SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: SCIENCE AND TECHNOLOGY

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (PHYSICS) following Three Years UG Programme wef 2023-24

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option

M.Sc. (Physics) First Year Semester- I Level 6.0

S.N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
0	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively If students wish to opt Minor Course of UG as Major for PG, **balance Credits** Course will have to be completed **(As and when applicable)**	Th-Prq		0	0	0	0	Additional Credits to be earned = [1 minus 2] 1. Credits from Major DSC Courses in UG (minus) 2. The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG.			2	15	35			50	06	14	P
1	**Research Methodology and IPR in PHYSICS**	Th-Major	**PHY 100**	4			4	4		4	3	40	60			100	16	24	P
2	**DSC-I : Mathematical Physics**	Th-Major	**PHY 101**	3			3	3		3	3	40	60			100	16	24	P
3	**DSC-II.: Classical Mechanics**	Th-Major	**PHY 102**	3			3	3		3	3	40	60			100	16	24	P
4	**DSC-III : Quantum Mechanics - I**	Th-Major	**PHY 103**	3			3	3		3	3	40	60			100	16	24	P
5	**DSE-I : (i) Computational Methods and C Programming (ii) Computational Methods and Scilab Programming (iii) Computational Methods and Python Programming**	Th-Major Elective	**PHY 104 (i/ii/iii/)**	3			3	3		3	3	40	60			100	16	24	P

	(iv) MOOC : Scientific Computing using Python (Phttps://nptel.ac.in/courses/115104135) **(v) MOOC : Problem Solving Through Programming in C** (https://nptel.ac.in/courses/106105171)																		
																Minimum Passing Marks			**Grade**
6	**Lab I: General Physics Experiments**	Pr-Major	**PHY 105**			**6**	**6**		**3**	**3**	**4**			**50**	**50**	**100**	**25**	**25**	**P**
7	**Lab II: Programming based Experiments (Computer Lab)**	Pr-Major	**PHY 106**			**6**	**6**		**3**	**3**	**4**			**50**	**50**	**100**	**25**	**25**	**P**
8	# On Job Training, Internship/ Apprenticeship; Field projects **Related to Major @ during vacations cumulatively**	Related to DSC		**120 Hours cumulatively during vacations of Semester I and Semester II**						**4***									**P***
9	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC,Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**															
	TOTAL									**22**				**700**					

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note : # On Job Training, Internship/ Apprenticeship; Field projects **Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY : Science and Technology

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (PHYSICS) following Three Years UG Programme wef 2023-24

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option

M.Sc. (Physics) First Year Semester- II Level 6.0

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme: Teaching Period Per Week				Credits			Duration Of Exam Hours	Examination & Evaluation Scheme: Maximum Marks: Theory		Practical		Total Marks	Minimum Passing		
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC- IV : Quantum Mechanics II	Th-Major	PHY 201	3			3	3		3	3	40	60			100	16	24	P
2	DSC-V: Electromagnetic Theory	Th-Major	PHY 202	3			3	3		3	3	40	60			100	16	24	P
3	DSC-VI: Atomic and Molecular Physics	Th-Major	PHY 203	3			3	3		3	3	40	60			100	16	24	P
4	DSE-II /MOOC : DSE II (i): Lasers and Laser Applications DSE-II (ii): Spectroscopic Techniques DSE-II (iii): Network Theorems and Solid State Devices	Th-Major Elective	PHY 204 (i/ii/iii/)	3			3	3		3	3	40	60			100	16	24	P
																	Minimum Passing Marks		Grade
5	Lab I: (DSC IV and DSC V)	Pr-Major	PHY 205			6	6		3	3	4			50	50	100	25	25	P
6	Lab II: (DSC VI and DSE)	Pr-Major	PHY 206			6	6		3	3	4			50	50	100	25	25	P
8	# On Job Training, Internship/ Apprenticeship; Field projects Related to Major @ during vacations cumulatively	Related to DSC		120 Hours cumulatively during vacations of Semester I and Semester II						4*									P*
9	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC,Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV	Generic **Optional**		90 Hours Cumulatively From Sem I to Sem IV															
	TOTAL									18 +4 =22						600			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note : # On Job Training, Internship/ Apprenticeship; Field projects **Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology

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(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option

M.Sc. (Physics) Second Year Semester- III Level 6.5

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	Contemporary Applied Technological Advancements in Research relevant/supportive to Major **DSC- VII : Nanoscience and Nanotechnology**	Th-Major	PHY 301	3			3	3		3	3	40	60			100	16	24	P
2	**DSC- VIII : Solid State Physics**	Th-Major	PHY 302	3			3	3		3	3	40	60			100	16	24	P
3	**DSC-IX : Statistical Mechanics**	Th-Major	PHY 303	3			3	3		3	3	40	60			100	16	24	P
4	DSE-III /MOOC **:** **DSE III (i): Condensed Matter Physics-I** **DSE-III (ii): Photonics- I** **DSE-III (iii): Digital Techniques -I**	Th-Major Elective	PHY 304 (i/ii/iii/)	3			3	3		3	3	40	60			100	16	24	P
																	Minimum Passing Marks		Grade
5	**Lab I: (DSC VII and DSC VIII)**	Pr-Major	PHY 305			6	6		3	3	4			50	50	100	25	25	P
6	**Lab II: (DSC IX and DSE)**	Pr-Major	PHY 306			6	6		3	3	4			50	50	100	25	25	P
7	**Research Project Phase-I**	**Major**			2	4	6	2	2	4		--		50	-	50	25		P
8	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**	90 Hours Cumulatively From Sem I to Sem IV																
	TOTAL									22						650			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note : # On Job Training, Internship/ Apprenticeship; Field projects **Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

FACULTY: Science and Technology

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (PHYSICS) following Three Years UG Programme wef 2023-24

