

Proposal for the Revised UG Curriculum of Physics Department

B.Tech. (Engineering Physics)

The Curriculum Review Committee (CRC) of the Physics Department through a series of meetings and lengthy discussions have come up with the following framework for the existing undergraduate program of the Department viz. *B.Tech. (Engineering Physics)*. This proposal, after discussion and approval in the DFB, is being submitted for consideration by the UCIC.

Review Process

The review of this UG program has been carried out as per the guidelines of the relevant *concept paper*, prepared by the CRC of the Institute and approved by the Senate. In addition, the CRC of the Department took into consideration feedback provided by the students and faculty members.

The salient points of the proposed course structure are as follows:

- All existing courses are thoroughly revised, and the problem of overlapping of topics among various courses was specifically addressed. In each case, course contents were revised by taking inputs from faculty colleagues, who have taught the course earlier.
- The total number of departmental core credits, including theory and lab, remain almost the same as before.
- Computational Physics, which was earlier a departmental elective, has now been made departmental core.
- A number of new departmental electives have been added.
- Theme-based laboratory courses are formed, and appropriately positioned in the 8-Semester program, to ensure that students have been exposed to the basic theoretical concepts before conducting experiments. The theory courses are also placed accordingly in the Program.
- Maximum possible Program Linked (PL) courses have been included, in addition to Open Category (OC) courses, to give an interdisciplinary flavor to the Program.
- Basket of courses for Departmental Specialization (DS) and Minor Area (MA) schemes has been created.

Proposed Credit Structure

The overall credit structure for a regular B.Tech. (Engineering Physics) is as follows:

Undergraduate Core (UC)		Undergraduate Elective (UE)	
Category	Credits	Category	Credits
DC	58	DE	12
BS	22	HU	15
EAS	18	OC	10
PL	14.5		
TOTAL	112.5	TOTAL	37

Total credits=149.5 + non-graded requirement of 15 credits for the B.Tech Degree.

In the new UG Curriculum, there is a provision for students to opt for “Departmental Specialization”, which refers to a group of courses in a specific area in which an interested student can specialize. Towards this, he/she would be required to earn 20 Credits from the basket of courses under a specific ‘Departmental Specialization’. The Department proposes that only those students who earn at least 70 credits by the end of four semesters, with a CGPA of 7.0 and above, would be eligible to opt for Departmental Specialization.

Those who opt for the ‘Departmental Specialization’ (or ‘Minor Area’) need not do the 10 credits under OC, and therefore, effectively, by earning additional 10 credits one can obtain a B.Tech Degree with Departmental Specialization (or Minor Area). Thus -

For the B.Tech. Degree with Departmental Specialization or Minor Area:

Total credits = 159.5 + non-graded requirement of 15 credits

For the B.Tech. Degree with Departmental Specialization and Minor Area:

Total credits = 179.5 + non-graded requirement of 15 credits

List of courses

Basic Science (BS) Core

1. PHL100	Electromagnetic Waves and Quantum Mechanics	3-0-0	3
2. CYL100	Introduction to Chemistry	3-0-0	3
3. MAL100	Calculus	3-1-0	4
4. MAL101	Linear Algebra & Differential Equations	3-1-0	4
5. SBL100	Introductory Biology for Engineers	3-0-2	4
6. PHP100	Physics Laboratory	0-0-4	2
7. CYP100	Chemistry Laboratory	0-0-4	2
Total BS Core		15-2-10	22

Engineering Arts and Science (EAS) Core

1. AML100	Engineering Mechanics	3-1-0	4
2. CSL100	Introduction to Computer Science	3-0-2	4
3. EEL100	Introduction to Electrical Engineering	3-0-2	4
4. MEP100	Introduction to Engineering Visualization	0.5-0-3	2
5. MEP101	Product Realization by Manufacturing	0-0-4	2
6. CEL140	Environmental Science	2-0-0	2
Total EAS Core		11.5-1-11	18

Program Linked (PL)

1. EEL201	Digital Electronics	3-0-3	4.5
2. EEL205	Signals & Systems	3-1-0	4
3. ESL350	Energy Conservation & Management	3-0-0	3
4. CYLxxx	Chemical Synthesis of Functional Materials	3-0-0	3
Total PL Core			14.5

Departmental Core (DC)

1. EPL101	Electrodynamics	3-1-0	4
2. EPL102	Quantum Mechanics	3-1-0	4
3. EPL103	Mathematical Physics	3-1-0	4
4. EPL104	Solid State Physics	3-1-0	4
5. EPL105	Applied Optics	3-1-0	4
6. EPL106	Elements of Materials Processing	3-1-0	4
7. EPL201	Fundamentals of Dielectrics & Semiconductors	3-1-0	4
8. EPL202	Statistical Physics	3-1-0	4
9. EPL203	Classical Mechanics & Relativity	3-1-0	4
10. EPL204	Computational Physics	3-1-0	4

11. EPP211 Engineering Physics Laboratory-I	0-0-6	3
12. EPP212 Engineering Physics Laboratory-II	0-0-6	3
13. EPP221 Engineering Physics Laboratory-III	0-0-8	4
14. EPP222 Engineering Physics Laboratory-IV	0-0-8	4
15. EPD401 Project-I	0-0-8	4

Department Electives (DE)

1. EPL301 Vacuum Technology & Surface Science	3-0-0	3
2. EPL302 Nuclear Science and Engineering	3-0-0	3
3. EPL303 Materials Science and Engineering	3-0-0	3
4. EPL304 Superconductivity and Applications	3-0-0	3
5. EPL305 Engineering Applications of Plasmas	3-0-0	3
6. EPL306 Microelectronic Devices	3-0-0	3
7. EPS300 Independent Study	0-3-0	3
8. EPD404 Project III	0-0-8	4
9. EPL311 Lasers	3-0-0	3
10. EPL312 Semiconductor Optoelectronics	3-0-0	3
11. EPL313 Fourier Optics and Holography	3-0-0	3
12. EPL321 Low Dimensional Physics	3-0-0	3
13. EPL322 Nanoscale Fabrication	3-0-0	3
14. EPL323 Nanoscale Microscopy	2-0-0	2
15. EPL324 Spectroscopy of Nanomaterials	2-0-0	2
16. EPL331 Applied Quantum Mechanics	3-0-0	3
17. EPL332 General Theory of Relativity & Cosmology	3-0-0	3
18. EPL411 Quantum Electronics	3-0-0	3
19. EPL412 Ultrafast Laser Systems and Applications	3-0-0	3
20. EPL413 Fiber and Integrated Optics	3-0-0	3
21. EPL414 Engineering Optics	3-0-0	3
22. EPV418 Selected Topics in Photonics	2-0-0	2
23. EPV419 Special Topics in Photonics	1-0-0	1
24. EPL421 Functional Nanostructures	3-0-0	3
25. EPL422 Spintronics	3-0-0	3
26. EPL423 Nanoscale Energy Materials & Devices	3-0-0	3
27. EPV428 Selected Topics in Nanotechnology	2-0-0	2
28. EPV429 Special Topics in Nanotechnology	1-0-0	1
29. EPL431 Relativistic Quantum Mechanics	2-0-0	2
30. EPL432 Quantum Electrodynamics	3-0-0	3
31. EPL433 Introduction to Gauge Field Theories	2-0-0	2
32. EPL434 Particle Accelerators	2-0-0	2
33. EPV438 Selected Topics in Theoretical Physics	2-0-0	2
34. EPV439 Special Topics in Theoretical Physics	1-0-0	1

Departmental Specializations

As per provision in the Concept Paper, a Project of 8 credits will also be available to those opting for Departmental Specialization; this Project could be a continuation of the DC course Project-I. The departmental CRC has proposed the following two specializations, and the corresponding basket of courses:

I. Photonics Technology

1. EPL311 Lasers	3-0-0	3
2. EPL312 Semiconductor Optoelectronics	3-0-0	3
3. EPL313 Fourier Optics and Holography	3-0-0	3
4. EPL411 Quantum Electronics	3-0-0	3
5. EPL412 Ultrafast Laser Systems and Appl.	3-0-0	3
6. EPL413 Fiber and Integrated Optics	3-0-0	3
7. EPL414 Engineering Optics	3-0-0	3
8. EPV418 Selected Topics in Photonics	2-0-0	2
9. EPV419 Special Topics in Photonics	1-0-0	1
10. EPD 402 Project-II	0-0-16	8

This Departmental Specialization is also offered as a 'Minor Area' for students outside the EP Program, with EPL102: Quantum Mechanics and EPL105: Applied Optics as core courses for the Minor Area.

II. Nano-Science & Technology

1. EPL321 Low Dimensional Physics	3-0-0	3
2. EPL322 Nanoscale Fabrication	3-0-0	3
3. EPL323 Nanoscale Microscopy	2-0-0	2
4. EPL324 Spectroscopy of Nanomaterials	2-0-0	2
5. EPL421 Functional Nanostructures	3-0-0	3
6. EPL422 Spintronics	3-0-0	3
7. EPL423 Nanoscale Energy Materials & Devices	3-0-0	3
8. EPV428 Selected Topics in Nanotechnology	2-0-0	2
9. EPV429 Special Topics in Nanotechnology	1-0-0	1
10. EPD402 Project-II	0-0-16	8

This Departmental Specialization is also offered as a Minor Area for students outside the EP Program with EPL102: Quantum Mechanics and EPL201: Fundamentals of Dielectrics & Semiconductors as core courses for the Minor Area.

Note:

1. A student can register for either Project II (if opted for Departmental Specialization) or Project III. Further, Project II or Project III could be continuation of Project I. The students will be eligible to do Project II or Project III, if he/she secures a grade not below 'A(-)' in the core B.Tech project (Project I). In all, not more than two Project courses can be taken in the Program.
2. The course placement grid for the Engineering Physics Program is shown below. Suggested plan of course work for students opting for Departmental Specialization is also indicated. The placement of DC courses in the semester plan would remain fixed; however, the DE/DS/OC/PL courses may be opted by the student as per availability/convenience.

Course Placement Grid (B.Tech.)

I Year	EEL100/ AML100	MEP100/ CSL100	PHL100/ CYL100	MAL100/ MAL101		EEL100/PHP100/MEP100/ MEP101/ SL100/CYP100		18
	EEL100/ AML100	MEP100/ CSL100	PHL100/CYL100	MAL100/MAL101		EEL100/PHP100/MEP100/ MEP101/CSL100/CYP100		16
II Year	EPL101: Electrodynamics (DC) (3-1-0)	EPL103: Mathematical Physics (DC) (3-1-0)	EPL105: Applied Optics (DC) (3-1-0)	HU-1 (3-1-0)	CEL140: Environ. Science (2-0-0)	EPP211: Engineering Phys. Lab I (DC) (0-0-6)	Intro. to Engineering Physics (0-0-2) (Non-graded)	21
	EPL102: Quantum Mechanics (DC) (3-1-0)	EPL104: Solid State Phys. (DC) (3-1-0)	EPL106: Elements of Materials Processing (DC) (3-1-0)	EEL201: Digital Electronics (PL-1)(3-0-0)	EEP201: Lab (PL-1) (0-0-3)	EPP212: Engineering Phys. Lab II (DC) (0-0-6)		19.5
III Year	EPL201: Fundamentals of Dielectrics & Semiconductors (DC) (3-1-0)	EPL203: Classical Mech. & Relativity (DC) (3-1-0)	EEL205: Signals & Systems (PL-2) (3-1-0)	HU-2 (3-1-0)	Chemical Syn. of Functional Materials (PL-3) (3-0-0)	EPP221: Engineering Phys. Lab III (DC) (0-0-8)		23 + DS
	EPL202: Statistical Physics (DC) (3-1-0)	EPL204: Computational Physics (DC) (3-1-0)	ESL350: Energy Conservation & Management (PL-4) (3-0-0)	HU-3 (3-1-0)	SBL100: Introduct. Biology for Engineers (3-0-2)	EPP222: Engineering Phys. Lab IV (DC) (0-0-8)		23 + DS
IV Year	DE-1 (3-0-0)	DE-2 (3-0-0)	OC-1 or DS (3-0-0)	HU-4 (3-0-0)		EPD401: Project- I (DC) (0-0-8)		16 + DS
	DE-3 (3-0-0)	DE-4 (3-0-0)	OC-2 or DS (3-1-0)	OC-3 or DS (3-0-0)		DS		13 + DS
						Total Credits		149.5 + DS

