XAC204	L	T	P	H
C:P:A	3:1:1	3	2	3	7

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Recognize the*** different units of measurements in basic chemical calculations and ***Calculate*** the composition of solutions and gas mixtures in different system of units and	Affective Cognitive	Receiving Analyzing
CO2	***Solve*** the material balances for distillation, extraction, mixing, absorption and evaporation operations and ***develop*** block diagrams	Cognitive Affective	Understanding Receiving
CO3	***Explain*** the basic principles of chemical reactions and reactors. ***Operate*** batch and Plug flow reactors	Cognitive Psychomotor	Understanding Guided response
CO4	***Interpret*** the characteristics of different types of fluids and filtration systems. ***Calibrate***s the flow meters, ***handle*** pumps and filtration systems	Cognitive Psychomotor	Understanding Perception Mechanism
CO5	***Describe*** the mechanism of different modes of heat transfer and ***measure*** rate of heat transfer in heat exchange equipments	Cognitive Psychomotor	Understanding, Mechanism

UNIT-I	INTRODUCTION TO ENGINEERING CALCULATIONS, UNITS AND DIMENSIONS	12 + 5

Introduction – Units and dimensions, Fundamental and derived quantities, Measurement conventions, Unit conversions, stoichiometric principles; Basic chemical calculations – solutions and gaseous mixtures, Ideal gas law and its application, Dalton law, Raoult's law, Henry's law.

UNIT –II	MATERIAL BALANCES	12 + 6

Material balance without chemical reactions: Process flow sheet, Three general methods of solving material balance problems, Material balance of unit operations like distillation columns, Extractors, dryers, evaporators and mixing; Material Balances for chemical reaction systems.

UNIT-III	CHEMICAL REACTION ENGINEERING	12 + 6

Reaction principles – Endothermic and Exothermic reaction – Order and Molecularity – Arrhenius equation - First order and second order reaction kinetics – reactor configurations – CSTR, PFR and batch reactors.

UNIT-IV	PARTICLE TECHNOLOGY	12 + 6

Particle characterization – Classification of solid particles- Particle size reduction and enlargement – Liquid Filtration and filters.

UNIT-V	HEAT TRANSFER	12 + 7

Introduction – Conduction, Convection and Radiation – resistance to heat transfer – conduction through - composite wall – forced and free convection mechanism - Heat exchangers – shell and tube – double pipe heat exchangers.

PRACTICAL		
S. NO	**NAME OF THE EXPERIMENT**	**CO**
1.	Batch reactors	3
2.	Plug flow reactors	3
3.	Continuous stirred tank reactors	3
4.	Study of Fluid flow characteristics	4
5.	Calibration of Orifice meter	4
6.	Determination of Coefficient of discharge of Venturimeter	4
7.	Particle size reduction using Jaw crushers	4
8.	Study on Plate and Frame filter press	4
9.	Particle size analysis	4
10.	Experiments on Fourier's Law	5
11.	Heat transfer studies through forced convection	5
12.	Heat transfer studies on Double pipe heat exchangers	5

LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
45	**30**	**30**	**105**

TEXT BOOKS:

1. K.V.Narayanan and Lakshmikutty, Chemical Process Calculations, Prentice Hall, 2004.
2. McCabe W.L., Smith J.C. and Hariott P,, "Unit Operation in Chemical Engineering"7th Edition,Tata McGraw – Hill, 2004.

REFERENCES:

1. Geankoplis C.J. " Transport Processes and Unit Operation"' 4 th Edition, Prentice Hall, 2007.
2. Coulson J.M. and Richardson J.F., " Coulson and Richardson's Chemical Engineering" Vol-I 3rd Edition,Butter woth – Heinemann Publishers,2004.
1. R K Bansal, "*A Textbook of Fluid Mechanics and Hydraulic Machines*", 9th ed. Laxmi Publications, New Delhi, 2004

E-REFERENCES:

http://www.msubbu.in/sp/pc/
www.vlab.co.in

TABLE 1: CO VS PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO 1	3				1								
CO 2	3		1		2								
CO 3	3		1		2								
CO 4	3		1		2								
CO 5	3		1		2								
Total	15		4		9								
Scaled Value	3		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			XNT404	L	T	P	C
COURSE NAME			NANOAPPLICATIONS	3	0	0	3
PREREQUISITE			Applied Physics, Applied Chemistry, Biology for Engineers ,Introduction to Nanotechnology				
C	P	A		L	T	P	H
2.5	0	0.5		3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Know*** and **Understand** the Current status of Nanotechnology applications on various fields	Cognitive Affective	Understand Remember Apply
CO2	***Relate and Understand*** the properties of diferent nanomaterials and its relavant applications	Cognitive Affective	Understand Remember Apply
CO3	***Identify*** the drawbacks of conventional techniques/products used in selected fields	Cognitive Affective	Understand Remember Apply
CO4	***Outline the Evolution*** of nanotechnology concepts to overcome the drawbacks of conventional techniques	Cognitive Affective	Understand Remember Apply
CO5	***Describe*** the Societal impact of nanotechnology.	Cognitive Affective	Understand Remember Apply

UNIT I	Nano in Agriculture	15

Nanotechnology In Agriculture, Nanotechnology In Food Industry, Nanotechnology In Food Microbiology, Nanotechnology For Controlled Release, Nanotechnology Research - Agriculture And Food Industry, Nanotechnology And Risk Assessment, Regulatory Approaches To Nanotechnology In The Food Industry

UNIT II	Nano in Textiles	15

Nanotechnology in manufacturing composite fibers :Carbon nano fibers and carbon nano particles, Clay Nano particles, Metal Oxide Nano particles, Carbon nano tubes, Nano cellular foam structures, Textile finishing :Upgrade of chemical finishes and resultant functions, Nano particles in finishing, Self-assembled nano layer

UNIT III	Nano in Energy and Environment	15

Nanomaterials for Clean and Sustainable Technology, Nanotechnology for Solar Energy Collection and Conversion, Energy Storage and Novel Generation, Nanotech for Oil and Gas, Fuels Applications, Renewable Energy Technologies, Green Chemistry and Materials, Water Technologies, Smart Grid

UNIT IV	Nano in Medicine	15

Nanocardiology, Nanopulmonology, Nanoneurology, Nanosurgery, Nanoopthomology, Nanonephrology, Nanohematology, Nanodentistry, Nanoradiology

UNIT V	Nanomechanics	15

Nano-beams for molecular detection, Carbon Nanotubes , Self-Assembly of semiconductor heterostructures Molecular motors ,Nanostructured Materials for Strength , Mechanical Testing at the Nanoscale ,Printing Indentation

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT

1. Nanotechnology Applications by K.P.Mathula, Neha Publishers & Distributors,2012
2. Nanoscience and Nanotechnology in Engineering, Dr. A.S. Pillai, Vijay K. Varadan, Dr LinFeng Chen, Mayank Dwivedi and Debashish Mukherji, Wiley ,2013.

REFERENCES

1. Encyclopedia of Nnaoscience and Nanotechnology by hari singh nalwa,American Scientific Bublisher ,2012

E REFERENCES

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1. Advanced Engineering Mathematics Prof. PratimaPanigrahi
   Department of Mathematics Indian Institute of Technology, Kharagpur.

TABLE 1: CO VS PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1					1	2				3	
CO 2	1					1	1				3	
CO 3	1					1	2				3	
CO 4	1					1	2				3	
CO 5	1					1	0				3	
	5					5	7				15	

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XMS405	L	T	P	C
COURSE NAME	Materials Science	3	1	0	4
C:P:A	2.5:0:0.5	L	T	P	H
PREREQUISITE	Engineering Physics and Engineering Chemistry	3	1	0	4

COURSE OUTCOMES		Domain	Level
CO1	***Recall***and***distinguish*** various crystal structures.	Cognitive Affective	Understand Remember Apply
CO2	***Describe***and***discuss*** the defects at the atomic and microstructure scales and their impact.	Cognitive Affective	Understand Remember Apply
CO3	***Describe*** the various Ceramic, Electrical & Electronic Materials.	Cognitive Affective	Understand Remember Apply
CO4	***Describe*** the basics of mechanical properties of material and ***identify*** how they can be tested.	Cognitive Affective	Understand Remember Apply
CO5	***Recognize***and***Describe***variousMagnetic Materials and Nano Materials.	Cognitive Affective	Understand Remember Apply

UNIT - I	Crystal Structure	9

Atomic structure and inter-atomic bonding; Structure of crystalline solids; Lattices, unit cells; Crystal systems, Bravais lattices; Indexing of directions and planes, notations, Inter-planar spacings and angles, co- ordination number, packing factors.

UNIT – II	Defects in Crystals	9

Point defects; Dislocations, Types of dislocations, Burgers vector and its representation; Planar defects, stacking faults, twins, grain boundaries.

UNIT - III	Ceramic, Electrical & Electronic Materials	9

Ceramic Materials: Introduction, ceramic structures, silicate structures, processing of ceramics; Properties, glasses; Composite Materials- Introduction, classification, concrete, metal-matrix and ceramic –matrix composites. Impact of ceramic materials in environment.**Electrical& Electronic Properties of Materials:** Electrical Conductivity, Electronic and Ionic Conductivity, Intrinsic and Extrinsic Semi conductivity,Semiconductor Devices Dielectric Properties, Piezo-electricity.

UNIT – IV	Mechanical, Magnetic Properties of Materials	9

Concepts of stress and strain, Stress-Strain diagrams; Properties obtained from the Tensile test; Elastic deformation, Plastic deformation. Impact Properties, Strain rate effects and Impact behavior. Hardness of materials.**Magnetic Materials:** Introduction, Magnetic fields or quantities, types of magnetism, classification of magnetic materials, soft magnetic materials, Hard magnetic materials, Ferrites, Ferro, and Para Magnetic materials.

UNIT – V	Nano Materials	9

Introduction – Nano material preparation, purification, sintering nano particles of Alumina and Zirconia,

Silicon carbide nanoparticle, nano-magnetic, nano-electronic, and other important nanomaterials.Impact of Nano materials in environment
TOTAL HOURS : 45 Hours
TextBooks
1. Askeland D.R.,& P. P. Fullay (2007), The Science and Engineering of Materials – 7thCengage Learning Publishers.
2. William D. Callister, Jr (2008), Callister‟s Materials Science and Engineering, (Adopted by R. Balasubramaniam) Wiley-Eastern
Reference books
1. A.S. Edelstein and R.C. Cammarata Ed.(1998), Nano Materials: Synthesis, Properties and Applications, Inst. Of Physics Publishing, UK.
2. Raghavan V (2007), Materials Science and Engineering - A First Course, Prentice Hall, India
3. James F. Shackelford (1996), Introduction to Materials Science for Engineers, Prentice Hall, India

TABLE 1: CO VS PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	1	1	0			1	2	0		1	1	
CO 2	0	0	0			1	0	0		1	1	
CO 3	1	1	0			1	2	1		1	1	
CO 4	1	1	0			1	2	1		1	1	
CO 5	1	1	3			1	2	1		1	1	
	4	4	3			5	8	3		5	5	

COURSECODE	XNT406	L	T	P	C
COURSE NAME	NANOSYSTEMS AND THEIR DESIGN	3	1	1	5
PREREQUISITES	PHYSICS AND CHEMISTRY	L	T	P	H
C: P: A	3:1:1	3	2	2	7

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Compare*** characteristics of conventional machining, micromachining, solution-phase chemistry, Biochemistry, and molecular manufacturing ***Write*** scaling laws and ***explain*** potential energy surface. ***Build*** complex molecular structures by combining atoms and molecular fragments and ***simulate*** their motion	Cognitive Psychomotor	Remember Understand Set
CO2	***Discuss*** the Molecular dynamics and positional uncertainty ***Study*** the vibrational properties of nanoscale systems ***Calculate*** elastic constants based on classical potential	Cognitive Psychomotor	Remember Understand Perception
CO3	***Explain*** Transitions, Errors, Damage and Energy Dissipation. ***Calculate*** the phonon bandstructure and density of states	Cognitive Psychomotor	Remember Understand Perception
CO4	***Describe*** Mechanosynthesis and Nanoscale Structural Components. ***Construct*** a sensor by molecular positioning	Cognitive Psychomotor	Remember Understand Set
CO5	***Appraise*** Mobile Interfaces and Moving Parts ***Construct*** and ***evaluate*** molecular gear and bearing	Cognitive Psychomotor	Evaluate Perception

Unit I – Classical Magnitudes, Scaling Laws And Potential Energy Surfaces	**9+3+3**
Overview, Molecular manufacturing, comparison, Approximation and classical continuum models, Scaling of classical mechanical systems, Scaling of electromagnetic systems, Scaling of classical thermal systems, Beyond classical continuum models ,PES: Overview Quantum theory and approximations, Molecular Mechanics, Potentials for chemical reactions, Continuum representations of surfaces	
Unit II- Molecular Dynamics And Positional Uncertainty	**9+3+3**
Overview, Nonstatistical mechanics, Statistical mechanics, PES revisited: accuracy requirements, Conclusions,PU: Overview, Positional uncertainty in engineering, Thermally excited harmonic oscillators, Elastic extension of thermally excited rods, Elastic bending of thermally excited rods, Piston displacement in a gas-filled cylinder, Longitudinal variance from transverse deformation, Elasticity, entropy, and vibrational modes, Conclusions	

Unit Iii- Transitions, Errors, Damage And Energy Dissipation	**9+3+3**
Overview, Transitions between potential wells, Placement errors, Thermo mechanical damage, Photochemical damage, Radiation damage, Component and system lifetimes, Conclusions LED: Overview, Radiation from forced oscillations, Phonons and phonon scattering, Thermoelastic damping and phonon viscosity, Compression of potential wells, Transitions among time-dependent wells, Conclusions	
Unit Iv- Mechanosynthesis And Nanoscale Structural Components	**9+3+3**
Overview, Perspectives on solution-phase organic synthesis, Solution-phase synthesis and mechanosynthesis, Reactive species, Forcible mechanochemical processes, Mechanosynthesis of diamondoid structures, Conclusions , NSC: Overview, Components in context, Materials and models for nanoscale components, Surface effects on component properties, Shape control in irregular structures, Components of high rotational symmetry, Adhesive interfaces, Conclusions	
Unit V- Mobile Interfaces And Moving Parts	**9+3+3**
Overview, Spatial Fourier transforms of nonbonded potentials, Sliding of irregular objects over regular surfaces, Symmetrical sleeve bearings, applications of sliding-interface bearings, Atomic-axle bearings, Gears, rollers, belts, and cams, Barriers in extended systems, Dampers, detents, clutches, and ratchets, Perspective: nanomachines and macromachines, Bounded continuum models revisited, Conclusions	

LIST OF EXPERIMENTS		**CO**
1	Molecular builder	1
2	Molecular dynamics: Basics	1
3	Green's function surface calculations	2
4	Elastic constants based on classical potential	2
5	Molecule-surface systems: Benzene on Au(111)	3
6	Phonons, Band structure and Thermo electrics	3
7	Thermoelectric effects in a CNT with isotope doping	3
8	Oxide dot on silicon surface	4
9	Spin transport in magnetic tunnel junctions	5
10	Spin-orbit transport calculations: Bi2Se3 topological insulator thin-film device	5
11	Spin Transfer Torque	5
12	Atomic-axle bearings, Gears	5

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**45**	**30**	**30**	**105**

TEXT BOOKS

1. Eric Drexler K, ***Nanosystems: Molecular Machinery, Manufacturing, and Computation***, Wiley India, 2010.

REFERENCES

1. Ben Rogers, Jesse Adams, Sumita Pennathur, **Nanotechnology: Understanding Small Systems**, Third Edition, CRC Press, 2014

2. H. S. Nalwa, Ed., **Encyclopedia of Nanoscience and Nanotechnology,** 10-Volume **Set,** American Scientific Publishers, Los Angeles**,** 2004.

3. DeMicheli G**.,** Leblebici Y**.,** Gijs M**.,** Vörös J**., Nanosystems Design and Technology**, Springer, 2009

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1. http://www.imm.org/research/parts/molvis/#MIMEtypes
2. http://ipn2.epfl.ch/lns/lectures/nanoscience/lecturenotes/cour-1.pdf
3. www.uniroma2.it/didattica/NANOSCIENZE/deposito/L1.ppt
4. http://www.nanoscienceworks.org/publications/books/4/9781420048056/instructors/ITNSLecture-1.pdf
5. http://uw.physics.wisc.edu/~himpsel/Nano/lectures.htm

Table 1: Mapping of COs with POs

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
1	1	1		0	1	1	0		0	1	0	0	2	0
2	2	1		0	2	2	0	1	0	1	0	0	2	0
3	1	2	1	0	2	2	0		0	1	0	0	2	0
4	1	1	1	0	2	2	0	1	0	1	0	0	2	0
5	1	1	1	0	2	2	0	1	0	2	0	0	2	0
Total	6	6	3	0	9	9	0	3	0	6	0	0	10	0
Scaled	2	2	1	0	3	3	0	1	0	2	0	0	2	0

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XGS 407	L	T	P	SS	C
COURSE NAME	TECHNICAL COMMUNICATION	1	0	0	2	1
		L	T	P	SS	H
C:P:A	1.8:0.8:0.4	1	0	0	2	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO 1	***Identify*** the features of a technical project report and Knowledge on the linguistic competence to write a technical report	Cognitive	Remember
CO 2	***Integrate*** both technical subject skill and language skill to write a project.	Cognitive	Create
CO 3	Confidence to ***present*** a project in 10 to 15 minutes	Affective	Response
CO 4	The learner ***identifies*** and absorbs the pronunciation of sounds in English Language and learns how to mark the stress in a word and in a sentence properly	Cognitive	Remember
CO 5	***Enables*** the speaker speaks clearly and fluently with confidence and it trains the learner to listen actively and critically	Psychomotor	Perception

SYLLABUS		HOURS
UNIT I	BASIC PRINCIPLES OF GOOD TECHNICAL WRITING	9
Style in technical writing, out lines and abstracts, language used in technical writing: technical words, jargons etc		
UNIT II	SPECIAL TECHNIQUES	9
Definition, description of mechanism, Description of a process, Classifications, division and interpretation		
UNIT III	REPORT/ PROJECT	9
Layout the formats: chapters, conclusion, bibliography, annexure and glossary, Graphics aids etc - Presentation of the written project 10 – 15 minutes		
UNIT IV	SOUNDS OF ENGLISH LANGUAGE	9
Vowels, consonants - Vocabulary building – synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, idioms and phrases.		
UNIT V	READING COMPREHENSION	9
Reading for facts, meanings from context, scanning, skimming, inferring meaning, critical reading, active listening, listening for comprehension etc.		