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option

M.Sc. (Physics) Second Year Semester- IV Level 6.5

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC- X: Nuclear and Particle Physics	Th-Major	PHY 401	3			3	3		3	3	40	60			100	16	24	P
2	DSC- XI: Operational Amplifier and Linear Integrated Circuits	Th-Major	PHY 402	3			3	3		3	3	40	60			100	16	24	P
3	DSC-XII : Radiation and Plasma Physics	Th-Major	PHY 403	3			3	3		3	3	40	60			100	16	24	P
4	DSE-IV /MOOC : DSE IV (i): Condensed Matter Physics-II DSE-III (ii): Photonics- II DSE-IV (iii): Digital Techniques-II	Th-Major Elective	PHY 404 (i/ii/iii/)	3			3	3		3	3	40	60			100	16	24	P
																	Minimum Passing Marks		Grade
5	Lab I: (DSC X and DSC XI)	Pr-Major	PHY 405			6	6		3	3	4			50	50	100	25	25	P
6	Lab II: (DSC XII and DSE)	Pr-Major	PHY 406			6	6		3	3	4			50	50	100	25	25	P
7	Research Project Phase-II	Major			2	8	10	2	4	6	3	--		75	75	150	40	40	P
8	Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV	Generic Optional	90 Hours Cumulatively From Sem I to Sem IV																
	TOTAL									24						750			

L: Lecre, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note : # On Job Training, Internship/ Apprenticeship; Field projects **Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

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Table: Comprehensive Credits distribution amongst the type of Courses over Two Years (Four Semesters) PG Programme and Minimum Credits to be earned for PG Degree [M.Sc. (Physics)]

Sr. No.	Type of Course		Total Credits Offered	Minimum Credits Required
1	**MAJOR**			
	i. DSC	**48**		**48**
	ii. DSE	**24**		**24**
	TOTAL		**72**	**72**
2	**Research Methodology and IPR (FSC/DSC: Major)**	**04**	**04**	**04**
2	On Job Training, Internship/ Apprenticeship; Field projects **Related to Major**	**04**	**04 for 120 Hours OJT/FP cum.**	**02 (Minimum 60 Hours OJT/FP is mandatory)**
3	**Research Project**	**10**	**10**	**10**
	OPTIONAL			
4	**Co-Curricular Courses (offline and/or online as applicable): Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts,** CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.).		**Limited to Maximum 03 only (For 90 Hours of CC cumulatively)**	**00**
	TOTAL			
	TOTAL		**93**	**88**

Table A: Comprehensive Credit Distribution for CC

<table>
<tr><th rowspan="2">S. N.</th><th rowspan="2">Activities (offline/online as applicable)</th><th colspan="6">Credits at Levels</th><th rowspan="2">Letter Grade</th></tr>
<tr><th>College</th><th>University</th><th>State</th><th>Zone if exist</th><th>National</th><th>International if exist</th></tr>
<tr><td>1</td><td>Health and wellness, Yoga* Competitions
*If a Course (online/offline) on Yoga is completed for 60 Hours, 2 credits will be awarded to the student
(1 Credit = 30 Hours)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>P (Pass)</td></tr>
<tr><td>2</td><td>Unnat Bharat Abhiyan [UBA]</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>P (Pass)</td></tr>
<tr><td>3</td><td>Sports and fitness activities (see separate Table B)</td><td>1</td><td>1 / 2</td><td>2 / 3</td><td>3 / 4</td><td>4 / 5</td><td>5 / 6</td><td>P (Pass)</td></tr>
<tr><td>4</td><td>Cultural activities, Fine/Applied/Visual/Performing Arts</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>P (Pass)</td></tr>
<tr><td>5</td><td>N.S.S. activities Camps</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>P (Pass)</td></tr>
<tr><td rowspan="2">6</td><td>Academic activities like Research Paper/Article/Poster presentations, Aavishkar, start-up, Hackathon, Quiz competitions, other curricular, co-curricular activities, students exchange programme etc.</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>P (Pass)</td></tr>
<tr><td>Research Paper/Article published</td><td>--</td><td>1</td><td>2</td><td>-</td><td>4</td><td>6</td><td>P (Pass)</td></tr>
<tr><td rowspan="4">7</td><td>Participation in Summer school/ Winter School / Short term course</td><td colspan="6">2 Credits</td><td>P (Pass)</td></tr>
<tr><td>(not less than 30 hours 1 or 2 weeks duration) (not less than 60 hours 2 or 3 weeks duration)</td><td colspan="6">4 Credits</td><td>P (Pass)</td></tr>
<tr><td>Scientific Surveys, Societal Surveys</td><td colspan="6">2 Credits</td><td>P (Pass)</td></tr>
<tr><td>Field Visits, Study tours, Industrial Visits,</td><td colspan="6">1 Credit</td><td>P (Pass)</td></tr>
<tr><td>8</td><td>NCC Activities</td><td colspan="7">As given in Table C</td></tr>
</table>

Table B: Credit Distribution for Sports and Fitness

Sr. No.	Particulars of Sports Status (Individual/ Team)	Credits	Letter Grade
1	College Level Participation	1	P (Pass)
2	University Level Participation	1	P (Pass)
3	University Level Rank 1, 2, 3	2	P (Pass)
4	State Level Participation	2	P (Pass)
5	State Level Rank 1, 2, 3	3	P (Pass)
6	Zonal Level Participation	3	P (Pass)
7	Zonal Level Rank 1, 2, 3	4	P (Pass)
8	National Level Participation	4	P (Pass)
9	National Level Rank 1, 2, 3	5	P (Pass)
10	International Level Participation	5	P (Pass)
11	International Level 1,2,3	6	P (Pass)

Table C: Credit Distribution for NCC activities

Sr. No.	Particulars of NCC Activities	Credits	Letter Grade
1	Participation in NCC activities	1	P (Pass)
2	'B' Certificate obtained	2	P (Pass)
3	'C' Certificate obtained	3	P (Pass)
4	State Level Participation	4	P (Pass)
5	National level Participation	5	P (Pass)
6	International Level Participation	6	P (Pass)

DSC- VII: NANO SCIENCE AND NANOTECHNOLOGY

(Contemporary Applied Technological Advancements in Research relevant/supportive to Major**)**

Theory: 3 hours per week (3 Credits)

External Marks: 60
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon completion of the course successfully, students would be able to

1. Understand physical properties of nano-structured materials.
2. Acquire the knowledge of different chemical deposition techniques.
3. Understand advanced concepts of different physical techniques for synthesis of nanomaterials.
4. Estimation of particle size of nano-structured materials.
5. Use of imaging techniques to analyze nano-structured materials.
6. Analyze and understanding on real time applications of nano-structured materials.

