Minutes of the Board of Studies Meeting of the Department of Physics and Materials Science held at 11:00 AM in Board Room, JUIT on 08th of May, 2019.

Agenda I: To introduce compulsory science Electives for V Semester students of B.Tech. in CSE, IT and ECE in view of new scheme of 160 credits for B. Tech programmes [Appendix-I (a & b)]

S. No.	Subject Code	Subject Name	Semester	Status
1	18B1WPH531	Science and Technology of Materials	Semester-V (ECE)	Science Elective (Category: Engineering Science)
2	18B1WPH532	Applied Materials Science	Semester-V (CSE, IT)	Science Elective (Category: Basic Science)

The members present agreed to the introduction of above mentioned compulsory science electives for V Semester students of B.Tech. in CSE, IT and ECE.

Agenda II: To introduce New Electives for VII and VIII Semester B.Tech. students in view of new scheme of 160 credits for B. Tech programmes [Appendix-II(a,b &c)]

S. No.	Subject Code	Subject Name	Semester	Status
1	18B1WPH731	Nanotechnology	Semester-VII	Open Elective
2	18B1WPH732	Optical Fiber Network Design	Semester-VII	Open Elective
3	18B1WPH831	Optolectronic Devices	Semester-VIII	Open Elective

The members present agreed to the introduction of above mentioned courses as open electives for VII and VIII semester students of B.Tech. in CSE, IT and ECE.

Agenda III: To change the nomenclature (along with the code) of the course Biophysical Techniques (Old) to Bioinstrumentation Techniques (new) [Appendix-III] along with the code for 2nd semester BT/BI students (2018 Batch) in view of new scheme of 160 credits for B. Tech programmes. The details are given under.

S. No.	Subject Code	Subject Name	Semester	Status
1	18B11PH212 10B11PH212	Bioinstrumentation Techniques (New) {Biophysical Techniques (Old)}	Semester-II (BT/BI)	Core, (Category: Basic Science)

The members present agreed to the change in nomenclature of the course Biophysical Techniques (Old) to Bioinstrumentation Techniques (new) for 2nd semester BT/BI students (2018 Batch).

Agenda IV: To introduce B.Tech with minors (20 Credits) in Engineering Physics as per the Academic Council Meeting held on October 25, 2018 vide Item No. 15 with following course structure [Appendix-IV(a,b,c,d,e &f)]

1. Advanced Statistical Mechanics (3-1-0) [Appendix-IV(a)]
2. Advanced Quantum Mechanics (3-1-0) [Appendix-IV(b)]
3. Laser and Photonics (3-0-0) [Appendix-IV(c)]
4. Nano electronics (3-0-0) [Appendix-IV(d)]
5. Mathematical Methods (3-0-0) [Appendix-IV(e)]
6. Computational Techniques (3-0-0) [Appendix-IV(f)]

The members agreed to the introduction of B.Tech with minors (20 Credits) course with a unanimous consent on nomenclature "**B.Tech with minors in Computational and Applied Physics**" instead of B.Tech with minors in Engineering Physics.
It was also agreed upon to make courses at Serial no. 1, 2, 5 and 6 (14 credits) compulsory and to have open options of few courses available for the opting students as far as courses at serial no. 3 and 4 are concerned in future.

The following members of Board of Studies meeting in Physics and Materials Science held at11:00AM on 08-05-2019 in JUIT Board Room were present

Members from Department

Prof. P.B. Barman HOD Chairman
Prof. Sunil K. Khah
Dr. Vineet Sharma
Dr. Pankaj Sharma
Dr. Dheeraj Sharma
Dr. Rajesh Kumar
Dr. Surajit Kumar Hazra
Dr. Ragini R. Singh
Dr. Sanjiv Kumar Tiwari

Members from other Departments of JUIT

Prof. Karanjeet Singh HOD, Mathematics (Dr Neelkanth , Dept. of Mathematics attended the BOS)

Following members were granted leave of absentia

Prof. S.P. Ghrera HOD, CSE & IT
Prof. Ashok K.Gupta HOD, Civil
Prof. Sudhir Syal, HOD, BI & BT
Prof. M.J. Nigam HOD, ECE

Prof. D.K. Rai, HOD, Physics & Materials Science, JIIT, Sec.62, Noida
(Member from Sister Institutes)

Prof. Anil Vohra Dean, Academic Affairs, Kurukshetra University, Kurukshetra, Haryana
(Professor, Dept. of Electronic Science, Kurukshetra University, Kurukshetra, Haryana)
(Member from Other Institutes)

Appendix-I (a)

Science and Technology of Materials

COURSE CODE: 18B1WPH531

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (ECE)

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Introduction to Dielectric materials, Capacitance, Polarization, Types of Polarization, Polarization mechanism & Dielectric Constant, Frequency Dependence of the Dielectric Constant, Ferroelectricity, Piezoelectricity Applications of Dielectric Materials.	**10**
2	Introduction to Optoelectronic materials, Applications of Optical Phenomena Luminescence, Materials of Importance—Light-Emitting Diode Materials, photoconductivity, Lasers, Optical Fibers in Communications	**6**
3	Introduction to Thermoelectric materials, Figure of merit, Heat Capacity, Conductivity (electronic and thermal), Applications in sensors, energy harvesting etc.	**6**
4	Introduction to Magnetic materials, Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Influence of Temperature on Magnetic Behavior; Domains and Hysteresis; Magnetic Anisotropy Applications in storage devices.	**8**
5	Introduction to Superconducting materials, Superconductivity Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**4**
6	Introduction to Composite materials-Polymers & Ceramics, Various types of Polymers and their applications, Structure, Types, Properties and Applications of Ceramics, Electrical Conduction in Ceramics and Polymers. Applications.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-I (b)