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics Department	
2.	Course Title (<i>< 45 characters</i>)	ELECTRODYNAMICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL101	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)	None	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	Existing EPL107	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, H.K. Malik, K.Thyagarajan, Arun Kumar, P. Senthilkumaran, Joby Joseph, B.D. Gupta		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The main objective is to introduce the fundamental theory and methods of electrodynamics based on the Maxwell's theory of electromagnetic fields.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Electrostatics and magnetostatics. Laplace and Poisson equations (solution), method of images. Multipole expansion. Maxwell's equations. Wave equation. Frequency dependence of permittivity. Absorption and dispersion. Kramers-Kronig relations. Conservation laws: Continuity equation, Poynting theorem, stress-energy tensor and Conservation of momentum. Solutions of Maxwell's equations in terms of potentials. Gauge transformations. Continuous distribution and retarded potentials. Lienard-		
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	Wiechert potentials. Field of moving point charge. Radiation, Electric dipole radiation, magnetic dipole radiation, Radiation from an arbitrary source. Power radiated by a point charge. Radiation reaction. Four vectors, Transformations of four vectors and tensors under Lorentz transformations. Formulation of Maxwell's equations in relativistic notations. Transformations of electric and the magnetic field vectors. Magnetism as a relativistic phenomenon. Lagrangian formulation of the electromagnetic field equations. Euler-Lagrange equations.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Electrostatics and magnetostatics. Laplace and Poisson equations (solution), method of images. Multipole expansion. Maxwell's equations, wave equation, frequency dependence of permittivity, absorption and dispersion.	10
2	Conservation laws: Continuity equation, Poynting theorem, stress-energy tensor and Conservation of momentum..	3
3	Solutions of Maxwell's equations in terms of potentials. Gauge transformations. Continuous distribution and retarded potentials. Lienard-Wiechert potentials. Field of moving point charge..	8
4	Radiation, Electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source. Power radiated by a point charge. radiation reaction.	6
5	Special relativity. Lorentz transformations. Four vectors, Transformations of four vectors and tensors under Lorentz transformations..	6
6	Formulation of Maxwell's equations in relativistic notations. Transformations of electric and the magnetic field vectors. Magnetism as a relativistic phenomenon.	6
7	Lagrangian formulation of the electromagnetic field equation. Euler-Lagrange equations.	3
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. D.J. Griffiths: Introduction to Electrodynamics (3rd Edition)
2. L.D. Landau and E.M. Lifschitz: Field Theory (2nd Volume of the Landau-Lifschitz series).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	LCD Projection facility
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	10%
20.2	Open-ended problems	10%
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics Department	
2.	Course Title (<i>< 45 characters</i>)	QUANTUM MECHANICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL102	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)	None	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL202	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, Sankalpa Ghosh, Joyee Ghosh, Amruta Mishra		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The main objective is to introduce the students to the concepts of quantum mechanics and reveal their radically new approach, compared to the notions of classical physics, in dealing with the physics of microscopic systems.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Dirac's bra-ket algebra, projection operator. Matrix representation of vectors and operators. Reformulating postulates in bra-ket language, Examples. 1D harmonic oscillator, ladder operators and construction of the stationary state wave functions, number operator and its eigenstates. Quantum mechanics in 2 and 3 dimensions in Cartesian coordinates. Quantum theory of angular momentum, eigenvalues and eigenfunctions. Quantum theory of spin angular momentum, addition of angular momenta and Clebsch-Gordan coefficients.		
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	Schroedinger equation in spherical coordinates, Free particle solution and solutions for spherically symmetric potentials, Hydrogen atom. Many particle Schredinger equation, independent particles and reduction to the system of single-particle equations. Identical particles, exchange symmetry and degeneracy, Pauli principle and its applications. EPR paradox, Entangled states,hidden variables, Bell's inequality.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	QM in Dirac notation, Bra-Ket algebra, projection operators. Matrix representation of vectors and operators. Examples.	4
2	1D harmonic oscillator, ladder operators and construction of the stationary state wave functions, number operator and its eigenstates.	3
3	Quantum mechanics in 2 and 3 dimensions in Cartesian coordinates. Separation of variables. Examples	3
4	Quantum theory of angular momentum, eigenvalues and eigenfunctions. Problem-solution.	4
5	Quantum theory of spin angular momentum, addition of angular momenta and Clebsch-Gordan coefficients. Examples.	8
6	Schroedinger equation in spherical coordinates, Free particle solution and solutions for spherically symmetric potentials, Hydrogen atom.	6
7	. Many particle Schrodinger equation, independent particles and reduction to the system of single-particle equations. Examples	5
8	Identical particles, exchange symmetry and degeneracy, Pauli principle and its applications.	4
9	EPR paradox, Entangled states, hidden variables, Bell's inequality.	5
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. David J. Griffiths: Introduction to Quantum Mechanics.(Prentice Hall)
2. R. Shankar: Principles of Quantum Mechanics (2nd Edition, Springer, 2006)

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	MATHEMATICAL PHYSICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL103	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)	None	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	Existing EPL103	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course H.C. Gupta, Varsha Banerjee, Kedar Khare, Sankalpa Ghosh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To introduce the basic mathematical techniques and methodology to physics students which are relevant/essential to most other Physics courses. The topics will be covered from the viewpoint of their applications to problems in Physics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Linear algebra, complex variables, partial differential equations, special functions, Fourier and Laplace transform, integral equations, vector and tensor analysis, brief introduction to group theory.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basics of Linear Algebra: Basic Ideas of vector spaces, Coordinate systems, basis and basis transformations, linear transformations and their Matrix representations, direct products of Matrices, Hermitian and Unitary operators, Brief discussion of extension to infinite dimensions.	4
2	Introduction to Complex variables: Functions of complex variables, The Riemann sphere, Cauchy - Riemann conditions, Holomorphic and meromorphic functions, Taylor and Laurent expansions, Multivalued functions and Riemann surfaces, Cauchy's Theorem, The residue theorem, simple applications to integrals.	8
3	Partial Differential Equations (PDE) and Special Functions: Brief Resume of Ordinary Differential Equations, First and second order linear PDE, Initial boundary conditions, method of characteristics, separation of variables, Green's functions, Application to vibrating strings, Laplace's Equation, Heat Equation and Wave equations.	8
4	Special functions: Orthogonal functions, Bessel functions, Legendre, Hermite and Laguerre polynomials, Generating functions, Recursion relations, asymptotic forms	5
5	Integral Equations: Linear integral equations, separable kernels, Fredholm and Volterra equations and simple applications	6
6	Vector and Tensor Analysis: General introduction to tensors and examples: permittivity tensor, tensors in elasticity. Covariant and contravariant tensors, Generalized Gauss and Stokes theorems in N dimensions, volume tensors	6
7	Introduction to Group Theory: Definition, Groups of transformations, Symmetry, Cayley's theorem, Lagrange's theorem. Translations, rotations and boosts, and other simple examples	5
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2		
3		
4		
5		
6		

7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Phillippe Dennery and Andre Krzywicki, Mathematics for Physicists, Sover Publications, New York, 1995.
2. Jon Mathews and Robert L Walker, Mathematical methods for Physics, Benjamin, New York (1970), reprinted by Pearson Education (LPE).
3. S D Joglekar, Mathematical Physics Vols I and II, University Press, India (2007).
4. Arfken, G. Mathematical Methods for Physicists, 3rd ed. Orlando, FL:Academic Press, 1985.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	LCD Projection facility
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	SOLID STATE PHYSICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL104	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL206	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Ratnamala Chatterjee, Neeraj Khare, G.B. Reddy, Pankaj Srivastava, Sujeet Chaudhary, Santanu Ghosh, Pintu Das, Rajendra Singh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To provide students a full exposure to the basic principles and essential concepts of Solid State Physics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Crystal Structure, concepts of reciprocal lattice and Brillouin zones, Defects in Crystals, Phonons, Crystal Vibrations with monoatomic and diatomic basis, Phonon Heat Capacity: Density of states in one dimension, Debye and Einstein models, thermal expansion, Free Electron Fermi Gas, Effect of temperature on the Fermi-Dirac Distribution, E-k diagrams, Effective Mass, Nearly free electron model, Bloch function, Kronig Penny Model, Atomic origin of magnetism: Diamagnetism, Langevin theory of paramagnetism, Curie-Weiss Law, Pauli paramagnetism, Ferromagnetism, Weiss molecular theory, Ferromagnetic domains, magnetic anisotropy, Superconductivity, types of superconductors, Heat capacity, energy gap, Thermodynamics of the		
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	superconducting transition, London equation, coherence length, BCS theory of superconductivity (qualitative), Brief introduction to high temperature superconductors.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Crystal Structure: Periodic array of atoms, lattice translational vectors, Basis and the crystal structure, Primitive lattice cell, Two- and three-dimensional lattice types, Simple crystal structures.	6
2	Reciprocal Lattice: Diffraction of waves by crystals, X-ray diffraction, Scattered wave amplitude, Concept of Brillouin zones, Structure and atomic form factors	6
3	Defects in Crystals: Thermodynamics of Point Defects, Schottky and Frenkel Defects, Colour centers	3
4	Phonons: Crystal Vibrations with monoatomic and diatomic basis, quantization of elastic waves, Phonon momentum	4
5	Phonon Heat Capacity: Normal mode enumeration, Density of states in one dimension, Debye and Einstein models of density of states, thermal expansion	4
6	Free Electron Fermi Gas: Energy levels in one dimension, Effect of temperature on the Fermi-Dirac Distribution, Energy bands, E-k diagrams, Concept of Effective Mass, Nearly free electron model, Bloch function, Kronig Penny Model, Wave equation of electron in a periodic potential.	5
7	Atomic origin of magnetism: Solution of the Schroedinger equation for a free atom, Zeeman effect, Electron spin, Diamagnetism, Langevin theory of paramagnetism, The Curie-Weiss Law, Quenching of orbital momentum, Pauli paramagnetism, Ferromagnetism, Weiss molecular theory, Ferromagnetic domains, Magnetization and hysteresis, Brief discussion on magnetic anisotropy	8
8	Superconductivity, Meissner effect, type I and II superconductors, Heat capacity, energy gap, Isotope effect, Thermodynamics of the superconducting transition, London equation, coherence length, BCS theory of superconductivity (qualitative), Brief introduction to high temperature superconductors	6
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- 1.Introduction to Solid State Physics by Kittel
- 2.Solid State Physics, Ibach and Lueth
- 3.Magnetic Materials: Fundamentals and Device Applications, Nicola Spaldin

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	APPLIED OPTICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL105	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	NIL	
8.3	Supercedes any existing course	Existing EPL105	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Aloka Sinha, Anurag Sharma, Arun Kumar, B. D. Gupta, Joby Joseph, Kedar Khare, K. Thyagarajan, P. Senthilkumaran, M. R. Shenoy, R. K. Varshney		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To provide basic theoretical foundations of various optical phenomena, and their applications in Science and Engineering.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Geometrical and Wave Optics: Fermat's Principle, Solution of ray equation, and applications. Review of Maxwell's equations and propagation of e. m. waves, reflection and refraction, total internal reflection and evanescent waves. Surface plasmons, Meta-materials. Plane waves in anisotropic media, Wave refractive index, Uniaxial crystals, some polarization devices.		
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	Interference and Diffraction: Concept of Coherence, Interference by division of wavefront and division of amplitude; Stoke's relations; Non-reflecting films; Michelson interferometer; Fabry-Perot interferometer and etalon. Fraunhofer diffraction: Single slit, circular aperture; limit of resolution. Diffraction grating, Resolving power. Fresnel diffraction: Half-period zones and the zone plate. Diffraction of a Gaussian beam. Lasers and Fiber Optics: Interaction of radiation and matter, Einstein coefficients, condition for amplification. Optical resonators, Condition for laser oscillation. Some Laser Systems. Light propagation in optical fibers, Attenuation and dispersion; Single-mode fibers, material dispersion, Fiber amplifiers and lasers. Fiber optic sensors. Introduction to Fourier Optics and Holography
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Geometrical Optics: Fermat's Principle, Ray paths in an inhomogeneous medium; Ray equation and its solutions. Applications in fiber optics, mirage formation, etc.	4
2	Wave Propagation: Review of Maxwell's equations and propagation of e. m. waves, various states of polarization, reflection and refraction of e. m. waves, Brewster angle; total internal reflection and evanescent waves. Surface plasmons and their excitation, Introduction to meta-materials.	5
3	Anisotropic Media: Plane waves in anisotropic media, Wave refractive index, Uniaxial crystals, some polarization devices, Malus' law, Analysis of polarized light, Faraday effect, Optical Isolator.	5
4	Interference: Superposition of waves, Coherence, Interference by division of wavefront and division of amplitude; Phase change on reflection, Stoke's relations; Non-reflecting films; Colors of thin films. Michelson interferometer; Multiple-beam interference; Fabry-Perot interferometer and etalon, some applications.	7
5	Diffraction: Fraunhofer diffraction: Single slit, circular aperture; limit of resolution. Double slit, Diffraction grating, Resolving power. Fresnel diffraction: Half-period zones and the zone plate. Diffraction of a Gaussian beam.	7
6	Lasers: Interaction of radiation and matter, Einstein coefficients, line shape function, condition for amplification. Optical resonators, resonator losses and the quality factor Q. Condition for laser oscillation. Longitudinal- and transverse modes of a laser. Some Laser Systems.	4
7	Fiber Optics: Light propagation in optical fibers, Optical fiber communication, Attenuation and dispersion; Modes of a step-index fiber; Single-mode fibers, material dispersion. Fiber amplifiers and lasers. Fiber optic sensors.	5
8	Fourier Optics and Holography: Basics of Fourier transformation, definition of spatial frequency, FT by diffraction and by lens, Spatial frequency filtering, Phase contrast microscope, Principle of holography, hologram recording and reconstruction, Types of holograms, some applications.	5
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided. Some visits to laboratory for demonstration of experiments may also be arranged.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		

2		
3		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Text Book:

OPTICS, Ajoy Ghatak, Tata McGraw Hill, New Delhi, (5th Edition), 2012.