COURSE CONTENTS: DSC-VII Nanoscience and Nanotechnology

Unit	**Contents**	**Hours**
Unit I	Size dependent properties, quantum size effect, quantum dot, quantum wire and quantum well. Mechanical and electrical properties of nano-structured materials, Super conductivity at nano scale, Hopping conduction, Polaron conduction.	8
Unit II	Chemical methods for preparation of Nanostructured materials, Bottom up and top-down process, sol-gel, electrode deposition, chemical bath deposition, successive ionic layer deposition (SILD).	7
Unit III	Physical methods for preparation of Nanostructured materials, thermal evaporation methods, physical vapor deposition (PVD), ball milling, pulsed laser deposition, chill block melting, gas atomization method.	8
Unit IV	Nano Structure determination, atomic structures, crystallography, stacking arrangement in nanocrystals, Methods for measuring the properties of Nanomaterials, powder diffraction method, estimation of particle size from XRD peaks.	8
Unit V	Optical verses electron microscopy, Transmission electron microscopy, conventional TEM and scanning TEM, Scanning electron microscopy, Field ion microscopy, Scanning tunneling microscopy, Atomic force microscopy.	7
Unit VI	Carbon nanostructures, carbon nanotubes (CNTs), Applications of carbon nanotubes: computers, fuel cells, chemical sensors, catalysis, Single electron transistor (no derivation), Molecular machine,	7

	applications of nanomaterials in energy, medicine and environment.	

REFERENCE BOOKS:

1. Introduction to Nanotechnology, Charles P Poole Jr., and Frank J. Ownes, John Wiley Sons, Inc.
2. Introduction to Nanoscience & Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, Publisher: PHI Learning and Private Limited.
3. NANO: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw Hill
4. Encyclopedia of Nanoscience &Nanotechnology‖, H. S. Nalwa (Ed.), American Scientific Publishers, California.
5. Nanotechnology Appin. Lab BPB publication New Delhi
6. Nanomaterials – A. K. Bandyopodhyay, New Age Publication
7. Physics of semiconductor nanostructures K. P. Jain Narosa Publication
8. Nanotechnology, Rakesh Rathi, S Chand & Company, New Delhi

Equivalent MOOC on SWAYAM:

1. https://onlinecourses.swayam2.ac.in/cec24_cy03/preview
2. https://onlinecourses.nptel.ac.in/noc19_mm21/preview
3. https://www.my-mooc.com/en/categorie/nanotechnology
4. https://nptel.ac.in/courses/118102003
5. https://onlinecourses.swayam2.ac.in/aic21_ge16/preview

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

1. https://www.youtube.com/channel/UC9wWhzPU0_BRtTYT2Zu25CQ
2. https://www.youtube.com/watch?v=ebO38bbq0_4&ab_channel=nptelhrd
3. https://www.youtube.com/watch?v=x35oSU3SP9A&ab_channel=Dr.SandeepAWaghuley
4. https://www.youtube.com/watch?v=4eRCygdW--c&ab_channel=MuonRay
5. https://www.youtube.com/watch?v=qvIWpLSzRhs&ab_channel=EngineeringPhysicsbySanjiv

DSC- VIII: SOLID STATE PHYSICS

Theory: 3 hours per week (3 Credits)

External Marks: 60
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon the successful completion of this course the student will be able to

1. Describe Single Crystal and Poly Crystals, Crystal Symmetry, Symmetry Elements, Crystal Types, Bravais Lattices.
2. Use different X-ray techniques.
3. Interpret the Powder Photograph; Bernel Chart; Brllioun Zones.
4. Discuss the inter-Atomic Forces Cohesive Energy of a Solid; Infrared Absorption by Ionic Crystal Lattice; anharmonicity and thermal Expansion.
5. Study the Dulong and Petit Law, Lattice Specific Heat, Einstein and Debye Theories, Electronic and Lattice Contributions to Specific Heat.

COURSE CONTENTS: DSC- VIII: Solid State Physics

Unit	Contents	Hours
Unit I	Crystallography: Single Crystal and Poly Crystals, Crystal Symmetry, Symmetry Elements, Crystal Types, Bravais Lattices in 2D and 3D, Point Groups and Space Groups in 2D and 3D.	7
Unit II	Diffraction of X-Rays: Bragg's Law in 1D and 3D, Laue Diffraction Equation, Atomic Scattering Factor, Structure Factor. X-Ray Diffractions Techniques: Laue, Rotating Crystal Method, Oscillation and Burger Precession Method, Powder-Photograph Method.	8
Unit III	Interpretation of Powder Photograph, Measurement of Bragg's Angle, Interplaner Spacing (d), Accurate Lattice Parameter Determination. Analytical and Graphical Methods for (Known Unit Cell), Bernel Chart, Interpretation of Oscillation Photographs.	8
Unit IV	Concept of Reciprocal Lattice, Vector Demonstration of Reciprocal Lattice In Two Dimensions, Bragg's Diffraction Condition In Terms of Reciprocal Lattice, Brllioun Zones. Diffraction of Electrons and Neutrons, Inelastic Scattering, Applications.	7
Unit V	Inter-Atomic Forces Cohesive Energy of a Solid, Molecular Crystals, Ionic Crystals and Madelung Constant, Covalent Crystals and Metals, Lattice Dynamics of Mono Atomic and Diatomic Lattices. Infrared Absorption by Ionic Crystal Lattice, Localized Lattice Vibrations, Localized States and Associates Wave Function, Anharmonicity and Thermal Expansion, Thermal Conductivity.	8
Unit VI	Specific Heat: Dulong and Petit Law, Lattice Specific Heat, Temperature Dependence of Specific Heat, Einstein and Debye Theories, Electronic and Lattice Contributions to Specific Heat.	7

TEXT BOOKS:

1. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).
2. Introduction to Solids, L V Azaroff (Tata-McGraw Hill, 1984).
3. Introduction to Modern Solid State Physics, Yuri M Galperin.
4. Solid State Physics, 9th Edition, S.O. Pillai (New Age International)
5. Solid State Physics, A.J. Dekker (Macmillan Education)
6. Solid State Physics R. K. Puri & V. K. Babbar

REFERENCE BOOKS:

1. Crystallography Applied to Solid State Physics, Verma, A.R., Srivastava, O.N., New Age International.
2. Solid State Physics, R. L.Sighal, Ram Nath Kedar Nath & Co., Publishers Meerut.
3. Solid State Physics by N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd, 2009).
4. Problems In Solid State Physics With Solutions, Fuxiang Han

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. https://onlinecourses.nptel.ac.in/noc19_ph14/preview
2. https://nptel.ac.in/courses/115106127
3. https://onlinecourses.nptel.ac.in/noc20_mm17/preview
4. https://nptel.ac.in/courses/115103108

DSC- IX: STATISTICAL MECHANICS

Theory: 3 hours per week (3 Credits) External Marks: 60

Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon completion of the course successfully, students would be able to

1. Understand the concept of microscopic and macroscopic states, classify ensembles.
2. Computation of partition functions with thermodynamic quantities.
3. Apply Bose-Einstein distribution functions to various systems.
4. Apply statistical mechanics to ideal Fermi gas and to relate results to physical problems.
5. Learn the specific heat at low and high temperature and understand the fluctuations.
6. Understand the Phase transition phenomena and experimentally observed properties of superfluid.