Applied Materials Science

COURSE CODE: 18B1WPH532

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE (CSE, IT)

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To enable the students to get better understanding about materials, properties and their applications in engineering
2. To familiarize students for making proper selection of materials for different applications..
3. To enable the students to use the knowledge about materials for their projects and ultimately apply the materials knowledge in their respective professional career.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, Computer-aided design, Computational Materials Science *etc*.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To learn the fundamentals and Science of Materials.	Familiarity
CO-2	To implement the concepts and theories for analyzing the behaviour of the materials.	Familiarity
CO-3	To execute the concepts and theories in solving the problems related to material properties and their applications.	Analytical & Computational skills
CO-4	To introduce innovations in areas like Display Technology and Engineering Materials Science, etc.	Innovative Skills
CO-5	To analyze various materials for scientific and technical applications	Technical skills

Course Contents:

Unit	Contents	Lectures required
1	Dielectrics: Polarization mechanism & Dielectric Constant, Behavior of polarization under impulse and frequency switching, Dielectric loss, Spontaneous polarization, Piezoelectric effect; Applications of Dielectric Materials.	**12**
2	Polymers: Various types of Polymers and their applications; Mechanical behaviour of Polymers, synthesis of polymers. Conducting polymers	**4**
3	Ceramics: Structure, Types, Properties and Applications of Ceramics; Mechanical 8behaviour and Processing of Ceramics	**3**
4	Magnetism: Concept of magnetism, Classification, dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Their properties and Applications; Hysteresis; Applications.	**9**
5	Superconductivity: Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; High temperature Superconductors and their Applications.	**6**
6	Optical fibres: Light propagation in fibers and Graded Index fibers, Numerical Aperture and Attenuation, Single and Multimode.	**4**
7	New Engineering Materials: Metallic Glasses, Shape Memory Alloys, Memory Effect, Nano-materials- significance of 8anoscale, 0-Dimensional, 1-Dimensional, 2- Dimensional, 3- Dimensional nanostructures, Applications.	**4**
Total lectures		**42**

Suggested Text Book(s):

1. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016)
2. William D. Callister and David G. Rethwisch, Materials science and engineering: an introduction, John Wiley & Sons, 8th edition (2010).
3. M.A. Wahab, Solid State Physics:Structure and Properties of Materials, Narosa, 3rd edition, (2015).

Suggested Reference Book(s):

1. Charles Kittel, Introduction to Solid State Physics. John Wiley & Sons, 8th edition 2005.
2. S. Sharma and J. Sharma, Engineering Physics, Pearson India (2018).

Other useful resource(s):

1. http://www.advancedsciencenews.com/best-of-advanced-optical-materials/
2. https://onlinecourses.nptel.ac.in/noc19_ph04/preview

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-II(a)

Nanotechnology

COURSE CODE: 18B1WPH731
COURSE CREDITS: 3
CORE/ELECTIVE: Elective
L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To provide basic knowledge of nanoscience & technology.
2. To make students familiar with synthesis techniques of nanomaterials
3. To make students familiar with characterization techniques and tools.
4. At the conclusion of the course, the student should have a far greater capacity to read and understand technical articles such as those seen in the IEEE Transactions on Electron Devices, IEEE Transactions on Nanotechnology, etc.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Students will be able to learn basics of nanotechnology.	Familiarity
CO-2	Synthesis of nanomaterials based on requirement.	Familiarity and Assessment
CO-3	Characterization techniques and tools.	Assessment
CO-4	Students will learn the effect of nano-transformation on properties of materials.	Familiarity, Assessment and Usage
CO-5	Applications of nanotechnology in their respective fields as well as in interdisciplinary science and engineering.	Assessment and Usage

Course Contents:

Unit	Content	Lectures required
1	Introduction to Nanotechnology: Surface energy. Nanoparticles etc.	**5**
2	Synthesis of nanomaterials: Different approaches of synthesis (chemical,	**9**

	mechanical, etc.)	
3	Characterization techniques: SEM, STM, AFM, X-ray diffraction, etc.	**10**
4	Properties of nanomaterials: Electronic, magnetic, optical, chemical and mechanical properties.	**12**
5	Applications of nanomaterials: Nanostructured materials in memory and electronic devices and for magnetic recording, sensors and interfaces, Biological applications.	**6**
Total Lectures		**42**

Suggested Text Book(s):

1. Michael Köhler, Wolfgang Fritzsche, Nanotechnology An Introduction to Nanostructuring Techniques, Wiley, 2nd edition, (2008).
2. G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific Series in Nanoscience and Nanotechnology, 2nd edition (2011).
3. Charles P. Poole, Jr., Frank J. Owens, Introduction to Nanotechnology, Wiley, (2003).

Suggested Reference Book(s):

1. Zheng Cui,Micro-Nanofabrication: Technologies and Applications , Springer; (2005).
2. Bhushan, Bharat (Ed.), Springer Handbook of Nanotechnology, Springer-Verlag Berlin Heidelberg (2017).
3. Guozhong Cao and Ying Wang, World Scientific Series in Nanoscience and Nanotechnology: Volume 2 , Nanostructures and Nanomaterials, Synthesis, Properties, and Applications, 2nd Edition (2011).