Supplementary Reference Books:

1. OPTICS, E. Hecht, Addison-Wesley Longman Inc. (Third Edition), 1998.
2. OPTICAL ELECTRONICS, A. K. Ghatak and K. Thyagarajan, Cambridge University Press, Cambridge, 1989.
3. FUNDAMENTALS OF OPTICS, F. A. Jenkins and H.E. White, McGraw-Hill, New York, 1957.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	5%
20.2	Open-ended problems	5%
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS DEPARTMENT	
2.	Course Title (<i>< 45 characters</i>)	ELEMENTS OF MATERIALS PROCESSING	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL106	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL211	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course D. K. Pandya, B. R. Mehta, G. B. Reddy, Sujeet Chaudhary, J. P. Singh, P. K. Muduli		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The central objective of the course is to provide basic understanding of physical and physio-chemical process taking place during material growth. The structure-process-property correlation achievable via nucleation controlled synthesis and control of processing will be emphasized. Possible applications demonstrating novel material designs and case studies in technological areas of current interest will be discussed.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Fundamentals of thermodynamic and kinetic aspects during nucleation and growth processes, Film growth modes, 2-D growth, Epitaxy and lattice misfits, Molecular beam epitaxy, Basics of vacuum, plasma discharge and sputtering important for material growth, Energy enhanced processes for low temperature processing, Reactive sputtering, Ion-beam deposition, Pulsed Laser		
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	Deposition, Plasma etching, E-beam and Ion-beam patterning, Chemical Vapor Deposition, Chemical Bath Deposition and Electrodeposition, Chemical epitaxy, Need for Epitaxy and its role in semiconductor devices, quantum wells, superlattices and hybrid structures. Mechanisms for confined materials growth for 0-D, 1-D and 2-D architecture and other complex forms, Case studies of material design by taking examples from current and emerging aspects of technologies and applications.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basics and importance of vacuum and controlled environment for material growth, Homogeneous and Heterogeneous nucleation, Capillarity and atomistic models, Nucleation rate and its dependence on deposition parameters, Coalescence, Textured growth.	8
2	Film growth modes, 3-D and 2-D growth, Wulff theorem and facets in nuclei,	3
3	Ordered growth, Homo, hetero, strained-layer and domain epitaxy, 2-D lattices and lattice matching, strain and misfit dislocations, Epitaxial relationship, Buffer layers, RHEED for 3-D and 2-D growth, Band-gap engineering via epitaxy, Quantum wells and Superlattices.	6
4	Physics of evaporation, evaporated flux distribution in various geometries, Molecular beam sources, XRR for ultrathin film thickness.	3
5	Energy enhanced processes, Physics of sputtering, plasmas, discharge, collective charge effects, Sputter yield, stoichiometry of binary alloys, Magnetron and RF sputtering, Reactive sputtering, Ion-beams for sputtering and ion-assisted growth.	7
6	Chemical Vapor Deposition, thermodynamics, reactions, gas transport and diffusion, Film growth kinetics, Plasma CVD and Plasma etching, Nanostructures by e-beam and ion-beam lithography.	5
7	Chemical reaction based techniques for novel architectures like quantum dots, nanoparticles, core-shell structured QD and Nanowires, Reaction kinetics, Chemical bath deposition, I-V kinetics of electrochemical cell and Electrodeposition, Chemical epitaxy.	5
8	Modification in growth process for low dimensional materials. Requirement of dimensional control and low size distribution. Growth techniques for novel architectures like nanoparticles, nanorod and nanowires, core-shell structures.	5
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided. Some visits to laboratory for demonstration of experiments may also be arranged.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Materials Science of Thin Films by Milton Ohring, Academic Press, 2002
2. Thin Film Deposition by Donald Smith, Mc Graw Hill, 1995
3. Thin Film Phenomena by K. L. Chopra, Mc Graw Hill, 1970

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	FUNDAMENTALS OF DIELECTRICS AND SEMICONDUCTORS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL201	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supersedes any existing course	Existing EPL213	

9.	Not allowed for (indicate program names)	Other than EP and Physics Minor Area Program	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Rajendra Singh, G.V. Prakash, J.P. Singh, Pankaj Srivastava, Neeraj Khare, Ratnamala Chatterjee, R.K. Soni, A.K. Shukla		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To impart basics understanding of the concepts involved in dielectrics, semiconductors and semiconductor junctions.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Dielectric Properties of insulators: Depolarization Field, Local electric field at an atom, Dielectric Constant and Polarizability, Clausius Mossotti relation, Kramers-Kronig relations, dielectric strength and insulation breakdown. Structural phase transition: Landau Theory of Phase transition, Piezo and Ferroelectricity, Energy bands in semiconductors: conduction and valence band characteristics, Equilibrium distribution of electrons and holes: Intrinsic carrier concentration. Dopants and energy levels, Statistics of donors and acceptors, variation of Fermi level with doping, concentration and temperature, defects in semiconductors, Carrier Transport Phenomena: Conductivity,		
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	Velocity saturation, Diffusion current density, Nonequilibrium Excess Carriers in Semiconductors: SRH recombination, Minority carrier lifetime, Continuity equations, Haynes-Shockley experiment, Quasi-Fermi energy levels, Surface states in semiconductors, pn Junction Variation of electric field and electrical potential, Reverse applied bias, Junction capacitance, Charge flow in a forward-biased pn junction. Junction breakdown in reverse-biased junction, Band diagrams of heterojunctions.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Dielectric Properties of insulators: Macroscopic Electric field, Depolarization Field, Local electric field at an atom, Dielectric Constant and Polarizability, Clausius Mossotti relation, Kramers-Kronig relations, Electronic Polarizability, Dielectric loss, dielectric strength and insulation breakdown, capacitor dielectric materials.	5
2	Structural phase transition, Classification of Ferroelectric crystals, Displacive transitions, Landau Theory of Phase transition, Ferroelectric domains	4
3	Piezo and Ferroelectricity, Quartz Oscillators and filters, piezo-spark generators	2
4	Types of semiconductor materials, Crystal structure: Diamond, zinc blende and wurtzite structures. Energy bands in semiconductors: Direct and indirect bandgaps, conduction and valence band characteristics.	4
5	Charge carriers in Semiconductors: Equilibrium distribution of electrons and holes, Intrinsic carrier concentration. Extrinsic Semiconductors: Dopants and energy levels, Equilibrium distribution of electrons and holes, Statistics of donors and acceptors, Charge neutrality, Compensated semiconductors, Variation of Fermi level with doping concentration and temperature.	5
6	Defects in Semiconductors: Impurities and defects, Shallow and deep level defects, Vacancy and Interstitial defects, Dislocations in semiconductors.	3
7	Carrier Transport Phenomena: Carrier drift, Carrier mobility and its temperature dependence, Conductivity, Velocity saturation, Carrier diffusion, Diffusion current density, Hall effect.	4
8	Nonequilibrium Excess Carriers in Semiconductors: Carrier generation and recombination, Band-to-band, SRH recombination, Auger process, Minority carrier lifetime, Characteristics of excess carriers, Continuity equations, Ambipolar transport, Haynes-Shockley experiment, Quasi-Fermi energy levels, Surface states in semiconductors	6
9	The pn Junction: Basic structure, Built-in potential barrier, Variation of electric field and electrical potential within the space-charge-region, Space charge width, Reverse applied bias, Junction capacitance, One-sided junctions.	4
10	The pn Junction Diode: Charge flow in a forward-biased pn junction, Ideal current-voltage relationship, Minority carrier distribution. Junction breakdown in reverse-biased junction: Zener effect and Avalanche multiplication. Heterojunctions: Types of heterojunctions, Band diagrams of heterojunctions.	5
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Text books:

- (i) Solid State Physics - Charles Kittel
- (ii) Principles of Electronic Materials and Devices - Kasap
- (iii) Semiconductor Physics and Devices: D.A. Neamen

Reference books:

- (i) Physics of Semiconductor Devices: S.M. Sze

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	STATISTICAL PHYSICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL202	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)	EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL204	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Varsha Banerjee, H.C. Gupta, Neeraj Khare, A.K. Shukla		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): 1. Use of statistical approach to understand many particles systems in material science, and introduction to the basic methodology of statistical mechanics 2. Derivation of thermodynamic properties in material systems using statistical approach and their practical use for science and engineering. 3. To provide basic understanding of Phase Transition 4. Concept of Indistinguishable particles and Quantum Statistical Mechanics		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Elementary Probability Theory: Binomial, Poisson and Gaussian Distribution, random walk problem, central limit theorem and its significance, average and distributions; diffusion and Brownian motion and their relation to random walk problem; Macrostate and microstate, Postulates of Statistical Mechanics, rules		
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	of calculations through microcanonical, canonical and grand canonical ensembles; Derivation of the thermodynamic relations from the statistical mechanics ; Application to classical systems: Systems of ideal gas molecules, Maxwell Boltzmann velocity distribution, paramagnetism of non interacting spins; specific heat of solids ; Concept of Thermodynamic stability and Phase Transition: Van der Waal equation of state , Ising model , critical exponents; Indistinguishability of particles and Quantum Statistical Mechanics; Bose Einstein and Fermi-Dirac distribution: Black Body radiation, Bose Einstein Condensation, Fermi level and electronic contribution to specific heat, White Dwarf stars and Chandrasekhar Limit.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Elements of Probability Theory: Random walk problem and Binomial, Poisson and Gaussian distributions, averages and distribution, central limit theorem and its significance, connection of random walk problem to Brownian motion and diffusion.	.7
2	Methodology of Statistical Mechanics: Macrostates and Microstates, Postulates of Statistical Mechanics, Gibb's paradox, rules of calculation through microcanonical, canonical and grandcanonical ensembles.	8
3	Thermodynamics from Statistical Mechanics: Derivation of thermodynamic relations using Statistical Mechanics, Lagrange Multipliers, Free energy and Thermodynamic potentials.	4
4	Application to Classical Systems: System of ideal gas molecules, the equipartition theorem, Maxwell-Boltzman velocity distribution; non-interacting spins and paramagnetism; specific heat of solids	7
5	Phase Transition and Critical Phenomena: Concept of thermodynamic stability and phase transition, Van der Waas equation of state, Ising model, critical exponents	6
6	Quantum Statistical Mechanics: Indistinguishability and quantum statistical, Bose Einstein and Fermi Dirac distribution, thermodynamics of black body radiation, Bose Einstein condensation, Fermi level and Fermi temperature, electronic contribution to specific heats, white dwarf star and Chandrasekhar limit	10
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Discussion on applications of each topic listed under the lecture plan (above), along with problem solving techniques, and numericals. Several tutorial sheets, covering various topics, with problems for exercise will be provided.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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COURSE TOTAL (14 times 'P')

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. J. K. Bhattacharjee, Statistical Physics: Equilibrium and Non-Equilibrium Aspects, Allied Publishes, 2000 (Text)
2. R. K. Pathria, Statistical Mechanics, 2nd Edition, Elsevier (Text)
3. F. Reif, Fundamentals of Statistical and Thermal Physics (Text)
4. H. Gould and J. Tobochnik, (E-book, Copyrighted), <http://stp.carku.edu/notes> (Reference)
5. Statistical Physics :Amit and Verbin, Word Scientific, 1999

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	CLASSICAL MECHANICS AND RELATIVITY	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL203	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (<i>course no./title</i>)	EPL103	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	EPL101	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course JOYEE GHOSH, AJIT KUMAR, SANKALPA GHOSH , AMRUTA MISHRA		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to learn mechanics of physical systems based on Non- Newtonian formulation. The formulation is based on Lagrangian and Hamiltonian equations for slow objects ($v \ll c$) and Special theory of Relativity for fast objects ($v \sim c$). Various applications based on the above mentions formulation will be introduced in this course.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Dynamics of a particle moving under central force, Canonican transformation and Poission bracket formulation, Hamilton-jacobi's theory, Non inertial (rotating) frames of references, Relativistic Mechanics.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Lagrangian and Hamiltonian of a particle moving under central force, Equation of motion and first integrals, Differential equation of the orbit, Kepler's problem, Bertrand's theorem.	6
2	The equations of canonical transformation, small oscillations, phase space diagrams, poisson bracket, equation of motion, conservation laws, Liouville's theorem.	8
3	Hamilton-Jacobi's equation for Hamilton's principal function, The harmonic oscillator, Hamilton's characteristic function, Action-angle variable, Jacobi's action integral, transition to quantum mechanics.	8
4	Non inertial frames, Rotating frames, Centrifugal and Coriolis force, Foucault's pendulum, Trade winds.	6
5	Lorentz transformation, velocity addition and Thomas precession, Relativistic kinematics for many particles, Relativistic angular momentum, Lagrangian of a relativistic system, covariant, Stress energy tensor, Maxwell's equations. Equivalence principle, gravitational redshift.	14
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12		
COURSE TOTAL (14 times 'L')		42 lectures.

16. Brief description of tutorial activities

The tutorial activities are based on (i) problem solving to illustrate the theoretical concepts, (ii) quantitative analysis of various dynamical quantities/parameters to understand real physical systems and (iii) some theoretical derivations highlighting various physical systems.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NONE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Recommended Books:

1. Classical Mechanics by Goldstein, Poole and Safko Pearson Education.
2. Introduction to special Relativity by Robert Resnick, Wiley Eastern Ltd.
3. Classical Mechanics: System of particles and Hamiltonian Dynamics by W. Greiner Springer International Edition.
4. An Introduction to Mechanics by Klepner and Kolenkow, McGraw Hill.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	COMPUTATIONAL PHYSICS	
3.	L-T-P structure	3 - 1 - 0	
4.	Credits	4	
5.	Course number	EPL204	
6.	Status (<i>category for program</i>)	DC for B.Tech "Engineering Physics" (EP)	

7.	Pre-requisites (course no./title)	EPL103	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL333	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course Prof. H. C. Gupta, Prof. Anurag Sharma, Dr. Varsha Banerjee, Dr. Kedar Khare		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to provide the students the knowledge of computational methods used for modelling and analysis of complex problems in diverse areas of Physics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): The course will consist of an introduction to the basic numerical tools, such as locating roots of equations, interpolation, numerical differentiation and integration, solutions of algebraic and differential equations, discrete Fourier transform, etc. Applications of Monte-Carlo simulations, optimization and variational methods etc. to problems of interest in multiple areas of Physics will also be studied.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Locating roots of equations	3
2	Interpolation methods	2
3	Numerical differentiation and integration	6
4	Systems of linear equations	3
5	Smoothing of data- method of least squares	3
6	Discrete and Fast Fourier transform	3
7	Ordinary differential equations	4
8	Partial differential equations	4
9	Chaos and non-linear dynamics	3
10	Random number generation	2
11	Monte-Carlo simulations (random walk, aggregation-diffusion)	5
12	Variational methods and optimization techniques	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

W. Cheney and D. Kincaid, Numerical Mathematics and Computing, International Thomson Publishing Company
 H. M. Antia, Numerical Methods for Scientists and Engineers
 H. Gould and J. Tobochnik, Computer Simulation Methods, Addison Wesley
 T. Pang, Introduction to Computational Physics, Cambridge University Press
 W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, Numerical Recipes in C, Cambridge University Press

