ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.TECH
NANO TECHNOLOGY

(Applicable for the batches admitted from 2013-14)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
KUKATPALLY, HYDERABAD – 500 085.

ACADEMIC REGULATIONS R13 FOR M. TECH. (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech. (Regular) Course from the Academic Year 2013-14 and onwards

The M. Tech. Degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.0 AWARD OF M. TECH. DEGREE

2.1 A student shall be declared eligible for the award of the M. Tech. Degree, if he pursues a course of study in not less than two and not more than four academic years. However, he is permitted to write the examinations for two more years after four academic years of course work.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his admission, shall forfeit his seat in M. Tech. course.

2.3 The student shall register for all 88 credits and secure all the 88 credits.

2.4 The minimum instruction days in each semester are 90.

3.0 A. COURSES OF STUDY

The following specializations are offered at present for the M. Tech. course of study.

1. Advanced Manufacturing Systems
2. Aerospace Engineering/ Aeronautical Engineering
3. Automation
4. Biomedical Signal Processing and Instrumentation
5. Bio-Technology
6. CAD/CAM
7. Chemical Engineering
8. Communication Systems
9. Computer Networks
10. Computer Networks and Information Security
11. Computer Science
12. Computer Science and Engineering
13. Computers and Communication Engineering.
14. Construction Management
15. Control Engineering
16. Control Systems
17. Cyber Forensic / Cyber Security & Information Technology
18. Design for Manufacturing/ Design and Manufacturing
19. Digital Electronics and Communication Engineering.
20. Digital Electronics and Communication Systems
21. Digital Systems and Computer Electronics
22. Electrical Power Engineering
23. Electrical Power Systems
24. Electronics & Instrumentation

25. Electronics and Communication Engineering
26. Embedded Systems
27. Embedded Systems and VLSI Design
28. Energy Systems
29. Engineering Design
30. Environmental Engineering
31. Geoinformatics and Surveying Technology
32. Geotechnical Engineering.
33. Heating Ventilation & Air Conditioning.
34. Highway Engineering
35. Image Processing
36. Industrial Engineering and Management
37. Information Technology
38. Infrastructure Engineering
39. Machine Design
40. Mechatronics.
41. Microwave & Radar Engineering
42. Nano Technology
43. Neural Networks
44. Parallel Computing
45. Power and Industrial Drives
46. Power Electronics
47. Power Electronics and Electrical Drives
48. Power Engineering and Energy Systems
49. Power Plant Engineering & Energy Management
50. Power System Control and Automation
51. Power System with Emphasis H.V. Engineering / H.V. Engineering
52. Production Engineering.
53. Real Time Systems
54. Software Engineering
55. Structural Engineering
56. Systems & Signal Processing
57. Thermal Engineering.
58. Transportation Engineering
59. VLSI
60. VLSI and Embedded System/ Electronics Design Technology
61. VLSI Design
62. VLSI System Design
63. Web Technologies
64. Wireless and Mobile Communication

and any other course as approved by the University from time to time.

3.0 B. Departments offering M. Tech. Programmes with specializations are noted below:

Civil Engg.	Construction Management Environmental Engineering Geoinformatics and Surveying Technology Geotechnical Engineering Highway Engineering Infrastructure Engineering Structural Engineering Transportation Engineering
EEE	Control Engineering Control Systems Electrical Power Engineering Electrical Power Systems Power and Industrial Drives Power Electronics Power Electronics and Electrical Drives Power Engineering and Energy Systems Power Plant Engineering & Energy Management Power System Control and Automation Power System with Emphasis H.V. Engineering / H.V. Engineering
ME	Advanced Manufacturing Systems Automation CAD/CAM Design for Manufacturing/ Design and Manufacturing Energy Systems Engineering Design Heating Ventilation & Air Conditioning Industrial Engineering and Management Machine Design Mechatronics. Power Plant Engineering & Energy Management Production Engineering Thermal Engineering.
ECE	Biomedical Signal Processing and Instrumentation Communication Systems Computers and Communication Engineering. Digital Electronics and Communication Engineering. Digital Electronics and Communication Systems Digital Systems and Computer Electronics Electronics & Instrumentation Electronics and Communication Engineering Embedded Systems Embedded Systems and VLSI Design

	Microwave & Radar Engineering Systems & Signal Processing VLSI VLSI and Embedded System/ Electronics Design Technology VLSI Design VLSI System Design Wireless and Mobile Communication
CSE	Computer Networks Computer Networks and Information Security Computer Science Computer Science and Engineering Cyber Forensic / Cyber Security & Information Technology Image Processing Information Technology Neural Networks Parallel Computing Real Time Systems Software Engineering Web Technologies
Aeronautical Engg.	Aerospace Engineering / Aeronautical Engineering
Bio-technology	Bio-Technology
Chemical Engg.	Chemical Engineering
Nano Technology	Nano Technology

4.0 ATTENDANCE

The programs are offered on a unit basis with each subject being considered a unit.

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class and their registration shall stand cancelled.

4.5 A prescribed fee shall be payable towards condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

4.7 A candidate shall put in a minimum required attendance at least in three (3) theory subjects in the present semester to get promoted to the next semester. In order to qualify for the award of the M. Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

4.8 A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the previous semester including the days of attendance in sports, games, NCC and NSS activities.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

5.1 For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the average of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction. Each mid term examination shall be conducted for a total duration of 120 minutes with Part A as compulsory question (16 marks) which consists of four sub-questions and carries 4 marks each and Part B with 3 questions to be answered out of 5 questions each question for 8 marks. If any candidate is absent from any subject of a mid-term examination, an on-line test will be conducted for him by the University. The details of the Question Paper pattern for End Examination (Theory) is given below:

- The End semesters Examination will be conducted for 60 marks which consists of two parts viz. i).Part-A for 20 marks, ii). Part –B for 40 marks.
- Part-A is compulsory question where it consists of five questions one from each unit and carries four marks each. This will be treated as Question 1.
- Part-B consists of five Questions (numbered from 2 to 6) carries 8 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice (that means there will be two questions from each unit and the student should answer only one question)

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 40 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during I year I semester and II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M. Tech. course of study. The Comprehensive Viva-Voce is evaluated for 100 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce.

5.5 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.5) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.

5.7 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the End Examination in that subject. He shall re-register the subject when next

offered.

5.8 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher and the second examiner shall be another Laboratory Teacher.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 A Project Review Committee (PRC) shall be constituted with Principal as Chairperson, Heads of all the Departments offering the M. Tech. programs and two other senior faculty members.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Departmental Academic Committee for approval. Only after obtaining the approval of the Departmental Academic Committee can the student initiate the Project work.