Other useful resource(s):

1. NPTEL course contents links
2. https://nanohub.org/groups/education
3. All relevant research articles

Evalution Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2

3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Couse Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Nanoscience and Technology)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	2	3	3	3	2	1	2	1	1	1	1	1.91
CO-2	3	3	2	2	3	1	2	2	1	1	1	1	1.83
CO-3	3	3	3	3	3	2	1	1	1	1	1	1	1.91
CO-4	3	2	3	2	2	1	1	1	1	1	1	1	1.58
CO-5	3	3	3	3	3	3	2	2	2	2	2	2	2.5
Average	3.00	2.60	2.80	2.60	2.80	1.80	1.40	1.60	1.20	1.20	1.20	1.20	

Appendix-II (b)

Optical Fiber Network Design

COURSE CODE: 18B1WPH732

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. Learn to analyze algorithms for Time and Space Complexity
2. Learn asymptotic notations for performance analysis of algorithms.
3. Learn various computing algorithms and data structure used in solving complex problems.
4. Apply important algorithmic design paradigms and method of analysis.
5. Synthesize efficient algorithm design in common engineering design situations.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To revise and understand about the basic working of optical fibers	Familiarity
CO-2	To design the basic structure of optical fibers	Assessment
CO-3	To understand the layout of optical fiber networks.	Assessment
CO-4	Apply CO-02 and 03 to design and understand working of optical fiber networks.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basics of fiber optics:** Propagation, Dispersion, Attenuation and loss limits, Wave propagation in step index fibers, fiber gratings, Nonlinear effects in Fibre	**10**
2	**Optical fiber components** Optical fiber splices, connectors, couplers, Transmitters and Receivers	**5**
3	**Optical Link design:** Data Coding, Source selection, Power Budget, Optical amplifiers, dispersion compensation, Solitons, Soliton link Design	**10**

4	**Single wavelength fiber optic networks:** Network topologies, Standard fiber networks, FDDI networks, SONET/SDH	**10**
5	**Wavelength division multiplexing:** Selective WDM, Broad band WDM, Multiplexers, sources, nonlinearity in WDM links, WDM and optical amplifiers, Multipoint, Multi wavelength networks	**7**
Total lectures		**42**

Suggested Text Book(s):

1. Gerd Keiser: Optical Fiber Communication, 4th Edition, Tata McGraw-Hill Ltd., 2008.
2. A. Ghatak, K. Thyagarajan: Introduction To Fiber Optics, Foundation Books, 2002.
3. J. M. Senior: Optical Fiber Communications Principles and Practice, 2nd Edition, Prentice Hall India Pvt. Ltd., 2004.

Suggested Reference Book(s):

1. Govind P Agrawal: Fiber-Optic Communication Systems, John Wiley & Sons Asia, 2003.

Other useful resource(s):

1. Link to NPTEL course contents: https://nptel.ac.in/courses/106104019/
2. Link to topics related to course:
   i. https://nptel.ac.in/courses/106104019/1
   ii. https://nptel.ac.in/courses/106104019/4
   iii. https://nptel.ac.in/courses/106104019/26
   iv. https://nptel.ac.in/courses/106104019/2Ev

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Parallel and Distributed Algorithms)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	2	2	2	1	1	1	2	2	2	2	**1.72**
CO-2	2	3	3	3	3	1	1	1	2	2	1	2	**2.00**
CO-3	2	2	2	2	3	1	1	1	2	2	1	2	**1.75**
CO-4	2	3	3	3	2	1	1	1	2	3	2	2	**2.08**
Average	**2.0**	**2.5**	**2.5**	**2.5**	**2.5**	**1.0**	**1.0**	**1.0**	**2.0**	**2.25**	**1.5**	**2.0**	

Appendix-II (c)

Optoelectronic Devices

COURSE CODE: 18B1WPH831

COURSE CREDITS: 3

CORE/ELECTIVE: ELECTIVE

L-T-P: 3-0-0

Pre-requisite: Engineering Physics-II

Course Objectives:

6. To enable the students to get better understanding about Photonic materials and their applications.
7. To familiarize students for making proper selection of Microwave devices for different applications.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To define and explain the physics governing laser behaviour and light matter interaction.	Familiarity
CO-2	To calculate properties of and design modern optical waveguides, microwave waveguides, photonic crystals fibers and microwave hybrid circuits.	Problem Solving/ Assesment
CO-3	To approach and solve new problems in a range of advanced topics in Non linear optics	Usage
CO-4	To understand important and unique engineering issues at microwave and millimeter wave frequencies.	Familiarity
CO-5	To learn the applications of the microwave devices in the design of useful systems such as radars, receivers, etc.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Photonics:** Optical sources, modulators and detectors: Introduction, laser sources, semiconductor sources, electro-optic modulator, magneto-optic modulator, and acousto-optic modulator. Photoconductive detectors, photodiodes.	10
2	**Waveguides:** Optical waveguides: Introduction, planar waveguides, integrated optics, cylindrical waveguides, optical fibers for communication, photonic crystal fibers.	4
3	**Non-linear optics:** Introduction, formalism of non-linear optics, second harmonic generation and phase matching, optical mixing, intensity dependent refractive index, non-linear effects in photonic crystal fibers. Antireflective coating, optical fiber current measurement, integrated optical spectrum analyzer, holography, optical fiber amplifier, optical fiber laser.	10
4	**Microwave waveguides:** Introduction, rectangular waveguides, circular waveguides, microwave cavities, microwave hybrid circuits.	2
5	**Microwave transistors and diodes:** Introduction, microwave bipolar transistor & microwave tunnel diodes, IMPATT diodes, Transferred electron devices (TED), Quantum electron devices, and hot electron devices.	9
6	**Microwave field effect transistor:** Introduction, junction field effect transistor, MESFET, MOSFET, HEMTS, CCDs, Transistors as memory devices.	4
7	**Microwave linear beam tubes (O-type):** Introduction, triode, tetrode, pentode, Klystron. Microwave crossed field tubes (M-type): Introduction, Magnetron oscillator, cylindrical magnetron, linear magnetron, voltage tunable magnetron, and frequency-agile coaxial magnetron	3
Total lectures		42