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	MATLAB
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19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	10%
20.4	Open-ended laboratory work	
20.5	Others (please specify)	20 % (Assignments)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	VACUUM TECHNOLOGY AND SURFACE PHYSICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL301	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL331	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Sujeet Chaudhary, Pankaj Srivastava, G.B. Reddy, J.P. Singh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To expose students to the basics aspects of surface physics and principles of vacuum instrumentation involved in the techniques employed for understanding of various surface phenomenon.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Need of Vacuum and basic concepts: Mean free path, Particle flux; Monolayer formation, Gas Flow regimes ; Gas release from Solids: Vaporization, Thermal Desorption, Permeation, Surface diffusion, Physisorption and Chemisorption; Measurement of Pressure: Gauges, Residual Gas Analyses; Production of Vacuum: Roughing - Rotary pumps, Oil free pumps; HV & UHV -		
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	Turbomolecular pumps, Cryopumps, Getter and Sputter Ion pumps; Materials and components in vacuum; Bulk versus surface; Electronic properties of surfaces: Contact potential and work function, Surface Plasmons; Atomic motion: Surface lattice dynamics, Surface diffusion, Surface melting and chemisorption; Adsorption of atoms and molecules; Experimental techniques for surface analysis: XPS, AES, SEXAFS, TEM, SEM, STM, AFM and RHEED.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Need of Vacuum & basic concepts: Mean free path, Particle flux; Monolayer formation, Gas Flow regimes – Viscous, Molecular flow regimes, Transition regime; Gas throughput, Conductance, Pumping Speed, Mass flow rate	4
2	Source of Gases inside a vacuum chamber: Vaporization, Thermal Desorption, Permeation, Virtual leaks, Physisorption, Chemisorption; Quantitative description of pumping; Vacuum Baking	4
3	Measurement of Pressure: Thermal conductivity & Pirani Gauge, Ionization Gauge, Cold Cathode Gauge, Spin Rotor gauge, Residual Gas Analyses	4
4	Production of Vacuum: Roughing - Rotary pumps, Oil free pumps; HV & UHV - Turbomolecular pumps, Cryopumps, Getter and Sputter Ion pumps	7
5	Materials & Components in Vacuum: Elastomer and Metal Seals & Gaskets; Electrical Feedthroughs; Motion Feedthroughs	2
6	Bulk versus surface: Basic differences Electronic properties of surfaces: Contact potential and work function, Surface states and band bending, Plasmons, Surface optics	5
7	Atomic motion: Surface lattice dynamics, Surface diffusion, Surface melting and chemisorption, epitaxial processes, case studies	4
8	Experimental techniques for surface analysis: Electron Spectroscopic techniques (XPS, AES), Surface extended X-ray absorption fine structure (SEXAFS), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Scanning Tunneling Microscopy (STM) and Atomic Force Microscopy (AFM), Reflection High Energy Electron Diffraction (RHEED)	12
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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6		
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COURSE TOTAL (14 times 'P')	
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18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. "High Vacuum Technology – A Practical Guide", Marsbed H. Hablanian, Marcel Dekker, INC. (New York and Besel) 1990.
2. "Vacuum Technology", A. Roth, Pergamon Press Ltd. (Oxford)
3. Surface Physics, M. Prutton, Oxford University Press (1985).
4. Physics at Surfaces, Andrew Zangwill, Cambridge University Press (1988).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	NUCLEAR SCIENCE AND ENGINEERING	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL 302	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	EPL332	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course SANTANU GHOSH, AMRUTA MISHRA, A. K. SHUKLA		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to learn various fundamental and engineering aspects of Nuclear physics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Introduction to nuclear structure, Radioactivity and applications, Nuclear detection and acceleration technology, Nuclear reactors engineering, Nuclear techniques for composition analysis, Nuclear radiation in biology.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to nuclear structure: basic properties of nucleus, nuclear mass, semi empirical mass formula, liquid drop model, shell structure	6
2	Radioactivity and applications: Radioactive decay law, theory of successive transformation, secular and transient equilibrium, radioactive dating, mass spectrometer.	8
3	Nuclear Detection and acceleration technology: Interaction of radiation with materials, basic characteristics of a nuclear detector, gas ionization chamber, proportional counter, G-M counter, Solid state detector, basic nuclear electronics, principle of particle acceleration, Linear accelerator, Cyclotron .	6
4	Nuclear Reactor Engineering: Q-value of nuclear reaction, concepts of chain reaction, Calculation of reproduction factor and power, Basic design of a fission reactor, thermonuclear reaction, Lawson criterion, magnetic mirror, fusion reaction in plasma (in tokamak configuration).	8
5	Nuclear Techniques for Composition analysis: Nuclear Reaction analysis, Nuclear activation analysis, Back scattering spectrometry, Nuclear particle induces X-ray analysis.	6
6	Nuclear Radiation in Biology: Concept and units of radiation dose, basic dosimetry, production of radioisotope and applications in diagnosis and therapy, positron emission tomography, nuclear magnetic resonance and magnetic resonance imaging.	8
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NONE	
2		
3		
4		
5		
6		
7		
8		

9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Recommended Books:

1. K. Heyde, Basic Ideas and Concepts in Nuclear Physics, Overseas Press, Second Edition, New Delhi, 2005.
2. W. R. Leo, Techniques for Nuclear and Particle Physics Experiments, Narosa Publishing House, India, 1995.
3. S. Glasstone and A. Sesonske, Nuclear Reactor Engineering, D. Van Nostrand Company, INC. 1967.

NPTEL course on 'Nuclear Science and Engineering' S. Ghosh, IIT Delhi.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	MATERIALS SCIENCE & ENGINEERING
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	EPL303
6.	Status (<i>category for program</i>)	DE for EP

7.	Pre-requisites (course no./title)	EPL104
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	EPL337

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Sujeet Chaudhary, Pankaj Srivastava, Ratnamala Chatterjee, Neeraj Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): The course will expose the students to the basic principles of materials science and their applications in engineering.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Elementary materials science concepts, thermally activated processes, diffusion in solids, phase diagram of pure substances, Gibbs phase rule, binary isomorphous systems, the Lever rule, zone refining, homogeneous and heterogeneous nucleation, martensitic transformation & spinodal decomposition, Temperature dependence of resistivity, Matthiessen's rule, TCR, Nordheim's rule, mixture rules and electrical switches, high frequency resistance of a conductor, thin metal films and integrated circuit inter-connections, thermoelectricity, seebeck, Thomson and Peltier effects, thermoelectric heating and refrigeration, thermoelectric generators, the figure of merit, Bonding characteristics and elastic modulii, Anelasticity, thermoelasticity, anelasticity energy losses, viscoelastic deformation,	
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	displacement models, Corrosion and Degradation of Materials: Electrochemical considerations, corrosion rates and their prediction, passivity environmental effects, forms of corrosion, corrosion environments, corrosion prevention, oxidation, protective and non-protective oxides, PB ratio, mechanisms of oxide growth, Materials Selection and Design Considerations.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Elementary materials science concepts: Structure-Property relationship, Thermally assisted Processes, Point Defects and their significance:	3
2	Diffusion processes: Fick's First and Second law and their industrial application	3
3	Phase diagrams: Gibbs phase rule, Cooling curves, binary isomorphous system	2
4	Binary eutectic systems, the Lever rule, Pb-Sn solders, microstructure under equilibrium and non-equilibrium cooling, zone refining and pure Si crystals	4
5	First/ Second order phase transitions, Mechanisms of phase changes, nucleation (homogeneous and heterogeneous) and growth	3
6	Fe-C phase diagram, Martensitic transformation	2
7	Electrical & thermal behavior: Temperature dependence of resistivity: Matthiessen's rule and temperature Coefficient of resistivity, Hume Rothery Rules, solid solutions and Nordheim's rule Mixture rules; Electrical contacts,	4
8	Thermal Conductivity and Weidmann Franz law, Lorentz number Thermoelectricity: Seebeck, Thomson and Peltier effects, Kelvin relations, phonon drag, the figure of merit, thermoelectric heating and refrigeration, thermoelectric generators	7
9	Elastic behavior of solids: elastic moduli, Anelasticity, thermoelasticity, viscoelastic deformation, displacement models	5
10	Corrosion and Degradation of Materials: Electrochemical considerations, Potential, Corrosion rates, forms of corrosion, corrosion environments, corrosion prevention Oxidation, PB ratio, mechanisms of oxide growth	7
11	Materials Selection and Design Considerations; Economic, Environmental and Societal issues in Materials Science and Engineering	2
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Not Applicable

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	Not Applicable	
2		
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10		

COURSE TOTAL (14 times 'P')	
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18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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|---|
| (i) Materials Science and Engineering-An Introduction, W. D. Callister,Jr., John Wiley, 1997.
(ii) Materials Science and Engineering, V. Raghavan, Prentice Hall of India (2006).
(iii) Principles of electronic Materials & Devices, S O Kasap, McGraw Hill, 2nd/3rd edition.
(iv) The structure and properties of materials, vol. II, John Wulff, John Wiley |
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19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	SUPERCONDUCTIVITY AND APPLICATIONS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL304	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL104	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Neeraj Khare, Sujeet Chaudhary, Sankalpa Ghosh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): This course aims developing the basic understanding of Superconductivity and its applications in upcoming technologies.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basic properties: zero resistance, perfect diamagnetism, difference from perfect conductors; Critical temperature, Basic Introduction to High Temperature superconductors, Meissner effect, London equations, penetration depth, flux quantization, critical current and critical magnetic field, Thermodynamics of superconducting state, Type I and Type II superconductors, BCS theory, electron pairs; coherence length; energy gap; Isotope effect, Ginzburg-Landau Theory, tunneling of electron in M/I/S, tunneling of electron pairs in S/I/S: DC and AC Josephson effect, Some applications: Electromagnet, SQUID, Oscillators, basics of superconducting electronics and superconducting quantum computing.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basic properties: zero resistance, perfect diamagnetism, difference from perfect conductors; Critical temperature, Introduction to High Temperature superconductors, Meissner effect, London equations, penetration depth, flux quantization, critical current and critical magnetic field, Thermodynamics of superconducting state, Type I and Type II superconductors,	14
2	BCS theory, electron pairs; coherence length; energy gap; Isotope effect, Ginzburg-Landau Theory	14
3	Tunneling of electron in M/I/S, tunneling of electron pairs in S/I/S: DC and AC Josephson effect, Some applications: Electromagnet, SQUID, Oscillators, basics of superconducting electronics and superconducting quantum computing.	14
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11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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| <ol style="list-style-type: none"> 1. Introduction to Superconductivity by A.C. Rose-inns and E.H. Roderic 2. Introduction to Superconductivity by M. Tinkham 3. Principles of Superconductive Devices and Circuits by Theodore Van Duzer and Charles W. Turner |
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4. Low Temperature Solid State Physics by H. M. Rosenberg

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING APPLICATIONS OF PLASMAS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL305	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL101	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course HITENDRA KUMAR MALIK, R D TAREY		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): THIS COURSE TALKS ABOUT THE ENGINEERING APPLICATIONS OF PLASMAS TO MATERIALS, FUSION, COHERENT RADIATION, PARTICLE ACCELERATION, SPACE PROPULSION DEVICES, AND AUTOMOTIVES. HERE BASICS OF NEW TECHNIQUES WILL BE TALKED ALONG WITH SOME MATHEMATICAL APPROACHES.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): PLASMA PROCESSING OF MATERIALS, SURFACE CLEANING, ETCHING, POWER/FUSION ENERGY, COHERENT RADIATION GENERATION, PLASMA PROCESSING OF TEXTILES, NITRIDING, SURFACE MODIFICATION, PLASMA BASED CHARGED PARTICLE ACCELERATORS, HALL THRUSTERS		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Processing plasma, plasma torch, plasma as a chemical catalyst, plasma for energetic particles, sputter generation of metal vapour flux	3
2	Precision cleaning techniques, plasma assisted cleaning, plasma cleaning reactors, measure of cleanliness, sterilisation and deodorisation of food containers, plasma cleaning of paintings	3
3	Etch requirement and processes, wet etching, dry etching, dry etch technologies/tools, reactive ion etcher (RIE), magnetically enhanced reactive ion etcher (MERIE), electron cyclotron resonance (ECR) tool, inductively coupled plasma (ICP) tool, etched materials and applications: Si etching, GaAs etching for low source grounding, GaAs/AlGaIn etching for HEMTs, substrate charging and damages	4
4	MHD power generator, Role of fusion energy, fusion reaction, nuclear energy by fission and fusion, fusion power generation: concepts of cross section, mean free path, and collision frequency, reaction rate, fusion power density, radiation losses; power balance in a fusion reactor, magnetic fusion reactor, critical reactor design parameters, nuclear physics constraints; tokamak, Stellarator, international thermonuclear experimental reactor (ITER)	8
5	Phase coherence and bunching, Cerenkov Free Electron Laser (FEL), Terahertz (THz) radiation, THz radiation sources: broadband sources, narrowband sources, THz detectors, applications of THz radiations in THz spectroscopy, material characterisation; THz imaging and tomography, biomaterial THz applications, medical imaging, x-ray generation	6
6	Plasma effects on textiles substrates, plasma textile technology, plasma activated dyeing, endless fibre surface engineering, treatment of nonwovens	2
7	Nitrogen interaction with metal surfaces, plasma nitriding and its variants, improvement of mechanical properties, plasma nitriding reactors	3
8	Plasma ion implantation, plasma ion implantation reactors, diamond like carbon, semiconductor doping	2
9	Electromagnetic waves and plasma interaction, particle acceleration: excitation of Langmuir waves/wakefield, laser beat wave acceleration, laser wakefield acceleration, self modulated laser wakefield acceleration, plasma wakefield acceleration, acceleration, acceleration using microwaves	5
10	Operation of a Hall thruster, Types of closed drift thruster: Dielectric Wall Thruster or Stationary Plasma Thruster (SPT), Thruster with Anode Layer (TAL), Performance of a Hall Thruster: Thrust, Impulse and Efficiency, Efficiency concerning Current, Ingredients of a Hall thruster: Propellant, Anode, Cathode, Discharge channel; Plasma Plume, Instabilities	6
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- 1) Principles of Plasma Discharges and Material Processing by M A Lieberman and A J Lichtenberg. Publisher: Wiley Interscience (2005).
- 2) Plasma Science and The Creation of Wealth by P I John. Publisher: Tata McGraw Hill (2005).
- 3) Plasma Physics and Fusion Energy by J Freidberg. Publisher: Cambridge University Press (2007).
- 4) Interaction of Electromagnetic Waves with Electron Beams and Plasmas by C S Liu and V K Tripathi. World Scientific (1994).
- 5) Wave Propagation / Book 2, INTECH Open Science, Croatia (2013).
<http://dx.doi.org/10.5772/52246>