COURSE CONTENTS: DSC- XI: Statistical Mechanics

Unit	Contents	Hours
Unit I	Micro and macro states, Phase space, phase trajectory, density of states, statement and proof of Liouville's theorem, ensemble, micro canonical, Canonical and grand canonical ensembles, comparison of ensembles.	8
Unit II	Partition function, Entropy and partition function, Thermodynamic energy and partition function, Helmholtz free energy and partition function, Specific heat and partition function, Gibbs Paradox, Entropy of an ideal gas, Sackur-Tetrode relation.	7
Unit III	Statistics of indistinguishable particles, Bose-Einstein system and Fermi-Dirac system, Bose-Einstein distribution, Ideal Bose-Einstein gas, fugacity, degenerate Boson gas, energy of Boson, Bose-Einstein condensation, chemical potential.	8
Unit IV	Fermi-Dirac distribution, degeneracy, fugacity of an ideal Fermi-Dirac Gas, Thermodynamic function of degenerate F-D gas, Free electron model and electron emission, thermionic emission, photoelectric effect.	7
Unit V	Einstein theory of specific heat, Debye theory of specific heat, diatomic molecule, Fluctuation in energy, Fluctuation in pressure, Fluctuation in volume, Fluctuation in enthalpy, Brownian motion and Random walk.	7
Unit VI	Phase transition, first order and second order phase transitions, Landau theory of phase transition, Super-fluidity, Experimentally observed properties of super-fluid He II, phonons and rotons.	8

REFERENCE BOOKS:

1. Statistical Mechanics, Pathria, R.K., Butterworth-Heinemann.
2. Fundamentals of Statistical and Thermal Physics, Reif, F., Waveland.
3. Statistical Mechanics, K.Huang, Wiley Eastern Limited.
4. Statistical Physics, Landau and Lifshitz.
5. Statistical mechanics, Donald Allan McQuarrie, University Science Books
6. Introduction to modern statistical mechanics, David Chandler, Oxford University Press.
7. Statistical Mechanics, B. K. Agarwal, New Age International.
8. Statistical mechanics, James Woods Halley, Cambridge University Press.

Equivalent MOOC on SWAYAM:

1. https://onlinecourses.nptel.ac.in/noc22_ph22/preview
2. https://onlinecourses.nptel.ac.in/noc19_ph10/preview
3. https://www.classcentral.com/course/swayam-introduction-to-statistical-mechanics-14140
4. https://onlinecourses.nptel.ac.in/noc20_cy28/preview
5. https://www.mooc-list.com/tags/statistical-mechanics

Any pertinent media (recorded lectures, YouTube, etc.) if relevant:

1. https://www.youtube.com/watch?v=FTwtzqV73dQ&ab_channel=ICTPPostgraduateDiplomaProgramme
2. https://www.youtube.com/playlist?list=PLUl4u3cNGP60gl3fdUTKRrt5t_GPx2sRg
3. https://www.youtube.com/watch?v=xLO77x9tZtU&ab_channel=JonathonRiddell
4. https://www.youtube.com/watch?v=K36Rb50jRCI&ab_channel=PazzyBoardman
5. https://www.youtube.com/watch?v=xT5SWnbdgTo&ab_channel=NPTEL-NOCIITM

DSE III (i): CONDENSED MATTER PHYSICS-I

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]

After successfully completing the course, student will have the understanding of:

1. Concept of energy bands of crystalline solids and their origin.
2. Magnetic properties of materials, origin of magnetism in solids and classical and quantum theories for the dia & paramagnetism.
3. Spontaneous magnetization in ferromagnetic solids.
4. Concept of spintronic and applications of ferromagnetic materials in spintronic.
5. Dielectric properties of materials.
6. Basic ideas in Superconductivity and applications of superconductor.

COURSE CONTENTS: Condensed Matter Physics-I

Unit	Contents	Hours
Unit-I	Periodic potential in crystal, Bloch theorem - statement and proof, square well potential, Kronig Penny Model. Reduced, periodic and extended Brillouin zone schemes. Crystal momentum, number of orbital's in a band, band index and the concept of effective mass. Nearly free electron model: qualitative proof for origin of gap in periodic potential and perturbation theory. Construction of Fermi surface in two dimensions. Tight binding model: assumptions and applications to SC, FCC and BCC structures.	8
Unit-II	Origin of atomic Magnetic Moment, Larmor Precession, Diamagnetism: Classical and Quantum Theory of Diamagnetism , Paramagnetism: Classical and Quantum Mechanical theories of Paramagnetism. Paramagnetism in rare earth and iron group ions.	7
Unit-III	Ferromagnetism: Weiss Theory, Curie Weiss Law, Heisenberg Model of Molecular Field Theory, Spin Waves And Magnons, introduction to Ferri and Antiferro Magnetism, ferromagnetic domains , domain walls and B-H curve.	7
Unit-IV	Spintronics: Introduction, Magnetoresistance, Giant Magnetoresistance(GMR), Metallic Multilayers, Mott's Theory of Spin-Dependent Scattering of Electrons, qualitative description of Camley–Barnas Model, introduction to CPP-GMR of Multilayered Nanowires & Introduction of Spintronics with Semiconductors.	8
Unit-V	Macroscopic and Local electric fields, Claussius Mosotti relation, Types of Polarization mechanisms, complex dielectric constant, relaxation time, Ferroelectricity, temperature dependence of dielectric constant of ferroelectric crystal, classification of	7

	ferroelectric crystals, ferroelectric domains and Piezo electricity	
Unit-VI	Superconductivity: Meissner effect, Type I and II superconductors. Phenomenological theories of superconductivity: London theory and Ginzsberg- Landau theory, coherence length and penetration depth, Macroscopic BCS theory of superconductor, flux quantization, Josephson effect, Superconducting quantum interference devices (SQUIDs).	8

REFERENCE BOOKS:

1. Solid State Physics, N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd, 2009).
2. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).
3. Introduction to Solids, L V Azaroff (Tata-McGraw Hill, 1984).
4. Introduction to Modern Solid State Physics, Yuri M Galperin.
5. Solid State Physics, R. L.Sighal, Ram Nath Kedar Nath & Co., Publishers Meerut

DSE-III (ii): PHOTONICS I

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon the successful completion of this course the student will

1. Understand the significance of Maxwell equations in electrodynamics, EM wave, radiation and fundamentals of geometric optics.
2. Understand and apply the fundamentals of modern optics.
3. Understand and the concepts Fourier optics and holography and their applications.
4. Understand and the concepts near field optics and evanescent waves and their applications.
5. Understand the radiation pressure of laser light, optical tweezers and concept of atom laser.