Suggested Text Book(s):

1. Chi H. Lee, Microwave Photonics, CRC Press, 2nd edition (2013).
2. Samuel Y. Liao, Microwave Devices & circuits , Prinston Hall 3rd edition (2015)..
3. Ralf Menzel, Photonics: Linear and Nonlinear Interactions of Laser Light and Matter, Springer Berlin Heidelberg 1st edition (2007).
4. S. M. Sze, Semiconductor Devices, John Wiley & Sons, 3rd edition (2006).

Suggested Reference Book(s):

1. Chuang, Shun Lien,Physics of Photonic Devices, John Wiley & Sons, 2nd edition (2009).
2. Sisodia M L, Microwave Circuits and Passive Devices, New Age International Publishers (2002).

Other useful resource(s):

1. Link to topics related to course:
   i. https://nptel.ac.in/courses/115102026/
   ii. https://nptel.ac.in/courses/115101008/
   iii. https://nptel.ac.in/courses/108101112/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Photonics and Microwave Devices)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	2	2	1	1	-	2				2		2	1.5
CO-2	3	3	3	3	2	2				2		2	2.5
CO-3	3	3	3	3	2	2				2		2	2.5
CO-4	3	2	1	1	1	2				1		2	1.6
CO-5	3	3	3	3	2	3				2		3	2.7
Average	2.8	2.6	2.2	2.2	1.4	2.2				1.8		2.2	

Appendix-III

Bioinstrumentation Techniques

COURSE CODE: 18B11PH212

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: None

Course Objectives:

1. To learn concepts for strong foundation of biophysical methods and their application in the field of biotechnology.
2. Exposure to various instruments used in Biophysics.
3. To be able to use important biophysical methods to decipher problems relevant to biology.
4. Understanding of the underlying theory of these methods and their practical applications in the laboratories.
5. Better understanding of the structure-function activity of biomolecules.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Knowledge about different degrees of freedom of biological molecules with varying energy of the electromagnetic spectrum.	Familiarity
CO-2	Basic underlying techniques of the analytical instruments, their principle and working.	Familiarity
CO-3	Information about different spectroscopic Techniques (microwave, Raman, FTIR, Electronic, Electronic, ESR, NMR etc).	Familiarity and assessment
CO-4	Strong foundation of biophysical methods and their practical application in the field of bioinformatics and biotechnology.	Assessment and Usage
CO-5	Complete understanding of the structure-function activity of biomolecules	Usage

Course Contents:

Unit	Contents	Lectures Required
1	Basic concepts: Quantization of energy, Regions of the electromagnetic spectrum, Representation of spectra, Basic elements of practical spectroscopy, The width and intensity of spectral lines. Crystal structure.	**3**
2	Electron Microscopy: Transmission electron microscope. Scanning electron Microscope, Tunneling Electron microscope and Atomic Force microscope.	**5**
3	Electronic Spectroscopy: Electronic Spectra of Diatomic molecules, Frank-Condon Principle, Dissociation energy, shape of molecular orbitals, Classification of states of diatomic molecules, Electronic spectra of polyatomic molecules. Analysis by Electronic spectroscopy, Fluorescence Spectroscopy	**8**
4	Infrared Spectroscopy: Vibration of diatomic molecules, Simple Harmonic Oscillator, Anharmonic oscillator, Vibration rotation spectra of diatomic molecules, Vibration of polyatomic molecules, Fourier Transform Infrared Spectroscopy, Analysis of Infrared techniques.	**6**
5	Raman Spectroscopy: Raman effect, Molecular polarisability, Rotational and vibrational Raman Spectra, Structure determination from Raman and Infrared spectroscopy.	**4**
6	Mass Spectroscopy: Basics of the technique, Producing the ion, Detection of ions and Identifying of compounds. Analysis and application.	**3**
7	Spin Resonance Spectroscopy: Interaction between spin and magnetic field, Nuclear Magnetic Resonance, Chemical Shift, Analysis by NMR Technique, NMR Applications in Biochemistry, Biophysics and Medicines. Electron Spin Resonance Spectroscopy and applications.	**5**
8	Microwave spectroscopy: Rotation of molecules, Rotational spectra of rigid diatomic molecule, Rigid and Non rigid, Polyatomic –Molecules, Analysis by microwave spectroscopy Technique.	**4**
9	Chromatography: Principles of chromatography- ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC, FPLC; Electro-chromatography	**4**
Total Lectures		**42**

Suggested Text Book(s):

1. C. N. Banwell, Fundamentals of Molecular Spectroscopy. McGraw-Hill, (1994).
2. Sune Svanberg, Atomic and Molecular Spectroscopy: Basic Aspects and Practical applications, Springer Science & Business Media (2012).
3. G. Aruldhas, Molecular structure and spectroscopy, PHI Learning Pvt. Ltd. (2007).
4. Charles H. Townes, A. L. Schawlow, Microwave Spectroscopy, Dover Publications Inc.(1975).
5. Barbara H. Stuart , Infrared Spectroscopy: Fundamentals and Applications, Wiley (2004).
6. S. O. Pillai, Solid State Physics, New age international publishers, 7th edition (2016).