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	MICROELECTRONIC DEVICES	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL306	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL201	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Rajendra Singh, J. P. Singh, R.D. Tarey, Mukesh Chander		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To introduce the students to the basics of semiconductor electronic devices such as pn junction, metal-semiconductor contacts, MOS capacitor, BJT, MOSFET, etc. They will learn about the various current transport processes in these electronic devices. They will study the electrical characteristics (I-V and C-V) of the electronic devices and understand the physics behind their operation.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Brief overview of semiconductor fundamentals; pn junction diode - energy-band diagrams, electrostatics, current-voltage relationship, junction breakdown mechanisms. Metal-semiconductor contacts: Schottky barrier diode, C-V and I-V		
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	characteristics of Schottky diode; ohmic contacts in semiconductors. MOS structure: Accumulation, depletion and inversion modes of operation, charge-voltage and capacitance-voltage behaviour, threshold and flatband voltages, fixed oxide and interface charge effects MOSFET: Output and transfer characteristics, I-V relations, nonideal effects, MOSFET scaling BJT: BJT action, current gain factors, modes of operation, I-V characteristics of a BJT, nonideal effects, cutoff frequency of a BJT.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Brief overview about fundamentals of semiconductors including carrier statistics, carrier transport and carrier recombination.	03
2	pn junction diode: pn junction structure, built-in potential barrier, electric field and potential distribution inside space charge region, junction capacitance; Ideal current-voltage (I-V) relationship, minority carrier distribution, diffusion resistance and diffusion capacitance of a junction diode, generation-recombination currents; Junction breakdown mechanisms in pn diode; Charge storage and diode transients.	08
3	Semiconductor heterojunctions: Heterojunction materials, various types of heterojunctions, two-dimensional electron gas formation	02
4	Metal-semiconductor contacts: Schottky barrier diode, Schottky and Bardeen models, concept of Fermi level pinning, capacitance-voltage (C-V) characteristics of a Schottky diode, nonideal effects on the barrier height; Current transport processes in metal-semiconductor contacts, thermionic emission current and ideal I-V characteristics; Ohmic contacts and its fabrication technology.	06
5	The MOS structure: Energy-band diagrams under accumulation, depletion and inversion conditions, work-function differences, flat-band voltage, threshold voltage, charge-surface potential relationship for a MOS structure; Capacitance-voltage (C-V) characteristics, frequency effects, fixed-oxide and interface charge effects, interface trap density in Si-SiO ₂ MOS structure.	08
6	MOSFET: MOSFET structures, current-voltage (I-V) relationships - concepts and derivation, transconductance, substrate bias effects, frequency limitation factors and cutoff frequency of a MOSFET; Nonideal effects - subthreshold conduction, channel length modulation, mobility variation, velocity saturation; MOSFET scaling.	08
7	Bipolar Junction Transistor (BJT): Basic principle of operation of a BJT, simplified transistor current relations, modes of operation; minority carrier distribution, forward active mode, current gain factors;; Nonideal factors - base width modulation, high injection, emitter bandgap narrowing; Frequency limitations - time-delay factors, transistor cutoff frequency.	07
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Suggested text:

1. D.A. Neamen, Semiconductor Physics and Devices, Third Edition, Tata McGraw-Hill.

Reference books:

2. S.M. Sze, Physics of Semiconductor Devices, Second Edition, John Wiley & Sons, 2005.
3. D.J. Roulston, Semiconductor Device Fundamentals, Addison-Wesley, 1996.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Normal infrastructure
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	LASERS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL311	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL105	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL334	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. R.K. Soni, Prof. K. Thyagarajan, Prof. M. R. Shenoy, Dr. Amartya Sengupta, Dr. Aloka Sinha		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To provide a detailed account of the basic physics, including resonator physics, and principle of operation, design and characteristics of Lasers. Some specific laser systems would also be discussed.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Interaction of Radiation with Matter: Einstein coefficients; Line shape function, Line-broadening mechanisms, Condition for amplification by stimulated emission, the meta-stable state and laser action. 3-level and 4-level pumping schemes Laser Rate Equations: Two-, three- and four-level laser systems, condition for population inversion, gain saturation; Laser amplifiers; Rare earth doped fiber amplifiers. Optical Resonators: Modes of a rectangular cavity, Plane mirror resonators, spherical mirror resonators, ray paths in the resonator, stable and		
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	unstable resonators, resonator stability condition; ring resonators; Transverse modes of laser resonators. Gaussian beams in laser resonators. Laser Oscillation: Optical feedback, threshold condition, variation of laser power near threshold, optimum output coupling, Characteristics of the laser output, oscillation frequency, frequency pulling, hole burning and the Lamb dip; Mode selection, single-frequency lasers; Methods of pulsing lasers, Q-switching, mode-locking. Some Laser Systems: Ruby, Nd:YAG, He-Ne, CO₂ and excimer lasers, Tunable lasers: Ti Sapphire and dye lasers, Fiber lasers, Semiconducto lasers; Laser safety.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Interaction of Radiation with Matter: Spontaneous and stimulated emissions, the Einstein coefficients; Line shape function, Line-broadening mechanisms: Homogeneous and inhomogeneous broadening, natural-, Doppler- and collision broadening. Rates of stimulated emission and absorption, condition for amplification by stimulated emission, the meta-stable state and laser action. 3-level and 4-level pumping schemes.	9
2	Laser Rate Equations: Two-, three- and four-level laser systems, condition for population inversion, gain saturation; Laser amplifiers, gain and bandwidth; Rare earth doped fiber amplifiers.	6
3	Optical Resonators: Modes of a rectangular cavity, density of modes, Plane mirror resonator: resonance frequencies, cavity loss, cavity lifetime and Q-factor; spherical mirror resonators, ray paths in the resonator, stable and unstable resonators, resonator stability condition; ring resonators; Transverse modes of laser resonators. Gaussian beams in laser resonators.	10
4	Laser Oscillation: Optical feedback, threshold condition, variation of laser power near threshold, optimum output coupling, Characteristics of the laser output, oscillation frequency, frequency pulling, hole burning and the Lamb dip; Mode selection, single-frequency lasers; Methods of pulsing lasers, Q-switching, mode-locking.	10
5	Some Laser Systems: Ruby, Nd:YAG, He-Ne, CO ₂ and excimer lasers, Tunable lasers: Ti Sapphire and dye lasers, Fiber lasers, Semiconductor lasers; Laser safety.	7
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')	
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18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. K. Thyagarajan and Ajoy Ghatak, Lasers: Fundamentals and Applications, 2nd Ed., Macmillan Publishers India Ltd. (2011).
2. W. T. Silfvast, Laser Fundamentals, Cambridge Univ. Press, Cambridge, 1996.
3. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, 2nd Ed., John Wiley & Sons, Inc. (2007), Ch.10, 13-15.
4. O. Svelto, Principles of Lasers, 4th Ed., Springer (1998).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	SEMICONDUCTOR OPTOELECTRONICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL312	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL105	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL336	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. R.K. Soni, Dr. G.V. Prakash, Dr. Amartya Sengupta, Prof. M. R. Shenoy		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To provide a detailed account of the basic physics, principle of operation, design and characteristics of semiconductor optoelectronic devices for applications in optoelectronics, optical communication and optical information processing. Specific emphasis is on semiconductor optical sources, amplifiers, modulators and photodetectors.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Energy bands in solids, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells. Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.		
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	Semiconductor Photon Sources: Electroluminescence. The LED, Semiconductor Laser, Single-frequency lasers; DFB and DBR lasers, VCSEL; Quantum-well lasers and quantum cascade lasers. Laser diode arrays. Semiconductor optical amplifiers (SOA), Electro-absorption modulators based on FKE and QCSE. Semiconductor Photodetectors: Types of photodetectors, Photoconductors, Photodiodes, PIN diodes and APDs: Quantum well infrared photodetectors (QWIP); Noise in photodetection;; Photonic integrated circuits - PICs
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Semiconductor Device Physics: Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells; Strained-layer quantum wells.	9
2	Interaction of photons with electrons and holes in a semiconductor: Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.	5
3	Semiconductor Photon Sources: Electroluminescence. The LED: Device structure, SLED and ELED; materials, device characteristics, and some applications	4
4	The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation. Single-frequency lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Quantum-well lasers and quantum cascade lasers. Laser diode arrays.	8
5	Semiconductor Optical Amplifiers & Modulators: Semiconductor optical amplifiers (SOA), SOA characteristics and some applications; Franz-Keldysh Effect (FKE) and Quantum-confined Stark Effect (QCSE). Electro-absorption modulators based on FKE and QCSE.	6
6	Semiconductor Photodetectors: Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Quantum well infrared photodetectors (QWIP); Photo-transistors and solar cells,	9
7	Photonic integrated circuits - PICs	1
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

N. A.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.
2. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communication, Oxford University Press (2007), 6th Ed., Ch.15-17.
3. G. Keiser, Optical Fiber Communications, McGraw-Hill Inc., 3rd Ed. (2000), Ch.4, 6.
4. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1995).
5. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	FOURIER OPTICS AND HOLOGRAPHY	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL313	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL105	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL443	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. Joby Joseph, Prof. P. Senthilkumaran, Dr. Kedar Khare, Prof. K. Thyagarajan, Prof. Anurag Sharma.		
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12.	Will the course require any visiting faculty?	NO	
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13.	Course objective (<i>about 50 words</i>): The course has been designed to introduce the students to basic principles of holography and optical information processing, and their applications in engineering and technology.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Signals and systems, Fourier transform (FT), FT theorems, sampling theorem, Space-bandwidth product; Review of diffraction theory: Fresnel-Kirchhoff formulation, Fresnel & Fraunhofer Diffraction and angular spectrum method,		
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	FT properties of lenses and image formation by a lens; Frequency response of a diffraction-limited system under coherent and incoherent illumination. Basics of holography, in-line and off-axis holography, plane and volume holograms, diffraction efficiency; Recording medium for holograms; Applications of holography: display, microscopy; memories, interferometry, NDT of engineering objects, Digital Holography etc.; Holographic optical elements. Analog optical information processing: Abbe-Porter experiment, phase contrast microscopy and other simple applications; Coherent image processing: vanderLugt filter; joint-transform correlator; pattern recognition, image restoration.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Signals and systems, Fourier transform (FT), FT theorems, sampling theorem, Space-bandwidth product	6
2	Review of diffraction theory: Fresnel-Kirchhoff formulation Fresnel & Fraunhofer Diffraction, and angular spectrum method, FT properties of lenses and image formation by a lens; Frequency response of a diffraction-limited system under coherent and incoherent illumination.	10
3	Basics of holography, in-line and off-axis holography, plane and volume holograms, diffraction efficiency; Recording medium for holograms; Applications of holography: display, microscopy; memories, interferometry, NDT of engineering objects, Digital Holography etc.; Holographic optical elements	12
4	Analog optical information processing: Abbe-Porter experiment, phase contrast microscopy and other simple applications;	4
5	Coherent image processing, vanderLugt filter; joint-transform correlator; pattern recognition; image restoration;	10
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Problems will be discussed during the course of lectures itself.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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10		
COURSE TOTAL (14 times 'P')		NA

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. J.W. Goodman: Introduction to Fourier Optics, McGraw Hill, New York, 1996.
2. J.D. Gaskill: Linear Systems, Fourier Transforms, and Optics, Wiley, New York, 1978.
3. E.G. Steward, Fourier Optics: An Introduction, Wiley, New York, 1983.
4. F.T.S. Yu: Optical Information Processing, Wiley, New York, 1983.

5. Papoulis: Systems and Transforms with Applications to Optics, McGraw Hill, New York, 1968.
6. A.B. VanderLugt: Optical Signal Processing, John Wiley, New York, 1992.
7. P. Hariharan, Optical Holography: Principle, Techniques and Applications, Cambridge University Press, Cambridge, 1983.
8. H. M. Smith, Principles of Holography, Wiley (Interscience), New York, 1969.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	15%
20.2	Open-ended problems	10%
20.3	Project-type activity	NIL
20.4	Open-ended laboratory work	NIL
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	LOW DIMENSIONAL PHYSICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL321	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (<i>course no./title</i>)	EPL201	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL335	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Dr. Rajendra Singh, Dr. J. P. Singh, Prof. R.K. Soni, Prof. B.R. Mehta		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To introduce the students to the basic physics of low dimensional systems such as quantum wells, quantum wires and quantum dots, band gap engineering, semiconductor heterostructures They will learn about the novel phenomena that occur in low dimensions such as quantum Hall effect and resonant tunneling; Also learn about some novel device application of low dimensional systems. Introduction to novel 2D materials such as graphene, topological insulators, and WS ₂ , and their properties.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Brief overview of band structure and density of states function for 0D, 1D and 2D systems, band gap engineering and semiconductor heterostructures. Quantum wells and their optical properties, multiple quantum wells and		
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	superlattices, Bloch oscillations. Two dimensional electron gas, modulation doped heterostructures, Quantum Hall effect. Quantum wires and nanowires, electronic transport, properties and applications. Quantum dots and their optical properties, Coulomb blockade. Device application of low dimensional systems: Double heterostructure laser, quantum cascade laser, high electron mobility transistors. 2D materials: Graphene, topological insulators, WS₂ and their properties.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Band structure in one, two and three dimensions; Density of states function for 1D, 2D and 3D systems.	04
2	Crystal structure and band structure of common semiconductors; General properties of heterostructures, growth of heterostructures, band gap engineering; Doped heterostructures, strained layers, SiGe heterostructures.	05
3	Quantum wells: Infinite and finite square well potentials, occupation of subbands, Quantum wells in heterostructures, electronic transitions in a quantum well, multiple quantum wells; Superlattices and minibands, Bloch oscillations.	05
4	Two dimensional electron gas (2DEG): Modulation doped semiconductor heterostructures and formation of 2DEG, triangular potential well and its wavenfunctions; Quantum Hall effect (QHE): Shubnikov de Haas oscillations, 2DEG at high magnetic field and low temperature, edge states, physics of QHE.	05
5	Quantum wires and nanowires: Growth and fabrication of semiconductor quantum wires/nanowire, electronic transport in 1D structures, novel properties and applications of nanowires.	05
6	Quantum dots: Growth of semiconductor quantum dots, optical properties of QDs, Coulomb blockade and single electron transistor,	04
7	Resonant tunneling phenomena, tunneling in heterostructures, resonant tunneling diode (RTD).	03
8	Device applications of low-dimensional systems: Double-heterostructure lasers, Quantum cascade lasers; High electron mobility transistors (HEMTs).	05
9	Two-dimensional materials: Graphene - Electronic band structure, electrical, mechanical, optical and thermal properties, applications of graphene; Structure and properties of other 2D materials such as MoS ₂ , WS ₂ and WSe ₂ ; Topological Insulators(TI): Characteristics of TIs, electronic band structure, spin quantum hall effect in TIs, novel physical phenomena such as existence of Majorana Fermions.	06
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NA	
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Suggested text:

1. The Physics of Low-Dimensional Semiconductors, J.H. Davies, Cambridge University Press, 1998.

Reference books:

2. Transport in nanostructures, D.K. Ferry, S.M. Goodnick, and J. Bird, Cambridge University Press, 2009.
3. Electronic transport in mesoscopic systems, Supriyo Datta, Cambridge Univ. Press, 1995.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	NA
19.5	Equipment	NA
19.6	Classroom infrastructure	Normal infrastructure
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	NA
20.4	Open-ended laboratory work	NA
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	NANOSCALE FABRICATION	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL322	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL201	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course B.R.Mehta, J.P. Singh, Rajendra Singh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The central objective of this course is to principles important for the growth and fabrication of nanoscale material and device fabrication		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Nucleation and growth, Basics priciples involved in growth with controllable dimensions, Chemicial and physical techniques for growth of nanoparticle, nanorod, ultrathin films, monolayer materials, multilayer structures, nanocomposite materials. Self organized growth on substrates and templates. Micro and nanoscale patterning techniques		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Nucleation and growth, hetrogenous and homogenous growth	4
2	Gas phase growth of nanostructures	4
3	PVD and CVD techniques for growth on substrates	5
4	Oblique and glancing angle deposition techniques	4
5	Growth in micro and nanoscale templates	4
6	Mechanisms and techniques for nanorod and CNT growth	5
7	Self organized growth	3
8	Growth of graphene and other monolayer materials	3
9	Growth of nanocomposite and nanoscale hybrid materials	4
10	Dip pen and 3D printing techniques	3
11	Ion beam and laser based micro and nanoscale patterning	3
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. K.L. Chopra, Thin Film Phenomenon, Robert E. Krieger Publishing Company, 1979
2. Milton Ohring, Material Scienc of Thin Films, Academic Press, 2001.
3. Gregory Timp, Nanotechnology, Springer, 2005
4. Vincenzo Turco Liveri, Controlled Synthesis of Nanoparticles in Microheterogeneous Systems, Springer, 2006

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	

19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	NANOSCALE MICROSCOPY	
3.	L-T-P structure	2 - 0 - 0	
4.	Credits	2	
5.	Course number	EPL323	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course JP SINGH, RAJENDRA SINGH, B.R.MEHTA , G.B. REDDY		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to learn state of the art experimental techniques to image and analyze materials down to nanoscale.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Scanning probe microscopy such as scanning electron microscope, atomic force microscope, scanning electron microscope. Transmission electron microscope with high resolution and near field optical microscopy.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	General principle of a scanning tunneling microscope (STM), Theoretical analysis of tunnel current, resolution and contrast of STM, STM spectroscopy, spectroscopy of quantum dots.	5
2	General principle of atomic force microscope (AFM), various imaging mode of AFM, Image resolution, nanoindentation, adhesive imaging, conducting AFM and magnetic force microscopy.	5
3	Basic principle of scanning electron microscope, Electron material interaction, secondary and backscattered electrons, image contrast, resolution and analysis, energy dispersive x-ray analysis.	5
4	Basic principle of transmission electron microscope, dark field and bright field imaging, selected area diffraction, composition mapping, cross sectional analysis, lattice imaging.	8
5	Basic concept of near field microscopy, Photon scanning tunneling microscope, apertureless near field microscope, Aperture SNOM, Diffraction limit and beyond.	5
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COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NONE	
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Recommended Books:

1. Materials Characterization Technique: S. Zhang, L. Li and A. Kumaret CRC Press, 2008.
2. An Introduction to Materials Characterization: P. R. Khangaonkar, PENRAM Int, 2010.

3. Nanoscience by Dupa, Houddy and Lahmani, Springer, 2004.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility.
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	SPECTROSCOPY OF NANOMATERIALS	
3.	L-T-P structure	2 - 0 - 0	
4.	Credits	2	
5.	Course number	EPL324	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)		
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Pankaj Srivastava, G.V. Prakash, Santanu Ghosh		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to learn fundamentals of optical and X-ray spectroscopic techniques used in the characterization of nanomaterials.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Absorption and Reflection spectroscopy, molecular spectroscopy fundamentals, band-gaps and quantum confinement effects, Photoluminescence and Electroluminescence spectroscopy: Origin of emissions, Infrared and Raman Spectroscopy: Vibration spectroscopy principles, Time-domain spectroscopy, Nonlinear optical spectroscopy, Single molecule single nanoparticle detection, X-Ray Diffraction: Overview of basics, Intensities of Diffracted Beams, Structure of Polycrystalline Aggregates, Determination of crystallite size, X-Ray Absorption Spectroscopy: Fundamentals, Qualitative analysis of XANES and EXAFS data, X-Ray Photoelectron Spectroscopy and Auger Electron Spectroscopy: Principles of the method, initial- and final-state effects, Applications and case studies using		
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	all techniques specific to nanomaterials, Introduction to synchrotron radiation and its application to study nanomaterials.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Absorption and Reflection spectroscopy: Operating principle and Beer's law, oscillator strengths, molecular spectroscopy fundamentals, band-gaps and quantum confinement effects, instrumentation, case studies specific to nanomaterials	04
2	Photoluminescence and Electroluminescence spectroscopy: Origin of emissions, Instrumentation, case studies specific to nanomaterials	03
3	Infrared and Raman Spectroscopy: Vibration spectroscopy principles (brief), Instrumentation and data analysis, case studies specific to nanomaterials	03
4	Time-domain spectroscopy: Transient absorption, Emission life times, photocarrier dynamics, Instrumentation. Nonlinear optical spectroscopy: material characteristics, Instrumentation. Single molecule single nanoparticle detection: Techniques and advantages	04
5	X-Ray Diffraction: Overview of basics, Directions of Diffracted Beams, Intensities of Diffracted Beams, Structure of Polycrystalline Aggregates, Determination of crystallite size, case studies specific to nanomaterials	06
6	X-Ray Absorption Spectroscopy: Fundamentals, Qualitative analysis of near edge (XANES) and far edge structures (EXAFS), instrumentation, Applications and case studies specific to nanomaterials	03
7	X-Ray Photoelectron Spectroscopy and Auger Electron Spectroscopy: Atomic Model and Electron Configuration, Principles of the method, initial- and final-state effects, instrumentation, limits of XPS, Applications and case studies specific to nanomaterials	03
8	Introduction to synchrotron radiation and its application to study nanomaterials.	02
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COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

In addition to lecture hours visits to laboratories will be organized.
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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NONE	
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Recommended Books:

- (1) Optical Properties and Spectroscopy of Nanomaterials, by Jin Zhong Zhang, World Scientific, (2009).
- (2) Materials Characterization Techniques, Sam Zhang, Lin Li and Ashok Kumar, CRC Press (2008).
- (3) Fundamentals of Nanoscale Film Analysis, Terry L. Alford, Leonard C. Feldman, James W. Mayer, Springer (2007).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics Department	
2.	Course Title (<i>< 45 characters</i>)	APPLIED QUANTUM MECHANICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL331	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, Sankalpa Ghosh, Joyee Ghosh		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The main objective is to make the students learn the techniques of calculation and their application to concrete problems of atomic physics, solid state physics and quantum optics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): 1. Electron in a magnetic field, Landau levels, Quantum Hall effect, Aharonov-Bohm effect. 2. Non-degenerate and Degenerate Time-independent perturbation theory, Examples, Stark effect, Atomic fine-structure, Atomic Hyperfine-structure, Zeeman Effect. 3. Variational method, Examples, WKB Approximation, Examples and comparison. 4. Time-dependent Perturbation theory, Examples, Fermi Golden Rule.		
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	Interaction of radiation with matter: Absorption and emission of radiation, Selection rules. 5. Scattering theory: Scattering amplitude, Differential and total cross-sections, Born's Approximation, Scattering by spherically symmetric potentials, Examples, Rutherford's formula for Coulomb scattering, Partial wave analysis and Optical theorem, Examples. 6. Relativistic Quantum Mechanics: Klein-Gordon equation, Properties of the free-particle KG equation including negative energy solutions. 7. Dirac equation, The Dirac matrices and Dirac algebra. Spin of the Dirac particle. Dirac particle in an electromagnetic field, including the Pauli equation, magnetic moment and the g-factor, Free particle plane wave solutions, including negative and positive energy solutions.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Electron in a magnetic field, Landau levels, Quantum Hall effect, Aharonov-Bohm effect.	5
2	Non-degenerate and Degenerate Time-independent perturbation theory, Examples, Stark effect, Atomic fine-structure, Atomic Hyperfine-structure, Zeeman Effect.	7
3	Variational method, Examples, WKB Approximation, Examples and comparison.	4
4	Time-dependent Perturbation theory, Examples, Fermi Golden Rule. Interaction of radiation with matter: Absorption and emission of radiation, Selection rules.	8
5	Scattering theory: Scattering amplitude, Differential and total cross-sections, Born's Approximation, Scattering by spherically symmetric potentials, Examples, Rutherford's formula for Coulomb scattering, Partial wave analysis and Optical theorem, Examples.	6
6	Relativistic Quantum Mechanics: Klein-Gordon equation, Properties of the free-particle KG equation including negative energy solutions.	4
7	7. Dirac equation, The Dirac matrices and Dirac algebra. Spin of the Dirac particle. Dirac particle in an electromagnetic field, including the Pauli equation, magnetic moment and the g-factor, Free particle plane wave solutions, including negative and positive energy solutions.	8
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COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
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COURSE TOTAL (14 times 'P')	
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18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. D.J. Griffiths: Introduction to Quantum Mechanics (2nd Edition, Pearson, 2005)
2. R. Shankar: Principles of Quantum Mechanics (2nd Edition, Springer 1994)
3. C. Cohen-Tannoudji, B. Diu, F. Laloë: Quantum Mechanics (Volumes 1 and 2)

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	None
19.2	Hardware	None
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	None
19.5	Equipment	None
19.6	Classroom infrastructure	yes
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	GENERAL RELATIVITY AND COSMOLOGY	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL332	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL203	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	None	
8.2	Overlap with any UG/PG course of other Dept./Centre	None	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, Amruta Mishra		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To impart the basic tools and understanding of the physical concepts of the general theory of relativity and cosmology. This course will prepare the student for pursuing a career in cosmology and astrophysics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Revision of special relativity, Notations, Equivalence principle, Introduction to tensor calculus, Metric, Parallel transport, covariant derivative and Christoffel symbols, Geodesic, Riemann curvature tensor, Ricci tensor, Geodesic deviation equation, Stress-Energy tensor, Einstein equation, Meaning of Einstein equation, Schwarzschild solution, Trajectories in Schwarzschild		
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	space-time, Perihelion shift, Binary pulsars, Gravitational deflection of light, Gravitational lensing, , Gravitational collapse, Black holes, Hawking Radiation, Gravitational waves, Cosmology: Models of the universe and the cosmological principle, Cosmological metrics, Types of universe, Robertson-Walker universes, Big Bang, Dark energy.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Revision of special relativity, Notations	1
2	Equivalence principle	1
3	Introduction to tensor calculus	5
4	Metric, Parallel transport, covariant derivative and Christoffel symbols, Geodesic	3
5	Riemann curvature tensor, Ricci tensor, Geodesic deviation equation, Stress-Energy tensor, Einstein equation, Meaning of Einstein equation	6
6	Schwarzschild solution, Trajectories in Schwarzschild space-time, Perihelion shift, Binary pulsars, Gravitational deflection of light, Gravitational lensing	6
7	Gravitational collapse, Black holes, Hawking Radiation	5
8	Gravitational waves	2
9	Models of the universe and the cosmological principle	2
10	Cosmological metrics, Types of universe	3
11	Robertson-Walker universes	4
12	Big Bang, Dark energy.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Bernard Schutz: A First Course in General Relativity
2. James Hartle: Introduction to General Relativity

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility

19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	QUANTUM ELECTRONICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL411	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. K.Tyagarajan, Prof. R.K. Soni, Dr. Amartya Sengupta		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): This course addresses the basic physics of nonlinear optical phenomena such as harmonic generation, parametric processes and self-phase modulation and applications in laser amplifier/oscillator and optical fibre communications. The course provides basic understanding of quantum nature of light which is playing a very important role in the field of quantum information science with applications in quantum cryptography, quantum computing etc..		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Light propagation through anisotropic media, nonlinear effects, nonlinear polarization, Second harmonic generation, sum and difference frequency generation, parametric amplification, parametric fluorescence and oscillation, concept of quasi--phase matching; periodically poled materials and their		
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	applications. Third-order effects: self-phase modulations, temporal and spatial solitons, cross-phase modulation, stimulated Raman and Brillouin scattering, four-wave mixing, phase conjugation. Quantization of the electromagnetic field; number states, coherent states and their properties: squeezed states of light and their properties, application of optical parametric processes to generate squeezed states of light, entangled states and their properties; Generation of entangled states; Quantum eraser, Ghost interference effects; Applications in quantum information science. Ultra-intense laser-matter interactions
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Brief review of electromagnetic waves, light propagation through anisotropic media, nonlinear effects, nonlinear polarization	6
2	Second-order effects: second harmonic generation, sum and difference frequency generation, parametric amplification, parametric fluorescence and oscillation, concept of quasi--phase matching; periodically poled materials and their applications in nonlinear devices.	10
3	Third-order effects: self-phase modulations, temporal and spatial solitons, cross-phase modulation, stimulated Raman and Brillouin scattering, four-wave mixing, phase conjugation.	10
4	Quantization of the electromagnetic field; number states, coherent states and their properties: squeezed states of light and their properties, application of optical parametric processes to generate squeezed states of light, entangled states and their properties; Generation of entangled states; Quantum eraser, Ghost interference effects; Applications in quantum information science	14
5	Ultra-intense laser-matter interactions	2
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
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5		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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| <ol style="list-style-type: none"> 1. Yariv A, Quantum Electronics, John Wiley, NY, 1989. 2. Gahtak A and Thyagaraja K, Optical Electronics, Cambridge Univ Press, UK, 1989. 3. Saleh B E A and Teich M C, Fundamentals of Photonics, John Wiley, 2007. |
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4. Agarwal G P, Nonlinear Fiber Optics, Academic Press, Boston, 1989