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Departmental Academic Committee. However, the Departmental Academic Committee shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.5 A candidate shall submit his status report in a bound-form in two stages at least with a gap of 3 months between them.

6.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Principal through Head of the Department and make an oral presentation before the PRC.

6.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/ School/Institute.

6.8 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.9 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected.

6.10 If the report of the examiner is favourable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent

B. Good

C. Satisfactory

D. Unsatisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva- Voce examination.

If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva- Voce examination, he will not be eligible for the award of the degree.

7.0 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	% of marks to be secured
First Class with Distinction	70% and above
First Class	Below 70% but not less than 60%
Second Class	Below 60% but not less than 50%
Pass Class	Below 50% but not less than 40%

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

8.0 WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

9.0 TRANSITORY REGULATIONS

9.1 Discontinued, detained, or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.

9.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per R13 academic regulations.

10. GENERAL

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/ year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   - (i) A show cause notice shall be issued to the college.
   - (ii) Impose a suitable fine on the college.
   - (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.TECH - NANO TECHNOLOGY

COURSE STRUCTURE AND SYLLABUS

I Year I Semester

Code	Group	Subject	L	P	Credits
		Structure, Bonding and Quantum mechanics	3	-	3
		Synthesis of Nanomaterials	3	-	3
		Science and Technology of Thin-films	3	-	3
		Nano Biotechnology, Materials and Devices	3	-	3
		Numerical Methods and Advanced Computing Techniques	3	-	3
		Properties of Nano Structures	3	-	3
	Lab	Synthesis, Characterization and Simulation Lab-I	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

I Year II Semester

Code	Group	Subject	L	P	Credits
		Material characterization Techniques	3	-	3
		Carbon Nanotubes and Applications	3	-	3
		Nano Composites – Design and Synthesis	3	-	3
		Micro/Nano Fabrication	3	-	3
	Elective - I	MEMS/NEMS Design and Application Nano Electronics and Nano Photonics Actuators and Sensors	3	-	3
	Elective – II	Nanotechnology for Energy Systems Strengthening Mechanisms with Nanomaterials Environmental Nano Technology	3	-	3
	Lab	Fabrication, Characterization and Simulation Lab-II	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

II Year - I Semester

Code	Group	Subject	L	P	Credits
		Comprehensive Viva	-	-	2
		Project Seminar	-	3	2
		Project work	-	-	18
		Total Credits	-	3	22

II Year - II Semester

Code	Group	Subject	L	P	Credits
		Project work and Seminar	-	-	22
		Total Credits	-	-	22

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech. (Nano Tech.)

STRUCTURE, BONDING AND QUANTUM MECHANICS

Objective:

The course is intended to cover, basics concepts of crystallography, quantum mechanics, matter and energy relations, de-Brogile hypothesis, wave function analogies, Schrodinger equation, quantum dot, wires and wells etc.

Outcome of the study:

1. To know the importance of crystal structures for property evaluation.
2. Students without quantum mechanics back ground will be able to understand the concept of quantum mechanics and nanotechnology.
3. To evaluate nanostructures in quantum mechanical approaches.

Unit-I

Crystal structure: Crystalline and amorphous solids- Crystal lattice and crystal structure-Translational symmetry-space lattice-unit cell and primitive cell-symmetry elements in crystal-the seven crystal systems-some imperfections in crystals-Wigner-seitz cells-Miller indices-Miller-bravais indices-Indices of a lattice direction-The spacing of a set of crystal planes.

Unit-II

Reciprocal lattice and crystal imperfections: Bragg law- Reciprocal lattice – Properties of Reciprocal lattice-Reciprocal lattice of simple cube- Reciprocal lattice of bcc- Reciprocal lattice of fcc- diffraction conditions-Brillouion zones. Importance of lattice imperfections- types of imperfection-Point defects-dislocations.

Unit-III

Introduction-Why quantum mechanics - matter waves-length scales - De-Broglie hypothesis – wave particle duality- Heisenberg's uncertainty principle-Schrodinger wave equation – General postulates of Quantum mechanics- particle in one dimensional box, Bohr's correspondence principle.

Unit-IV

Quantum mechanics of electronics: Electron as particle and electron as wave-Time independent Schrodinger equation and boundary condition on the wave function-Analogies between quantum mechanics and classical electromagnetic theory-Probabilistic current density-multiple particle systems.

Unit-V

Free and confined electrons: Free electrons-the free electron gas theory of metals-electrons confined to abounded region of space and quantum numbers-electrons confined to atom-the hydrogen atom and the periodic table-quantum dots-wires-wells.

TEXTBOOKS:

1. Solid state Physics by Kittle {Unit-I,II}
2. P.M.Mathews and K.Venkatesan, "A textbook of Quantum Mechanics", Tata McGraw Hill Publishing Company Ltd {Unit-III}
3. An introduction to solid states electronic devices by Ajay kumar saxena Macmillan India Ltd {Unit-I, II}
4. Quantum Mechanics – Schiff {Unit-III}
5. Quantum Mechanics by B.k.Agarwal and Hariprakash, PHI {Unit-III}

6. Fundamentals of nanoelectronics by George W.Hanson Pearson education {Unit-IV,V}

REFERENCE BOOKS:

1. Introduction to Nanotechnology by Charles P.Poole Jr & Frank J. Owens;Wiley India Pvt. Ltd.
2. The Feynman lectures on Physics; Vol I to III.
3. Quantum mechanics by Brandsen & Joachem.
4. J.J.Sakurari, "Modern Quantum Mechanics Mc.Graw Hill, Addison Wesley Longman Inc., USA, 1999.
5. Nano Technology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer.
6. Nano Technology – science, innovation and opportunity by Lynn E Foster;Prentice Hall - Pearson education.
7. Hand book of Nano structured materials; Vol I to V Bio Ethics Readings and cases by Branch A.Brody & H.Tristram Engelhardt.Jr; Pearson Education.
8. Quantum mechanics: - Pawling & Wilson.
9. Quantum physics by A.Ghatak.
10. Introduction to quantum chemistry by A.K.Chanda.
11. Introduction to Quantum Mechanics – Gupta, Kumar, Sharma.
12. Quantum Mechanics - Aruthas.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

SYNTHESIS OF NANOMATERIALS

Objective:

The course is intended to cover the two groups of synthesis of nanostructure namely top-fown and bottom-up approach various synthesis methods, including biological methods, advantages and disadvantages etc,.

Outcome of the study:

1. The students will be exposes to various structure specific synthesis methods, their advantages etc.
2. To know Top-down to Bottom up approach techniques.
3. To optimize the methods for specific material application.