	LECTURE	SELF STUDY	PRACTICAL	TOTAL
HOURS	15	30	0	45

TEXT BOOKS

1. Gordon H. Mills, Technical Writing – April, 1978, Oxford Univ Press
2. Barun K. Mitra, Effective Technical Communication: A Guide for scientists and Engineers. Author, Publication: Oxford University press. 2007

REFERENCES

1. Clifford Whitcomb, Effective Interpersonal and Task Communication Skills for Engineers, Atlantic Publishers. 2010

TABLE 1: CO VS PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	0	0	0	0	0	1	3	0	0	0	0	0
CO 2	0	0	0	0	0	1	1	0	0	0	0	0
CO 3	0	0	0	0	0	1	2	0	0	0	0	0
CO 4	0	0	0	0	0	1	1	0	0	0	0	0
CO 5	0	0	0	0	0	1	1	0	0	0	0	0
	0	0	0	0	0	5	8	0	0	0	0	0

1-5 = 1, 6-10 = 2, 11-15 = 3

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

SYLLABUS

SEMESTER - V

COURSE CODE	XNT501	L	T	P	C
COURSE NAME	QUANTUM MECHANICS FOR ENGINEERS	3	1	0	4
PREREQUISITES	XAP104 - Applied Physics, XMA 101 Partial differentiation and their applications	L	T	P	H
C:P:A	2:1:0	3	2	0	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Understand*** the basic ideas of QM through demonstrations of quantum system and formulation of Hamiltonian eigen value problem	Cognitive	Understand Analyze
CO2	***Explain*** the basis for description of elements & bonds, ***Apply*** in Hydrogen atom and ***discuss*** eigen functions	Cognitive Psychomotor	Understand, Apply
CO3	***Explain,*** the basis for description to multiple particle and ***discuss*** eigen functions	Cognitive Psychomotor	Understand Comprehend. Analyze
CO4	***Explain,*** the basis for description to heavier elements & their bonds	Cognitive Psychomotor	Understand, Analyze
CO5	***Describe*** and ***Discuss*** time evolution and the development with advanced concept of angular momentum	Cognitive Psychomotor	Understand, Analyze

UNIT I	BASIC IDEAS OF QM	9+6=12

Mathematical Prerequisites,Basic Ideas of Quantum Mechanics, Statistical Interpretation, A Particle Confined Inside a Pipe: The physical system, The Hamiltonian eigenvalue problem and solutions including, Three-dimensional solution, Quantum confinement, The Harmonic Oscillator

UNIT II	SINGLE-PARTICLE SYSTEMS	9+6=12

Angular Momentum, The Hydrogen Atom, Expectation Value and Standard Deviation, Commutator, The Hydrogen Molecular Ion: The Hamiltonian: Energy when fully dissociated, Energy when closer together, States that share the electron, Comparative energies of the states, Variational approximation of the ground state, Comparison with the exact ground state.

UNIT III	MULTIPLE-PARTICLE SYSTEMS	9+6=12

Generalization to Multiple Particles, The Hydrogen Molecule, Multiple-Particle Systems Including Spin: Wave function for a single particle with spin, Inner products including spin, Wave function for multiple particles with spin, the hydrogen molecule, Triplet and singlet states, Identical Particles, Ways to Symmetrize the Wave Function, Matrix Formulation, Global Symmetrization [Background].

UNIT IV	MULTIPLE-PARTICLE SYSTEMS – HEAVIER THAN HYDROGEN ATOM	9+6=12

Heavier Atoms: The Hamiltonian eigenvalue problem, Approximate solution using separation of variables, Hydrogen and helium Lithium to neon, Chemical Bonds, Confined Electrons: The

Hamiltonian eigenvalue problem, Solution by separation of variables, The density of states and confinement, Band Structure, Quantum Statistical Mechanics.		
UNIT V	**TIME EVOLUTION**	**9+6=12**
The Schr¨odinger Equation, The Position and Linear Momentum Eigenfunctions, Wave Packets in Free Space: Solution of the Schr¨odinger equation, The fundamental commutation relations, Ladders, Possible values of angular momentum, Triplet and singlet states, Clebsch-Gordan coefficients, Pauli spin matrices, The Relativistic Dirac Equation, The Electromagnetic Field, The Hamiltonian, Maxwell's equations, Electrons in magnetic fields.		

TOTAL HOURS

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	**30**	**0**	**75**

TEXT BOOK

1. Leon von Dommelen, "Fundamental Quantum Mechanics for Engineers", Version 3.1, beta 3, 2007.

REFERENCES

1. David J. Griffiths, Introduction to Quantum Mechanics (Cambridge University Press India; 2/ed edition, 2016).
2. L. Schiff, Quantum Mechanics (Tata McGraw Hill, New Delhi, 1968).
3. V. K. Thankappan, Quantum Mechanics (Wiley-Eastern, New Delhi, 1985).
4. P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics (Tata McGraw Hill, New Delhi, 1987).

E-REFERENCE

1. http://nptel.ac.in/courses/115106066/
2. http://freevideolectures.com/Course/2669/Quantum-Physics

Table 1 : COs versus POs mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7/PO8/PO9	PO10	PO11/PO12	PSO1	PSO2	Total	Scaled
CO1	3	2				1		2				**8**	**2**
CO2	2	2				2		2				**8**	**2**
CO3	1	2		**1**	2	2		1		**1**		**10**	**2**
CO4	1	1		**1**	2	2		1		**1**		**9**	**2**
CO5	2	1				1		1		**1**		**6**	**1**
Total	9	8		**2**	4	8		7		**3**		**41**	**9**
	2	2			1	2		1		**1**		**9**	**1**

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XNT502	L	T	P	C
COURSE NAME	NANOMATERIALS FABRICATION TECHNIQUES –I	3	0	1	4
C:P:A	1.5:1.5:1	L	T	P	H
PREREQUISITE		3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Describe*** and ***Demonstrate the*** **Fabrication** nanomaterial	Cognitive Psychomotor Affective	Understand Apply
CO2	***Describe*** the basics of Theorem of electric circuits and ***identify*** how they can be tested.	Cognitive Psychomotor Affective	Understand Mechanism set Apply
CO3	***Describe*** the Physical techniques and ***Recognize*** the different types of processing	Cognitive Psychomotor Affective	Understand Remember Apply
CO4	***Identify*** the different types of chemical methods and how they can be tested. ***Describe*** the basics of Chemical methods for fabrication	Cognitive Psychomotor Affective	Understand Remember Mechanism set Apply
CO5	***Describe the basic Self Assembly and identify*** and ***Recognize*** the different types of processing	Cognitive Psychomotor Affective	Understand Remember Mechanism set Apply

UNIT - I	Basic Concepts of Nano Fabrication	9+6=15

Drexler-Smalley debate; realistic projections; outline of various preparation techniques; basic concepts of nano-structured materials; nucleation: surface nucleation, growth, grain size distribution; nano-particle transport in low density media.

UNIT – II	Physical Techniques I	9+6=15

Physical processes in semiconductor nano structures. Introduction; thin film deposition methods; fundamentals of film deposition; thermal evaporation; spray pyrolysis; flame pyrolysis;

UNIT - III	Physical Techniques II	9+6=15

molecular beam epitaxy; pulsed laser deposition; sputter deposition; different types sputtering processes; thermal forming processes; plasma processes; physical methods for the preparatioof nano tubes

UNIT – IV	Chemical Methods I	9+6=15

Chemical vapor deposition (CVD); plasma-enhanced CVD; low pressure plasma CVD; metal-organic CVD (MOCVD); photo-enhanced CVD; electron enhanced CVD

UNIT – V	Chemical Methods II	9+6=15

Laser induced CVD; atmospheric pressure CVD; reactive ion etching (RIE) molecular-beam epitaxy (MBE); chemical beam epitaxy (CBE); chemical bath deposition.

TOTAL HOURS

Lecture	Tutorial	Practical	Total
45	0	30	75

TEXTBOOK	
1. "Introduction to Nanotechnology," Frank J. Owens & Charles P. Poole, Wiley-IEEE, 2003. 2. "Encyclopedia of Nanoscience & Nanotechnology," H. S. Nalwa, American Scientific Publishers, 2004. 3. ."The Powder Method," L.V. Azaroff & M. J. Buerger, McGraw-Hill, 1958.	
REFERENCE	
1.	"Encyclopedia of Nanoscience & Nanotechnology," H. S. Nalwa, American Scientific Publishers, 2004.
2.	"X-ray Diffraction Procedures," H. P. Klung & L. E. Alexander

Table 1 : COs versus POs mapping

CO/PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PSO1
CO1	1	2	3	1	2	1	1	1	2
CO2	1	2	3	1	2	1	1	1	2
CO3	1	2	3	1	2	1	1	1	2
CO4	1	2	3	1	2	1	1	1	2
CO5	1	2	3	1	2	1	1	1	2
Total	5	10	15	5	10	5	5	5	10
	1	2	3	1	2	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	XNT504	L	T	P	C
COURSE NAME	NANOMATERIALS CHARACTERIZATION TECHNIQUES – I	3	0	1	4
PREREQUISITES	PHYSICS AND MATERIALS SCIENCES	L	T	P	H
C:P:A	2:0.5:0.5	3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Demonstrate*** the ***understand the*** Metrology concepts relevant to the nanomaterials	Cognitive Psychomotor	Understanding Applying
CO2	***Identify*** and ***Understand and Realize*** the Standards of nanometrology and its calibration techniques	Cognitive Psychomotor	Understanding, Identifying Guided Response
CO3	***Understand*** and ***Apply*** the principles of Optical tools and its applications to characterize the nanomaterials and nanostructures	Cognitive Psychomotor	Understanding, Applying
CO4	***Classify*** and ***Evaluate*** the different spectroscopic techniques and its application for nanomaterials charecterization	Cognitive Psychomotor	Understanding, Applying
CO5	***Understand*** and ***Apply*** the principles and applications of surface charectization techniques for nanomaterials	Cognitive Psychomotor	Understand, Guided Response

UNIT I	Metrology	9+6=15

Concepts of Metrology- Accuracy, precision and reliability; Standards of Measurement-Standards for linear measurements (Line Standard & Wavelength Standard); Subdivision of standards (Primary, Secondary, Tertiary Standards, Working standards); Calibration- Types of Errors (Static Errors, Systematic Errors and Random Errors); Statistical analysis of errors, Six Sigma concept.

UNIT II	Calibration Standards for Nanometrology	9+6=15

Calibration Standards for Nanometrology: Flatness standards; Lateral Standards; Step-height standards; Nanoroughness Standards; Film thickness standards; Accuracy of optical interferometry.

UNIT III	Optical Characterization Techniques	9+6=15

Elliphsometry; plasma resonance; Photoluminescence (PL); micro-photoluminescence (μ-PL); Cathode Luminescence (CL); photo-conductance decay and photoluminescence decay; Quartz Crystal Micro-balance (QCM)

UNIT IV	Spectroscopic Techniques	9+6=15

UV-Visible spectroscopy; Infrared (IR) & Fourier Transform infrared (FTIR) spectroscopy; Nuclear Magnetic Resonance (NMR) spectroscopy; Dynamic nuclear magnetic resonance (Dynamic NMR); Raman spectroscopy techniques; micro-Raman and Laser Raman; SQUID Magnetometer

UNIT V	Surface Characterization Techniques	9+6=15

Basic principles and their applications of Scanning Probe Techniques (SPM): Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Electric Force Microscopy (EFM), Magnetic Force

Microscopy (MFM); ECAFM, ECSTM, Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscopy (FE-SEM); Reflection High Energy Electron Diffraction (RHEED); Low Energy Electron Diffraction (LEED); gas adsorption spectroscopy for porosity measurement.				
TOTAL HOURS				
	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**45**	**0**	**30**	**75**
TEXT BOOK				
1. Skoog, Holler, Nieman " Principles of Instrumental Analysis" 2. Rainer Waser " Nanoscale Calibratin Standards"Wiley-VCH **3.** Rainer Waser " Nanometrology"Wiley-VCH				
REFERENCES				
1. Sabu Thomas Raju Thomas Ajesh Zachariah Raghvendra Mishra, "Microscopy Methods in Nanomaterials Characterization" Volume 1,2017, Elsevier 2. Ratna Tantra "Nanomaterial Charecterization: An Introductions" Wiley-VCH 3. R. K. Jai "Engineering Metrology," n, Khanna Publishers, Delhi, 2003. 4. Ted Busch "Fundamentals of Dimensional Metrology " Delmar Publishers Inc., USA, 1989.				
E-REFERENCE				
www.nptel.ac.in www.mit.co.in				

Table 1 : COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
CO1		1	2	**3**	1	2	1	**1**	**1**			**2**	
CO2		1	2	**3**	1	2	1	**1**	**1**			**2**	
CO3		1	2	**3**	1	2	1	**1**	**1**			**2**	
CO4		1	2	**3**	1	2	1	**1**	**1**			**2**	
CO5		1	2	**3**	1	2	1	**1**	**1**			**2**	
Total		5	10	**15**	5	10	5	**5**	**5**			**10**	
		1	2	**3**	1	2	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	XNT505	L	T	P	C
COURSE NAME	ENGINEERING THERMODYNAMICS	3	1	0	4
PREREQUISITES	PHYSICS AND CALCULUS	L	T	P	H
C:P:A	2.75:0:0.25	3	2	0	5

COURSE OUTCOMES (COs)		Domain	Level
CO1	To ***Recall*** the basic laws of thermodynamics and ***Apply*** them.	Cognitive	Remember Apply
CO2	To ***Summarize*** the concepts in statistical thermodynamics	Cognitive	Understanding
CO3	To ***Construct*** models of statistical thermodynamics.	Cognitive	Applying
CO4	To ***Analyze*** and ***Use*** thermodynamic principles in chemical and metallurgical processes.	Cognitive Affective	Analyzing Receiving
CO5	To ***Summarize*** phase transitions.	Cognitive	Understanding

UNIT-I	BASIC CONCEPTS AND LAWS OF THERMODYNAMICS	9+6=15

Classical approach: Thermodynamics systems – Boundary – Control Volume – System and surroundings – Universe – Properties – State-Process – Cycle – Equilibrium – Work and heat transfer – Point and path functions – First law of thermodynamics for open and closed systems – First law applied to a control volume – SFEE equations [steady flow energy equation] – Second law of thermodynamics – Heat engines – Refrigerators and heat pumps – Carnot cycle – Carnot theorem – Clausius inequality – Concept of entropy – Principle of increase of entropy – Basic thermodynamic relations.

UNIT –II	FUNDAMENTALS OF STATISTICAL THERMODYNAMICS	9+6=15

Statistical thermodynamics- energy states and energy level – micro and macro state – thermodynamic probability – B.E, F.D and M B statistics – entropy - B.E, F.D and classical distribution function and their comparison – M.B distribution function – partition function and thermodynamic properties.

UNIT-III	STATISTICAL THERMODYNAMICS MODELS	9+6=15

Boltzmann statistics- Ensembles- Classical statistical thermodynamics-Partition functions-Virial expansions-Brownian dynamics- Lagrangian and Hamiltonian functions-Extended Lagrangian methods-Simulations in different ensembles-Force fields for molecules, liquids and solids- Many-body and polarisation models.

UNIT-IV	SOLUTION THERMODYNAMICS AND ELECTROMETALLURGY	9+6=15

Ideal and non-ideal solutions, Partial and integral molar quantities, Gibbs-Duhem equation, Quasi-Chemical approach to solutions, Sievert's law, Chemical potential, Fugacity and Activity, Free energy diagram for binary alloy systems, Phase diagrams, Clapeyron equation. Electrometallurgy cells, Reversible Galvanic cells, Relationship between cell EMF and free energy of cell reaction.

UNIT-V	PHASE EQUILIBRIA AND PHASE TRANSFORMATIONS	9+6=15

Unary, binary and multicomponent systems, Phase equilibria, Phase rule, evolution of phase diagrams, metastable phase diagrams, calculation of phase diagrams.

Thermodynamics of phase transformations: Melting and solidification, precipitation, eutectoid, massive, spinodal, martensitic and order disorder transformations. First and second order transitions.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	30	0	75

TEXT BOOKS:

1. P.K.Nag, “Basic and Applied Engineering Thermodynamics”. Tata McGraw Hill, New Delhi, 2012.
2. Herbert Goldstein “Classical Mechanics” II edition, Narosa Publishing House.

REFERENCES:

1. Rogers and Mayhew, “Engineering Thermodynamics – Work and Heat Transfer“, Addision Wesley, New Delhi, 1999.
2. Eastop and McConkey, “Applied Thermodynamics“, Addision Wesley, New Delhi, 1999.
3. K.C. Gupta, “Classical Mechanics” New Age Publishers.
4 . B.K.Sankar, “Thermal Engineering“, Tata McGraw Hill, New Delhi, 1998.