Suggested Reference Book(s):

1. Brian C. Smith, Fundamentals of Fourier Transform Infrared Spectroscopy, Second Edition, CRC Press (2011).
2. Walter Gordy, Microwave Spectroscopy, Springer Berlin Heidelberg (1957).

Other useful resource(s):

1. NPTEL course contents
2. Relevant research articles

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3	T-3	35	2 Hours	Entire Syllabus
4	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Biophysical Techniques)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3	2	3	1	1	1	1	1	1	1	3	1.75
CO-2	3	3	3	3	2	1	1	1	2	1	1	3	2.00
CO-3	3	3	3	3	3	1	1	2	2	1	1	3	2.16
CO-4	3	3	3	3	3	2	2	2	2	1	2	3	2.42
CO-5	3	3	3	3	2	2	1	1	1	1	1	1	1.83
Average	3.00	3.00	2.80	3.00	2.20	1.40	1.20	1.40	1.60	1.00	1.20	2.60	

Appendix-IV(a)

Advanced Statistical Mechanics

COURSE CODE:

COURSE CREDITS: 4

CORE/ELECTIVE:

L-T-P: 3-1-0

Pre-requisite: None

Course Objectives:

1. To induce an essential background in those areas of physics which are specifically required by engineering students in order to pursue higher studies.
2. Elaborate on the comprehensive understanding about the theoretical foundations and corresponding applications in statistical mechanics.
3. To familiarize students about statistical thermodynamics and its implication in engineering.
4. To enable the students to have better understanding about ensemble theory and its applications in engineering.
5. To familiarize students with the advanced theories related to gases in order to enhance the ability of students to think logically about the problems and their solutions.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	To implement the fundamentals of statistical thermodynamics.	Familiarity
CO-2	To implement the concepts related to the ensemble theory.	Familiarity
CO-3	To execute the concepts and theories in solving science/engineering problems.	ProblemSolving skills
CO-4	To analyzetechnical aspects related to the behavior of different states of matter.	Analytical Skills

Course Contents:

Unit	Contents	Lectures required
1	Laws of thermodynamics, entropy, potentials. Statistical Thermodynamics: Macroscopic and microscopic states, connection between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.	**10**
2	Phase space, Liouville's theorem, microcanonical ensembles, ensemble, examples, quantum states and phase space.	**6**
3	Canonical Ensembles: Equilibrium, partition function, energy fluctuation, equipartition and virial theorem, harmonic oscillators, statistics of Para magnetism.	**6**
4	Grand Canonical Ensembles: Equilibrium, partition function, density and energy fluctuation, correspondence with other ensembles, examples. Formulation of Quantum mechanical ensemble theory, density Matrix, statistics of various ensembles, examples.	**6**
5	Ideal gas in different quantum mechanical ensembles. System of: monatomic, diatomic and polyatomic molecules. Ideal Bose Gas: Thermodynamics Bose-Einstein condensation, blackbody radiation, phonons, Helium II.	**7**
6	Ideal Fermi Gas: Thermodynamics, Pauli Para magnetism, Landau diamagnetism, DeHass-Van Alphen Effect, thermionic and photoelectric emissions, white dwarfs. Interacting Systems: Cluster expansion, Virial Expansion, evaluation of Virial coefficients.	**7**
Total lectures		**42**

Suggested Text Book(s):

1. R.K. Patharia, Statistical Mechanics, Butterworth-Heinemann (1996)

Suggested Reference Book(s):

1. F. Reif, Statistical and Thermal Physics, McGraw-Hill (1985).
2. W. Greiner, L Neise, and H. Stocker, Thermodynamics and Statistical Mechanics, Springer (1994).
3. K. Huang, Statistical Mechanics, John Wiley Asia (2000).
4. L.D. Landau and E.M. Lifshitz, Statistical Physics-1, Pergamon (1980).

Other useful resource(s):

1. https://nptel.ac.in/courses/115103028/

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-IV(b)

Advanced Quantum Mechanics

COURSE CODE: xxBxxPHxx

COURSE CREDITS: 4

CORE/ELECTIVE: CORE

L-T-P: 3-1-0

Pre-requisite: None

S.No.	Course Outcomes	Level of Attainment
CO-1	**Student will be able to formulate the operators for physical Observables like energy , momentum etc.**	Familiarity
CO-2	Students will learn about second quantization and failure of classical physics.	Familiarity
CO-3	Students will have in-depth visualization of self occurring of electron spin and spin matrices.	Assessment
CO-4	Students will learn about in depth knowledge of Coherent optical source. Which is widely used in medical and cosmetic Industries?	Assessment and Usage
CO-5	Students will be able to design the future prospects of Quantum technology like Spintronic devices and Quantum computing.	Usage