Unit-I

Introduction to synthesis of nanostructured materials, Bottom-up approach and Top-down approaches with examples.

Unit-II

Physical methods: Inert gas condensation, Arc discharge, RF-plasma, electric explosion of wires, ball milling, molecular beam epitaxy, sputtering, evaporation (Thermal evaporation).

Unit- III

Chemical methods: Nanocrystals by chemical reduction, photochemical synthesis, electrochemical synthesis, co-precipitation method, Nanocrystals of semiconductors and other materials by arrested precipitation, emulsion synthesis, sonochemical routes, microwave assisted synthesis, Template based synthesis of nanomaterials.

Unit – IV

Thermolysis route - spray pyrolysis and solvated metal atom dispersion, sol-gel method, solvothermal and hydrothermal routes, solution combustion synthesis, Chemical vapor synthesis and Chemical Vapor Deposition.

Unit – V

Biological methods – use of bacteria, fungi, actinomycetes for nano-particle sythesis-magnetotatic bacteria for natural synthesis of magnetic nano-particle, role of plants in nanoparticle synthesis.

TEXTBOOKS:

1. Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F. Dean, John Wiley & Sons Inc.
2. Introduction to Nano Technology by Charles P. Poole Jr and Frank J. Owens. Wiley India Pvt Ltd.
3. The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R. Rao, A. Muller and A.K. Cheetham.
4. The Physics of Micro/Nano- Fabrication by Ivor Brodie and Julius J.Muray.

REFERENCE BOOKS:

1. Encyclopedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X, Campus books.
2. Encyclopedia of Nanotechnology by H.S. Nalwa.
3. Nano: The Essentials – Understanding Nano Scinece and Nanotechnology – by T.Pradeep; Tata Mc.Graw Hill.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

SCIENCE AND TECHNOLOGY OF THIN FILMS

Objective:

The course covers the importance of thin film technology and nanofabrication, vaccum technology, various physical and chemical methods of thin film a fabrication and various applications of thin films including sensors.

Outcome of the study:

1. Vaccum technology and principle of vaccum pumps- various types and ranges will be covered.
2. Various fabrication methods of thin films will be dealt in detail.
3. Advantages, applications of thin films for devices also will be discussed.

Unit – I

Vacuum technology: principles of vacuum pumps in range of 10^{-2} torr to 10^{-11} torr, principle of different vacuum pumps: roots pump, rotary, diffusion, turbo molecular pump, cryogenic-pump, ion pump, Ti-sublimation pump, importance of measurement of Pressure, Concept of different gauges: Bayet- Albert gauge, Pirani, Penning and pressure control.

Unit-II

Physical Vapor Depostion techniques: Thermal evaporation, resistive evaporation,e-beam evaporation, Electron beam evaporation, Laser ablation, Flash and Cathodic arc deposition, Electron beam, Ion beam lithography techniques and Pulsed LASER Deposition, Electrical discharges used in thin film deposition: Sputtering, Glow discharge sputtering, Magnetron sputtering, Ion beam sputtering, Ion plating, difference between thin films and coating.

Unit–III

Electro deposition, molecular beam epitaxy and laser pyrolysis. Chemical vapor deposition techniques: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, boundaries and flow, Different kinds of CVD techniques: Metallorganic CVD (MOCVD),Plasma Enhanced CVD (PECVD) Thermally activated CVD, CVD, Spray pyrolysis, etc.

Unit – IV

Conditions for the formation of thin films: Environment for thin film deposition, deposition parameters and their effects on film growth, formation of thin films (sticking coefficient, formation of thermodynamically stable cluster – theory of nucleation), capillarity theory, Growth modes: zone model for sputtering and evaporation, Island growth, Volmer weber, Layer growth, Van Vawler Megrue, S.K. (Stranski – Krans Favour) mode. microstructure in thin films, adhesion,

Unit – V

properties of thin films: Mechanical, electrical, and optical properties of thin films, few applications of thin films in various fields. Application to Renewable energy technology – Thin film solar cells, Quantum well and Quantum dot solar cells, dye – sensitized solar cells.

TEXT BOOKS & REFERENCES

1. Materials Science of Thin Films: Milton Ohring.
2. Thin Film Phenomenon by K.L. Chopra, McGraw-Hill.
3. Methods of Experimental Physics (Vol 14) by G.L.Weissler and R.W. Carlson “Vacuum Physics and Technology”.
4. A User’s Guide to vacuum Technology by J.F.O’Hanlon, John Wiley and Sons.
5. Vacuum Physics and Techniques by T.A. Delchar, Chapman and Hall.
6. Evaporation: Nucleation and Growth Kinetics” by J.P. Hirth and G.M.Pound, Pergamon Press.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

NANO BIO-TECHNOLOGY-MATERIALS AND DEVICES

Objectives:

The course is intended to cover fundamental terms and basics of biotechnology and building blocks; biological nanostructures, biosensors and biomedical applications of nanotechnology, nanodrugs and drug delivery systems.

Outcome of the study:

1. To familiarize student with biological systems, materials, sensors and building blocks.
2. To familiarize about biomedical applications, nanodrugs, molecular modeling of drugs and drugs delivery systems.

Unit–I

Fundamentals terms in biotechnology, Biological building blocks: Sizes of building blocks and Nanostructures, nucleic acids, genetic code and protein synthesis, DNA double nano wires, protein nanoparticles and polypeptide nanowires.

Unit-II

Biological Nanostructures: Bio-mimitics with examples, Bio mineralization, Bio compatible Bio sensors, Examples of proteins, micelles, vesicles, bilayers, and Multilayer films, application of bio- nanotechnology: bio nano machines, molecular modeling.

Unit – III

Nano bio-sensors and biomedical applications, organic semiconductors, biological neurons and their functions, bio-chemical and quantum mechanical computers: DNA computers, parallel processing, Bit and 'Q' bit, Quantum parallelism.

Unit –IV

Biomolecular sensing for cancer diagnostics using carbon nanotubes, nano devices in biomedical applications, nanoscale polymer fabrication for biomedical application, nanotechnology in cancer drug therapy: A biocomputational approach.

Unit –V

Introduction to drugs, Classification of drugs, Encapsulation of drugs, Nano drug delivery: Conventional drug delivery, targeted drug delivery, chemistry of drug delivery, role of nanotechnology in drug delivery, bionanoimaging, magnetic nanoparticles for MR imaging, Magnetic hyperthermia in cancer treatment.