ADDITIONAL READINGS

1. Quantum optics, O Scully and M S Zubairy, Cambridge Univ. Press, UK, 1997.
2. Lasers: Theory and Applications, K. Thyagarajan and A. K. Ghatak, Plenum Press, N.Y., 1981; Reprinted by Macmillan India.
3. Introductory Quantum Optics, C. Gerry and P. Knight, Cambridge University Press, 2005.
4. The Quantum Challenge, Jones and Bartlett, Ma, USA, 2006.
5. Quantum Optics: An Introduction, M. Fox, Oxford Univ. Press, 2006.
6. Principles of Nonlinear Optics, Y R Shen, John Wiley, Singapore, 1988.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ULTRAFAST LASER SYSTEMS AND APPLICATIONS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL412	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL311	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL441	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. R.K. Soni, Dr. G.V. Prakash, Dr. Amartya Sengupta		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): The course provides a detailed account of physical phenomena for generation and measurment of ultrashort laser pulses (pico, femto- and atto second) and their applications in emerging in science and technology.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Review of Laser Physics: Gain media, laser oscillation, spectral line broadening, mode selection, Q-switching and mode-locking. Generation of Ultrashort Pulses: Temporal, spectral and spatial properties of pulses, Group velocity dispersion, Self-phase modulation; Pulse chirping, broadening and compression; Optical solitons, Chirp filters; High repetition-rate, high-energy few-cycle pulses. Measurement of Ultrashort Pulses: Optical and electronic pulse profiling; Intensity autocorrelation; Spectral measurement and frequency gating, FROG; Spectral interferometry, SPIDER. Ultrafast Optical Processes:		
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	Higher harmonic generation, Supercontinuum generation, Attosecond generation, Ultra-wideband optical parametric amplification. Femtosecond Laser Systems: Solid-state laser and fiber laser based systems, next-generation mid-IR lasers. Ultrafast Laser Processing: Laser ablation and surface micro/nano-structuring, Laser inscription of photonic devices, fabrication of optical waveguides and micro-fluidic chips. Ultrafast Spectroscopy: Transient absorption and emission spectroscopy, Terahertz spectroscopy; Femtosecond optical frequency combs and their applications.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Laser Physics: Gain media, laser oscillation, spectral line broadening, Longitudinal- and transverse modes, mode selection, Q-switching and mode-locking.	5
2	Generation of Ultrashort Pulses: Temporal, spectral and spatial properties of pulses, Group velocity dispersion, Self-phase modulation; Pulse chirping, broadening and compression; Optical solitons, Chirp filters; High repetition-rate, high-energy few-cycle pulses.	9
3	Measurement of Ultrashort Pulses: Optical and electronic pulse profiling; Intensity autocorrelation; Spectral measurement and frequency gating, FROG; Spectral interferometry, SPIDER.	6
4	Ultrafast Optical Processes: Nonlinear optical frequency conversion, Higher harmonic generation, Supercontinuum generation, Attosecond generation, Ultra-wideband optical parametric amplification	8
5	Femtosecond Laser Systems: Solid-state laser (Ti:Sapphire) and fiber laser based systems, next-generation mid-IR lasers.	4
6	Ultrafast Laser Processing: Laser ablation and surface micro/nano-structuring, Laser inscription of photonic devices in transparent materials, fabrication of optical waveguides and micro-fluidic chips	6
7	Ultrafast Spectroscopy: Transient absorption and emission spectroscopy, Terahertz spectroscopy; Femtosecond optical frequency combs and their application to optical clocks and frequency metrology.	4
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9		
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Course will have build-in design and problem solving components

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Silfvast W. T., Laser Fundamentals, Cambridge University Press 2004.
2. Weiner A.M. Ultrafast Optics, John Wiley 2009.
3. Trebino, R, Frequency-resolved optical gating: the measurement of ultrashort laser pulses
4. Diels, J.C, Rudolph, W, Ultrashort Laser Pulse Phenomena: Fundamentals, Techniques, and Applications on a Femtosecond Time Scale (2nd Edition), Elsevier 2006..
5. Sugioka K. and Cheng Y, Ultrafast Laser Processing: From Micro- to Nanoscale, Pan Stanford Publishing 2013.

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	x
19.2	Hardware	x
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	FIBER AND INTEGRATED OPTICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL413	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL105	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Prof. K. Thyagarajan, Prof. Arun Kumar, Prof. Anurag Sharma, Prof. M.R. Shenoy, Dr. R.K. Varshney		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): Fiber and Integrated Optics has important applications in the area of optical communications and sensing. The objective of this course is to teach the fundamental principles involved in the understanding of various applications of Fiber and Integrated Optics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Modes in planar optical waveguides: TE and TM modes, Modes in channel waveguides: Effective index and Perturbation method . Directional coupler: coupled mode theory, Integrated Optical devices: Prism Coupling, optical switching and wavelength filtering etc. Step Index and graded index fibers, Attenuation in optical fibers, LP Guided Modes of a step-index fiber, Single-mode fibers, Gaussian approximation and splice loss.		
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	Pulse dispersion, Dispersion compensation, Optical communication Systems and recent trends. Fiber fabrication technology and fiber characterization Periodic interaction in waveguides: Coupled Mode Theory, Fiber Bragg Gratings, Long period Gratings and applications, Optical fiber sensors; basic principles and applications.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Modes in planar optical waveguides: TE and TM modes	5
2	Modes in channel waveguides: Effective index and Perturbation method	3
3	Directional coupler: coupled mode theory, Some integrated Optical devices: Prism Coupling, optical switching and wavelength filtering etc,	6
4	Step index and graded index fibers, Attenuation in optical fibers, LP Guided Modes of a step-index fiber	5
5	Single-mode fibers, Gaussian approximation and splice loss	2
6	Pulse dispersion, Dispersion compensation	3
7	Optical communication Systems and recent trends	4
8	Fiber fabrication technology and fiber characterization	3
9	Periodic interaction in waveguides: Coupled Mode Theory	3
10	Fiber Bragg Gratings, Long period Gratings and applications	3
11	Optical fiber sensors; basic principles and applications	5
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
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5		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. A.K.Ghatak and K.Thyagarajan, "Optical Electronics" Cambridge University Press (1989),
2. A.K.Ghatak and K.Thyagarajan, "Introduction to Fiber Optics", Cambridge University Press (1998).
3. G. Keiser, "Optical Fiber Communications" McGraw-Hill, Inc. New Delhi (1991) .
4. A. Yariv and P. Yeh, "Photonics", Oxford University Press (2007).

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	Matlab
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19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	10%
20.2	Open-ended problems	10%
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING OPTICS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	EPL414
6.	Status (<i>category for program</i>)	DE for EP

7.	Pre-requisites (course no./title)	EPL105
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	IDL731
8.3	Supercedes any existing course	No

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Anurag Sharma, Joby Joseph, B.D. Gupta, P. Senthilkumaran, Kedar Khare	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): This course is intended to give the students, an exposure to the working principles of various optical systems and components. The topics covered in this course will have direct applications to many present day opto-electronic, imaging, reconnaissance, diagnosis, testing, security and entertainment engineering systems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Lens systems and basic concepts in their design; Optical components: Mirrors, prisms, gratings and filters; Sources, detectors and their characteristics; Optical systems: Telescopes, microscopes, projection systems, photographic	
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	systems, interferometers and spectrometers; Concepts in design of optical systems; Applications in industry, defense, space and medicine; CCD, compact disc, scanner, laser printer, photocopy, laser shows, satellite cameras, IR imagers, LCD, Spatial Light modulators.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Lens systems and basic concepts in their design	8
2	Optical components: Mirrors, prisms, gratings and filters	5
3	Sources, detectors and their characteristics	6
4	Optical systems: Telescopes, microscopes, projection systems photographic systems, interferometers and spectrometers	9
5	Concepts in design of optical systems	8
6	Applications in industry, defense, space and medicine; CCD, compact disc, scanner, laser printer, photocopy, laser shows, satellite cameras, IR imagers, LCD, Spatial Light modulators.	6
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12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

Problems will be discussed during the course of lectures itself.

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- (i) Optical Principles and Technology for Engineers by J.E. Stewart, Marcel Dekker Inc., 1996.
- (ii) Principles of Optical Engineering by Francis T.S. Yu, John Wiley & Sons, 1990.
- (iii) Principles of Modern Optical Systems by I. Andonovic and D. Uttamchandani, Artech House, MA 1989.
- (iv) Engineering Optics by K.J. Habell and A. Cox, Sir Isaac Pitman & Sons Ltd. London, 1960.
- (v) Optics and Optical Instruments by B.K. Johnson, Dover Publications Inc., New York, 1960.

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	15%
20.2	Open-ended problems	10%
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	FUNCTIONAL NANOSTRUCTURE	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL421	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL201	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	EPL444	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course J.P. Singh, B.R. Mehta, P.K. Muduli, Pintu Das, G.V. Prakash		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): Basic course for undergraduate to give them idea about current applications of nanoscience and nanotechnology in different fields.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basics of low dimensional structures, QD, QW, nanostructures for optical and electronic applications, QD lasers, detectors, SET, Carbon based nanostructures, CNT, CNT optical, electrical, mechanical, chemical properties, sensors, drug delivery, photonic crystals, GMR, nanostructured magnetism, hydrogen storage, nanoclays, colloids, nanomachines, organic and biological nanostructures.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basics of low dimensional structures, density of states	6
2	QD, QW, nanostructures for optical and electronic applications	4
3	QD lasers, Coulomb blockade, single electron transistor, qubits	4
4	Quantum Hall effect, Schrodinger equation in electric and magnetic field	5
5	Carbon based nanostructures, CNT, graphene, optical, electrical, mechanical, chemical properties of these materials	5
6	GMR, nanostructured magnetism, hydrogen storage	4
7	nanoclays, colloids, nanomachines, organic and biological nanostructures, drug delivery	5
8	nanophotonics	4
9	characterization tools for nanoscience, different synthesis methods for nanostructures	5
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
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10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- Poole and Owens, Introduction to Nanotechnology, Publication John Wiley & Sons, Ltd. 2003
- Edited by Robert Hamley and Geoghegan, Nanoscale Science and Technology Publication John Wiley & Sons, Ltd. 2005
 - Edited by Fahrner, Nanotechnology and Nanoelectronics, Publication Springer, 2004.
 - Edited by Klabunde Nanoscale Materials in Chemistry Publication Wiley Interscience, 2001

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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	DLP projector
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	SPINTRONICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL422	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	None	
8.2	Overlap with any UG/PG course of other Dept./Centre	None	
8.3	Supercedes any existing course	EPL446	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Sujeet Chaudhary, P. K. Muduli, Pintu Das		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): Providing foundation for the important emerging area of spin based electronics via the new concepts in magnetism, nano-magnetism and spin-based effects; magnetic data storage in the high and ultra density regime; and high speed & GHz frequency communication. The course will discuss the ongoing and future applications and devices in the area.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Spintronics, its need and future vision; Basics of magnetic materials, spin orbit interaction, spin polarized current and their injection, accumulation and detection, Magnetoresistance and concepts of spin detection and magnetic memory; Spin valves & GMR, CIP and CPP transport, Semiclassical transport models; Basics of spin valve and magnetic tunnel junctions, Tunnel magnetoresistance, Quantum mechanical model of coherent tunneling and Giant TMR; Magnetic anisotropies and exchange bias, Spin valves with AF and SAF		
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	layers, Magnetization switching in AF and SAF layers, Magnetic domains and domain walls, single domain nano-particles; Pure spin and charge currents, spin-Hall effect and inverse spin-Hall effect, spin Seebeck effect, magnetocaloric effect, generation of spin current by charge and thermal current; Current induced magnetization switching, Spin torque effect and spin torque oscillators of tunable GHz frequency; High density data storage: MRAM, two stable states, half-select problem, Sato switching and Toggle MRAM; Ultra high density devices: Current & STT driven DW motion: Race track memory, Shift resistor; Q-bits and spin logic.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Overview: What is Spintronics? Its advantages over the conventional electronics; Applications; Overview to the new concepts and physical phenomena that drive the area of Spintronics; Future vision	2
2	Basics of magnetic metals and half-metallic systems: Magnetic moments of electrons and atoms; Langevin's theory of paramagnetism, Concept of Molecular field; Quantum theory of Paramagnetism & space quantization, Crystal Field	3
3	Ferromagnets (FM) -, Exchange Splitting in a ferromagnets, Band structure - Fermi level, Majority & minority spins; Half metals, Spin polarization & its measurement – Andreev Reflection technique;	3
4	Magnetic domains – formation and domain wall width, Single domain and Superparamagnetic particles, Ferromagnetic Semiconductors, Exchange interaction via Magnetic Polarons, and RKKY mechanism	3
5	Antiferromagnets(AF), Exchange coupling in an AF/FM bilayers, Magnetization switching in AF and SAF layers	3
6	Anisotropic Magnetoresistance (AMR) and Spin-orbit interaction; Anomalous Hall Effect; Spin-dependent transport – Giant Magnetoresistance(GMR) effect, Metallic Multilayers and Spin Valves; Applications in Magnetoresistive read heads – basic principle, GMR based CIP and CPP heads, signal to noise ratio	6
7	Spin dependent tunneling – Tunnel magnetoresistance (TMR), Bias dependence of TMR;Magnetic tunnel junctions (MTJs), Tunneling conductance measurement for determination of barrier height and barrier thickness; Resonant tunneling;Half metals and Exchange bias in MTJs, Spin Filters;Magnetic Random Access Memories (MRAMs)	7
8	Spin currents from charge current &Spin Hall Effect, Charge current from Spin current and Inverse Spin Hall effect; Experimental on SHE and ISHE	5
9	Spin dynamic effects at Microwave frequencies; Mechanisms of Damping in the spin precession; Ferromagnetic resonance technique as a tool to investigate spin dynamics;Spin-transfer torque effects - Spin pumping;	7
10	Current driven domain wall Motion &Race track memory – next generation memory technology; Quantum bits	3
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
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6		
7		
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COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Magnetoelectronics by Mark Jhonson, Academic Press, UK, 2004, Indian Edition 2005
2. Magnetism in Condensed Matter by Stephen Blundell, Oxford University Press, 2001
3. Spin Transport and Magnetism by E.Y. Tsymbal and Igor Zutic, CRC Press, 2012
4. Introduction to Magnetic Materials by B.D. Culity and C.D. Graham, Wiley, 2009