Course Contents:

Unit	Contents	Lectures required
1	**Basics of Quantum Mechanics:** Basic postulates of quantum mechanics, Schrodinger equation, Operators, eigen values and eigen functions.	**5**
2	Simple potential problems: bound states, delta-function potential, linear harmonic oscillator, Rigid Rotator, Hydrogen and Hydrogen like atoms.	**7**
3	**Matrix formulation of Quantum Mechanics:** Linear and matrix algebra, matrix representations of operators, position, momentum, angular momentum, unitary operators, parity operation, creation and annihilation operator.	**7**
4	Pauli's Spin matrices, Dirac's bra and ket notation of states . Second quantization. Application of second quantization in harmonic oscillators', absorption, and emission.	**7**

5	Theory of Angular Momentum: Spherical harmonics, eigenvalues for L^2 and L_z, commutation relations, quantum numbers, degeneracies. spin-orbit coupling, hyperfine interaction, exclusion principle, exchange interaction. WKB approximation, applications of WKB. Perturbation Theory: Non-degenerate and Degenerate cases.	**8**
6	Application: Zeeman and stark effects. Induced electric dipole moment of hydrogen. Time Dependent Perturbation Theory: Sinusoidal perturbation, Fermi's Golden Rule, special topics in radiation theory, semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers.	**8**
Total lectures		**42**

Suggested Text Book(s):

1. S. Gasiorowicz, Quantum Physics, John Wiley, Asia (2000).
2. E. Merzbacher, Quantum Mechanics, John Wiley, Asia (1999).
3. P.W. Mathews and K. Venkatesan, A textbook of Quantum Machanics, Tata McGraw Hill (1995).
4. F.Schwabl, Quantum Machanics, Narosa (1998).
5. L.I. Schiff, Quantum Mechanics, McGraw-Hill (1968).
6. E. Merzbacher, Quantum Mechanics, John Wiley, Asia (1999).
7. B.H. Barnsden and C.J. Joacjain, Introduction to Quantum Machanics, Longman (1993).

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-IV(c)

Lasers & Photonics

COURSE CODE: 19B1WPHxxx

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisite: Lasers and Photonics

Course Objectives:

8. Provides the students a thorough understanding of the fundamentals of lasers: their unique properties, their operations and their applications.
9. Learn the fundamental principles of photonics and light-matter interactions, Develop the ability to formulate problems related to photonic structures/processes and analyze them, and Understand processes that help to manipulate the fundamental properties of light.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Familiarity about the Lasers and Photonic devices with reference to light matter interaction.	Familiarity
CO-2	To calculate and design the Lasers with desired properties	Problem Solving/ Assessment
CO-3	Application of Photonic devices in variable fields of application.	Usage
CO-4	To approach and solve new problems in a range of topics in Non linear optics.	Familiarity/ Assessment

Course Contents:

Unit	Contents	Lectures required
1	**Lasers:** Review of elementary quantum physics, Schrodinger equation, concept of coherence, absorption, spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, optical cavities.	10
2	**Laser Systems & Applications:** Main components of Laser, principle of Laser action, introduction to general lasers and their types. Three & four level Lasers, CW & Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and Measurement. Laser applications in medicine and surgery, materials processing, optical communication, metrology and LIDAR and holography.	10
3	**Non-linear optics:** Introduction, formalism of non-linear optics, second harmonic generation and phase matching, optical mixing, intensity dependent refractive index, non-linear effects in photonic crystal fibers. Antireflective coating, optical fiber current measurement, integrated optical spectrum analyzer, holography, optical fiber amplifier, optical fiber laser.	12
4	**Photonics:** Optical sources, modulators and detectors, semiconductor sources, electro-optic modulator, magneto-optic modulator, and acousto-optic modulator. Photoconductive detectors, photodiodes. Application of photonic devices.	10
Total lectures		42

Text Books:

1. O. Svelto, Principles of Lasers, Plenum Press (1998).
2. R. W. Boyd, Non-Linear Optics, 2nd ed., Academic Press (2003).
3. K. lizuka, Elements of Photonics, John Wiley & Sons (2002).
4. B.E. Saleh and M. C. Teich, Photonics, John Wiley (2002).

References:

1. A. E. Seigmen, Laser, University Science Books (1986).
2. A. Yariv, Optical Electronics, 4th ed., Saunders College Publishing (1991).
3. Y.R Shen, The principle of Non Linear Optics, John Wiley (1984).
4. G. Keisser, Optical Fiber Communication, McGraw-Hill (1991).

EvaluationScheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-IV (d)
Nanoelectronics

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3

Pre-requisite: None

Course Objectives:

1. The rapid growth of the integrated circuit (IC) industry has led to the emergence of nano microelectronics process engineering as a new advanced discipline.
2. Elementary level of quantum mechanics, fundamental knowledge of nanotechnology; preparation, fabrication and characterization techniques of nano-materials and nanodevices are discussed.
3. There is a need to impart quality education at a sufficiently advanced level in the current state of art Nano electronics and Nano Micro Fabrication and design discipline.
4. Representative two-dimensional (e.g. 2DEG in quantum wells, graphene, etc), one dimensional (e.g. nanowire, nanotube), zero-dimensional (e.g. quantum dots) nano-material systems are presented.
5. This course will help to students earn the basic understanding of nano electronics and followed the advanced understanding of the nano-micro fabrication.
6. Thus, It provides a advanced level vast understanding to the device electronics for integrated circuits, a foundation for the device fabrication and various application in the field of sensors technology, optoelectronics, communication and nanotechnology etc.