TEXT BOOKS:

1. Bio Nano Technology by Good Sell, Wiley Liss.
2. Nanotechnology by John F. Mongillo.
3. Introduction to Nanotechnology by Charles. P.Poole Jr and Frank J. Owens, Wiley India Pvt Ltd.
4. Nano Technology, A gentle introduction to the next big idea by Mark Ranter and Daniel Ranter, Pearson education.
5. Nanotechnology – science, innovation and opportunity by Lynn E Foster, Prentice Hall-Pearson education.
6. Biological and Biomedical nanotechnology by Abraham P.Lee and L.James Lee.
7. Biomedical Applications of Nanotechnology by Vinod Labhasetwar and Diandra L. Leslie - Pelecky.

8. Biomedical Nanostructures by Kenneth E.Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S.Nair.

9. Sensors, Nanoscience, Biomedical, Engineering and Instruments by Richord C.Dorf.

REFERENCE BOOKS:

1. Encyclopedia of Nanotechnology by H.S.Nalwa.

2. Encyclopaedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy (Vol I to X), Campus books.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

NUMERICAL METHODS AND ADVANCED COMPUTING TECHNIQUES

Objective:

The course is intended to cover, basics concepts of mathematics like numerical algebra, probability , simulations specially Monte- Carlo simulations which will help in understanding theoretical concepts of Nanotechnology.

Outcome of the study:

1. To know the importance of simulations in nanotechnology.
2. Students without mathematics back ground will be able to understand the concept of mathematics.
3. To evaluate nanostructured simulations in nanotechnology.

Unit – I

Numerics in general: Interpolation, Gauss elimination, Solution by iteration, least square method.

Unit - II

Numeric Linear Algebra and differential equations: Matrix Eigen value problems: Introduction, Inclusion of Matrix Eigen values, Tridiognalization and RQ factorization. Methods for first order ODEs, Multi step methods, Higher order ODES.

Unit-III

Introduction to probability: Probability, Sample space and events- Probability- the axioms of probability, some elementary theorems-conditional probability Baye's theorem Random Variables- Discrete and continuous – distribution- distribution function Distribution Binomial and poison distributions and normal distribution – related properties.

Unit- IV

Systems, Models, Simulations and the Monte Carlo Methods:Systems,Models,Simulation and the Monte Carlo Methods, Random number generation, Introduction, Congruential Generators, Statistical Tests of Pseudorandom Numbers, Random variate generation, inverse Transform Method, Composition Method, Acceptance-Rejection Method.

Unit-V

Monte Carlo integration and Variance reduction techniques: Introduction, Monte Carlo Integration, The Hit or Miss Monte Carlo Method, The Sample-Mean Monte Carlo Method, Efficiency of Monte Carlo Method, Integration in Presence of Noise.

TEXT BOOKS:

1. Advanced engineering mathematics, by Erwin Kreyszig, wiley publications.
2. Probability and statistics, scham series, Arnold o. allen, academic press.
3. Probability and statistics, Arnold o. allen, academic press.
4. Probability and statistics for engineers, miller and john e. freund, prentice hall of india.
5. A primer for the monte carlo method, llya M. Sobol' CRC Press.
6. Simulation and monte carlo method by reuven y. rubisten.
7. The monte carlo method, popular lectures in mathematics by sobol.i.m

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

PROPERTIES OF NANOSTRUCTURES AND MATERIALS

Objective: To bring out the distinct properties like electrical, magnetic, optical, thermal and mechanical properties of nanostructures.

Outcome of the study:

1. To familiarize about the various properties of nanostructures.
2. To bring out the differences between nano and macro structures.
3. To discuss applications specific properties of nanomaterials.

Unit – I

Electronic properties, Energy bands and gaps in semiconductors, Fermi surfaces ,localized particle, donors, acceptors, deep traps,excitons,mobility,size dependent effects, conduction electrons and dimensionality Fermi gas and density of states, semiconducting nanoparticles.

Unit – II

Optical properties , Photonic crystals, optical properties of semiconductors, band edge energy, band gap, Core-shell nanomaterials, Quantum dots etc., for size influences of optical properties, optical transitions, absorptions, interband transitions, quantum confinements, Fluorescence/luminescence, photoluminescence/ fluorescence, optically excited emission, electroluminescence, Laser emission of quantum dot, Photo fragmentation and columbic explosion, luminescent quantum dots for biological labeling.

Unit – III

Magnetic properties, Introduction of magnetic materials, basics of ferromagnetism – ferro magnetic resonance and relaxation, magnetic properties of bulk nanostructures, magnetic clusters, dynamics of nanomagnets, nanopore containment of magnetic particles, nanocarbon ferromagnets, ferrofluids, electron transport in magnetic multilayers.

Unit – IV

Thermal properties of nanostructures- thermal conductivity measurements for nanowires, nanotubes, thin films.

Unit – V

Mechanical Properties of nanomaterials, Types of indentation: Oliver & Pharr, Vickers indentation process, Nano Indentation by AFM.

TEXT BOOKS:

1. Introduction to Nano Technology by Charles. P. Poole Jr & Frank J. Owens. Wiley India Pvt. Ltd.
2. Solid State physics by Pillai, Wiley Eastern Ltd.
3. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

REFERENCE BOOKS:

1. Nano Technology and Nano Electronics – Materials, devices and measurement
2. Techniques by WR Fahrner – Springer
3. Encyclopaedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books.
4. Nano Technology - Science, innovation and opportunity by Lynn E. Foster. Prentice Hall- Pearson education.

5. Hand book of Nano structured materials Vol I & V.
6. Encyclopedia of Nano Technology by H.S.Nalwa.

JOURNAL REFERENCES:

1. K K Nanda, Pramana J. Phys., Vol. 72, No. 4, April 2009.
2. A.A.Shavtsburg & M.F.Gerald, Chemical Physics Letters 317 2000. 615–618.
3. V P Skripov, V P Koverda and V N Skokov, Phys. Status Solid A66, 109 (1981).
4. R Goswami and K Chattopadhyay, Act Mater. 52, 5503 (2004).
5. V. Germain et al. J. Phys. Chem. B, Vol. 107, No. 34, 2003.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – I Sem. (Nano Tech.)

SYNTHESIS, CHARACTERIZATION AND SIMULATION LAB-I

LAB - I

Unit I:

Methods for the synthesis of nanomaterials and thin film technology (CVD method, Spin Coating, Spray Pyrolysis and Sputtering).

Unit II:

Nano – material Preparation by Chemical methods.

Unit III:

Synthesis of oxide Nanostructures / nano composites by Sol-gel Process.

Unit IV:

ARGUS LAB:

1. Construction of fullerene & its energy calculations.
2. Construction of Bucky balls (C20, C40, C60, C80, C100, C120).
3. Construction of Carbon nanotubes.
4. Energy minimization of lysozyme and its mutant.
5. Energy minimization of chymotrypsin and its mutant.
6. Energy minimization of enzymes involved in Neurological science.