E-REFERENCES:

www.nptel.ac.in
www.mit.edu

Table 1 : COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	
CO1	3	3	0	1	0	1	2	0	2	0	0	1	1	0	**14**
CO2	3	3	2	1	0	1	2	0	2	0	0	1	1	0	**16**
CO3	3	3	1	1	0	1	2	0	2	0	0	1	1	0	**15**
CO4	3	3	0	1	0	1	2	0	2	0	0	1	1	0	**14**
CO5	3	3	2	1	0	1	2	0	2	0	0	1	1	0	**16**

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XNT506A	L	T	P	C
COURSE NAME	EMERGING TOOLS FOR BIOLOGY AND MEDICINE:	2	0	1	3
PREREQUISITE	BIOLOGY FOR ENGINEERS	L	T	P	H
C:P:A	1.5:0.5:1	2	0	2	4

	COURSE OUTCOME	DOMAIN	LEVEL
CO1	***Explain*** and ***Discuss*** the nanoscale paradigm in terms of properties at the nanoscale dimension	Cognitive Affective	Understanding Receiving
CO2	***Identify*** and ***Build*** the current nanotechnology solutions for selected biological issue	Cognitive Psychomotor	Understanding Manipulation
CO3	***Read*** and ***Present*** current nanotechnology literature applied to a particular problem domain	Cognitive Affective	Receiving Applying Responding
CO4	***Apply*** key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology	Cognitive Affective	Remembering Internalizing Value
CO5	***Identify*** career paths and ***Acquire*** knowledge on advanced biomedical stream	Cognitive Affective	Understanding and applying

UNIT I	Nanotechnology in Biology and Medicine:The New Frontier	6+6

Introduction -Cellular Nanomachines and the Building Blocks of Life - A New Generation of Nanotools -bio-Inspired Nanomaterials for a New Generation of Medicine: Liposomes – Virosomes - Polymersomes: Toward a Synthetic Cell - Peptoids - Peptide Nucleic Acid, Functionally Inspired Biomaterials: Mussel-Adhesive Proteins

UNIT II	Nucleoprotein-Based Nanodevices in Drug Design and Delivery	6+6

Bionanotechnology for Molecular Targeting – Assembly of Three - Address Nucleoprotein Arrays, Molecular Model, Oligodeoxynucleotide Preparation: Cloning- Expression- and Purification of Fusion Proteins- Y-Junction Device Assembly - Applications of Ordered Arrays in Smart Drug Design - Molecular Payloads.

UNIT III	Quantum Dots	6+6

Novel Optical Proper ties-Synthesis - Solubilization, and Bioconjugation - Delivery, Binding Specificity, and Toxicity, Applications in Biology and Medicine : Cellular Imaging and Tracking - Ly mph Node and Vascular Mapping - Tumor Targeting and Imaging -Molecular Profiling of Clinical Tissue Specimens -Single Virus Detection.

UNIT IV	Single-Molecule Detection Techniques for Monitoring Cellular Activity at the Nanoscale Level	6+6

Basic Requirements for Single-Molecule Detection :Signal-to-Noise Ratio and Signal-to-Background Ratio - Ensure That the Signal Actually Originates from a Single Molecule

Optical Techniques for Single-Molecule Detection: Laser-Induced Fluorescence- Near-Field Scanning Optical Microscopy-Surface-Enhanced RamanSpectroscopy - Optical Tweezers

Applications in Fixed and Living Cells - Molecular Motors- Cell Signaling – Protein Conformational Dynamics- Ion Channels -. Monitoring Reactions and Chemical Constituents in Living Cells

UNIT-V	Nanotube-Based Membrane Systems	6+6

Materials and Methods of Nanotube- Based Membrane Systems -Template Synthesis - Biochemical Separations with Nanotube Membranes - Separation of Proteins by Size . Charge-Based Separation of Ions - Separations Using Molecular Recognition, Toward Nanotube Membranes for Biochemical Sensors : Ligand-Gated Membranes - Voltage-Gated Conical Nanotube Membranes – Electromechanically Gated Conical Nanotube Membranes

	LECTURE	TUTORIAL	LAB	TOTAL
	30	0	30	60

TEXT

1. Nanotechnology In Biology And Medicine , Methods, Devices, and Applications, by Tuan Vo-Dinh

REFERENCES

1. "Handbook of Nanostructured Materials & Nanotechnology," Hari Singh Nalwa (Ed.), Academic Press, 2000.
2. "Nanotechnology: Basic Science & Engineering Technologies," Michael Wilson, CRC Press, London, 2004.
3. "Drug Delivery: Engineering Principles for Drug Theraphy," M. Salzman, Oxford University Press, 2001.
4. "Drug Delivery & Targeting," A.M. Hilley, CRC Press, 2002.
5. "Handbook of Nano and Molecular Electronics," Sergy Edward Lyshevski.
6. "Nanotechnology: Information Technology – II," vol. 4, Rainer Waser, Wiley–VCH.
7. "Theraputic Micro and Nanotechnology," Tejal Desai & Sangeeta Bhatia, Springer.

E-REFERENCES:

www.nptel.ac.in
www.mit.edu

S.No	Lab Experiments	Domain	Level	CO
1.	Charecterization of Polymerosomes	Affective	Applying	**1**
2.	Cell array Farication on Silicon Surface – Video Lecture	Affective	Applying	**2**
3.	Surface Functionalization of quantum dot	Affective	Applying	**3**
4.	Molecular detection using Raman Spectroscopy	Affective	Applying	**4**
5.	Biocompatability of Carbon Nanotube	Affective	Applying	**5**

Table:1 Mapping of CO's with PO:

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO2	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO3	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO4	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO5	1	1	0	0	2	1	1	0	0	1	0	0	1	1
Total	**5**	**5**	**0**	**0**	**10**	**5**	**5**	**0**	**0**	**5**	**0**	**0**	**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	XNT506B	L	T	P	C
COURSE NAME	ENZYME TECHNOLOGY	2	0	1	3
PREREQUISITES	CHEMISTRY	L	T	P	H
C:P:A	3:1:1	2	0	2	4

COURSE OUTCOMES (COs)		Domain	Level
CO1	To ***Classify*** and ***Describe*** enzymes. ***Detection*** of enzyme activity.	Cognitive Affective Psychomotor	Understanding Receiving Perception
CO2	To ***Summarize*** and ***Measure*** the parameters of enzyme kinetics.	Cognitive Psychomotor	Understanding Mechanism
CO3	To ***Identify*** and ***Discuss*** enzyme extraction procedures.	Cognitive Affective Psychomotor	Applying Responding Perception
CO4	To ***Classify*** and ***Describe*** enzyme immobilization.	Cognitive Affective Psychomotor	Understanding Receiving Perception
CO5	To ***Explain*** and ***select*** biosensors according to various applications.	Cognitive Affective Psychomotor	Understanding Responding Perception

UNIT-I	INTRODUCTION TO ENZYMES	6 + 6

Classification of enzymes - Mechanisms of enzyme action, concept of active site and energetic of enzyme substrate complex formation - Specificity of enzyme action - Principles of catalysis - Collision theory, transition state theory - Role of entropy in catalysis - Types of enzymes - constitutive enzyme, induced enzymes, intracellular and extracellular enzymes - Application of enzymes in food, pharmaceutical and other industries - Enzymes for analytical and diagnostic applications.

UNIT –II	KINETICS OF ENZYME ACTION	6 + 6

Kinetics of single substrate reactions - Estimation of Michaelis -Menten parameters, Turnover number , Multi-substrate reactions, Mechanisms and kinetics - Types of inhibition, Kinetic models, Substrate and product inhibition - Allosteric regulation of enzymes, The Monod-Changeux-Wyman model and the Koshland-Nemethy-Filmer model - pH and temperature effect on enzyme and deactivation kinetics.

UNIT-III	PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES	6 + 6

Methods of production of enzymes, Extraction of enzymes from various sources like plant, animal and microbial sources, soluble enzymes, and membrane bound enzymes - Nature of extraction medium - Purification of enzyme - Criteria of purity - Determination of molecular weight of enzymes.

UNIT-IV	ENZYME IMMOBILIZATION	6 + 6

Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with example - Advantages and disadvantages of different immobilization techniques - Overview of applications of immobilized enzyme systems.

UNIT-V	BIOSENSORS	6 + 6
Introduction to biosensors , History - Types and design of enzyme electrodes , Biosensors applications in industry, healthcare and environment.		

PRACTICALS:

S.NO	NAME OF THE EXPERIMENT	CO
1	Enzyme denaturation and renaturation.	1
2	Determination of specific activity of enzyme.	1
3	Enzyme kinetics of phosphatase.	2
4	Effect of pH, temperature and substrate concentration on enzyme activity.	2
5	Determination of stability of enzyme activity.	2
6	Production of microbial enzymes.	3
7	Downstream processing (Purification) of enzymes	3
8	Comparison of enzyme activity on immobilized and free enzyme.	4
9	Immobilization of yeast cells as biocatalyst for ethanol production from sugar.	4
10	Biosensors for detection of glucose.	5

LECTURE	TUTORIAL	PRACTICAL	TOTAL
30	**0**	**30**	**60**

TEXT BOOKS:

1. Chaplin, M. and Bucke, C. (1990). Enzyme Technology, 1st Edition, Cambridge University Press, London, 1st Edition, 1990.
2. Palmer, T., Enzymes: Biochemistry Biotechnology and Clinical Chemistry, East West Press Pvt Ltd, New Delhi, 5th Edition, 2001.

REFERENCES:

1. James Lee, M. (1992). Biochemical Engineering, 1st Edition, Prentice-Hall Inc Publishers, Delhi, 1st Edition, 1992.
2. Blanch, H. W. and Clark, D.S., Biochemical Engineering, CRC Press, USA, 2nd Edition, 1997.
3. Zubay, G., Biochemistry, 4th Edition, McGraw Hill Publishers, New Delhi, 1999.

E-REFERENCES:

www.nptel.ac.in
http://www1.lsbu.ac.uk/water/enztech/
www.vlab.co.in

Table:1 Mapping of CO's with PO:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	0	0	1	2	2	2	0	0	1	1	0	1	0
CO2	1	1	0	1	2	1	1	1	0	1	1	0	2	0
CO3	0	0	1	1	1	1	1	1	0	1	1	0	1	0
CO4	1	1	2	1	2	1	2	1	0	1	1	0	2	0
CO5	1	1	2	1	1	1	2	1	0	1	1	0	2	0
Total	4	3	5	5	8	8	8	4	0	5	5	0	8	0
Scale	1	1	1	1	2	2	2	1	0	1	1	0	2	0

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XNT506C	L	T	P	C
COURSE NAME	ELECTRIC AND ELECTRONIC CIRCUITS	2	0	1	3
C:P:A	1.5:1.5:1	L	T	P	H
PREREQUISITE	BASIC ENGINEERING	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Describe*** the basics of Theorem of electric circuits and ***idenify*** how they can be tested.	Cognitive Psycomotor Affective	Understand Remember Mechanism set Apply
CO2	***Classify*** and ***explain*** AC and DC Machines and ***show*** the input output characteristics of Machines	Cognitive Psycomotor Affective	Understand Remember Mechanism set Apply
CO3	***Recognize*** and ***Describe*** various Power plants and about Protection switch gears	Cognitive Affective	Understand Remember Apply
CO4	***Describe*** the basics of Semiconductor devices ***identify*** how they can be tested.	Cognitive Psycomotor Affective	Understand Remember Mechanism set Apply
CO5	***Describe*** the basic of digital electronics and ***identify*** Opto electronics devices.	Cognitive Psycomotor Affective	Understand Remember Mechanism set Apply

UNIT I	Fundamentals of Electric Circuits	6+6

Introduction to Electrical Circuits, Single Phase A.C. Circuits: R.M.S. and Average values and form factor, Network Topology, Network Theorems (With A.C. & D.C)

UNIT II	Electrical machines and drives	6+6

Basic principle Operation and construction AC machine and DC Machine , Speed Control AC machine and DC Machine Characteristics of AC machine and DC Machine and Application-Fundamental of Electric drives

UNIT III	Eco Power Generation and Utilization:	6+6

Power plant-Types of power plants- Schematic arrangement, advantages and disadvantages of power plants, Protection switchgear-Relay, circuit breakers-Introduction of Transmission and Distribution, Tariff and Economic aspects in power Generation

UNIT IV	Electronic Devices and Circuits;	6+6

Semiconductor device-Characteristics of Power diode, Zener diode, Transistor, Construction and operation of Voltage control device and Current control device

UNIT V	Digital electronics and Opto Electronic Devices	6+6

Binary Systems and Logic Circuits: Boolean Algebra and Mapping Methods: Logic Function Realization with MSI Circuits: Flip Flops, Counters and Registers: Logic Families: Programmable Logic Devices: Elements of light and solid state physics, Display devices and lasers, Optical detection devices, Optoelectronic Modulator, Optoelectronic integrated circuit.

LAB EXPERIMENTS

Electrical :

1.Load characteristics of DC Machines.
2. Speed control of Dc Machines.
3.Load test on single phase Transformer
4. Study on Protection and switchgear devices.
5.Study on Renewable power plants(Bio Methanization ,Solar plant and wind mill)
6.Study and prove the Network theorems.

Electronics:

7.Study of Basic gates.
8.Half wave and full wave rectifiers
9.IV Characteristics of Silicon Controlled Rectifiers
10. Numerical Aperture
11.Loss measurement using optical fibre.
12. Differential Amplifiers.

TOTAL HOURS : 45 Hours

THEORY	TUTORIAL	PRACTICAL	TOTAL
30	0	30	60

TEXTBOOKS

1. Electric Circuits - A.Chakrabarhty, Dhanipat Rai & Sons.
2. Network analysis - N.C Jagan and C. Lakhminarayana, BS publications.
3. *Electrical Machinery* by *Dr.P.S.Bimbhra*
4. Elecric Drives N. K. DW, P. K. SEN
5. PHI Learning Pvt. Ltd., 01-Jan-1999 - Technology & Engineering
6. Electronics Device and circuits by Jacob Milman and Christos C. Halkias, Tata Macgraw Hill Publication [Second Edition].
7. Utilization of Electric Energy – by E. Openshaw Taylor, Orient Longman.

1.Digital Electronics: An Introduction to Theory and Practice- William Gothmann H
2.PallabBhattcharya “semiconductor opto electronic devices”Prentice Hall of india Pvt Ltd,New Delhi,2006

REFERENCE

1	Basic Electronics devices and Circuits by Mahesh B Patil, PHI Learning PVT. Ltd.
2.	Utilization of Electrical Power including Electric drives and Electric traction – by N. V. Suryanarayana, New Age International (P) Limited, Publishers, 1996

Table:1 Mapping of CO's with PO:

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO2	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO3	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO4	1	1	0	0	2	1	1	0	0	1	0	0	1	1
CO5	1	1	0	0	2	1	1	0	0	1	0	0	1	1
Total	**5**	**5**	**0**	**0**	**10**	**5**	**5**	**0**	0	5	0	0	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	XNT506D	L	T	P	C
COURSE NAME	MECHANICAL SYSTEM DESIGN	2	0	1	3
PREREQUISITES	Nil	L	T	P	H
C:P:A	2.75:1:0.25	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Define*** mechanical systems and ***solve*** various mechanical system elements in mathematical form.	Cognitive, Psychomotor	Remembering, Applying Guided response
CO2	***Explain*** *different* mechanical system behaviour and their configurations	Cognitive, Psychomotor	Remembering, Applying Guided response
CO3	***Explain*** *about cylinders*, ***Design*** different type of cylinders and pressure vessels and *Solve* for different dimensions of cylinders and pressure vessels.	Cognitive, Psychomotor	Understanding , Applying Origination
CO4	***Find*** and ***Tell*** different configurations of belt conveyor system, *Measure* design parameters of belt conveyor system, *solve* for different conditions of material transportation system.	Cognitive, Psychomotor	Understanding , Applying Guided response
CO5	***Explain*** about high energy ball mill *Identify sketch* Mohr's circle for different complex loading conditions in 2D *Solve* stress value for different failure condition.	Cognitive, Psychomotor	Understanding , Applying, Complex or overt response

UNIT I	MECHANICAL SYSTEMS	6+6
Mechanical systems –Basic elements of mechanical system – Spring-Damper-Mass–Translational Systems-Rotational Systems–Energy storage elements		
UNIT II	**SPRING,DAMPER AND MASS**	**6+6**
Capacitance–Resistance–Inductance behavior of mechanical system elements–modeling of system elements– springs in series –springs in parallel–frequency response of mass–spring, spring–damper and mass–spring–damper system		
UNIT III	**DESIGN OF CYLINDERS AND PRESSURE VESSELS**	**6+6**
Design of Cylinders: Thin and thick cylinders–design of hydraulic and pneumatic cylinders– auto-frettage and compound cylinders– Gasketed joints in cylindrical vessels.		
UNIT IV	**DESIGN OF BELT CONVEYER SYSTEM FOR MATERIAL HANDLING**	**6+6**
System concept – basic principles – objectives of material handling system – unit load and containerization. Belt conveyors – Flat belt and troughed belt conveyors – capacity of conveyor – rubber covered and fabric ply belts – belt tensions – conveyor pulleys – belt idlers – tension take-up systems – power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys		
UNIT V	**NANOTECHNOLOGY AND MECHANICAL SYSTEM DESIGN**	**6+6**
Design of nano particle synthesizing systems-High Energy Ball mills-Chemical Vapour deposition and physical vapour deposition system –spin coating units-Design of Mechanical system in nanoscale (MEMS/NEMS) – DFM and DFMA .		