COURSE CONTENTS: Photonics-I

Unit	Contents	Hours
Unit I	Maxwell's equations, Maxwell's wave equations for a vacuum, solution of the general wave equation, Group and Phase velocity, generalized solution of the wave equation, transverse electromagnetic wave, flow of electromagnetic energy, electric dipole radiation.	7
Unit II	Fundamentals of geometrical optics, ray tracing, paraxial approximation, aberrations, designing optical set-ups, thin lens theory	7
Unit III	Fundamentals of Modern Optics: Wave propagation, wave particle duality, Kramers - Kronig relations, electromagnetic fields in homo and inhomogeneous dispersive media, diffraction theory, polarization of light.	8
Unit IV	Fourier Optics: Plane waves, spatial frequency, optical Fourier transform, diffraction of light, special function in photonics and their fourier transform, convex lens and its function, image formation, spatial filters, holography, applications of holography.	8
Unit V	Near Field optics: The evanescent waves, Goos-Hänchen shift, generation of evanescent waves, photon tunnelling microscope, scanning near field optical microscope, probes to detect the evanescent field.	8
Unit VI	Radiation pressure of laser light, optical tweezers and its applications, Raman-optical tweezers, laser cooling of atoms, Bose Einstein condensate, atom laser.	7

TEXT BOOKS:

1. Eugene Hecht, “Optics (International Edition),” Addison Wesley, (2003). Page 14
2. F G Smith, T A King and D Wilkins, “Optics and Photonics: An Introduction,” John Wiley & Sons, Ltd, San Francisco, USA, (2007).
3. David J. Griffiths, “Introduction to Electrodynamics (3rd edition),” Pearson Publishers.
4. Joseph W Goodman, “Introduction to Fourier Optics,” McGraw-Hill.

REFERENCE BOOKS:

1. Keigo Iizuka, “Elements of PHOTONICS Vol. 1 (In free space and special media) and 2 (for fiber and integrated optics),” Wiley Series in Pure and Applied Optics.
2. Born and Wolf, “Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light,” Cambridge University Press.
3. Hand Book/Optics, Vol. 1-IV, Optical Society of India, McGraw Hill. Page 15

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. https://onlinecourses.nptel.ac.in/noc23_ee84/preview
2. https://www.classcentral.com/course/swayam-introduction-to-photonics-12961
3. https://www.shiksha.com/college/iit-hyderabad-indian-institute-of-technology-32726/course-online-fundamentals-of-nano-and-quantum-photonics-1196535

DSE-III (iii): DIGITAL TECHNIQUES I

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]

Upon the successful completion of this course the student will be able:

1. To interpret the basics of the number systems and their conversions
2. To analyse the construction and designing logic circuits.
3. To Provides the knowledge of memories and flips flops.
4. Secure first hand idea about CPU, Registers, Internal buses, Timer Controller Unit in Intel 8085 Microprocessor.
5. Learn microprocessor and assembly language programming with special reference to Intel microprocessor 8085, its architecture, pin diagram, timing diagram, instruction set.
6. Learn organization of Intel microprocessor 8085, to analyse Instruction Sets & Basic of Programming in Intel 8085 Microprocessor.

2. COURSE CONTENTS: DIGITAL TECHNIQUES I

Unit	Contents	Hours
Unit-I	**Number system:** Introduction of number system, Binary, Octal, Hexadecimal. Decimal to Binary and Hexadecimal Conversion, Binary Coded Decimal (BCD) to Binary and binary to BCD conversion, Seven Segment Display (SSD), Binary addition, subtraction, multiplication and division.	7
Unit-II	**Logic gates**: OR gate, AND gate, Not gate, NOR gate, NAND gate and Ex-OR and Ex-NOR gate, Universal gates, common applications of logic gates. **Arithmetic Circuits:** Half adder, full adder, BCD adder, Multiplexer, Demultiplexer and Encoders.	7
Unit-III	**Flip Flops:** Bistable, Monostable and Astable multivibrator, IC multivibrator, R-S flip flop, Level Triggered and Edge Triggered flip flop, J-K flip flop, Toggle flip flop, D-flip flop, FF as switch debouncing and detecting the sequence of Edges	7
Unit-IV	**8085 Microprocessor:** Block diagram and Pin diagram of 8085 microprocessor, Inside a microprocessor, Arithmetic logic unit, program counter, instruction register, Buffer register, status register, stack pointer, general purpose register, temporary registers, control unit, flag register and Interrupt.	8

Unit-V	**Basic microprocessor instructions:** Data transfer instructions, Arithmetic instructions, logical instructions, Branch control instructions and machine control instructions. **Addressing modes of 8085:** Absolute or memory direct addressing mode, Immediate addressing mode, Register addressing mode, Register indirect addressing mode, Indexed addressing mode, Implicit addressing mode.	8
Unit-VI	**Instruction sets** of 8085 microprocessor. **8085 Microprocessor Programming:** 8-bit addition, subtraction, multiplication, division, right and left shift, ascending order, descending order and factorial of a number programs using 8085 microprocessor.	8

TEXT BOOKS:

1. Digital Electronics Principles, Devices and Applications by Anil K. Maini (2007), John Wiley & Sons Ltd.
2. Modern Digital Electronics by R.P. Jain Publication Mc-Grow hill.
3. Fundamental of Digital Circuits by A. Anand Kumar (2016), PHI leaning private Ltd
4. Digital Logic and Computer Design by M. Morris Mano (2016), Pearson India Education Services Pvt. Ltd
5. Digital Logic Circuit by A. P. Godase and D. A. Godse (2007), Technical Publication
6. Digital Electronics: Theory and Experiments by Virendra Kumar (2015), New Age International Publishers
7. An Introduction to microprocessor 8085 by Dr. D. K. Kaushik, Dhanpat Rai Publishing Company Pvt. Ltd. New Delhi
8. Microprocessor Architecture, Programming and Applications with 8085 by Ramesh Gaonkar (2013), Penram International Publishing
9. The 8085 Microprocessor Architecture, Programming and Interfacing (2008) by K. Udaya Kumar Dorling Kindersley
10. Microprocessor 8085 Architecture, Programming, and Interfacing (2010) by Ajay Wadhwa PHI Learning

REFERENCE BOOKS:

1. Schaum’s Outline Series of Digital Principles by R. L. Tokheim (1994), McGraw-Hill Companies, USA.
2. A Survey of Arithmetic by S. K. Atiyah (2005), Trafford Publishing, Canada
3. Foundations of Digital Logic Design by G. Langholz, J. L. Mott and A. Kandel (1998), World Scientific Publ. Co., Singapore.

4. Practical Digital Electronics by N. P. Cook (2003), Prentice-Hall, USA
5. Arithmetic and Logic in Computer Systems by M. Lu (2004), John Wiley & Sons, USA.
6. 8085 Microprocessors & Its Application (2013) by A. Nagoorkani Tata McGraw-Hill
7. Microprocessor 8085 and Its Interfacing (2010) by Sunil Mathur Prentice-Hall of India Pvt. Limited
8. Ten Days with 8085 Microprocessor (2010) by K. A. Krishnamurthy Prentice-Hall of India Pvt. Limited
9. 8085 Microprocessor Programs (2019) by Robert Karamagi Amazon Digital Services LLC-KDP Print US
10. Fundamental of Microprocessor 8085: Architecture Programming, and Interfacing by V. Vijayendran, Viswanathan S. Printers & Publishers Pvt Ltd

LABORATORY COURSE I (DSC VII and DSC VIII)

Practical: 6 hours per week (3 Credits) **External Marks: 50**

Internal Marks: 50

(Note: Student should perform at least ten experiments from Lab on DSC- VII and Lab on DSC- VIII)

Lab on DSC- VII: NANO SCIENCE AND NANOTECHNOLOGY

COURSE OUTCOMES [COS]:

List of Experiments:

1. To study antibacterial/antifungal activity of a given nanomaterial
2. Fabrication of Few-Layer Graphene.
3. Fabrication of thin films of a given materials by using SILAR method
4. Synthesis of ZnO-PANI nanocomposite by chemical method
5. To study characteristic of solar cell as calculation of fill factor, maximum power point and efficiency.
6. Fabrication of SnO2 thin film for gas sensing applications.
7. Analysis of cyclic Voltammogram and calculation of specific capacitance of a given nanocomposite.
8. Synthesis of nanoparticles of a given material by thermal decomposition.
9. Preparation of thick films of a given nanocomposite by screen printing techniques.
10. Green synthesis of silver nanoparticles
11. Synthesis of CNT nanocomposites.
12. Analysis of surface morphology using SEM/FESEM/TEM/HRTEM of a given nanoparticles.
13. To study optical properties of given nanoparticles by using UV-Vis spectroscopy.
14. Structural Characterization of Materials (Virtual Lab Experiments http://vlabs.iitkgp.ac.in/scm/#)

Lab on DSC- VIII: SOLID STATE PHYSICS

COURSE OUTCOMES [COS]:

List of Experiments:

1. Indexing of given XRD powder patterns and estimation of precise lattice parameters of cubic crystals.
2. To Study the Crystal models of cubic crystal system.
3. Study of Crystal Structure by Laue's Method.
4. Determination of Crystal Structure by Powder Diffraction Method.
5. Determination of Crystal Structure by Bragg's Law.
6. To study lattice vibrations in monoatomic and diatomic lattices.
7. To determine specific heat of graphite.

REFERENCE BOOKS:

1. 1st Edition, Experimental Physics, Principles and Practice for the Laboratory, Edited By Walter Fox Smith
2. An Introduction to Practical Laboratory Optics, J.F. James
3. Experiments in Modern Physics, Adrian C. Melissinos, Jim Napolitano
4. Advanced Practical Physics by S.P.Singh, Pragati Prakashan, Meerut
5. Advanced Physics Laboratory Manual by P. Mishra, J. C. Mohanty,2007, South Asian Publishers Pvt. Ltd, New Delhi

Weblink to Equivalent Virtual Lab if relevant:

1. https://vlab.amrita.edu/?sub=1
2. https://nptel.ac.in/courses/115105120
3. https://onlinecourses.nptel.ac.in/noc20_ph16/preview

LABORATORY COURSE II (DSC IX and DSE III (i)/(ii)/(iii))

Practical: 6 hours per week (3 Credits) **External Marks: 50**

Internal Marks: 50

(Note: Student should perform at least ten experiments from Lab on DSC- IX and Lab on DSE III (i)/(ii)/(iii))

Lab on DSC- IX: STATISTICAL MECHANICS

COURSE OUTCOMES [COS]:

List of Experiments:

1. Determination of the Coefficient of Thermal Conductivity of Copper.
2. Determination of the Coefficient of Thermal Conductivity of a Bad Conductor.
3. Study of Variation of Thermo-emf with Temperature.
4. Determination of Specific Heat Capacity of a Liquid using the Method of Cooling.
5. Study of Temperature Variation of Surface Tension of a Liquid.
6. Study of Phase Transitions and Interpretation of Cooling Curves.
7. Demonstration of Brownian motion.
8. To study the behavior of a specific statistical mechanical system from Monte Carlo simulations.

Lab on DSE III (i): CONDENSED MATTER PHYSICS-I

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Determine Magnetic Susceptibility and Study Magnetic Properties.
2. Characterize Dielectric, Thermal, and Thermoelectric Properties.
3. Analyze Electronic Properties Using Spectroscopy and Temperature Variation.
4. Understand Superconductivity and Related Phenomena.
5. Measure Acoustic and Thermodynamic Properties.