Unit V:

MOSES 1.2

1. Study single electron transistor using MOSES 1.2 simulator.
2. Simulation of I – V characteristics for a single junction circuit with a single quantum dot using MOSES 1.2 simulator.

REFERENCE BOOKS

1. Advanced catalysis and Nano structured material by WR Moser.
2. Introduction to Nano Technology by Charles. P.Poole Jr and Frank J. Owens Wiley India Pvt Ltd.
3. Encyclopedia of Nanotechnology by H.S. Nalwa.
4. Nano: The Essentials – Understanding Nano Science and Nanotechnology – by T.Pradeep; Tata Mc.Graw Hill.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

MATERIAL CHARACTERIZATION TECHNIQUES

Objectives:

To familiarize students with material characterization techniques and its importance and to get exposure with various techniques of characterization and interpretation of results including standards etc.,

Outcome of the study:

1. To bring out the importance of material characterization and various methods.
2. To bring out electrical, thermal and other characterization techniques.
3. To familiarize about various equipment.

Unit – I

Compositional and structural Characterization techniques: X-ray Photoelectron Spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), Principles and applications of X-ray diffraction; electron diffraction, Electron probe microanalysis (EPMA), Ion beam techniques: SIMS & RBS.

Unit – II

Advanced Microscopy Techniques: High resolution microscopy; Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), scanning tunneling microscopy (STM).

Unit – III

Spectroscopic techniques: UV- Visible Spectroscopy, Photo-luminescence Spectroscopy, Mossbauer spectroscopy, Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy techniques: micro Raman and laser Raman.

Unit – IV

Electrical characterization techniques: Measurement of resistivity by 4-probe method, Hall measurement, electron beam induced current measurement (EBIC). LCR meter cyclic vottammetery.

Unit-V

Thermal and Magnetic characterization: Thermal analysis, Vibrating Sample Magnetometer, SQUID magnetometer.

TEXT BOOKS:

1. Nano: The Essentials -Understanding Nano Science and Nanotechnology by T.Pradeep, TataMc.Graw Hill.
2. Introduction to Nano Technology by Charles. P. Poole Jr and Frank J. Owens, Wiley India Pvt Ltd.
3. A practical approach to X-Ray diffraction analysis by C.Suryanarayana.
4. Electron Microscopy and analysis by P.J. Goodhew and F.J. Humpreys.
5. Scanning electron microscopy and x-ray microanalysis by J.I. Goldstein.
6. Characterization of nanostructured materials by Z.L. Wang.
7. Modern Raman Spectroscopy: A practical approach by E. Smith and G.Dent.
8. Principles of Instrumental analysis by D.A. Skoog, F.J. Hollen and T.A. Niemann.
9. Atomic and Molecular Spectroscopy: Basic Aspects and Applications by S.Svanberg.

REFERENCE BOOKS:

1. Nanotechnology: Principles and Practices – Sulabha K. Kulkarni – Capital Publishing Company.
2. Specimen preparation for Transmission Electron microscopy by John & Bravmno et al, published by MRS.
3. Photoelectron spectroscopy by JHD Eland, Butterworth & Co. publishers, 2nd education.
4. Encyclopedia of Nanotechnology by H.S. Nalwa.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

CARBON NANO TUBES AND APPLICATIONS

Objective: The course covers the structural and electronic properties of CNTs apart from various synthesis and characterization methods and applications.

Outcome of the study:

1. To understand the properties of CNTs as active component.
2. To familiarize with controlled synthesis method.
3. To identify applications of CNTs.

Unit – I

Carbon Nano structures and types of Carbon Nano tubes, growth mechanisms Mechanical reinforcements, Solid Disordered carbon Nanostructures, Nano structured crystals. Graphene, Carbon nano-fibers.

Unit –II

Electrical, Vibrational, Mechanical Properties of CNTs, optical properties & Raman spectroscopy of CNTs.

Unit –III

Carbon clusters and Fullerenes, Synthesis of CNTs by Flame, CVD, Laser & Arc-discharge process, synthesis of Graphene & Graphene Oxide functionalization of CNTs & their applications.

Unit –IV

Lithium ion based batteries, Hydrogen adsorption & Hydrogen storage technology, Fuel cell technology and applications, Chemical Sensor applications of CNTs.

Unit – V

Computer applications (Nano chip), optical and telecommunication applications, field demission propertis of CNTs, CNT-Nano composites, CNT-FET.

TEXT BOOKS:

1. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J.Owens Wiley India Pvt Ltd.
2. Nanotechnology and Nano Electronics – Materials, devices and measurement techniques by WR Fahrner, Springer publications

REFERENCE BOOKS:

1. Encyclopaedia of Nanotechnology by M.Balakrishna rao and K.Krishna Reddy, Vol I to X Campus books.
2. Encyclopedia of Nanotechnology by HS Nalwa.
3. Nanotechnology – science, innovation and opportunity by Lynn E.Foster. Prentice Hall Pearson education.
4. Nano:The Essentials – Understanding Nano Scinece and Nanotechnology by T.Pradeep; Tata Mc.Graw Hill.
5. Fuel storage on Board Hydrogen storage in carbon nanostructures by R A Shatwell.
6. Fuel Cell Technology Handbook by Hoogers, CRC presss.
7. Hand book of fuel cells: Fuel cell technology and applications by Vielstich, Wiley: CRC press.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

NANOCOMPOSITES - DESIGN AND SYNTHESIS

Objective:

This course intended to cover nanocomposites, reinforcing nanostructures dispersed in various matrix materials like polymers, ceramics, metals, etc,. The subject covers mainly the synthesis methods, modeling and evaluation of nanocomposites.

Outcome of the study:

1. To synthesize and evaluate nanostructure reinforce matrix material.
2. To understand the importance of various nanomaterial matrix.
3. To discuss various application including aerospace applications.

Unit – I

Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity.

Unit – II

Ceramic-Metal Nanocomposites, Ceramic based nanoporous composite, Metal matrix nanocomposites, Polymer-based nanocomposites Carbon nanotube based nanocomposites and Natural nanobiocomposites, Biomimetic nanocomposites and Biologically inspired nanocomposites.

Unit – III

Synthesis methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; DLC coatings; Thin film nanocomposites; Modeling of nanocomposites.

Unit – IV

Types of indentation: Oliver & Pharr, Vickers indentation process, Nano Indentation by AFM.