LIST OF EXPERIMENTS					CO
1	Observation of mechanical system elements like spring, mass, Damper and Shock absorber.				1
2	Design of spring and damper				2
3	Exercise on Pressure Vessels Designing as per IS code				3
4	Observation of Hydraulic and Pneumatic system and its components				3
5	Observation of specification of different type of material handling system				4
6	Design of belt conveyor system				4
7	Design of Ball mill (nano particle synthesizer)				5
8	Design of molecular mechanical system components				5
	LECTURE	TUTORIAL	**PRACTICAL**	**TOTAL**	
HOURS	**30**	0	**30**	**60**	

TEXT BOOKS

1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.
2. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

REFERENCES

1. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design‖, McGraw Hill Pub. Co.
2. M. F. Spotts, ―Mechanical Design Analysis‖, Prentice Hall Inc
3. Design Data―, P.S.G. College of Technology, Coimbatore
4. Mulani, I. G., ―Belt Conveyors‖
5. Rudenko,‖Material Handling Equipment‖, M.I.R. publishers, Moscow

E-REFERENCES

6. http://nptel.ac.in/courses/112106064/1#

Table 1: COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO2	3	3	2	3	3	1	3	1	1	1	3	3	3	-
CO3	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO4	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO5	3	3	2	3	3	1	3	1	1	1	3	3	3	-
CO6	3	3	1	3	3	2	3	2	3	3	2	3	3	-

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COUSE CODE	XNT506E	L	T	P	C
COUSE NAME	MECHANICS OF MATERIALS	2	0	1	3
PREREQUISITES	ENGINEERING MECHANICS, APPLIED PHYSICS	L	T	P	H
C:P:A	3:0:0	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Understand*** the concepts of Stress and Strain	Cognitive	Understand
CO2	***Analyse*** deformation in shaft and springs	Cognitive	Analyse
CO3	***Identify*** the stresses in thin and thick cylinders	Cognitive	Apply
CO4	***Solve*** beams for transverse loading	Cognitive	Evaluate
CO5	***Calculate*** the deflection of Symmetric beams	Cognitive	Evaluate

UNIT – I	STRESS AND STRAIN	6+7

Stress and strain – Definition – Tension, Compression and Shear stress - Deformation of simple and compound bars – Thermal Stress – Volumetric strain – Elastic Constants.

UNIT – II	TORSION	6+8

Torsion Formulation Stress – Deformation in hollow shaft and stepped shaft –deflection in shaft Springs – types – Stresses in helical springs – deflection of helical springs and leaf springs

UNIT – III	THIN CYLINDERS AND THICK CYLINDERS	9

Stresses in cylindrical shell – Longitudinal stress and circumferential stress – Deformation in thin and thick cylinders – Spherical Shells – Deformation in Spherical Shells

UNIT – IV	BENDING OF BEAMS	6+6

Beams – Types of Loading – Cantilever ,Simply supported and overhanging beams – Shear force and bending moment diagrams – Theory of Simple bending

UNIT – V	DEFLECTION OF SYMMETRIC BEAMS	6+6

Deflection of beams – Computation of Slope and deflection - Double Integration method – Moment Area method – Macaulay's method

LIST OF EXPERIMENTS

1. Determination of compressive strength of a brick specimen
2. Determination of tensile strength of a HYSD bar
3. Determination of shear strength of given timber specimen
4. Determination of compressive strength and tensile strength of helical spring
5. Determination of torsion for a given mild steel specimen.
6. Determination of modulus of rupture through static bending test.
7. Verification of Maxwell's reciprocal theorem
8. Determination of Young's modulus of given specimen by conducting deflection test.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	30	0	30	60

TEXT

1. Dr.R. K Bansal ,A Text Book of Strength of Materials, Laxmi Publication, 2007.
2. R.K Rajput , Strength of Materials, S.Chand & co., New Delhi, 2008.

REFERENCES

1. Egor P Popov , " Engineering Mechanics of Solids, Prentice Hall of India- New Delhi 2001.
2. R .Subramanian , " Strength of Materials" , Oxford University Press. Oxford Higher Education Series 2007

Table 1: COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO2	3	3	2	3	3	1	3	1	1	1	3	3	3	-
CO3	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO4	3	3	2	3	3	1	3	1	1	1	2	3	3	-
CO5	3	3	2	3	3	1	3	1	1	1	3	3	3	-
CO6	3	3	1	3	3	2	3	2	3	3	2	3	3	-

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XGS507	L	T	P	C
COURSE NAME	BUSINESS COMMUNICATION	1	0	0	1
PREREQUISITE:	Communication Skill and Basic Grammar Knowledge	L	T	P	H
C:P:A	3:0:0	1	0	2*	3

COURSE OUTCOMES		Domain	Level
CO1	***Define*** and ***Identify*** different styles to various forms of business communication.	Cognitive	Remember
CO2	***Identify*** the proper tone of language required in writing and speaking in business communication.	Cognitive	Remember
CO3	***Display*** knowledge on grammar and other linguistic features in writing various forms of business communication.	Cognitive	Understand
CO4	***Distinguish*** between letters and memos and various forms of Business Communication.	Cognitive	Analyse
CO5	***Prepare*** business reports, minutes, proposals.	Cognitive	Apply

UNIT I	INTRODUCTION TO BUSINESS COMMUNICATION	10
Modern developments in the style of writing letters memos and reports: block letters, semi block letters, full block letters, simplified letters etc.,		
UNIT II	**USE OF LANGUAGE**	**10**
Memos/minutes/telephone memos/ letters/ assignments, art of writing E-mail etc. features of written and spoken communication.		
UNIT III	**GRAMMAR**	**10**
The use of active and passive voice; the use of grammar, propriety, accuracy, exactness, the tone & other elements of language used in these writings.		
UNIT IV	**TYPES OF REPORTS**	**5**
The format of various types of Reports/ projects etc.		
UNIT V	**BUSINESS WRITING**	**10**
Writing Business reports, proposals and minutes.		

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS

1. John Sealy, Writing and Speaking Author:, Oxford University Press, New Delhi Third Edition 2009.
2. Williams K S, Communicating in Business (8th Edition) Engage Learning India Pvt. Ltd.; 2012

E – REFERENCES

1. https://is.muni.cz/el/1456/jaro2014/MPV_COMA/um/E-book_Business-Communication.pdf
2.http://communication-revolution.biz/wp-content/uploads/2013/12/The-Business-Communication-Revolution.pdf

SYLLABUS

SEMESTER - VI

COURSE CODE	XNT601	L	T	P	C
COURSE NAME	TOTAL QUALITY MANAGEMENT	3	0	0	3
PREREQUISITE	Nil	L	T	P	H
C:P:A	3 : 0 : 0	3	0	0	3

COURSE OUTCOMES		Domain	Level
CO1	***List*** and ***Explain*** the basic concepts of total quality concepts and its limitations.	Cognitive	Remembering, Understanding
CO2	***Analyze*** and ***Explain*** the Customer satisfaction, Employee involvement, supplier selection and appraise the performance by TQM principle.	Cognitive	Analyzing, Evaluating
CO3	***Explain*** and ***Apply*** the Statistical Process Control Tools.	Cognitive	Understanding, Appling
CO4	***Select*** and ***Explain*** the different TQM tools and their significance.	Cognitive	Remembering, Understanding
CO5	***Explain*** the importance aspects of different quality systems.	Cognitive	Understanding

UNIT I INTRODUCTION **9**

Definition of quality – Dimensions of quality – Quality planning – Quality costs – Analysis techniques for quality costs – Basic concepts of Total Quality Management – Historical review –Principles of TQM – Leadership – Concepts – Role of senior management – Quality Council –Quality statements – Strategic planning – Deming philosophy – Barriers to TQM implementation

UNIT II TQM PRINCIPLES **9**

Customer satisfaction – Customer perception of quality – Customer complaints – Service quality – Customer retention – Employee involvement – Motivation, empowerment, teams, recognition and reward – Performance appraisal – Benefits – Continuous process improvement – Juran trilogy – PDSA cycle – 5S – Kaizen – Supplier partnership – Partnering – Sourcing – Supplier selection – Supplier rating – Relationship development – Performance measures – Basic concepts – Strategy – Performance measure.

UNIT III STATISTICAL PROCESS CONTROL (SPC) **9**

The seven tools of quality – Statistical fundamentals – Measures of central tendency and dispersion – Population and sample – Normal curve – Control charts for variables and attributes – Process capability – Concept of six sigma – New seven management tools.

UNIT IV TQM TOOLS **9**

Benchmarking – Reasons to benchmark – Benchmarking process – Quality Function Deployment (QFD) – House of quality – QFD process – Benefits – Taguchi quality loss function – Total Productive Maintenance (TPM) – Concept – Improvement needs – FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS **9**

Need for ISO 9000 and other quality systems – ISO 9000:2000 quality system – Elements – Implementation of quality system – Documentation – Quality auditing – TS 16949 – ISO 14000 –Concept, requirements and benefits.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

TEXT BOOKS

1.Dale H. Besterfiled, et. Al. "Total Quality Management", New Delhi, Pearson Education, Inc.. 2007.
2.James R. Evans and William M. Lidsay, "The Management and Control of Quality", 5th Edition, South-Western, 2002.

REFERENCES

1. Feigenbaum, A.V., "Total Quality Management", McGraw Hill, 1991.

2. Oakland, J.S., "Total Quality Management", Butterworth Heineman, 1989.

3. Narayana V. and Sreenivasan, N.S., "Quality Management – Concepts and Tasks", New Age International, 1996.

4. Zeiri, "Total Quality Management for Engineers", Wood Head Publishers, 1991.

Table 1: Mapping of COs with POs

Mapping COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1										2
CO2							2			
CO3				2						
CO4			2	2				2		
CO5								2		2
Total										
Scaled										

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

COURSE CODE	XNT602	L	T	P	C
COURSE NAME	COLLOIDS AND SURFACES ENGINEERING	3	0	1	4
C:P:A	2:1:0	L	T	P	H
PREREQUISITE	PHYSICS,CHEMISTRY AND MATERIAL SCIENCE	3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Define*** and ***explain*** colloids and its properties	Cognitive Psychomotor	Understand Remember Applying Guided response
CO2	***Understand*** and ***describe*** the properties of interfaces	Cognitive Psychomotor	Understand Remember Applying Guided response
CO3	***Understand*** and ***describe*** the properties of interfaces	Cognitive Psychomotor	Understand Remember Applying Guided response
CO4	***Explain*** radiation and light scattering colloids and surfaces	Cognitive Psychomotor	Understand Remember Applying Guided response
CO5	***Understand*** and ***explain*** the Vander walls forces and its significance on colloids and surfaces	Cognitive Psychomotor	Understand Remember Applying Guided response

UNIT - I	The colloidal state	9+6

Introduction- Classification of colloidal systems- Structural characteristics-Preparation and purification of colloidal systems. Kinetic properties-The motion of particles in liquid media-Brownian motion and translational diffusion- The ultracentrifuge-Osmotic pressure-Rotary Brownian motion.

UNIT – II	Optical properties	9+6

Optical and electron microscopy- Light scattering. Liquid-gas and liquid-liquid interfaces-Surface and interfacial tensions- Adsorption and orientation at interfaces- Association colloids-micelle formation- Spreading- Monomolecular films.

UNIT - III	Interfaces	9+6

The solid-gas interface- Adsorption of gases and vapours on solids- Composition and structure of solid surfaces. The solid-liquid interface- Contact angles and wetting- Ore flotation- Detergency-Adsorption from solution.

UNIT – IV	Static and Dynamic Light Scattering and Other Radiation Scattering	9+6

Introduction Interaction of Radiation with Matter Scattering by Small Particles: Theory of Rayleigh Scattering-Experimental Aspects of Light Scattering-Extension to Larger Particles and

to Intra particle- Interference Effects and Structure of Particles Scattering by Large, Absorbing Particles - Dynamic Light Scattering.		
UNIT – V	**Vander Waals Forces**	**9+6**
Introduction- Vander Waals Forces and Their Importance in Colloid and Surface Chemistry- Molecular Interactions and Power Laws- Molecular Origins and the Macroscopic Implications of Vander Waals Forces- Vander Waals Forces Between Large Particles and Over Large Distances. Calculating Vander Waals Forces Between Macroscopic Bodies Theories of Vander Waals Forces Based on Bulk Properties Effect of the Medium on the Vander Waals Attraction.		
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**

TEXTBOOK

1. "Principles of Colloids and Surface Chemistry, 1997 Third Edition by Paul. C. Hiemenz and Raj Rajagopalan, Marcel Dekker Publishers, Inc. 270 Madison Avenue, New York- 10016."

REFERENCE and E-REFERENCE

1. NPTEL

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	
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	XNT603	L	T	P	C
COURSE NAME	NANOMATERIALS FABRICATION TECHNIQUES –II	3	0	1	4
C:P:A	2:0.75:0.25	L	T	P	H
PREREQUISITE	MATERIAL SCIENCE, APPLIED PHYSICS AND CHEMISTRY	3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Define*** and ***explain*** different Self assembly techniques and its principles for nanomaterial fabrication	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***List*** and ***Describe*** self-assembly techniques for nanomaterial fabrication	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***Find*** and ***illustrate*** the Nano fabrication techniques using photon beam	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Label*** and ***explain*** the Nanofabrication by Charged Beams	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Label, Outline*** different types of nanomaterial fabrication using Scanning probes	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	Self-Assembly -I	9+3

Unified approach to self-assembly - intermolecular and colloidal forces - molecular self-assembly in solution i: micelles - molecular self-assembly in solution ii: bilayers,liquid crystals, and emulsions ,Mechanochemistry: grinding and milling devices

UNIT – II	Self Assembly –II	9+3

Self-assembly at interfaces - bio-mimetic self-assembly - metals, semiconductors, and oxides fabrication by self assembly – Nanostructured thin film fabrcrication – Nanoassembly by external forces – Nanodevices and nanomachines

UNIT - III	Nanofabrication by Photons	9+3

Introduction - Principle of Optical Projection Lithography - Optical Lithography at Shorter Wavelengths - Deep UV - Extreme UV-X-ray - Optical Lithography at High NA-Optical

Lithography at Lowk1Factor - Off-Axis Illumination (OAI) - Phase-Shifting Mask (PSM) - Optical Proximity Correction (OPC)- Photoresists - Design for Manufacturing (DFM) - Double Processing - Near-Field Optical Lithography - Interferometric Optical Lithography -Maskless Optical Lithography .

UNIT – IV	**Nanofabrication by Charged Beams**	**9+3**

Introduction - Focusing Charged Particle Beam - Charged Particle Optics – Sources -Aberrations -Scattering and Proximity Effect - Electron Scattering - Proximity Effect and Correction - Effect of Secondary Electrons -Low-Energy E-Beam Lithography - Ion Scattering -Resist Materials and Processes-Sensitivity of Resist Materials - Contrast of Resist Materials - Resolution Enhancement Processes - Ion Sputtering and Redeposition - Charged Particles Projection Lithography.

UNIT – V	**Nanofabrication by Scanning Probes**	**9+3**

Introduction - Principles of SPMs - Exposure of Resists - Field Electron Emission - Exposure of Resist by STM - Exposure of Resist by NSOM- Oxidation Lithography . - Additive Nanofabrication -Field-Induced Deposition - Dip-Pen Nanolithography- Subtractive Nanofabrication - Electrochemical Etching - Field-induced Decomposition . -Thermomechanical Indentation - Mechanical Scratching - High-Throughput SPL.

List of Experiments

1. Nano micelle fabrication by self assembly
2. Nanocrytal synthesis by self assembly
3. Wet Chemical Etching of Copper on predefined pattern
4. Mask Preparation on Silk Screen for moderate resolution lithography
5. Lithography Mask transfer using screen printing technique
6. Herbal Nano powder synthesis by Ball Milling
7. Nanowire fabrication by self-assembly
8. Copper nanoparticle synthesis by Electrochemical deposition
9. 3D nanostructure building with DNA Bricks (Video Demo)
10. Oxide dot fabrication using AFM
11. SAM Fabrication using AFM
12. Synthesis of liposomes/Niosomes
13. Fullerene/Graphene synthesis

TOTAL HOURS

Lecture	Tutorial	Practical	Total
45	**0**	**15**	**60**

TEXTBOOK

1. "Nanofabrication – Principles, Capabilities and Limits" Zheing Cui, Springer ,2008
2. " Self-assembly and nanotechnology" Yoon S. Lee ,Wiley,2008

REFERENCE

3.	"Introduction to Nanotechnology," Frank J. Owens & Charles P. Poole, Wiley-IEEE, 2003.
4.	"Encyclopedia of Nanoscience & Nanotechnology," H. S. Nalwa, American Scientific Publishers, 2004.
5.	"X-ray Diffraction Procedures," H. P. Klung & L. E. Alexander

Table 1 : COs versus POs mapping

CO/PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PSO1	PSO2
CO1	3	3	1	1	2	1	1	1	1	1
CO2	3	3	1	1	2	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1
CO4	3	3	1	1	2	1	1	1	1	1
CO5	3	3	1	1	2	1	1	1	1	1
Total	15	15	5	5	10	5	5	5	5	5
	3	3	1	1	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	XNT604	L	T	P	C
COURSE NAME	NANOMATERIALS CHARACTERIZATION TECHNIQUES – II	3	1	1	5
PREREQUISITES	NANOMATERIALS CHARACTERIZATION TECHNIQUES – I	L	T	P	H
C:P:A	1.5:1.2:0.3	3	2	2	7

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** the concepts Basic Micro scopes	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Types of microscopes to characterise the nano materials	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** the Magnetic Resonance Spectroscopy & Thermal analysis techniques	Cognitive Psychomotor	Understand, Guided Set
CO4	*Describe and Illustrate the* Electrical characterization techniques & Magnetic characterization techniques	Cognitive Psychomotor	Understand, Mechanism
CO5	*Classify* and *Describe the* Optical characterization techniques	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Microscopy techniques-I**	15+6+6

Introduction to Microscopes, Optical microscopy (OM)- Transmission Electron Microscopy (TEM); Basic Electron scattering, Concepts of resolution, TEM instruments, Various imaging modes, Analysis of micrographs,

UNIT II	**Microscopy techniques-II**	15+6+6

Electron Energy Loss Spectroscopy- Scanning Electron Microscopy, - Atomic Force Microscopy, Scanning Probe Microscopy

UNIT III	**Magnetic Resonance Spectroscopy & Thermal analysis techniques**	15+6+6

NMR Spectroscopy- Introduction to NMR spectroscopy- Chemical shifts and J-coupling- One-dimensional proton NMR- One dimensional NMR of X-nuclei (13C, 15N, 31P and 19F)—
Thermal Analysis: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo-gravimetric analysis (TGA)

UNIT IV	**Electrical characterization techniques & Magnetic characterization techniques**	15+6+6

Electrical resistivity in bulk and thin films, Hall effect, Magneto resistance- Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method

UNIT V	**Optical characterization techniques**	15+6+6

UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy

TEXT

1. Colin N. Banwell & Elaine M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw-Hill Pub. Co. Ltd., 2000.
2. Ewen Smith & Geoffrey Dent, Modern Raman Spectroscopy – A Practical Approach, John Wiley & Sons Ltd. 2005

3. Y. Leng, Materials Characterization: Introduction to microscopic and spectroscopic methods, John Wiley & Sons, 2008
4. P. F. Bernath, Spectra of Atoms and Molecules (Second Edition), Oxford University Press, 2005.
I. N. Levine, Molecular Spectroscopy, Wliey-Interscience, New York, 1975.
5. E. B. Wilson Jr., J. C. Decius and P. C. Cross, Molecular Vibrations, Dover Publications, New York, 1980
6. J. M. Hollas, Modern Spectroscopy (Fourth Edition), John Wiley & Sons, New York, 2004.
7. J. I. Steinfeld, Molecules and Radiation, Dover, New York, 1986.