List of Experiments:

1. Determination of Magnetic Susceptibility of Material by Quincke's Method.
2. Study of Magnetic Properties (Coercivity, retentivity, saturation magnetization and hysteresis loops) of ferromagnetic samples (soft iron, hard steel & nickel).
3. Study of variation of Dielectric constant of a given solid / liquid with temperature.
4. Determination of magnetic susceptibility of a solid by Guoy balance method.
5. Determination of Curie temperature of a given sample.
6. Determination of Lande's g-factor of DPPH using Electron Spin Resonance Spectrometer.
7. Determination of band gap of semiconductor by variation of conductivity with temperature.
8. Determination of band gap by absorption coefficient measurement.
9. Determination of critical temperatures of high T_C (YBCO, BSCCO) superconductors.
10. Demonstration of Meissner effect.
11. Determination of adiabatic compressibility of a given liquid.
12. Determination of Thermoelectric Power of a substance.

Lab on DSE III (ii): PHOTONICS-I

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Properly handle and keep maintenance of Optical Components and Laser Systems.
2. Characterize and Analyze Laser Beams and Optical Interference.
3. Use measurement Techniques Using Interferometry and Spectroscopy.
4. Understand Laser Operation and Temporal Analysis.

List of Experiments:

1. Handling, cleaning, maintenance of optical components and laser systems. Laser safety demonstration.
2. Characterization of laser beam.
3. Setting up of two and multi-beam Interferometer.
4. Measurement of UV-Visible Absorption spectra of standard samples.
5. Measurement of refractive index of the transparent material using Mach-Zahnder Interferometer.
6. Conversion of continuous wave laser into pulsed laser.
7. To study relaxation oscillation of diode laser.
8. Temporal pulse shaping of laser beam.
9. To study various polarized states of light.
10. To record and study Laser Induced Breakdown spectroscopy signal of known and unknown samples.(Demo)
11. Setting up of high power interferometer demonstrative experiment.

REFERENCE BOOKS:

1. Stephen G Lipson, Optics Experiments and Demonstrations for Student Laboratories, IOP Publishing
2. Photonics Essentials: An Introduction with Experiments, Thomas P. Pearsall, McGraw-Hill
3. Stephen G Lipson, Optics Experiments and Demonstrations for Student Laboratories, IOP Science

Weblink to Equivalent Virtual Lab if relevant:

1. https://vlab.amrita.edu/index.php?sub=1&brch=189
2. https://opc.iitd.ac.in/virtual_lab

Lab on DSE III (iii): DIGITAL TECHNIQUES-I

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Understand and Implement Basic Digital Logic Circuits.
2. Analyze and Verify Complex Digital Circuits.
3. Understand and Verify Flip-Flops and Their Applications.
4. Develop and Implement Programs for Arithmetic Operations Using 8085 Microprocessor.

List of Experiments:

1. To study and verity the truth table of logic gates.
2. To realize half/full adder and half/full subtracter using: i) X-OR and basic gates ii) Only NAND gates.
3. To realize IC7483 as parallel adder/Subtractor.
4. To verify the truth table of MUX and DEMUX using NAND gate.
5. To verify the truth table of one bit and two bit comparators using logic gates.
6. To convert a given octal input to the binary output and to study the LED display using 7447 seven segment decoder/driver
7. Truth table verification of Flip-Flops: i) JK Master Slave, ii) D-type, iii) T-type.
8. Write a program to add two hexadecimal and decimal numbers using 8085 microprocessor.
9. Write a program to subtract two hexadecimal and decimal numbers using 8085 microprocessor.
10. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
11. Write a program to perform multiplication of two 8 bit numbers using bit addition method using 8085 microprocessor.
12. Write a program to perform multiplication of two 8 bit numbers using bit rotation method using 8085 microprocessor.
13. Write a program to perform division of two 8 bit numbers using Repeated Subtraction method using 8085 microprocessor.
14. Write a program to perform division of two 8 bit numbers using bit rotation method using 8085 microprocessor.
15. Finding the largest and smallest number from an array using 8085 microprocessor.

DSC X: NUCLEAR AND PARTICLE PHYSICS

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

After completing the course, students must be able to

1. Explain the Distribution of Nuclear Charge, Nuclear Mass, Bound States of Two Nucleons, Spin States and Pauli's Exclusion principle
2. Discuss the Stability and properties of different nuclei by various nuclear models.
3. Describe Radioactive α, β, γ -decay of nuclei by their respective quantum mechanical theories, Conservation laws and various nuclear reactions.
4. Discuss the method and analysis of Scattering process & understand meson theory of nuclear forces
5. Discuss the Elementary particles as the building blocks of matter and interacting fields. Conservation laws and quantum numbers for production and decay of particles.

Unit	Content	Hours
Unit I	General Properties of Atomic Nucleus: Nuclear charge, Nuclear Mass, (Atomic Number and Mass Number), Meaning of isotopes, Isobars, Isotones, Isomers, Isodiapheres with examples, Nuclear Radius, Mirror Nuclei method, Mass Defect, Binding energy, Variation of Binding energy per nucleon with mass number, semi empirical Mass Formula, Mass Parabola.	**08**
Unit II	Quantum Numbers for individual nucleons (Principal, Orbital, Radial, Spin, Total, Iso-spin, Quantum Numbers) Parity, Quantum Statistics; Nuclear Angular Momentum, Nuclear Magnetic Momentum, Nuclear Magnetic Dipole Moment, Measurements of nuclear magnetic moment by Rabi's method and Block's method, Problems. Deuteron , Ground state properties of Deuteron (Properties of Nuclear Forces, number, Range and depth of potential, excited States of Deuteron) phase , spin dependence, Coherent scattering , shape independent effective range theory; Proton-Proton scattering at low energies, similarity between n-n and p-p forces, Meson Theory of Nuclear forces, spin dependence of Nuclear forces.	**08**
Unit III	Beta Decay and Nuclear Models: Three forms of β decay, continuous nature of β-ray energy spectrum, difficulties encountered in explaining β-ray energy spectrum, Pauli's Neutrino hypothesis (properties of neutrino and explanation of β-decay using Pauli's Neutrino hypothesis), Assumption of Fermi's theory of β-decay, Fermi-Kurie Plots, Seargents Plots.Liquid drop model of Nucleus, Magic numbers, Evidences in support of Magic Numbers, Shell Model.	**08**
Unit IV	Neutron Physics, Properties of neutrons, classification of neutronsaccording to their energy, neutrons sources, neutrons detectors, slowing down of fast neutrons, absorption of neutrons.	**07**
Unit V	Nuclear Detectors - Gas filled, solid state and high energy detectors. Wilson cloud chamber, Spark Counter. Particle Accelerators - Need for particle accelerators, classification, wave guide type linear accelerator, focusing in linear accelerators, Betatron, Synchrotron.	**07**