Unit – V

Processing of polymer nanocomposites, properties of nanocomposites, Infiltration techniques, Stir mixing, Extrusion method, Exfoliation & intercalation, Solution casting method, impregnation techniques: Hot melt impregnation, solution impregnation.

TEXT BOOKS:

1. Nanocomposite Science & Technology by P.M. Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co.
2. Introduction to Nano Technology by Charles. P.Poole Jr and Frank J. Owens; Wiley India Pvt Ltd.
3. Nanotechnology, A gentle introduction to the next big idea by Mark Ratner, Daniel Ratner Pearson education.
4. Polyoxometalate Chemistry for Nano- Composite Design.

REFERENCE BOOKS:

1. Encyclopedia of Nanotechnology by H.S.Nalwa.
2. Encyclopaedia of Nano Technology by M.Balakrishna rao and K.Krishna Reddy, Vol I to X Campus books.

JAWAHAR LAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

MICRO/NANO-FABRICATION

Objective: This course is intended to cover information about different types of lithography techniques, Microdevices, pattern generation using electron beam lithography and ion beam lithography.

Outcome of the study:

1. To know the importance of semiconducting solids have important physical properties that are used in the operation of electronic devices.
2. To know how the pattern is done by different ways like photo lithography, X-ray lithography and electron beam lithography.
3. To know multidecked sandwich of patterned layers is made to form various circuit elements such as transistors, capacitors, and rectifiers, and these are finally interconnected by a patterned conducting overlayer to form an integrated circuit (IC).

Unit I:

Microelectronic Devices: Background, Bipolar Transistor, MOS Transistors, MOS Devices. Pattern Generation: Background, Contact Photolithography, Projection Photolithography, Electron-Beam Lithography, X-ray Lithography.

Unit II:

Microdevices: Optical Components, X-ray Optical Components, Superconducting Junction Devices, Vacuum Microelectronic Devices, Field Ion Sources, Micromechanical Devices.

Unit III:

Pattern Generation: Introduction, Optical Lithography: Contact Printing, Proximity Printing, Projection printing. The Physics of Photoresists: Positive Photoresist Exposure, Resist Characterization, Exposure, Interference Effects, Resist Development, Negative Photoresists. Projection Systems, Holographic Lithography, X-ray Lithography: The X-ray Lithography System, X-ray Sources, Plasma Sources, X-ray Masks, X-ray Resists, Alignment, Linewidth Control.

Unit IV:

Electron-Beam Lithography, Major System Components: Projection Systems, Beam-Scanning Systems. Parallel-Scanning systems: Screen Lens Tool, Mirror Machine, Multicolumn Machine. Electron-Beam Resists: Resist Characterization, Negative Resists, Inorganic Resists.

Unit V:

Ion-Beam Lithography: Ion-Beam Resists, Liquid-Metal Ion Sources, Scanning Systems, Projection Systems, Multibeam Systems and Resolution.

TEXT BOOKS

1. "MEMS and NEMS: Systems, Devices and Structures" by Sergey Edward Lyshevski, CRC press,2002 edition.
2. An introduction to Micro electro mechanical systems Engineering" by Nadim Malut and Kirt Williams – Second edition – Artech House, Inc, Boston.
3. "Micro electro mechanical systems Design"./ by James J Allen- CRC Press – Taylor and Francis Group.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

MEMS /NEMS DESIGN AND APPLICATIONS

(Elective-I)

Objective: The course is intended to cover deep understanding of micro and nano electromechanical systems their design and various applications as well as micro and nano fabrication techniques

Outcome of the study:

1. To provide understanding of MEMS/NEMS applications specially sensors, Micro machining tools etc.,
2. To provide silicon micro fabrication techniques etc.,
3. To bring out scaling and packaging issues of physical system

Unit-I

Introduction to MEMS : MEMS and NEMS – working principles- MEMS processes & features, various components of MEMS, applications and standards, micromachining, basic process tools- epitaxy, sputtering, chemical vapor deposition and spin on methods, oxidation, evaporation, lithography and etching, advanced process tools, sol gel process, EFAB

Unit-II

Materials for MEMS and Engineering aspects: Silicon, Silicon oxide and nitride, Thin metal films, Polymers, Other materials and substrates, polycrystalline materials, mechanics of Microsystems, static bending, mechanical vibrations, thermo mechanics, fracture mechanism, fatigue, stress and strain, young's modulus and modulus of rigidity, scaling laws in miniaturization

Unit-III

MEMS Sensors, Design and processing: Microsensors (acoustic wave sensors, biomedical sensors, chemical sensors, optical sensors, capacitive sensors, pressure sensors, thermal sensors), microactuators (thermal, piezoelectric, electrostatic actuators, micrometers, microvalves & pumps, accelerometer, microfluidics and devices), design consideration, process design and mechanical design.

Unit-IV

MEMS/NEMS Scaling issues and Packaging: Introduction – Scaling of physical systems – Mechanical system scaling, Thermal system scaling, Fluidic system scaling, Electrical system scaling, Packaging-mechanical and microsystem package, design considerations, Process steps, Die preparation-interconnects, surface and Wafer bonding, wire bonding and scaling, 3D packaging and assembly signal Thermal management, Hermetic packaging, Electrical//Micro fluidic/and optical interconnects, Signal mapping transduction, Microfluidic technology - MEMS and NEMS technology for microfluidic devices.

Unit-V

MEMS/NEMS applications: Applications in automotive industry – health care – aerospace – industrial product consumer products – lab on chip – molecular machines – data storage devices – micro reactor – telecommunications, Servo systems.

TEXT BOOKS

1. "An introduction to Micro electro mechanical systems Engineering" by Nadim Malut and Kirt Williams – Second edition – Artech House, Inc, Boston.
2. "Micro electro mechanical systems Design"/ by James J Allen- CRC Press-Taylor and Francis Group.

3 "Mechanics of micro electro mechanical systems " by Nicolae Lobontiu and Ephrahim Garcia Kluwer. Academic Publishers – Boston.

4. The Physics of Micro/Nano- Fabrication by Ivor Brodie and Julius J.Muray.

5. Nano- and Micromaterials by Kaoru Ohno, Masatoshi Tanaka, Jun Takeda and Yoshijuki Kawazoe.

REFERENCES BOOKS

1. "Springer Hand Book of Nano Technology " by Bharath Bhushan – Springer.

2 . " Nano and Micro electro Mechanical systems" by Sergey Edward Lysherski – CRC Press.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

NANO ELECTRONICS AND NANO PHOTONICS

Objective:

This course is intended to cover basics of electronics, transistor, band structure models, nanocapacitors, coulomb blockade, single electron transistor and nanophotonics.