REFERENCES

3. Basic One and Two Dimensional NMR: by Horst Fiebrolin
4. NMR Spectroscopy Explained: by Neil Jacobsen
5. Understanding NMR spectroscopy: by James Keeler
6. Introduction to Spectroscopy: by Pavia et al.

LABORATORY

1.	The functioning of the metallurgical microscope, and observe and interpret the microstructures
2.	UV/VIS Spectroscopy and Spectrophotometry: Spectrophotometric Analysis of Potassium Permanganate Solutions
3.	Determination of Food Quality by UV Spectroscopic Methods
4.	Experimental studies on Thermal and Electrical properties of NiO2 thin film using SEM
5.	Experimental setup for the measurement of the electrical resistivity and thermo power of thin films and bulk materials
6.	Measuring Magnetization by Induction method
7.	To determine the composition of a piece of tire tread using thermo gravimetric analysis (TGA).
8.	Analysis of the Thermal Properties of Ammonium Nitrate and Polystyrene by Differential Scanning Calorimetry (DSC)
9.	Nano mechanical Measurements On Different Materials using Contact Mode AFM

REFERENCE BOOKS

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL HOURS**
	45	**30**	**30**	**105**

Table 1 : COs versus POs mapping

CO/PO	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO10**	**PSO1**
CO1	1	2	2	1	1	1	1	1	2
CO2	1	2	2	1	1	1	1	1	2
CO3	1	2	2	1	1	1	1	1	2
CO4	1	2	2	1	1	1	1	1	2
CO5	1	2	2	1	1	1	1	1	2
Total	5	10	10	5	5	5	5	5	10
	1	2	2	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	XNT605A	L	T	P	C
COURSE NAME	NANOPHYSICS	2	0	1	3
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Applied Physics	2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Define*** and ***explain*** modern electronics	Cognitive Psychomotor	Understand Remember Applying Guided response
CO2	***Understand*** and ***describe*** the solid state physics	Cognitive Psychomotor	Understand Remember Applying Guided response
CO3	***Understand*** and ***describe*** about two dimensional electron systems	Cognitive Psychomotor	Understand Remember Applying Guided response
CO4	***Explain*** single electron tunnelling	Cognitive Psychomotor	Understand Remember Applying Guided response
CO5	***Understand*** and ***explain*** the principle and methods of sample growth and fabrication	Cognitive Psychomotor	Understand Remember Applying Guided response

UNIT - I	Modern Electronics	6+6

Road map of modern electronics: From CMOS technology to molecular electronics, spintronics, nanophotonics, and quantum computations. Mesoscopic transport: Brief overview of main principles, materials, and devices.

UNIT – II	Solid State Physics	6+6

A Brief Update of Conventional Solid State Physics. Crystal structures. Electronic energy bands and their occupation, envelope functions and effective mass, doping.Diffusive transport, scattering mechanisms, screening. Surfaces, Interfaces, and Layered Devices Electronic surface states. Semiconductor-metal interface. Semiconductor heterostructures. Field-effect transistors and quantum wells. Mesoscopic Physics.

UNIT - III	Two-dimensional electron systems	6+6

Two-dimensional electron systems: general properties, magneto-conductance, the quantum Hall effect.Quantum Wires and Quantum Point Contacts: Diffusive quantum wires, ballistic wires (conductance quantization), carbon nanotubes, quantum point contactsElectronic Phase Coherence: The Aharonov-Bohm effect, weak localization, resonant tunneling.

UNIT – IV	Single Electron tunnelling	6+6

Single-Electron Tunneling: Coulomb blockade, single-electron tunneling devices, electron pumping, etc.Quantum Dots: Role of electron-electron interaction, conductance resonances, etc.Mesoscopic superconductivity: Josephson effect and its applications, hybrid systems, etc.New Directions in Electronics. Spintronics, Molecular Electronics, Nanomechanics, Nanophotonics, Devices for Quantum Computation. Experimental Aspects (will be presented by students and taken into account for the exam grade).

UNIT – V	**Sample growth and fabrication**	**6+6**

Sample growth and fabrication: Single crystal growth; growth of layered structures, epitaxy - liquid phase epitaxy (LPE), molecular chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE), magnetron sputtering, etc. Lateral patterning (electron beam patterning) and bonding.Sample characterization: Electron microscopy (TEM, SEM); Tunneling microscopy (STM); Secondary ion mass spectroscopy (SIMS); X-ray spectroscopy; Elements of cryogenics.

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**	**30**	**60**

TEXTBOOK

1. Handbook of Nanophysics: Principles and Methods: Volume 7 Hardcover – Import, 28 Sep 2010 by Klaus D. Sattler (Editor).

REFERENCE and E-REFERENCE

1. Nanophysics And Nanotechnology: An Introduction To Modern Concepts In Nanoscience Paperback, Wolf L. E.
2. nptel

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

COURSE CODE	XNT605B	L	T	P	C
COURSE NAME	**Molecular Assembler and molecular Modelling**	2	0	1	3
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science	2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Define*** and ***explain the various*** molecular simulation theory and its principles	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***Understand*** and ***describe*** the properties of interfaces	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***Understand*** and ***describe*** the property analysis using Classical statistical mechanics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Investigate and interpret*** the property optimization of molecules using molecular dyanamics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Understand*** and ***explain*** the Monte Carlo simulation and its applications	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	Molecular Simulation	9+6
Fundamentals of molecular simulations -Ab-initio Methods, Basis Sets, Hartree-Fock Theory, Density Functional Theory, Geometry Optimization, Vibrational Analysis.		
UNIT – II	**Classical statistical mechanics**	**9+6**
Classical statistical mechanics, elementary concepts of temperature, ensembles and fluctuations, partition function, ensemble averaging, ergodicity.		
UNIT - III	**Molecular Dynamic Methodology**	**9+6**
Molecular Dynamics Methodology - Force Field, Integrating Algorithms, Periodic Box and Minimum Image Convention, Long Range Forces, Non Bonded Interaction.		
UNIT – IV	**Property optimization using molecular dynamics**	**9+6**

Temperature Control, Pressure Control, Estimation of Pure Component Properties, Radial Distribution Function; Molecular Dynamics Packages.

UNIT – V	**Monte Carlo simulation**	**9+6**

Monte Carlo simulation - Monte Carlo integration, simple biasing methods, importance sampling, Markov chain, transition-probability matrix, detailed balance., Metropolis algorithm. Monte Carlo simulation in different ensembles, Monte Carlo simulation for polymer; Advanced applications.

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**	**30**	**75**

TEXTBOOK

1. DaanFrenkel and BerendSmit, Understanding Molecular Simulation: From Algorithms to Applications, 2e, Academic Press, New York, 2002.
2. M.P. Allen and D.J. Tildesley, Computer Simulation of Liquids, Clarendon Press, Oxford, 1987.

REFERENCE and E-REFERENCE

1. K. Binder, The Monte-Carlo Method in Condensed Matter Physics, Berlin : Springer-verlag, 1992.
2. D. A. McQuarrie, Statistical Mechanics, Harper and Row, New York, 1976.
3. Andrew R. Leach, Molecular modelling: principles and applications, 2e, Pearson, New Delhi, 2001
4. NPTEL

Table 1 : COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	-	-	-	-	**1**			**1**	**1**
CO2	2	2	2	2	-	-	-	-	**1**			**1**	**1**
CO3	2	2	2	2	-	-	-	-	**1**			**1**	**1**
CO4	2	2	2	2	-	-	-	-	**1**			**1**	**1**
CO5	2	2	2	2	-	-	-	-	**1**			**1**	**1**
Total	10	10	10	10	-	-	-	-	**5**			**5**	**5**
	2	2	2	2	-	-	-	-	**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	XNT605C	L	T	P	C
COURSE NAME	NANO SENSORS, NANO ACTUATORS AND NANO PROBES	2	0	1	3
PREREQUISITES	Basic electrical and electronics engineering, Nano fabrication and nano characterization	L	T	P	H
C:P:A	2:1:1	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Understand*** the sensor principles, characteristics, functional specification and classify the sensors based on their measured.	Cognitive	Understand
CO2	***Explain*** the types of sensors, conditioning the signal and actuators and their applications	Cognitive	Understand, Analyze, Apply
CO3	***Explain,*** the micromachining tools for nano systems	Cognitive	Understand Analyze
CO4	***Describe*** and ***Discuss*** sensors and their measurements	Cognitive	Understand, Analyze, Apply

UNIT I	Transducer Basics	6+6=12

The transducer and transduction principles: active transducers-passive transducers-sensor error sources –Principles of transduction and measurement: Sensor: Characteristics, Sensor classification – measurands-strain-force-pressure-acceleration-flow-volume-temperature and bio signals. Functional specifications of sensors: static and dynamic characteristics of measurement systems

UNIT II	Sensors & Actuators	6+6=12

Sensors: Resistive, capacitive, inductive types – reactance type-electromagnetic type. Signal conditioning: Wheatstone bridge-AC bridges. Amplifiers: AC – instrumentation-isolation-carrier-electrostatic shields-phase sensitive detectors-induction type and reduction shield grounding. Nano sensors and types. Actuator; Definition, components, design goals, types & applications

UNIT III	Micromachining tools for nano systems	6+6=12

Nano probes: Combining top-down and bottom-up approaches, Micro- and nano machining, micro machined nano devices, Micro systems for single-molecule handling and modification, manipulation of single DNA molecule, AFM: Imaging from DNA to cell motion, Nano tribology, control, fabrication, characterization

UNIT IV	Sensors and Measurement	6+6=12

Colorimetric sensors. Smart chemical sensing, Dendrimers: Synthesis, Chemical sensor, biosensor.
Organic electronics. SAMS: Preparation, patterning, composition and applications

TEXT

Micromachines as tools for Nanotechnology, H. Fujita (Ed.), Springer International Edition, 2003
Nanomaterials Chemistry, Edited by C.N.R. Rao, A. Muller and A.K. Cheetham, Wiley-VCH, 2008

REFERENCES

1. David J. Griffiths, Introduction to Quantum Mechanics (Cambridge University Press India; 2/ed edition, 2016).
2. L. S Nano composites, edited by Challa Kumar, Wiley-VCH Publications, Nanotechnology for the Life Sciences Series, Vol 8, 2010.
3. Nanoparticles, Vincent Rotella (Ed.), Springer International Edition, 2004
4. Nanoscience and Nanotechnology in Engineering, Vijay K. Vardan, A. Sivathanu Pillai, D. Mukherji, M.Dwivedi, L. Chen, World Scientific, 2010
5. Nano: The Essentials-Understanding Nanoscience and Nanotechnology, T. Pradeep, TMH, 2010

e-references

http://nptel.ac.in/courses/112104158/
http://cas.ee.ic.ac.uk/people/dario/files/E302/1-Sensors.pdf
https://www.slideshare.net/SyedHaris6/nano-sensors-technology
http://www.egr.msu.edu/classes/ece480/capstone/480-sensors.pdf

LABORATORY

1.	Study on sensor, actuator and probe
2.	Sensor characteristics (Photo diode/Thermistor/phototransistor)
3.	Actuator – Stepper motor
4.	Amplifier characteristics
5.	Signal Conditioning
6.	Bridge circuit
7.	Gas sensing (Use sensor)
8.	Colorimetry (Use sensor)
9.	Probe for AFM
10.	Shape shifting nanoprobe (Simulation)

REFERENCE BOOKS

	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL HOURS**
	30	**0**	**30**	**60**

Table 1: COs versus POs mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9/10	PSO11/12	PSO1	PSO2	Total
CO1	1	2			2	1							6
CO2	1	2		2	1	2							8
CO3						2		2			1	1	6
CO4						2		2			1	1	6
Total													

1-5 = 1, 6-10 = 2, 11-15 = 3

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

COURSE CODE	XNT605D	L	T	P	C
COURSE NAME	NANOROBOTICS	2	0	1	4
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Basic Engineering ,	2	0	2	4

COURSE OUTCOMES		*Domain*	*Level*
CO1	***Define*** and ***explain*** the manipulation and assembly of nanorobotics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***Understand*** and ***describe*** types of nanomanipulation	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***Understand*** and ***describe*** the sensing and fast imaging systems and its principles	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Explain*** nanorobotic assembly by CAD and others	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Understand*** and ***explain*** applictaions of nanorobot.	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	ACTUATION METHODS FOR NANOROBOTIC MANIPULATION & ASSEMBLY	9+6

Interaction forces in nanomanipulation-electro kinetic based actuation- electro kinetic manipulation of Carbon nanotubes, Graphene, Nanoparticles & Biological entities-Laser based actuation-Optical tweezers manipulation of Biological entities & Chemical entities – Piezoelectric enabled actuators

UNIT – II	NANOMANIPULATION	9+6

Dielectrophoretic based Nano manipulation-theory- Modelling of electro rotation- Dynamic effects of fluid medium nanoparticles by Dielectrophoretic-Manipulation of CNT- Nano manipulation by Scanning probe-Reducing Atomic scale stick-slip motion by feedback control Nano manipulation

UNIT - III	SENSING & FAST IMAGING SYSTEM	9+6

Art of compressive sensing-compressive sensing based fast imaging system- AFM based imaging – AFM based nanorobotic system enhanced by augmented reality, Hardware & software setup –Experiments on nano manipulation of nanoparticles

UNIT – IV	**CAD & REAL- TIME NANOROBOTIC MANIPULATION & ASSEMBLY**	**9+6**

CAD models of nanostructures – Automated manipulation of nanoparticles, nanorods and nanowires –Limitation of Augmented reality system- Real time faultdetection& correction- Real time random drift compensation with local scan-Onlinefault detection & correction-implementation & experimental results .

UNIT – V	**NANOROBOTIC APPLICATIONS**	**9+6**

Wireless capsules endoscopy images & video – Vibration energy harvesting nanorobotic-capsules robot in gastro-intestinal tract – Cooperative control design fornanorobots in drug delivery – cancer targeted therapy using nanorobots .

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**	**30**	**60**

TEXTBOOK

1. **Klaus D. Sattler, "Hand Book of Nanophysics: Nano medicine & Nanorobotics", CRC Press, 2010.**

REFERENCE and E-REFERENCE

1. . Mustapha Hamdi, Antoine Ferreira, "Design, Modeling and Characterization of Bio-Nanorobotic Systems", Springer, 2011.

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**	PO2
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**	1
	2	1	1	1	-	-	-	-	**1**			**2**	5

1-5 →1, 6-10 → 2, 11-15 →3

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

COURSE CODE	XNT605E	L	T	P	C
COURSE NAME	NANO OPTICS AND NANOPHOTONICS	2	0	1	3
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science	2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Know*** and ***understand*** the basics concepts of Nano optics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***Understand*** and ***describe*** the optical properties of various materials	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***Know*** and ***understand*** the basics concepts of nanpohotonics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Understand*** and ***Explain*** the nanophotonic devices	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Understand*** and ***explain*** nanobiophotonics and its biomedical applications	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	Nano Optics I	9+6

Introduction - Theoretical foundations - Propagation and focusing of optical fields - Spatial resolution and position accuracy - Nanoscale optical microscopy - Near-field optical probes - Probe-sample distance control - Light emission and interactions in nanoscale environment

UNIT – II	Nano Optics II	9+6

Optical properties- Optical and electron microscopy- Light scattering. Liquid-gas and liquid-liquid interfaces-Surface and interfacial tensions- Adsorption and orientation at interfaces- Association colloids-micelle formation- Spreading- Monomolecular films.

UNIT - III	Basis of Nano photonics	9+6

Optical near fields and effective interactions as a base for Nano photonics – Principles of operations of Nano photonic devices using optical near fields – Principles of nanofabrication using optical near fields.

UNIT – IV	Fundamentals of Nano photonic Devices	9+6

Excitation energy transfer – Device operation: Nano photonic AND gate & Nano photonic OR gate – Interconnection with photonic devices – Room temperature operation. Adiabatic nanofabrication – Nondiabetic nanofabrication: near field optical CVD and near field photolithography – Self assembling method via optical near field interactions – Regulating the size and position of nanoparticles using size dependent resonance – Size controlled, position controlled and separation controlled alignment of nanoparticles.

UNIT – V	**Fundamentals of Nano-Bio photonics**	**9+6**

Introduction – The cell: scale and constituents – Origin and optical contrast mechanisms – Classical contrast mechanisms: bright field, dark field, phase contrast and interferometric contrast – Fluorescence contrast mechanism – Nonlinear microscopy based on second harmonic generation and coherent anti-Stokes Raman scattering – Reduction of the observation volume – Far field methods: 4Pi microscopy, microscopy on a mirror and stimulated emission depletion – Near field methods.