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	15
20.2	Open-ended problems	15
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	NANOSCALE ENERGY MATERIALS AND DEVICES	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL424	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL201	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course JP SINGH, RAJENDRA SINGH, B.R.MEHTA, NEERAJ KHARE		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The objective of this course is to teach physics conepts involoved in the use of nanoscale materials and devices for energy applications such as photovoltaic cells, thermoelectric materials, photoelectrochemical cells.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Basics of photovoltaics, Quantum confinement and plasmonics in photovoltaic devices, Nanorod solar cells, Principle of operation of hybrid and dyesensitized solar cells, Nanoscale materials for improving thermoelectric figure of merit, Photoelectrochemical cells		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Basics principles of photovoltaics, silicon and thin film solar cell devices and technology	6
2	Plasmonic properties of metal nanoparticles, Dependence of plasmonic properties on size, shape and core-shell configuration, Application of nanostructures for increased absorption and light trapping	6
3	Concepts of Up conversion and down conversion of energy, Application of nanostructures for realization of these concepts.	4
4	Hot carrier solar cell, Electron thermalization processes, New materials for hot carrier solar cells, Resonant tunneling contacts,	4
5	Nanoparticle and nanorod solar cells, Bandgap tuning and directional flow of carriers, Device fabrication techniques.	4
6	Hybrid, Dye-sensitized, solid state dye sensitized and Gratzel solar cells	6
7	Basics of thermoelectric materials, Electron and phonon transport in nanocomposite materials, 'Electron crystal and phonon gas' concepts for enhancing figure of merit	6
8	Basics of photoelectrochemical cells, solar to hydrogen conversion Concepts of energy level alignments, semiconductor-electrolyte interface, nanostructured, nanocomposite and porous materials	6
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	NONE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Das and Chopra, Thin Film Solar cells, Springer, 1983.
2. T.J Coutts and J.D.. Meakin, Current Topics in Photovoltaics, Academic Press, 1985

3. Tetsuo Soga, Nanostructured Materials for Solar Energy Conversion, Springer, 2006.
4. V. Badescu, Physics of Nanostructured Solar Cells, Nova Science Publishers, Inc. 2010
5. M.D.Archer, Nanostructured And Photoelectrochemical Systems For Solar Photon Conversion, Imperial College Press, 2010.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics Department
2.	Course Title (<i>< 45 characters</i>)	RELATIVISTIC QUANTUM MECHANICS
3.	L-T-P structure	2 - 0 - 0
4.	Credits	2
5.	Course number	EPL431
6.	Status (<i>category for program</i>)	DE for EP

7.	Pre-requisites (<i>course no./title</i>)	EPL102
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Ajit Kumar, Amruta Mishra, Sankalpa Ghosh
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12.	Will the course require any visiting faculty?	No
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13.	Course objective (<i>about 50 words</i>): Learn in detail the relativistic quantum mechanics and its applications.
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Revision of Lorentz transformations, relativistic notations, Lorentz group. The Klein-Gordon equation, negative and positive energy solutions. Charged spin-zero particle, Difficulties with K-G theory. The Dirac equation, Relativistic invariance, Relativistic invariance, spin and energy projection operators.. Nonrelativistic limit, Pauli equation, Solutions and their properties. Dirac sea, Anti-particle, Klein paradox, Fodly-Wouthuysen representation. Hydrogen atom, Dirac electron in an electromagnetic field, Charge conjugation.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Revision of Lorentz transformations, relativistic notations, Lorentz group.	6
2	The Klein-Gordon equation, negative and positive energy solutions.	3
3	Charged spin-zero particle, Difficulties with K-G theory.	2
4	Dirac equation, Relativistic invariance, spin and energy projection operators.	4
5	Nonrelativistic limit, Pauli equation, Solutions and their properties.	5
6	Dirac sea, Anti-particle, Klein paradox, Fodly-Wouthuysen representation.	3
7	Hydrogen atom, Dirac electron in an electromagnetic field, Charge conjugation.	5
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. J.D. Bjorken and S.D. Drell: "Relativistic Quantum Mechanics", McGraw-Hill 1964.
2. J. J. Sakurai: "Modern Quantum Mechanics", 2nd ed., Addison-Wesley, 1994.
3. F. Mandl and G. Shaw: "Quantum Field Theory", John Wiley & Sons.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
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19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics Department	
2.	Course Title (<i>< 45 characters</i>)	QUANTUM ELECTRODYNAMICS	
3.	L-T-P structure	3 - 0 - 0	
4.	Credits	3	
5.	Course number	EPL432	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (<i>course no./title</i>)	EPL101 and EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (<i>indicate program names</i>)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, Amruta Mishra		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): Learn in detail the fundamentals and applications of quantum electrodynamics.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Lagrangian formulation of classical field theory, Field equations, symmetries, Noether's theorem and conservation laws. Energy-momentum tensor. Classical field equations: Neutral and charged scalar fields, Electromagnetic field, Dirac field, Momentum representation, Second quantization of the free fields, Interacting fields, interaction picture, Dyson-series, Feynman diagrams and Feynman rules for quantum electrodynamics. Wick's theorem. Cross-section and S-matrix, Moeller and Bhabha scattering, Compton scattering, photoelectric effect etc. Divergence, Renormalization technique, Mass and charge renormalization.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Lagrangian formulation of classical field theory, Field equations.	2
2	Symmetries: External and internal, Noether's theorem and conservation laws. Energy-momentum tensor.	4
3	Classical field equations: Neutral and charged scalar fields, Electromagnetic field, Dirac field.	3
4	Momentum representation, Second quantization of the free fields.	4
5	Interacting fields, Interaction picture, Perturbation theory and Dyson series.	3
6	Feynman diagrams and Feynman rules for quantum electrodynamics.	5
7	Wick's theorem, Cross-section and S-matrix.	4
8	Moeller and Bhabha scattering, Compton effect, photoelectric effect etc.	10
9	Divergence, Renormalization technique.	4
10	Mass and charge renormalization.	3
11		
12		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities

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17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. M. Peskin and D. Schroeder, An Introduction to Quantum Field Theory
2. M Srednicki, Quantum Field Theory
3. S. Weinberg, The Quantum Theory of Fields, Vol 1

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
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19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Physics	
2.	Course Title (<i>< 45 characters</i>)	INTRODUCTION TO GAUGE FIELD THEORIES	
3.	L-T-P structure	2 - 0 - 0	
4.	Credits	2	
5.	Course number	EPL433	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL101 and EPL102	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	No	
8.2	Overlap with any UG/PG course of other Dept./Centre	No	
8.3	Supercedes any existing course	No	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Ajit Kumar, Amruta Mishra		
12.	Will the course require any visiting faculty?	No	

13.	Course objective (<i>about 50 words</i>): To introduce the students to the modern developments in field theory which have several applications in condensed matter theory, particle physics, cosmology etc.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Maxwell's equations and Gauge invariance, Quantum mechanics of a charged particle as a gauge theory, Vector potential as phase, Aharonov-Bohm Effect, Superconductivity and Magnetic flux quantization in superconductors, Introduction to continuous symmetry groups, U(1) and SU(2) symmetry groups, Classical field theories, Local gauge invariance and the gauge fields, Yang-Mills gauge theories, Spontaneous symmetry breaking, Goldstone bosons, Higgs mechanism, Weinberg-Salam Model.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Maxwell's equations and Gauge invariance,	1
2	Quantum mechanics of a charged particle as a gauge theory,	2
3	Vector potential as phase, Aharonov-Bohm Effect,	2
4	Superconductivity and Magnetic flux quantization in superconductors,	3
5	Introduction to continuous symmetry groups, U(1) and SU(2) symmetry groups	5
6	Classical field theories, Local gauge invariance and the gauge fields,	5
7	Yang-Mills gauge theories,	3
8	Spontaneous symmetry breaking, Goldstone bosons,	3
9	Higgs mechanism,	2
10	Weinberg-Salam Model.	2
11		
12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NA

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. K. Moriyasu: " An Elementary Primer For Gauge Theory", World Scientific Publishing Co Pte Ltd, Singapore, 1983.
2. José Leite Lopes: " Gauge Field Theories: an introduction", Pergamon Press, 1981.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	None
19.2	Hardware	None
19.3	Teaching aides (videos, etc.)	None
19.4	Laboratory	None

19.5	Equipment	None
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	PARTICLE ACCELERATORS	
3.	L-T-P structure	2 - 0 - 0	
4.	Credits	2	
5.	Course number	EPL434	
6.	Status (<i>category for program</i>)	DE for EP	

7.	Pre-requisites (course no./title)	EPL101 and EPL302	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)		
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem	
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11.	Faculty who will teach the course Santanu Ghosh, Rajendra Singh, Amruta Mishra		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The main objective of this course is to learn the fundamental aspects of particle acceleration from eV to TeV range and science and technology associated with it.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Electrostatic and electromagnetic accelerators: Van de Graff, Tandem acceleration, Linear accelerators, Synchrocyclotron, Storage ring, Free electron laser, High energy colliders.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Advances in accelerators, Acceleration of particles in electrostatic field: Cockroft Walton, Tandem Van de Graaf generator.	6
2	Acceleration of particles in electromagnetic field: Linear accelerator, Radio frequency cavity resonators, Resonance and life time, branching ratio. Synchrotron and synchro cyclotron, Betatron, Relativistic energy limit.	6
3	Concepts of storage ring, Relativistic formulation of energy, generation of high energy photons in synchrotrons, Energy modulation, free electron laser.	7
4	Generation of very high energy particles by collision, Relativistic calculation of energy in centre of mass and laboratory frame, generation of antiparticle, proton-proton collision, particle-antiparticle collision, hadron collision and large hadron collider, symmetry, conservation lawas and Investigation on symmetry breaking.	9
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10		
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12		
COURSE TOTAL (14 times 'L')		28

16. Brief description of tutorial activities

NOT APPLICABLE

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. An Introduction to particle accelerators, Edmund Wilson and Edward Wilson, Oxford University Press, 2001.
2. Particle accelerators, colliders and story of high energy physics, Raghavan Jayakumar, Springer (2005).

19. Resources required for the course (*itemized & student access requirements, if any*)

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD Projection facility
19.4	Laboratory	.
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING PHYSICS LABORATORY - I	
3.	L-T-P structure	0 - 0 - 6	
4.	Credits	3	
5.	Course number	EPP211	
6.	Status (<i>category for program</i>)	DC	
7.	Pre-requisites (course no./title)		
8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supersedes any existing course	EPP109	
9.	Not allowed for (<i>indicate program names</i>)	Other than EP	
10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
11.	Faculty who will teach the course G. B. REDDY, G. VIJAYA PRAKASH, JOBY JOSEPH, B. D. GUPTA		
12.	Will the course require any visiting faculty?	NO	
13.	Course objective (<i>about 50 words</i>): The main objective of this course is to learn fundamental experiments based on E.M.Theory and Quantaum Mechanics .		
14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Experiments with various Lasers, Optical spectrometer, Microwaves, Fundamentals of Quantum Mechanics, atomic spectroscopy and Tunneling.		

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	NOT APPLICABLE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

NOT APPLICABLE

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Laboratory manuals and hand outs will be provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	.
19.4	Laboratory	Yes.
19.5	Equipment	As per requirements.

19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING PHYSICS LABORATORY - II	
3.	L-T-P structure	0 - 0 - 6	
4.	Credits	3	
5.	Course number	EPP212	
6.	Status (<i>category for program</i>)	DC	

7.	Pre-requisites (course no./title)	EPL105	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	EPP110	

9.	Not allowed for (indicate program names)	Other than EP	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course G.B. REDDY, M.R. SHENOY, G.V. PRAKASH, JOBY JOSEPH		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The main objective of this course is to learn experiments related to Applied optics, lasers, fibre optics etc. .		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Characterisation of Optoelectronics/SC devices, Holography, Determination of various parameters of fiber Optic cables, Applications of Fiber Optics – communication and/or pressure sensors.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	NOT APPLICABLE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

NOT APPLICABLE

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Laboratory Manuals and Hand outs will be provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Yes.
19.5	Equipment	As per requirements.
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING PHYSICS LABORATORY - III	
3.	L-T-P structure	0 - 0 - 8	
4.	Credits	4	
5.	Course number	EPP221	
6.	Status (<i>category for program</i>)	DC	

7.	Pre-requisites (course no./title)	EPL106	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	EPP215	

9.	Not allowed for (indicate program names)	Other than EP	
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course R.K. SONI, SUJEET CHAUDHARY, P.K. MUDULI, PINTU DAS		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The main objective of this course is to learn experiments related to materials synthesis, growth and design.		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Synthesis of thin films, multilayers, nanoparticles by physical and chemical vapor deposition techniques, phase diagrams, study of surface, design of thin film resistor and magnetic field sensor.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	NOT APPLICABLE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

NOT APPLICABLE

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Laboratory Manuals and Handouts will be provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	Yes.
19.5	Equipment	As per requirements.

19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	PHYSICS	
2.	Course Title (<i>< 45 characters</i>)	ENGINEERING PHYSICS LABORATORY - IV	
3.	L-T-P structure	0 - 0 - 8	
4.	Credits	4	
5.	Course number	EPP222	
6.	Status (<i>category for program</i>)	DC	

7.	Pre-requisites (course no./title)	EPL104, EPL106	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)		
8.1	Overlap with any UG/PG course of the Dept./Centre	NO	
8.2	Overlap with any UG/PG course of other Dept./Centre	NO	
8.3	Supercedes any existing course	NO	

9.	Not allowed for (indicate program names)	Other than EP	
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☒ 2 nd sem ☐ Either sem	
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11.	Faculty who will teach the course R. K. SONI, S. CHAUDHARY, P. K. MUDULI, PINTU DAS		
12.	Will the course require any visiting faculty?	NO	

13.	Course objective (<i>about 50 words</i>): The main objective of this course is to learn experiments related to advance solid state physics, semiconductors, dielectrics, Thermal and Stat Mech .		
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Resistivity of metals and semiconductors, Band gap, charge carrier density and mobilities of semiconductor, basics of junction diode and its characteristics in solar cell configuration, study of crystal structure, dielectric constant, specific heat and superconductivity.		
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	NOT APPLICABLE	
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities

NOT APPLICABLE

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Hand outs and laboratory manuals will be provided.

19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	As per requirements.
19.6	Classroom infrastructure	

19.7	Site visits	
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20. Design content of the course *(Percent of student time with examples, if possible)*

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)