Outcome of the study:

1. To know nanoelectronics holds the capacity for mass production of high-quality nanodevices with an enormous variety of applications from computers to biosensors, from cell phone to space shuttles and from large display screens to small electronic toys.
2. To know the scaling of transistors and other devices to smaller and smaller sizes, which has provided the basis for this exponential growth, has limits, physical (size of the atoms), technological (lithography) and economic, which will be reached by nanoelectronics in the next coming decade.
3. In the near future from photonics, molecular electronics or revolutionary engineering solutions, such as departure from two-dimensional ICs on the surface of silicon wafers to three-dimensional structures. All these gigantic challenges and potential nanotechnology solutions are actively debated.

Unit-I:

Energy band structure of solids- Kronig Penny model, Effective mass approximation of Schrodinger equation, Single-electron and few-electron phenomena and devices: Tunnel junction and applications of tunneling, Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces, Metal—Insulator, Metal-Semiconductor, and Metal-Insulator-Metal Junctions,

Unit-II:

Applications of Tunneling; Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode.

Unit-III:

Coulomb Blockade: Coulomb Blockade, Coulomb Blockade in a Nanocapacitor, Tunnel Junctions, Tunnel Junction Excited by a Current Source, Coulomb Blockade in a Quantum Dot Circuit.

Unit-IV:

The Single-Electron Transistor: The Single-Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics.

Unit –V:

Nano-Photonics: Foundation of Nano- Photonics, Photonic band gap materials, quantum wells, wires, dots - optical applications, Plasmonics.

TEXT BOOKS:

1. Fundamentals of nano electronics by George W Hanson Pearson publications, India 2008{Unit-I- IV).
2. Introduction to photoelectron Spectroscopy (Chemical Analysis Vol. 67) by P.K. Ghosh; Wiley Interscience.
3. Nanophotonics by P.N.Prasad – Springer Education series.
4. Nanotechnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer.

5. Nanomaterials: Synthesis, properties and applications\edited by A S Edelstein and R C Cammarata (Institute of Physics, UK Series in Micro and Nanoscience and Technology).

REFERENCE BOOKS:

1. Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy (Vol I to X) Campus books.
2. Nano: The Essentials – Understanding Nano Science and Nanotechnology by T.Pradeep; Tata Mc.Graw Hill.
3. Spin Electronics by M. Ziese and M.J. Thornton.
4. Nanoelectronics and Nanosystems – From Transistor to Molecular and Quantum Devices by Karl Goser, Peter Glosekotter, Jan Dienstuhl.
5. Silicon Nanoelectronics by Shunri Odo and David Feny, CRC Press, Taylor & Franicd Group.
6. Nanotubes and nanowires by C.N.R. Rao and A. Govindaraj, RSC Publishing.
7. Encylopedia of Nanotechnology by H.S. Nalwa, American Scientific Publishers.
8. Handbook of Nanoscience, Engineering and Technology by W. Goddard, D. Brenner, S. Lyshevski, G.J.Iafrate, CRC Press (2000).
9. Quantum-Based Electronic Devices and Systems by M. Dutta and M.A. Stroscio, WorldScientific.

JAWAHAR LAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

ACTUATORS AND SENSORS

(ELECTIVE-I)

Objective: This course is intended to know sensor and actuators characteristics, principle of operation and different types of micro and nano- sensor and also of Micro and Nano-actuators.

Outcome of the study:

1. To know the importance of physics behind sensor and actuator transduction.
2. To know working of linear, rotational, acceleration, force, torque, pressure, flow sensor, temperature, proximity, light, smart material, capacitive and inductive sensors in micro and nano dimensions.
3. To know actuator operation and its characteristics such resolution, range, sensitivity, error, repeatability, linearity, accuracy and impedance etc.,

Unit I:

Introduction to Micro- and Nanotechnology: Introduction, Physics of Scaling – General Mechanisms for Electromechanical transduction – Sensor and Actuator Transduction Characteristics.

Unit II:

Introduction to Sensors: Sensors – Classification, Principle of operation – Linear and rotational sensors, Acceleration sensors, Force, torque and pressure sensors, Flow sensors, Temperature sensors, Proximity sensors, Light sensors, Smart material sensors, Micro and nano-sensors, Capacitive and Inductive sensors, Selection criteria of sensors – Signal conditioning and calibration.

Unit III:

Introduction to Actuators

Classification – Principle of operation – Electrical, Electromechanical, Electromagnetic, Hydraulic and pneumatic and smart material Actuators, Micro and Nano-actuators, Selection criteria.

Unit IV:

Sensor and Actuator Characteristics: Range, Resolution, Sensitivity, Error, Repeatability, Linearity and Accuracy, Impedance, Nonlinearities, Static and Coulomb Friction, Eccentricity, Backlash, Saturation, Dead-band, System Response, First-Order System Response, Under-damped Second Order System Response, Frequency Response.

Unit V:

Nanotechnology enabled sensors: Electromagnetic sensors, Optical Sensors, Magnetic Sensors, Physical Sensors, Chemical Sensors and biological sensors, Possibilities, Realities and applications.

TEXT BOOKS:

1. Mechatronics – An introduction by Robert H Bishop, Taylor & Francis.
2. Sensor Technology Handbook edited by Jon Wilson – Elsevier & Newnes.
3. Nanotechnology – Basic Science and Emerging Technologies, Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Chapman & Hall CRC.
4. Nanotechnology – A gentle Introduction to the next big idea by Mark Ratner and Daniel Ratner.
5. Nano the essentials – Understanding Nanoscience and Technology by T Pradeep.

REFERENCES:

1. Introduction to Nanotechnology – Charles P Poole Jr, Frank J Owens, Wiley Interscience – John Wiley & sons.
2. Nanotechnology for Dummies – Richard Booker, Earl Boysen, Wiley Publishing Inc.
3. Nanotechnology demystified by Linda Williams, Dr Wade Adams, Tata Mc Grawhill.
4. Bionanotechnology by David Goodsell.
5. Biosensing using nanomaterials edited by Arben Mercoci, Wiley Publishing Inc.
6. Engines of Creation by K Eric Drexler.

JAWAHAR LAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

NANO TECHNOLOGY FOR ENERGY SYSTEMS

(Elective - II)

Objective:

The course covers the various energy forms, alternate and renewable energy system using nanotechnology.

Outcome of the study:

1. To cover various renewable energy technologies.
2. To study hydrogen production and storage techniques.
3. To study solar energy generation and enhancement of conversation efficiency microfluidics and fuel cell technology will be covered.

Unit–I

Battery materials and types of batteries: Lithium Ion based batteries (Dry batteries, Alkali batteries).