Course Outcomes:

S.No.	Course Outcomes	Level of Attainment
CO-1	Student will be familiar with certain nanoelectronic systems and building blocks such as: low-dimensional semiconductors, heterostructures, carbon nanotubes, quantum dots, nanowires etc.	Familiarity
CO-2	Students will understand the divers electronic device fabrication.	Familiarity and Assessment
CO-3	Students will have in-depth technical knowledge in one or more areas of specialization.	Assessment and Usage
CO-4	Students will have practical understanding of the major engineering concepts and demonstrate application of their theoretical knowledge of the concepts and help to get the academic and industrial jobs.	Assessment and Usage
CO-5	Students will be able to interact scientifically with industry both within and outside of a classroom setting. Students will appreciate their role as engineers in society.	Usage

CO-6	Students will develop an appreciation of continuing educational and professional development. Finally, a goal is to familiarize students with the present research front in Nanooelectronics and to be able to critically assess future trends.	Usage

Course Contents:

Unit	Contents	Lectures required
1	Basic quantum mechanics and solid state physics, Tunnel junction and applications of tunneling, Tunneling through a Potential Barrier, Metal—Insulator, Metal-Semiconductor, and Metal-Insulator-Metal Junctions, Coulomb Blockade, Tunnel Junctions, Tunnel Junction Excited by a Current Source. Spintronics and Foundations of nano-photonics.	**6**
2	Field Emission, Gate-Oxide Tunneling and Hot Electron Effects in nano MOSFETs, Theory of Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode.	**6**
3	Introduction to lithography- Contact, proximity printing and Projection Printing, Resolution Enhancement techniques, overlay-accuracies, Mask-Error enhancement factor (MEEF), Positive and negative photoresists, Electron Lithography, Projection Printing, Direct writing, Electron resists. Lithography based on Surface Instabilities: Wetting, De-wetting, Adhesion, Limitations, Resolution and Achievable / line widths etc. Lift off process, Bulk Micro machining.	**8**
4	Introduction to MEMS and NEMS, working principles, as micro sensors (acoustic wave sensor, biomedical and biosensor, chemical sensor, optical sensor, capacitive sensor, pressure sensor and thermal sensor), micro actuation (thermal actuation, piezoelectric actuation and electrostatic actuation–micro gripers, motors, valves, pumps, accelerometers, fluidics and capillary electrophoresis, active and passive micro fluidic devices, Pizoresistivity,Pizoelectricity and thermoelectricity, MEMS/NEMS design, processing, Oxidation, Sputter deposition, Evaporation, Chemical vapor deposition etc.	**12**
6	Scaling of physical systems – Geometric scaling & Electrical system scaling. 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,Coulomb Blockade in a Nanocapacitor, Molecular SETs and Molecular Electronics.	**10**
Total lectures		**42**

Suggested Text Book(s):

1. Stephen D. Sentaria, Microsystem Design, Kluwer Academic Press
2. Marc Madou, Fundamentals of microfabrication & Nanofabrication.

3. T. Fukada & W.Mens, Micro Mechanical system Principle & Technology, Elsevier, 1998.

4. Julian W.Gardnes, Vijay K. Varda, Micro sensors MEMS & Smart Devices, 2001.

5. Rainer waser (ed.), Nanoelectronics and Information Technology: Advanced Electronic Material and Novel Devices, Wiley-VCH (2003).

6. P. N. Prasad, Nanophotonics, Wiley Interscience (2004).

Suggested Reference Book(s):

1. Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer 2005

2. Nano: The Essentials – Understanding Nano Scinece 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 & Franic Group

6. Nanotubes and nanowires by C.N.R. Rao and A. Govindaraj, RSC Publishing

7. Quantum-Based Electronic Devices and Systems by M. Dutta and M.A. Stroscio, World Scientific.

8. James R Sheats and Bruce w.Smith, "Microlithography Science and Technology", Marcel Dekker Inc., New York, 1998. 9. J.P. Hirth and G.M.Pound "Evaporation: Nucleation and Growth Kinetics" Pergamon Press, Oxford, 1963

9. A. S. Edelstein and R. C. Cammarata (Eds), Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing (1996).

10. Z. L. Wang (ed.), Characterization of Nanophase Materials, Wiley-VCH (2001).

11. T. Heinzel, Mesoscopic Electronics in Solid State Nanostructures, Wiley-VCH (2003).

12. Charles P. Poole and Frank J. owens, Introduction to Nanotechnology, Wiley-Interscience (2003).

Other useful resource(s):

1. https://nptel.ac.in/courses/117108047/

Evaluation Scheme:

S. No	Exam	Marks	Duration	Coverage / Scope of Examination
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus

4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes (2) - 10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes (POs)

Course outcomes (Nanoelectronics)	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**Average**
CO-1	3	3	2	2	3	1	1	2	1	1	1	3	**1.9**
CO-2	3	3	3	3	3	2	1	2	3	2	3	3	**2.6**
CO-3	3	2	2	3	2	3	1	3	3	3	3	3	**2.6**
CO-4	3	3	3	3	3	3	2	1	3	2	3	3	**2.7**
CO-5	3	2	2	3	2	3	1	2	3	3	1	3	**2.3**
CO-6	3	3	3	3	3	2	2	1	2	1	2	3	**2.3**
Average	**3**	**2.7**	**2.5**	**2.8**	**2.7**	**2.3**	**1.3**	**1.8**	**2.5**	**2.0**	**2.1**	**3**	

Appendix-IV (e)
Mathematical Methods

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3

Pre-requisites: None

Objective: The objective of the course is to train the students to analyze and model physical systems in versatile domains and explore the methods of the solutions.