List of Experiments

TOTAL HOURS

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

TEXTBOOK

1. Motoi chi Oht su, Ki yoshi Kobayashi , Tadashi Kawazoe,Takashi Yatsui and Makotoaruse, Principles of Nano photonics. New York, USA: CRC Press-Taylor & Francis Group, 2008

REFERENCE and E-REFERENCE

1. **NPTEL**
2. **https://www.photonics.ethz.ch/en/our-range/education/courses/nanooptics.html**

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	PO2	PO3	PO4	PO2	1			2	
CO2	2	1	1	1	1	1	1	1	1			2	
CO3	2	1	1	1	1	1	1	1	1			2	
CO4	2	1	1	1	1	1	1	1	1			2	
CO5	2	1	1	1	1	1	1	1	1			2	
Total	10	5	5	5	1	1	1	1	5			10	
	2	1	1	1	5	5	5	5	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	XNT606A	L	T	P	C
COURSE NAME	MOLECULAR ARCHITECTURE	2	0	1	3
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science	2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Explain*** the investigation of molecular architecture using Raman, Fluorescence and STM	Cognitive Psychomotor	Understand Remember Applying Guided response
CO2	***Understand*** and ***describe*** the localized plasma resonance of metal nanoparticles using NFOI	Cognitive Psychomotor	Understand Remember Applying Guided response
CO3	***Understand*** and explain the molecular structure using non linear spectroscopy	Cognitive Psychomotor	Understand Remember Applying Guided response
CO4	***Explain*** the molecular dynamics using photon force measurement	Cognitive Psychomotor	Understand Remember Applying Guided response
CO5	***Understand*** and ***explain construction of micro spectroscopic systems for molecular dynamics***	Cognitive Psychomotor Affective	Understand Remember Applying Guided response

UNIT - I	Raman and Fluorescence Spectroscopy Coupled with Scanning Tunneling Microscopy	6+6

Introduction-Outline of STM Combined with Optical Spectroscopy -Raman Spectroscopy - Fluorescence Spectroscopy - Theoretical Approaches - Experimental Approaches - STM Combined with Raman Spectroscopy -STM Combined With Fluorescence Spectroscopy - Future Prospects

UNIT – II	Near-Field Optical Imaging of Localized Plasmon Resonances in Metal Nanoparticles	6+6

Introduction- Near-Field Spectroscopic Method - Fundamental Spectroscopic Characteristics of Gold Nanoparticles - Wavefunction Images of Plasmon Modes of Gold Nanorod - Near-Field Transmission Method - Ultrafast Time-Resolved Near-Field Imaging of Gold Nanorods-Near-Field Two-Photon Excitation Images of Gold Nanorods - Enhanced Optical Fields in Spherical Nanoparticle Assemblies and Surface Enhanced Raman Scattering

UNIT - III	Real Time Monitoring of Molecular Structure at Solid/Liquid Interfaces by Non-Linear Spectroscopy	6+6

Introduction -Sum Frequency Generation Spectroscopy-Brief Description of SFG-Origin of SFG Process-SFG Spectroscopy-Experimental Arrangement for SFG Measurements-Laser and Detection Systems-Spectroscopic Cells-Dependent Structure of Water at a Pt Electrode/Electrolyte Solution Interface- Photoinduced Surface Dynamics of CO Adsorbed on a Platinum - Interfacial Water Structure at Polyvinyl Alcohol (PVA) Gel/Quartz Interfaces Investigated by SFG Spectroscopy-Introduction-Results and Discussions- Hyper-Raman Spectroscopy-Selection Rules for Hyper-Raman Scattering-Enhancement of Hyper-Raman Scattering Intensity

UNIT – IV	**Dynamic Analysis Using Photon Force Measurement**	**6+6**

Weak Force Measurements-Potential Analysis Method Using Photon Force Measurement-Measurement of the Hydrodynamic Interaction Force Acting between. Two Trapped Particles Using the Potential Analysis Method-Two-Beam Photon Force Measurement System-Potential Analysis Method for Hydrodynamic Force
Measurement-Trapping Potential Analysis-Kinetic Potential Analysis

UNIT – V	**Construction of Micro-Spectroscopic Systems and their Application to the Detection of Molecular Dynamics in a Small Domain**	**6+6**

Development of a Near-Infrared 35 fs Laser Microscope -Excitation Source-Detection of Higher Order Multiphoton Fluorescence from Organic-Crystals-Multiphoton Fluorescence Imaging with the Near-Infrared 35 fs Laser Microscope-Application of Fluorescence Correlation Spectroscopy to the Measurement of Local Temperature at a Small Area in Solution-Experimental System of FCS-The Principle of the Method of Measurement of Local Temperature Using FCS-Relaxation Dynamics of Non-Emissive State for Water-Soluble CdTe .Quantum Dots Measured by Using FCS-Samples and Analysis of Experimental Data Obtained with FCS - Non-Emissive Relaxation Dynamics in CdTe Quantum dots

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**	**30**	**75**

TEXTBOOK

1. Molecular Nano Dynamics by Hiroshi Fukumura, Masahiro Irie

REFERENCE and E-REFERENCE

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	
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	XNT606B	L	T	P	C
COURSE NAME	NANOBIOPHOTONICS FOR BIOTECHNOLOGY AND NANOMEDICINE	2	0	1	3
C:P:A	2:0.5:0.5	L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science	2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Define*** and ***explain*** basic concepts of nano photonics with biological molecules	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO2	***Understand*** and ***describe*** Second-Harmonic Generation with nano bio photonics	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO3	***Understand*** and ***describe*** the infrared spectroscopic imaging for biological applications	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO4	***Explain*** the basic concepts of plasmonics and application on biomedical field	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing
CO5	***Understand*** and ***explain*** the interferometric techniques and its applications in nanomedicine	Cognitive Psychomotor Affective	Understand Remember Applying Guided response Organizing

UNIT - I	Nano photonics vs bio molecules	9+6

Biology of the Cancer Cell, Review of Electromagnetic Fields, Introduction to Nano photonics, Tissue Pathology: A Clinical Perspective, Light Scattering in Inhomogeneous Media.

UNIT – II	Theory of Second-Harmonic Generation	9+6

Theory of Second-Harmonic Generation, Vision Restoration in the Nanobiophotonic Era, Optical Low-Coherence Interferometric Techniques for Applications in Nanomedicine, Plasmonics and Metamaterials

UNIT - III	Infrared Spectroscopic Imaging	9+6

Infrared Spectroscopic Imaging: An Integrative Approach to Pathology, Scattering, Absorbing, and Modulating Nano probes for Coherence Imaging,. Second-Harmonic Generation Imaging of Collagen-Based Systems

UNIT – IV	Plasmonic	9+6
Plasmonics: Toward a New Paradigm for Light Manipulation at the Nanoscale, Plasmon Resonance Energy Transfer Nano spectroscopy, Erythrocyte Nanoscale Flickering: A Marker for Disease		
UNIT – V	**Interferometric techniques**	**9+6**
Super resolution Far-Field Fluorescence Microscopy, Optical Low-Coherence Interferometric Techniques for Applications in Nanomedicine: Introduction, Basic Theoretical Aspects of Low-Coherence Interferometry Functional Extensions of OCT and Other LCI-Based Techniques for Applications in Nanomedicine		
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	30	75

TEXTBOOK

REFERENCE and E-REFERENCE

1. https://www.accessengineeringlibrary.com/browse/nanobiophotonics

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	
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	XNT606C	L	T	P	C
COURSE NAME	Nano Spintronics	2	0	1	3
PREREQUISITES	Applied Physics	L	T	P	H
C:P:A	1.5:1.2:0.3	3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic **Concept** of Introduction to Spintronics	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Transport in magnetic materials	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Nanomagnetism	Cognitive Psychomotor	Understand, Guided set
CO4	***Describe and Illustrate*** *the* Spin transfer torque	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe*** *the* Spintronic Devices	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction to Spintronics**	15
Historical view, Quantum Mechanics of spins, Bloch Sphere, Spin-orbit interaction, exchange interaction. Spin relaxation; spin relaxations in nano dots.		
UNIT II	**Transport in magnetic materials**	**15**
Magneto-transport in metals, Anisotropic magneto resistance, Giant magneto resistance, Colossal Magneto resistance, Spintronic materials.		
UNIT III	**Nano magnetism**	**15**
Physics of low dimensional structures, Density of states in low dimensions, Micro magnetic formulation: Magnetic energy contributions, LLG equation, Domain walls in low dimensions		
UNIT IV	**Spin transfer torque**	**15**
Qualitative description of spin transfer torque, spin transfer driven magnetization dynamics, Current driven switching of magnetization, domain wall scattering. **Spin injection:** Spin current, Spin injection, spin accumulation, Henley effect, Spin Hall effect, Hetero structures for spintronic devices.		
UNIT V	**Spintronic Devices**	15
Spin Valve transistor, Spin FET, Spin – tunnelling devices (TMR devices), Magnetic Memories: GMR technology, MRAM, New memory technologies in proposal. Introduction to oxide spintronics. Spin based computing: Basic principle, proposed methods of computing: NMR, Superconducting junctions.		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	45		30	75

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

Book reference

REFERENCES

1. Principles of Nanomagnetism, Alberto P. Guimaraes, Springer, 2009.
2. Magnetism: Materials and Applications, Edited by Etienne du TREMOLET de LACHEISSERIE, Damien GIGNOUX, Michel SCHLENKER, Springer, 2008.
3. Magnetism and Magnetic Materials, J. M. D. Coey, Cambridge University Press, 2009.
4. Introduction to Spintronics, Supriyo Bandyopadhyay and Marc Cahay, CRC press, 2008.

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	XNT606D	L	T	P	C
COURSE NAME	Nanomaterials and photo catalytic nanoparticles for water/ air detoxification	2	0	1	3
PREREQUISITES	Nil	L	T	P	H
C:P:A	2.8:0.8:0.4	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Identify*** and ***describe*** the aspects of Free electron theory and its features, band gap and difference between conductors, semiconductors and Insulators.	Cognitive Psychomotor	Remember Perception
CO2	***Explain*** the fundamental principles and different routes of synthesis of various nanoparticles.	Cognitive Psychomotor	Understand Set
CO3	***Interpret*** the various characterization techniques, ***use*** *and* ***identify*** the nanomaterials synthesized with the help of these techniques**.**	Cognitive Psychomotor Affective	Apply Mechanism Receive
CO4	***Describe, Illustrate*** and ***Discuss*** the Photo catalytic mechanism, general pathways & kinetics	Cognitive Affective	Remember Analyse Respond
CO5	***Apply*** and ***measure*** the different types of nanomaterials for detoxification of air and water.	Cognitive Psychomotor	Remember Apply Mechanism

UNIT I	INTRODUCTION TO NANOMATERIALS	6+6

Introduction to Nanomaterials and nature, Nano the beginning, Introductory Aspects of Free electron theory and its features, Density of state in bands and its variation with energy – Idea of band structure – Metals, Insulators and Semiconductors. Effect of crystal size on physical, chemical and optical properties of nanoparticles – Electronic structure of nanoparticles

UNIT II	CHEMICAL ROUTES FOR SYNTHESIS OF NANOMATERIALS	6+6

Process of synthesis of Nano powders, Sol-Gel process, Electro-Deposition, Plasma enhanced vapour decomposition, sputtering of Nano crystalline powders. Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Microemulsions or reverse micelles;
Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; Photochemical synthesis, Synthesis in supercritical fluids

UNIT III	CHARACTERIZATION TECHNIQUES	6+6

Application of General Characterization Techniques UV – Vis- NIR - absorption and reflectance Spectroscopy,
X- Ray Diffraction studies – Bragg's law – particle size – Scherer's equation – Photoluminescence (PL) studies Fourier Transform Infrared Spectroscopy (FTIR) – FT Raman studies –Surface Enhanced Infrared spectroscopy, Resonance Raman Spectroscopy –SEM, TEM and AFM to nanotechnology

UNIT IV	ITRODUCTION TO HETEROGENOUS PHOTOCATALYSIS	6+6

Introduction to heterogeneous photocatalysis, Photo catalytic mechanism, general pathways & kinetics, Aerobic oxidation processes, Intrinsic, Photocatalytic activity, Reaction variables, Photocatalytic Degradation of Specific Water-borne pollutants

UNIT V	AIR/WATER PURIFICATION USING NANOMATERIALS	6+6

Introduction to nature and cause of toxicity in air and water, Mechanism of detoxification of air/ water by nanostructured catalysts; TiO_2 as a semiconductor photocatalyst ; TiO_2 nanoparticles as benchmark catalyst for water purification:, Detoxification of air using nanocrystalline TiO_2,Treatment of wastewater/ air using nanoparticles such as CeO_2, ZnO, Nb_2O_5, Ta_2O_5 and other metal oxides

TEXT

1. V. Pokropivny, R. Lohmus, I. Hussainova A. Pokropivny and S. Vlassov "Introduction to nanomaterials and nanotechnology" Tartu University, Tallinn University, Frantsevich Institute for Problems of Materials Science of NASU.

2.Marcel Lahmani, Catherine Br´echignac and Philippe Houdy "Nanomaterials and Nanochemistry", Springer.

3.U. Heiz and U. Landman, "Nanocatalysis" Springer, 2006

4.Y. Gogotsi " Nanomaterials" Taylor and Francis, 2006

REFERENCES

1. K.W. Kolasinski, "Surface Science: Foundations of Catalysis and Nanoscience", Wiley, 2002.

2. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004.

3. Joel I. Gersten, "The Physics and Chemistry of Materials", Wiley, 2001.

4. A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 1998.

5. S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials", Taylor & Francis, 2000.

6. G.A. Ozin and A.C. Arsenault,"Nanochemistry:Achemical approach to nanomaterials", Royal Society of Chemistry, 2005.

7. Physical Chemistry –Atkins Peter, Paula Julio

8. Simon Parsons, Advanced oxidation processes for water and wastewater treatment, IWA Publishing, 2004.

9. Thomas Oppenländer, Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts, Wiley-VCH Publishing, Published by, 2003.

10. Vincenzo Belgiorno, Vincenzo Naddeo and Luigi Rizzo, Water, wastewater and soil treatment by Advanced Oxidation Processes (AOP), Lulu Enterprises, 2011.

11. Harold J.Ratson, Odor and VOC control handbook, Newyork, Mcgraw-hill, 1998.

E Resources - MOOCs:

1. http://www.mooc-list.com/course/nanochemistry-minor-saylororg
2. https://www.canvas.net/courses/exploring-nanochemistry
3. http://freevideolectures.com/Course/2263/Nanotechnology-I
4. http://freevideolectures.com/Course/3001/Nanotechnolgy-I
5. http://freevideolectures.com/Course/3167/Advanced catalysis-II
6. http://ocw.mit.edu/courses/nanochemistry

LABORATORY

1.	Synthesis of zirconium oxide nanomaterials
2.	Synthesis of cerium oxide nanomaterials
3.	Synthesis of niobium pentaoxide nanomaterials

4.	Synthesis of vanadium oxide nanomaterials
5.	Characterization of zirconium oxide nanomaterials using XRD, SEM, XPS, UV-Vis NIR
6.	Characterization of cerium oxide nanomaterials using XRD, SEM, XPS, UV-Vis NIR.
7.	Characterization of niobium pentaoxide nanomaterials using XRD, SEM, XPS, UV-Vis NIR
8.	Characterization of vanadium oxide nanomaterials using XRD, SEM, XPS, UV-Vis NIR
9.	Determination of photocatalytic efficiency of cerium oxide nanoparticles demonstrated by degradation of Methylene blue/ Rhodamine B dye
10.	Determination of photocatalytic efficiency of niobium pentaoxide nanoparticles demonstrated by degradation of Methylene blue/ Rhodamine B dye
11.	Determination of photocatalytic efficiency of vanadium oxide nanoparticles demonstrated by degradation of Methylene blue/ Rhodamine B dye

REFERENCE BOOKS

1. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
2. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), Handbook of NanoScience, Engg. and Technology, CRC Press, 2002.
3. K. Barriham, D.D. Vvedensky, Low dimensional semiconductor structures: fundamental and device applications, Cambridge University Press, 2001.
4. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties &Applications, Imperial College Press, 2004.