Unit–II

Renewable energy Technology: Energy challenges, nanomaterials and nanostructures in energy harvesting, developments and implementation of nanotechnology based renewable energy technologies,

Unit–III

Solar cell structures: quantum well and quantum dot solar cells, photo- thermal cells for solar energy harvesting, Thin film solar cells, CIGS solar cells, Dye sensitized solar cells, polymer based solar cells.

Unit–IV

Hydrogen storage Technology : Hydrogen production methods, purification, hydrogen storage methods.Hydrogen storage materials: metal hydrides and metal-organic framework materials, volumetric and gravimetric storage capacities, hydriding and dehydriding kinetics, high enthalphy formations and thermal management during hydriding reaction, multiple catalytic – degradation of sorption properties, automotive applications.

Unit–V

Fuel cell Technology: Fuel cell Principles, types of fuel cells (Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell.

TEXT BOOKS & REFERENCES

1. Renewable Energy Resources by J. Twidell and T.Weir, E&FN Spon Ltd.
2. Hydrogen from Renewable Energy Source by D.Infield.
3. Fundamentals of Industrial Catalytic Process by C.H. Bartholomew and Robert J. Farraoto, John Wiley & Sons Inc.
4. Fuel storage on Board Hydrogen storage in Carbon Nanostructures by R.A. Shatwell.
5. Fuel cell Technology Handbook by Hoogers, CRC Press.
6. Hand book of fuel cells: Fuel cell technology and applications by Vielstich, Wiley:CRC Press.

JAWAHAR LAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

STRENGTHENING MECHANISMS WITH NANOMATERIALS

(ELECTIVE-II)

Objective:

To familiarize students how the material strength changes when things goes from macro level to nanometer level.

Outcome of the study:

1. To learn about the mechanical properties of nano-materials such as yield strength, strain hardening, strain rate, grain boundary dislocation, grain boundary sliding, rotation and coalescence and shear bands etc.,
2. To know the importance of strengthening of materials using coarse grained, dispersion hardening, precipitation hardening and composite strengthening.
3. To know the fatigue behavior and creep behavior of nanocrystalline materials and also wear characteristics of nano-materials.

Unit-I:

Nanomaterials: Origin and their classification, Processing methods (Top-Down and Bottom-Up), Processing of bulk nanomaterials by various severe plastic deformation methods (ECAP, HPT, ballmilling, ARB,RCS etc.,) Processing by plastic deformation.

Unit-II:

Mechanical properties of coarse grained materials and nanocrystalline materials, Yield strength, Ductility, Hall-Petch effect, Strain Hardening,Strain rate sensitivity, Deformation mechanisms in nanocrystalline materials, Dislocation pile-up break down, Grain boundary dislocation sources and sinks, Grain boundary sliding, rotation and coalescence, Shear bands.

Unit-III:

Strengthening methods in coarse grained materials,Grain refinement, Strain hardening, Dispersion strengthening, Precipitation hardening, Composite strengthening.

Unit-IV:

Fatigue behavior and Creep behavior of nanocrystalline materials, Wear characterstics of nano materials,

Unit-V:

Tools to probe the nano-mechanical behavior and the associated mechanics (for bulk materials and thin films).

TEXT BOOKS:

1. Nanostructured materials: Processing, Properties and Potential Applications, edited by C.C.Koch, Noyes Publications (2002).
2. Structural nanocrystalline Materials: Fundamentals & Applications, by C.C.Koch, I.A.Ovidko, S.Seal, and S.Veprek, Cambridge University Press (2011).

JAWAHAR LAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

ENVIRONMENTAL NANOTECHNOLOGY

(Elective - II)

Objective:

This course covers the importance of all different aspects and effects of environmental nanotechnology.

Outcome of the study:

1. To know about nanostructured catalysts such as TiO_2 nanoparticles for water purification.
2. To learn about nanoparticles for treatment of chlorinated organic contaminants.
3. To have knowledge about nanoparticles for treatment of arsenic, environmental risks of nanomaterials

Unit-I:

Introduction: Introduction to Environmental Applications, Implications of Nanotechnology & Research needs

Unit-II:

Nanostructured Catalysts TiO_2 Nanoparticles for Water purification: TiO_2 as a semiconductor photocatalyst,Photo catalytic mechanism,general pathways & kinetics, Intrinsic Photocatalytic activity,Reaction variables,Photocatalytic Degradation of Specific Waterborne pollutants.

Unit-III:

Nanoparticles for treatment of Chlorinated Organic Contaminants: Introduction, Overview of Chlorinated Organic Solvents, Biodegradation of Chlorinated Organic Solvents, Nanoscale zero-valene iron (NZVI), Application of other Nanoscale metallic particles in chlorinated organic compound degradation.

Unit-IV:

Nanoparticles for treatment of Arsenic: Introduction, Environmental Chemistry of Arsenic, Treatment of Arsenic using Nanocrystalline TiO_2, Treatment of Arsenic using nanoparticles other than TiO_2.

Unit-V:

Nanomembranes: Nanomembranes in Drinking water treatment, Nanomembranes in Sea desalination, Microfiltration, Nano filtration, Reverse osmers, Nano filters in drinking water.

Environmental Risks of Nanomaterials: Routes of NMS into the Water environment, Hazardous effects of NMs on Human and Animal Health,Risk Management**.**

TEXT BOOK:

1. Nanotechnologies For Water Environment Applications American Society of Civil Engineers (ASCE) Publications by Tian C.Zhang, Zhiqiang Hu, Rao Y. Surampalli, R.D.Tyagi, Keith C.K.Lai and Irene Mc.Lao.

REFERENCE BOOK:

1. Nanotechnology in Water Purification Applications Caister Academic Press by T.Eugene,Michele de Kwaadsteniet, Marelize Botes and J.Manuel Lopez-Romero.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Nano Tech.)

FABRICATION, CHARACTERIZATION AND SIMULATION LAB - II

Unit I:

Preparation of any two types of Ceramic Powders – ball milling method (e.g., Magnesium ferrite)

Unit II:

a) Composite preparation (Ball Milling)

b) X-ray Diffraction measurements of Nano Crystallites

Unit III:

Thermal Analysis (TG / DTA Analysis)

Nano Particle Size Analysis

Unit IV & V :

SIMULATION OF MATHEMATICAL MODELS LAB –I

1. Introduction to MATLAB Programming
2. Program assembly, Execution, Data processing and graphic analysis
3. Study of Fermi – Dirac distribution function
4. Introduction to symbolic math computations
5. MATLAB program to plot the one-dimensional rectangular potential well with infinite potential barrier
6. Introduction to Simulink and Simelectronics