S.No.	Course Outcomes	Level of Attainment
CO-1	A precise understanding, ability to reason and present in an acceptable manner the basic equations of mathematical physics and the methods of their solutions.	Assessment
CO-2	Special emphasis on the use of Bessel functions, Legendre polynomials, associative Legendre polymomials, Lagerre and Hermitian polynomials	Assessment and Usage
CO-3	To realize the solutions in terms of special formulations.	Usage
CO-4	Familiarity with series expansion and integral transforms	Familiarity

Course Contents:

Unit	Contents	Lectures required
1	Taylor formulation; Green functions (formulation for PDE) and Delta function	**8**
2	Four functions: (1) Legendre, (2) Laguerre, (3) Hermite (4) Bessel; and recurrence relations	**10**
3	Fourier Series – Introduction Fourier trigonometric and exponential series; eigen value problems and orthogonal functions; Fourier integral representation, Fourier transforms and their properties.	**10**

4	Hankel transform; Mellin transform and its applications, Discrete Fourier transform	**14**
Total lectures		**42**

Course Assessment:

Category	**Marks**	**Time/Duration**
T 1	15	1 Hour
T 2	25	1 Hour 30 Min
T 3	35	2 Hours
Teacher Assessment	25	During the semester
Total	100	

Text Book:

1. Mathematical methods for Physicists: G.B. Arfken and H.J. Weber, Academic Press

Reference Books:

1. Larry C Andrews and Ronald L Phillips, Mathematical Techniques for Engineers and Scientists, SPIE Press, 2003.
2. D W Jordan and P Smith, Mathematical Techniques: An Introduction for the Engineering, Physical, and Mathematical Sciences, Oxford University Press, 2008.
3. Mathematical Methods for Physicists: Arfken

Evaluation Scheme:

S. No	**Exam**	**Marks**	**Duration**	**Coverage / Scope of Examination**
1	T-1	15	1 Hour.	Syllabus covered upto T-1
2	T-2	25	1.5 Hours	Syllabus covered upto T-2
3.	T-3	35	2 Hours	Entire Syllabus
4.	Teaching Assessment	25	Entire Semester	Assignment (2) - 10 Quizzes(2) -10 Attendance - 5

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425

Appendix-IV (f)

COMPUTATIONAL TECHNIQUES

COURSE CODE: XXXXXXXX

COURSE CREDITS: 3

CORE/ELECTIVE: CORE

L-T-P: 3-0-0

Pre-requisites: NIL

Objective: The objective of the course is to apprise the student about various computational techniques to solve a system of linear equations and differential equations.

Course Outcomes: Students that successfully complete this course will be able to:

S.No.	Course Outcomes	Level of Attainment
CO-1	Solve the under-determined/over determined system of linear equations with conditioning	Assessment
CO-2	Find the roots of the transcendental equations/system of nonlinear equations	Assessment and Usage
CO-3	Develop the habit of real problem solving by Matlab	Usage
CO-4	Solve initial value problem/boundary value problem and partial differential equation.	Familiarity

Topics Covered:

Unit	Contents	Lectures required
1	**Linear System of Equations:** Direct Methods, Conditioning of the System, Iterative Methods, Eigen values and vectors -Power & Jacobi Methods, Gauss elimination method.	7
2	**Computation and Error analysis**: Accuracy and precision, truncation and round of errors, error propagation.	7

3	**Numerical Differentiation and Integration** : Forward and backward difference method, higher order formulas, Trapezoidal rules, Simphons rule, Newton Raphosn, Runga-Kutta and Monte Carlo simulation.	10
4	**Regression and Curve Fitting:** Linear regression; Least squares; Total Least Squares; Interpolation; Newton's Difference Formulae; Cubic Splines.	10
5	**Initial Value Problem and PDE:** Initial and Boundary value problems in O.D.E. Introduction to numerical solutions of Partial Differential equations	**8**
Total lectures		**42**

Course Assessment:

Category	**Marks**	**Time/Duration**
T 1	15	1 Hour
T 2	25	1 Hour 30 Min
T 3	35	2 Hours
Teacher Assessment (Based on Assignments, quizzes etc.)	25	During the semester
Total	100	

Text Books:

1. Gerald, C.F, Wheatley, P.O : Applied Numerical Analysis, Pearson Education.
2. Schilling, R.J., Harries, S.L. : Applied Numerical Methods for Engineers, Thomson Brooks/Cole, 2000.
3. Smith, G.D : Numerical solution of Partial Diff. Equations, Oxford.
4. Conte, S.D , de Boor,C. : Elementary Numerical Analysis, McGraw-Hill.

Course Outcomes (COs) contribution to the Programme Outcomes(POs)

Course outcomes (Materials Science)	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	Average
CO-1	3	3										3	3
CO-2	3											3	3
CO-3	1	1	1									1	1
CO-4	2	2	2	2								2	2
CO-5	3	3	3	3					3			3	3
Average Score	2.4	2.25	2	2.5					3			2.4	2.425