J.George, Preparation of Thin Films, Marcel Dekker, Inc., New York. 2005

E Resources - MOOCs:

1.http://freevideolectures.com/Course/2380/NanoChemistry-LaboratoryTechniques

2. http://freevideolectures.com/Course/2941/Chemistry-1A-General-Nanotechnology-Fall-2011

3.http://ocw.mit.edu/courses/chemistry/5-30/Nanotechnology-laboratory-techniques

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
	30	**0**	**30**	**60**

Table 1: Mapping of CO's with PO's

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	3	3	3	3	1	2	3	1	3	1	1	2	1
CO2	3	2	3	3	3	2	3	3	1	3		1	2	1
CO3	3	3	3	3	3	1	3	3	1	2	1	1	2	2
CO4	3		3	3	3	3	3	3	1	1		1	3	2
CO5	1	3		2	2	1	2		1	1		1	2	2
Total	13	11	12	14	14	8	13	12	5	10	2	5	11	8
Scaled Value	3	3	3	3	3	2	3	3	1	2	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	XGS607	L	T	P	C
COURSE NAME	ACADEMIC WRITING SKILLS	0	0	2	0
PREREQUISITE:	Nil	L	T	P	H
C:P:A	1.5:1.5:0	0	0	2*	2

COURSE OUTCOMES		Domain	Level
CO1	***Identify*** the features and types of paragraph writing.	Cognitive	Remember
CO2	***Comprehends*** the meaning and principles of discourse	Cognitive	Understand
CO3	***Adapts*** thenuances of language used in various types of essays	Psychomotor	Set
CO4	***Constructs*** novel ideas creatively and competence in writing	Psychomotor	Origination

UNIT I	Introduction	6

Definition of a paragraph - writing different types of paragraphs: descriptive paragraph-process paragraph-comparison and contrast paragraph

UNIT II	Discourse features	6

Cohesion – Coherence (connectives) – précis writing – summarizing

UNIT III	Types of Essays	6

Discursive – argumentative – cause & effect – chronological – language used in essays according to the types of essays

UNIT IV	Writing	12

Components of Good Essay - Essay writing practice

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
	0	0	30	30

TEXT BOOKS

- Peter Chin, Yusa Koizumi, Samuel Reid, Sean Wray, Yoko Yamazaki. *Academic Writing Skills.*Cambridge University Press 2012
- Bailey S.*ACADEMIC WRITING : A PRACTICAL GUIDE FOR STUDENT* (ROUTLEDGE STUDY GUIDES) 01 Edition, 2010

E – REFERENCES

- http://www.worc.ac.uk/movingon/Academic%20writing.pdf
- https://www.academiccoachingandwriting.org/academic-writing/resources/good-academic-writing

SYLLABUS

SEMESTER - VII

COURSE CODE	**XNT701**	**L**	**T**	**P**	**C**
COURSE NAME	**CYBER SECURITY**	**3**	**0**	**0**	**3**
C:P:A	**2:0.5:0.5**	**L**	**T**	**P**	**H**
PREREQUISITE	**Physics, Chemistry and Material Science**	**3**	**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*** *t*he 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 – Intellectual property 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
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	XNT702	L	T	P	C
COURSE NAME	HEALTH AND SAFETY ISSUES OF NANOTECHNOLOGY	3	0	0	3
C:P:A	2:0:1	L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science	3	0	0	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	Relate the toxic effects of nanotechnology on human health.	Cognitive Affective	Understand Remember Apply
CO2	Analyse the various issues on environmental effects.	Cognitive Affective	Understand Remember Apply
CO3	Identify suitable remedial measures	Cognitive Affective	Understand Remember Apply
CO4	Suggest start-of-the pipe solution for environmental issues based on nanomaterials	Cognitive Affective	Understand Remember Apply
CO5	Work out problems on nanomaterials related to toxicity. To frame a model policy on preventing health hazards.	Cognitive Affective	Understand Remember Apply

UNIT - I	Risks of Nanomaterials	9
Risks with nanomaterials: Identification of Nano, Specific Risks, Responding to the Challenge, Human health hazard, Risk reduction, Standards, Safety, transportation of NP, Emergency responders		
UNIT – II	**Risk assessment**	**9**
Risk assessment: Risk assessment –Environmental Impact – Predicting hazard – Materials Characterization. Risk Assessment related to nanotechnology – Environmental and policy making		
UNIT - III	**Ecotoxicity of nanomaterials**	**9**
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		
UNIT – IV	**Ecotoxicological tests**	**9**
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		
UNIT – V	**Legal aspects and regulations on toxicity of nanomaterials**	**9**
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		
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**	**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	PO11	PO12	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; Polymercarbon						

nanotubes 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.

TOTAL HOURS

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

COURSE CODE	XNT705A	L	T	P	C
COURSE NAME	Encapsulation Techniques	2	0	1	3
PREREQUISITES		L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept of Encapsulation Techniques	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Nanoencapsulation Techniques	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Nano encapsulation Techniques based on specialized equipments	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Preparation Methods And Mechanisms	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** Application Of Encapsulation Technique	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction Of Encapsulation Techniques**	6+6

Introduction- An overview of microencapsulation and nano encapsulation- Structure of particles: Matrix structure, Core / shell structure, (matrix core) / shell, or core / (matrix shell); Encapsulation materials-Selection of encapsulation materials-properties of encapsulation materials-Active compounds-Objectives of encapsulation techniques-General principle of encapsulation technique-Classification of nano encapsulation techniques: Top down and bottom up approach; Five nano encapsulation techniques

UNIT II	**Nanoencapsulation Techniques-1**	6+6

Lipid formulation nanoencapsulation techniques-Encapsulation by nanoemulsions-Encapsulation by nanoliposomes-Encapsulation by nanostructured lipid carriers

Nano encapsulation techniques based on natural nanocarriers- Nanocapsule formation by caseins- Nanocapsule formation by nanocrystals-nanocapsule formation by cyclodextrin-Nanoencapsulation by amylase nanostructures

UNIT III	**Nanoencapsulation Techniques-2**	6+6

Nano encapsulation technique based on specialized equipments-Nanocapsule formation by electro spinning- Nanocapsule formation by electro spraying-nanocapsule formation by nanospray dryer

Nano encapsulation techniques based on biopolymer nanoparticles- Nanocapsule formation by individual biopolymer nanoparticles-protein nanoparticles-carbohydrate nanoparticle-Nanocapsule formation by complexation of biopolymer

Other nanoencapsulation techniques- Nanoencapsulation by protein nanotubes-nanoencapsulation by carbohudrate nanogels

UNIT IV	**Preparation Methods And Mechanisms**	6+6

Lipid formulation nano encapsulation techniques methods and mechanisms- Nano encapsulation techniques based on natural nanocarriers methods and mechanisms- Nano encapsulation technique based on specialized equipments methods and mechanisms- Nano encapsulation techniques based on biopolymer nanoparticles methods and mechanisms

UNIT V	**Application Of Encapsulation Technique**	6+6

Medical application-food and nutraceuticals application-cosmetics application-agricultural applications-pharmaceutical application-electronic applications				
	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**30**	**0**	**30**	**60**
TEXT BOOK				
1. Nanoencapsulation Technologies for the Food and Nutraceutical Industries edited by Seid Mahdi Jafari 2. Encapsulation Nanotechnologies-edited by Vikas Mittal 3. Encapsulation technologies for electronic applications- Haleh Ardebili and Michael G. Pecht				
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

COURSE CODE	XNT705B	L	T	P	C
COURSE NAME	Lithography techniques	2	0	1	3
PREREQUISITES		L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept Of Micro fabrication	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** And ***Understand*** Photolithography And Patterning Of Thin Films	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine And Describe*** Direct Writing Methods - Maskless Optical Lithography	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe And Illustrate The*** Electron Beam Lithography (Ebl), X-Ray And Ion Beam Lithography	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** And ***Describe The*** Nanoimprint Lithography And Soft Lithography	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction And Micro fabrication**	**6+6**

Micro fabrication process flow diagram – Chip cleaning, coating of photo resists, patterning, etching, inspection – Process integration - Etching techniques- Reactive Ion etching- RIE reactive ion etching- Magnetically enhanced RIEIBE Ion beam etching.

UNIT II	**Photolithography And Patterning Of Thin Films**	**6+6**

Lithography -Optical lithography - different modes - Optical projection lithography - Multistage scanners – resolution and limits of photolithography – Resolution enhancement techniques – Photo mask- Binary mask- Phase shift mask - Attenuated phase shift masks - alternating phase shift masks - Off axis illumination- Optical proximity correction - Sub resolution assist feature enhancement-Optical immersion lithography

UNIT III	**Direct Writing Methods - Maskless Optical Lithography**	**6+6**

Mask less optical projection lithography – types, Advantages and Limitations – required components - Zone plate array lithography - Extreme ultraviolet lithography – Light sources - Optics and materials issues

UNIT IV	**Electron Beam Lithography (Ebl), X-Ray And Ion Beam Lithography**	**6+6**

Scanning electron-beam lithography- Electron sources and electron optics system mask less EBL-parallel direct-write e-beam systems-electron beam projection lithography - Scattering with angular limitation projection e-beam lithography (SCALPEL) - Projection reduction exposure with variable axis immersion lenses. XRPP - Ion beam lithography-Focusing ion beam lithography - Ion projection lithography.

UNIT V	**Nanoimprint Lithography And Soft Lithography**	**6+6**

Nanoimprint lithography (NIL)- NIL - hot embossing - UV-NIL- Soft LithographyMoulding/Replica moulding: PDMS stamps - Printing with soft stamps- Edge lithography - DipPen Lithography-set up and working principle – Self-assembly – LB films – Rapid prototyping.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	30	0	30	60

TEXT BOOK
1.“Lithographic and Micromachining Techniques for Optical Component Fabrication: II: 2 (Proceedings of SPIE)” by Ernst-Bernhard Kley and Hans Peter Herzig
2.“Nanoscale CMOS VLSI Circuits: Design for Manufacturability” by Sandip Kundu and Aswin Sreedhar
3.“Organic Nanomaterials: Synthesis, Characterization, and Device Applications” by Tomas Torres and Giovanni Bottari
4.“Fabrication Techniques for Micro-Optical Device Arrays” by Ryan D Conk
5.“Aligned Carbon Nanotubes: Physics, Concepts, Fabrication and Devices (NanoScience and Technology)” by Yucheng Lan and Zhifeng Ren
6.“Nanomaterials: A Guide to Fabrication and Applications (Devices, Circuits, and Systems)” by Sivashankar Krishnamoorthy
REFERENCES

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

COURSE CODE	XNT705C	L	T	P	C
COURSE NAME	Self Assembly Techniques	2	0	1	3
PREREQUISITES	Introduction to Nanotechnology	L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept of **Introduction**	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Self Assembled monolayers techniques	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Bottom up method	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate*** Self assembly technique in printing	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** Biological Application	Cognitive Psychomotor	Understand, Mechanism

UNIT I	Introduction	6+6
Self organization of nanostructured materials, Growth Mechanism, Self assembly of Nanostructures: Chemical, physical and biological self assembly, Assembling and patterning of particles, Self organization of different Nano-morphologies (Quntum Dots, Nanorods, Nanowires and Nanotubes)		
UNIT II	**Self Assembled monolayers techniques**	**6+6**
Self Assembled Monolayers (SAM), Guided Self Assembly - Nanolithography - Surface Topography - Surface Wetting - Electrostatic force; Nanomanipulators - Grippers – design - gripper arm geometry.		
UNIT III	**Bottom up method**	**6+6**
Bottom-up manufacturing: bottom-up approach, Self-assembly of single electron transistors, Photovoltaic related devices, Langmuir Bladgett films (LB): principle of formation of monolayer formation – from molecules to nanoparticles, compression of monolayer-fabrication of LB films-applications.		
UNIT IV	**Self assembly technique in printing**	**6+6**
Self Assembly by micro contact printing- creating the stamp, substrate- creating self assembled monolayers -applications, Macroscopic expressions of Natural Nanomaterials- Hierarchical Ordering in Natural Nanoscale Materials		
UNIT V	**Biological Application**	**6+6**
Bio-Inspired Approach for Complex Superstructures and Biological World, Self Assembly in biological systems: Super hydro phobicity, Self cleaning property, Multi scale ordering and function in Biological Nanoscale Materials: Proteins, Lipids, DNA and RNA and Shell as a Composite Materials.		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	**30**	**0**	**30**	**60**

TEXT BOOK

1. Self-Assembly and Nanotechnology Systems: Design, Characterization, and Applications 1st Edition by Yoon S. Lee.
2. Self-Assembled Nanostructures by Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen, and Gang-yu Liu.

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

COURSE CODE	XNT705D	L	T	P	C
COURSE NAME	NANO IN WIRELESS COMMUNICATION	2	0	1	3
C:P:A		L	T	P	H
PREREQUISITE		2	0	2	4

COURSE OUTCOMES		Domain	Level
CO1	***Explain*** the nanotechnology applications on wireless communication	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** applications of nanotechnology on fiber optics and microwave communications	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** applications of CNT in telecommunications	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate*** MEMS based application on wireless communications	Cognitive Psychomotor	Understand, Mechanism
CO5	***List , explain and practice*** the feasible experiments on nano wireless communication	Cognitive Psychomotor	Understand, Mechanism

UNIT - I	**Impact of Nanotechnology on Telecommunications**	**5**

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

UNIT – II	**Nanotechnology in Fiber-Optic Telecommunications and Microwave**	**10**

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

UNIT - III	**Carbon Nanotubes in Telecommunications**	**5**

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)

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

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

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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	**XNT705E**	**L**	**T**	**P**	**C**
COURSE NAME	**OPTIMIZATION TECHNIQUES**	**2**	**0**	**1**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
C:P:A	**1.5:1.2:0.3**	**2**	**0**	**2**	**4**

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	***Explain*** Formulate optimization problems	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** the various types of functions	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** the concept of optimality criteria for various type of optimization problems	Cognitive Psychomotor	Understand, Guided set
CO4	***Describe and Illustrate the*** various constrained and unconstrained problems in single variable as well as multivariable	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** methods of optimization in real life situation	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction and Basic Concepts**	**15**

Historical Development; Engineering applications of Optimization: Art of Modelling Objective function; Constraints and Constraint surface; Formulation of Design problems as Mathematical programming problems; Classification of optimization problems Optimization techniques – classical and advanced techniques.

UNIT II	**Optimization Using Calculus**	**15**

Stationary points; Functions of single and two variables; Global Optimum Convexity and concavity of functions of one and two variables Optimization of function of one variable and multiple variables; Gradient vectors; Examples Optimization of function of multiple Variables subject to equality constraints; Lagrangian Function Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation-Eigen values Kuhn-Tucker Conditions; Examples.

UNIT III	**Single Variable Optimization Problems**	**15**

Optimality criterion, Bracketing methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method, Gradient Based Methods: Newton-Raphson method: Bisection Method: Secant Method, Application to Root finding

UNIT IV	**Multivariable Optimization Algorithms**	**15**

Optimality criteria; Unidirectional Search; Direct Search Methods; Hooke-Jeeves pattern search methods; Powell's conjugate Direction Method; Gradient Based Methods; Cauchy's Steepest

Descent method; Newton's methods; Marquadrat's Methods.				
UNIT V	**Advanced Topics in Optimization**			15
Piecewise Linear approximation of a nonlinear function; Multi objective optimization – Weighted and Constrained methods; Multi level optimization Direct and indirect search methods; Evolutionary algorithms for optimization; Applications in Nano dimension.				
	LECTURE	**TUTORIAL**	**PRACTICAL**	**TOTAL**
HOURS	**45**		**30**	**75**

TEXT BOOK

1. S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P)Ltd., New Delhi, 2000.
2. G. Hadley, "Linear programming", Narosa Publishing House, New Delhi, 1990.
3. H.A. Taha, "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 1992.
4. K. Deb, "Optimization for Engineering Design- Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995
5. K. Srinivasa Raju and D. Nagesh Kumar, "Multicriterion Analysis in Engineering and Management", PHI Learning Pvt. Ltd., New Delhi, India, ISBN 978-81-203-3976 pp.288, 2010.

REFERENCES

1. S. S. Rao: Engineering Optimization, New Age International.
2. E. J. Haug and J.S. Arora, Applied Optimal Design, Wiley, New York.
3. Kalyanmoy Deb, Optimization for Engineering Design, Prentice Hall of India.
4. A. Ravindran and K.M. Rogsdeth, Optimization G.V. Reklaites, Wiley, New York.

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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	XNT706A	L	T	P	C
COURSE NAME	MEMS AND NEMS fabrication	2	0	1	3
PREREQUISITES	Nano materials Fabrication Techniques I and II	L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic concept of MEMS and NEMS	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Fabrication Process	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Mechanical and Thermal MEMS	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Magnetic and RF MEMS	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** MOEMS and Micro fluidic Systems	Cognitive Psychomotor	Understand, Mechanism

UNIT I	Introduction to MEMS and NEMS	6+6

MEMS and NEMS- Micro- and Nano electromechanical Systems: Scaling Laws- Mathematical Modelling- Micro sensors and micro actuators- Mechanical MEMS, Thermal MEMS- MOEMS, Magnetic MEMS, RF MEMS- Micro fluidic systems, Bio-Chemo devices- MEMS Architectures- NEMS Architectures

UNIT II	FABRICATION PROCESS	6+6

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

UNIT III	Mechanical and Thermal MEMS	6+6

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

UNIT IV	Magnetic and RF MEMS	6+6

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	MOEMS and Micro fluidic Systems	6+6

Principles of MOEMS technology- Applications Light modulators , beam splitters- Micro lens, micro mirror, digital micro mirror device- Optical switch, wave guide and tuning- Properties of fluids, fluid actuation methods- Dilectrophoresis, electro thermal flow, thermo capillary effect- Micro pumps, Micro pumps: 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
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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	XNT706B	L	T	P	C
COURSE NAME	Nano Coatings	2	0	1	3
PREREQUISITES	Nanomaterial Fabrication Techniques I and II	L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** the basic concepts of coating	Cognitive	Understand Remember
CO2	***Explain*** And ***Understand*** The Special Coating Technique	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine And Describe*** Hard And Soft Coatings	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe And Illustrate The*** Surface Coating	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** And ***Describe The*** Characterization Technique And Application Of Nano coating	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Concept Of Coating**	6+6
Introduction to surface Engineering, Differences between surface and bulk, Properties of surfaces-wear, wettability		
UNIT II	**Special Coating Technique**	**6+6**
Electroplating and electroplating ,Metallic and non metallic coatings, Galvanizing,advantages and disadvantages - conventional verses nanocoatings		
UNIT III	**Hard And Soft Coatings**	**6+6**
Caser cladding, laser alloying, Electron beam hardening, ion beam implantation, electrophoretic deposition, DLC and diamond coatings, antifriction and anti scratch coatings		
UNIT IV	**Surface Coating**	**6+6**
Conductive Coatings, Sol-Gel Coatings, Radiation-Cured Coatings, Metal Coating		
UNIT V	**Characterization Technique And Application Of Nanocoating**	**6+6**
Professional Method - **Hand finishing** – **Spraying**-DIP Nanocoating Process-Nanocoating for tribological Application- Textiles-drugs-		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	30	0	30	60

List of Lab 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. Nanocoatings *By R. Abdel-Karim and A. F. Waheed*

2.Nanocoatings & Ultra-Thin Films Makhlouf Tiginyanu (Woodhead 2011)

REFERENCES

1. Coatings technology handbook marcel dekker, inc., by d. Satash, arthur a. Tracton
2. Surface engineering of metals, principles, equipments and technologies tadeusz burakowski, padeusg and weirzxhon,crc press, 1998 kwaadsteniet, marelize botes and j.manuel lopezromero.
3. Surface coatings for protection against wear edited by bg miller, woodhead publishing,-2006,caister academic press by t.eugene,michele de
4. Nanocoatings: principles and practice destech publications,inc., by steven abbott, nigel holmes
5. Nanocoatings and ultra-thin film a.s.h. makhlouf and i. Tiginyanu a volume in woodhead publishing series in metals and surface engineering

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	XNT706C	L	T	P	C
COURSE NAME	Thin Film	2	0	1	3
PREREQUISITES	Nano material Fabrication-I	L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept of THIN FILM DEPOSITION TECHNIQUES Introduction	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** CHARACTERIZATION TECHNIQUES Surface analysis techniques	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** ADSORPTION AND DIFFUSION IN THIN FILMS	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** STRESS IN THIN FILMS	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** MODIFICATION OF SURFACES AND FILMS	Cognitive Psychomotor	Understand, Mechanism

UNIT I	THIN FILM DEPOSITION TECHNIQUES Introduction	6+6

Kinetic theory of gases - Physical vapour deposition techniques – Physics and Chemistry of Evaporation - Thermal evaporation – Pulsed laser deposition – Molecular beam epitaxy – Sputtering deposition – DC, RF, Magnetron, Ion beam and reactive sputtering - Chemical methods – Thermal CVD – Plasma enhanced CVD – Spray Pyrolysis – Sol Gel method – Spin and Dip coating – Electro plating and Electro less plating – Deposition mechanisms

UNIT II	CHARACTERIZATION TECHNIQUES Surface analysis techniques	6+6

Auger Electron spectroscopy – Photoelectron Spectroscopy – Secondary Ion Mass Spectroscopy – X-ray Energy Dispersive Analysis – Rutherford Backscattering spectroscopy - Imaging Analysis Techniques – Scanning Electron Microscopy – Transmission Electron Microscopy – Optical analysis Techniques – Ellipsometry – Fourier Transform Infrared Spectroscopy – Photoluminescence Spectroscopy

UNIT III	ADSORPTION AND DIFFUSION IN THIN FILMS	6+6

Physisorption – Chemisorptions – Work function changes induced by adsorbates – Two dimensional phase transititions in adsorbate layers – Adsorption kinetics – Desorption techniques. Fundamentals of diffusion –Grain Boundary Diffusion – Thin Film Diffusion Couples - Inter Diffusion -Electro migration in thin films – Diffusion during film growth

UNIT IV	STRESS IN THIN FILMS	6+6

Origin of Thin film stress - Classifications of stress – Stress in epitaxial films – Growth Stress in polycrystalline films – Correlation between film stress and grain structure – Mechanisms of stress evolution – film stress and substrate curvature – Stoney formula – Methods of curvature measurement – Scanning laser method.

UNIT V	MODIFICATION OF SURFACES AND FILMS	6+6

Introduction – Laser and their Interactions with Surfaces – Laser modification effects and applications – Laser sources and Laser scanning methods - Thermal analysis of Laser annealing - Laser surface alloying - Ion implantation effects in solids – Energy loss and structural modification – compositional modification - Ion beam modification phenomena and applications

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	30	0	30	60

TEXT BOOK

REFERENCES

1. Amy E. Wendt, Thin Films - High density Plasmas, Volume 27, Springer Publishers. (2006).
2. .Rointan F. Bunshah, Hand Book of Deposition technologies for Thin Films and coatings by Science, Technology and Applications ,Second Edition , Noyes Publications, (1993).
3. Milton Ohring, Materials Science of Thin films Published by Academic Press Limited(1991)
4. L.B. Freund and S.Suresh, Thin Film Materials, (2003).
5. Hans Luth, Solid surfaces, Interfaces and Thin Films' 4 th edition, Springer Publishers (2010).
6. Harald Ibach, Physics of Surfaces and Interfaces, Springer Publishers (2006).AM

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	XNT706D	L	T	P	C
COURSE NAME	Nano Scaffolds and Characterization Techniques	2	0	1	3
PREREQUISITES		L	T	P	H
C:P:A	1.5:1.2:0.3	3	0	2	5

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept of nanoscaffolds	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Methods and techniques Nano scaffolds	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Characterization Techniques of Nanoscaffolds	Cognitive Psychomotor	Understand, Guided set
CO4	***Describe and Illustrate the*** Application of NanoScaffolds	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe*** the future trends on scaffolds	Cognitive Psychomotor	Understand, Mechanism

UNIT I	INTRODUCTION	15
Fundamentals of nano scaffolds -developments, types of nano scaffolds, working principle and conditions, properties-physical, mechanical, chemical, biological, nanomaterials for scaffolds-strength and efficiency.		
UNIT II	**METHODS AND FORMATION**	**15**
Construction of scaffold, Methods and techniques- electro spinning, Phase separation, Freeze-drying, Self-assembly, Top-down approach for tissue engineering, Bottom-up approach for tissue engineering-folding, molding, photolithography, tissue fabrication and assembly process.		
UNIT III	**CHARACTERIZATION TECHNIQUES**	**15**
Photolithography- background, design,3D printed scaffolds, bio printing technique, XRD analysis, Electron microscopy-observation, SEM analysis.		
UNIT IV	**APPLICATIONS**	**15**
Nano-engineered scaffolds, Tissue engineering, bone re growth-mechanism, Nano scaffolds-biological uses, diagnostic, therapeutic, and cosmetic applications.		
UNIT V	**FUTURE TRENDS ON SCAFFOLDS**	**15**
Advances on- cardiac, nerve, skin, bone, cartilage, recent research on bone repair technology-tissue engineering, drug delivery system.		

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	45		30	75

TEXT BOOK

Nanotechnology and Tissue Engineering: The Scaffold Based Approach Lakshmi S. Nair, Subhabrata Bhattacharyya, and Cato T. Laurencin.

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

SYLLABUS

SEMESTER – VIII

COURSE CODE	**XNT802A**	**L**	**T**	**P**	**C**
COURSE NAME	**Graphene Nanotechnology**	**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*** Basic Concept of Graphene	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Properties of graphene	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Synthesis of Graphene	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Characterization of Graphene	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** Application of Graphene	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction of Graphene**	**6+6**
Graphene: Introduction of graphene, Graphite, Definition and structure of graphene, Types of graphene: stacking AA, BB, AB dispersion relation, Single layer, Bi-layer, few layer		
UNIT II	**Properties of graphene**	**6+6**
Properties of graphene; Optical: thickness dependency, optical conductivity, electric filed tunable transparency, plasmons and polaritons, carrier multiplication. Electrical: Boltzmann equation, ambipolar conduction, density of states and doping (electrostatic and chemical), quantum hall effect, Klein tunneling, diamagnetism, magnetoresistance and spin current, thermal conductivity. Mechanical, Surface phenomenon.		
UNIT III	**Synthesis of Graphene**	**6+6**
Preparation of graphene: Epitaxial growth of graphene on Silicon carbide, Chemical deposition (CVD) growth of graphene films, Chemically derived graphene, Synthesis of graphene oxide: Hummer's method, Modified Hummer's method, Reduction of graphene oxide: Chemical methods, Physical methods, Electrochemical exfoliation, Nanotube slicing, from solid state carbon sources.		
UNIT IV	**Characterization of Graphene**	**6+6**
Characterization of graphene: Transmission electron microscopy (TEM), Scanning tunneling microscopy (STM), Raman Spectroscopy, Electrical measurements: electric field effect, temperature dependent resistivity measurement.		
UNIT V	**Application of Graphene**	**6+6**
Applications of graphene: Graphene in the energy application: Li-ion batteries, Supercapacitors, Photovoltaic, Radio-frequency transistor, Photodetector, Modulator, Mode locked lasers, Other applications of graphene: Anti-corroison coating, Anti- bacterial coating, catalyst, Sensors, Transparent Conductors		

	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
Book reference 1. Graphene: Fundamentals, Devices, and Applications-by Serhii Shafraniuk 2. An Introduction to Graphene and Carbon Nanotubes-by John E. Proctor (Author), Daniel Melendrez Armada (Author), Aravind Vijayaraghavan (Author)
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

COURSE CODE	XNT802B	L	T	P	C
COURSE NAME	CARBON NANOTUBES	2	0	1	3
PREREQUISITES	Introduction to Nanotechnology Materials Science, Nano Applications	L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept Of Carbon Nanotube	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** And ***Understand*** Properties Of Carbon Nanotubes	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine And Describe*** Application Of Carbon Nanotubes	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe And Illustrate The*** Metal Nanoparticles	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** And ***Describe The*** Synthesis Process Of Metal Nanoparticles	Cognitive Psychomotor	Understand, Mechanism

UNIT I	INTRODUCTION OF CNT	6+6

Basic Concept of Carbon Nanotube, the structure of Carbon Nanotubes, Symmetry of Single-walled-Carbon Nanotube, Symmetry of Double walled- Carbon Nanotube, Symmetry Operation, Symmetry-based Quantum Numbers.

UNIT II	PROPERTIES OF CARBON NANOTUBES	6+6

Mechanical Properties, Thermal Stability, Heat transport in Carbon Nanotubes, Electronic Properties, Optical Properties, 12 14% Suggested Specification table with Marks (Theory): Elastic Properties, Vibrational Properties, Intrinsic Properties of individual Carbon Nano Tube.

UNIT III	APPLICATION OF CARBON NANOTUBES	6+6

Carbon Nanotubes in Electronics, Carbon Nanotubes in Energy Applications, Carbon Nanotubes For Mechanical Applications, Carbon Nanotube Sensors, Carbon Nanotubes in Field Emission and Lighting Applications, Carbon Nanotubes for Biological Applications

UNIT IV	METAL NANOPARTICLES	6+6

Introduction, Size-Dependent Properties of Metal nanoparticles, Band gap measurement, Magic Metal nanoparticle, Noble Metal Nanoparticles, Geometric configuration.

UNIT V	SYNTHESIS PROCESS OF METAL NANOPARTICLES	6+6

Wet Chemical Synthesis Routes, Phase Transfer Method, Stabilization Mechanisms, Electrochemical Method

	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. Carbon Nanotubes: Basic Concepts and Physical Properties, Stephanie Reich, Christian Thomsen, Janina Maultzsch
2. Understanding Carbon Nanotubes: From Basics to Applications -English, Paperback, Annick Loiseau, Pascale Launois-bernede, Jean-paul Salvetat, Pierre Petit, Stephan Roche)
3. Carbon Nanotubes and Their Applications (English, Hardcover, Qing Zhang)

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

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. The Fullerenes- 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	XNT802D	L	T	P	C
COURSE NAME	QUANTUM DOT	2	0	1	3
PREREQUISITES		L	T	P	H
C:P:A	1.5:1.2:0.3	2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic Concept of Quantum dots	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** **Quantum Mechanical Tunnel Devices**	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** **Semiconductor and Device**	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** **Quantum computing**	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** **Quantum DOT cellular Automata**	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction**	6+6
Introduction: Recent past, the present scenario of Computing and its challenges, Future, Overview of basic Nano electronics.		
UNIT II	**Quantum Mechanical Tunnel Devices**	**6+6**
Overview of current research in nano-scale electronics and devices		
UNIT III	**Semiconductor and Device**	**6+6**
Photonic Device and Materials, CMOS Device, Limit of CMOS technology-Scaling Theory. Quantum Dots & Quantum wires.		
UNIT IV	**Quantum computing**	**6+6**
Quantum computing: Basics and examples: introduction, axioms, quantum states and notation, unitaries, Measurement, Quantum circuits: classical reversible circuits, quantum circuits, universality.		
UNIT V	**Quantum DOT cellular Automata (QCA)**	**6+6**
Introduction to nano-electronic and nano-computers, Quantum DOT cellular Automata (QCA), molecular circuits, Nano-computer Architecture. Defect analysis and Reliability: purpose of defect analysis in nano computing and Challenges. Reliability measurement in nano scale computing. Different soft computing tool for reliability analysis like Bayesian Network, Neural Network		

	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. Quantum Dots - Theory and Applications *by Vasilios N. Stavrou*, CBS Publishers & Distributors Pvt. Ltd

2. Quantum Dots: Optics, Electron Transport and Future Applications 1st Edition by Alexander Tartakovskii.

3. Quantum Dots – A Variety of New Applications Edited by Ameenah Al-Ahmadi Published by InTech

REFERENCES

1. "Quantum -dot Devices and Quantum-dot Cellular automata" by Wolfgang Prodog, Elsevier Science.
2. "Electronic Transport in Quantum dot Cellular Automata", Leo P. Kouwenhoven
3. "Quantum-dot Cellular Automata, Theory, Experimentation and Prospects" M. Macucci
4. "Probabilistic Modeling of Quantum-dot Cellular Automata", Saket Rivastava, PhD dissertation
5. "Quantum Computation: Theory and Implementation", Edward Stuart Boyden

.**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	XNT802E	L	T	P	C
COURSE NAME	POLYMERIC CARRIERS	2	0	1	3
PREREQUISITES	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*** Basic Concept of Polymers	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** Microstructure of polymer chains	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Mechanical properties	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Flow properties of polymer	Cognitive Psychomotor	Understand, Mechanism
CO5	***Classify*** and ***Describe the*** Polymer Fabrication Techniques	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Introduction**	6+6
Polymers and chemical bonding. Polymerization mechanism. Addition and Condensation polymerization. Chain transfer reaction. Co-polymerization. Polymerization by coordination catalyst. Ring opening polymerization. Molecular weights and their distribution.		
UNIT II	**Microstructure of polymer chains**	**6+6**
Configuration and conformation. Simple and hindered rotation. Radius of gyration and end-to-end distances. Crystallinity and melting. Glass transition. Physical states of polymers and mode of motions of polymer chain. Measurement of viscosity. Cohesive energy density. Compatibility and solubility parameters. Polymer additives, blends and composites.		
UNIT III	**Mechanical properties**	**6+6**
Rheology of polymers. Rubber elasticity. Viscoelasticity. Creep and stress relaxation. Dynamic behaviour. Strength and fracture of rubber and glassy polymers		
UNIT IV	**Flow properties of polymer**	**6+6**
Bulk deformation, elongational and shear flow. Hagen Poiselli equation for polymers, non-Newtonian flow. Extrusion. Injection moulding. Blow moulding. Compression and transfer moulding. Spinning of fibers.		
UNIT V	**Polymer Fabrication Techniques**	**6+6**
Vulcanization of rubber. Flat film and sheet formations. Laminations. Forming of foam.		

	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. Nano-Carrier Systems Theories, Methods & Applications Author(s) :Amit K. Goyal, Goutam Rath, PharmaMed Press / BSP Books 2018.

2. Polymer Nanoparticles for Smart Drug Delivery *By Devasier Bennet and Sanghyo Kim*

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	XNT803F	L	T	P	C
COURSE NAME	LIGNOCELLULOSES BIOMASS	2	0	1	3
PREREQUISITES		L	T	P	H
C:P:A		2	0	2	4

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	***Explain*** Basic structure and properties of **Lignocellulose**	Cognitive Psychomotor	Understand Remember
CO2	***Explain*** and ***understand*** biodiesel production using lignocellulose	Cognitive Psychomotor	Understand, Guided Response
CO3	***Determine and Describe*** Bioethanol production from lignocellulose	Cognitive Psychomotor	Understand, Guided Set
CO4	***Describe and Illustrate the*** Bio refinery applications of lignocellulose	Cognitive Psychomotor	Understand, Mechanism
CO5	***Describe the*** other chemical and polymer production applications of lignocellulose	Cognitive Psychomotor	Understand, Mechanism

UNIT I	**Properties of Lignocellulose**	6+6

Valorization of Ligno cellulosic Materials to Polyhydroxyalkanoates PHAs. Biological Gaseous Energy Recovery from Ligno cellulosic Biomass. Alkali Treatment to Improve Physical Mechanical and Chemical Properties of Ligno cellulosic Natural Fibers for Use in Various Applications

UNIT II	**Biodiesel**	6+6

Biodiesel Production from Ligno cellulosic Biomass Using Oleaginous Microbes. Bio pulping of Ligno cellulose

UNIT III	**Bioethanol**	6+6

Second Generation Bioethanol Production from Residual Biomass of the Rice Processing Industry. Microbial Enzymes and Ligno cellulosic Fuel Production

UNIT IV	**Biorefinery**	6+6

A Potential Agricultural Crop for Bio economy through Bio refinery. A GIS Based Approach for Assessing Production Statistics of Ligno cellulosic and its Application in Bio refinery

UNIT V	**Others**	6+6

Ligno cellulosic Biomass Utilization for the Production of Sustainable Chemicals and Polymers
Utilization of Ligno cellulosic Biomass for Bio butanol Production
Application of Ligno cellulosic Biomass in the Paper Industry

	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.A Kuila, V. Sharma, Ligno cellulosic Biomass Production and Industrial Applications, Wiley & Sons, 2017

2. Biomass Fractionation Technologies for a Lignocellulosic Feedstock Based Biorefinery *Edited by:Solange Inês Mussatto*.

3. Lignocellulosic Biomass Production and Industrial Applications Hardcover – 1 Aug 2017 by Arindam Kuila (Editor), Vinay Sharma (Editor).

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

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	Psychomotor	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO10	PO11	PO12	PSO1	PSO2
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													

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	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	
	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	XNT805		L	T	P	C
COURSE NAME	SURFACE PLASMON RESONANCE		3	0	1	4
C:P:A	2:0.5:0.5		L	T	P	H
PREREQUISITE	Physics, Chemistry and Material Science		3	0	2	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	ELECTROMAGNETICS OF METALS					9+6
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.						
UNIT – II	SURFACEPLASMONPOLARITONSATMETAL/INSULATOR INTERFACES					9+6
The Wave Equation, Surface Plasmon Polaritons at a Single Interface, Multilayer Systems, 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

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3. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001

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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