Unit VI	Particle Physics: Classification of elementary particles, types of interactions between elementary particles, symmetry and conservationlaws, Basic ideas of CP and CPT invariance, the quark model, Lie algebra, SU(2) and SU(3) multiplets (Meson and Baryon states), the General model.	**07**

REFERENCE BOOKS:

1. Nuclear Physics, Second Edition - Irving Kaplan, Addison-Wesley Publishing - Massachusetts.
2. Concepts of Nuclear Physics - Bernard L.Cohen, Tata McGrawHill Publishing Co. -New Delhi.
3. Elements of Nuclear Physics - Pandya M.L.
4. Nuclear Physics : An Introduction - S.B.Patel, Wiley Eastern LimitedNew Delhi.
5. Nuclear Physics : Theory and Experiment : R.R.Roy and B.P.Nigem,New Age International (P) Ltd.-New Delhi.
6. Nuclear Physics - D.C.Tayal, Himalaya Publishing House, Bombay.
7. Nuclear Physics - S.N.Ghoshal, S.Chand & Company, New Delhi.
8. Elementary - Particle Physics - Committee on Elementary Particle Physics Universities Press (India) Ltd., Hyderabad.
9. The Elements of Nuclear Reactor - Glasstone Samuel, D.Van Nestrand Company-New Jersey.

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. https://onlinecourses.nptel.ac.in/noc24_cy19/preview
2. https://nptel.ac.in/courses/115103101
3. https://nptel.ac.in/courses/115104043
4. https://nptel.ac.in/courses/115102017

DSC XI: OPERATIONAL AMPLIFIER AND LINEAR INTEGRATED CIRCUITS

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon successful completion of this course the student will be able to

1. Demonstrate a comprehensive understanding of differential amplifier configurations, including DC and AC analysis, input offset current and voltage, common-mode rejection, and biasing techniques.
2. Explain the fundamental concepts of operational amplifiers, including their block diagram, characteristics, ideal vs. real behavior, and configurations for inverting and non-inverting amplifiers.
3. Design and analyze linear applications of operational amplifiers, such as voltage followers, summing amplifiers, instrumentation amplifiers, integrators, and differentiators.
4. Design first and second-order Butterworth high-pass and low-pass filters and understand the principles and operations of A/D and D/A converters, including R–2R and integrated circuit converters.
5. Design various waveform generators, including phase shift, Wein bridge, quadrature, square wave, triangular wave, and saw-tooth wave generators, and understand the operation of voltage-controlled and function generators.
6. Describe the basics of integrated circuit technology and various fabrication processes, such as crystal growth, oxidation, masking, etching, diffusion, and metallization, as well as the classification of ICs (SSI, MSI, LSI, and VLSI).

Unit	Content	Hours
Unit I	The Differential Amplifier: Circuit configurations DC Analysis, Input Offset Current and Voltage, AC Analysis, Common Mode Rejection, constant current bias, Current Mirror and level translator.	**7**
Unit II	Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback(excluding derivations).	**7**
Unit III	General Linear Applications: Voltage follower, DC and AC amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier, integrator and differentiator, logarithmic and anti-logarithmic amplifiers	**7**
Unit IV	Active Filters: First & Second order high pass & low pass Butterworth filters. A/D & D/A Converters: Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC Nonlinear Applications: Comparators and Schmitt triggers	**8**
Unit V	Waveform Generators and Converters: Waveform Generators: Phase shift Oscillators, Wein bridge Oscillators, Quadrature Oscillators, Square Wave Generator, Triangular Wave Generator, Saw-tooth Wave Generator. Voltage Controlled Oscillator - IC 566, Function Generator - IC 8038.	**8**

Unit VI	I.C. Fabrication Technology: Basics of Integrated Circuit Technology, Monolithic fabrication technique, Different Fabrication Processes: Crystal growth, epitaxial growth, Oxidation, Masking and Etching, Diffusion of Impurities, Metallization, Transistors for Monolithic Circuits (NPN & PNP), Monolithic Diodes, Integrated Resistors, Classification of ICs (SSI, MSI, LSI and VLSI).	**8**

TEXT BOOKS:

1. Op-Amps & Linear Integrated Circuits (Second Edition) Ramakant Gaikwad, Prentice Hall of India
2. Linear Integrated Circuits D Roy Choudhry & Shail B Jain New Age International Publishing
3. Electronic Devices (Sixth Edition) Floyd Pearson Education
4. Op Amps & Linear Integrated Circuits James M Fiore Thomson Learning
5. Integrated Circuits K R Botkar, Khanna Publishers, New Delhi.
6. Advanced Electronics, Fourth Edition, MADE EASY Publications

REFERENCE BOOKS:

1. Fundamentals of Electronic Devices and Circuits, Oxford University Press India, Fifth Edition, David A Belll.
2. Op-amp & Linear ICs, Oxford University Press India, Third Edition, David A. Bell,.
3. Analysis and design of Analog Integrated Circuits, Wiley International, Fifth Edition, Gray and Mayer.
4. Electronics Principles and Applications (Fifth edition) John D Ryder.

DSC XII : RADIATION AND PLASMA PHYSICS

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

After completing the course, students must be able to

1. Discuss charged particle dynamics and radiation from localized time varying electromagnetic sources and the basic mathematical concepts related to electromagnetic vector fields.
2. Discuss and solve wave equation for electric field and magnetic fields in free space.
3. Be familiar with concepts of plasma physics and its relation with ordinary electromagnetics.
4. Discuss the concept and application of wave guide, plasma and confinement and effect of magnetic field on electromagnetic wave.
5. Be familiar with the Magneto sonic and Alfven Waves

Unit	Content	Hours
Unit I	Wave Equation for Electric and Magnetic Fields in free space, Wave Equations for Vector and Scalar Potential, Retarded and Lienard- Wiechert Potentials, Electric and Magnetic fields due to a Uniformly moving charge and an Accelerating Charge.	**7**
Unit II	Total power radiated and Angular Distribution of Power Radiated by moving charge with linear and circular acceleration, Cerenkov radiation, Radiation Reaction Force.	**7**
Unit III	Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Non-uniform Fields, Diffusion Across Magnetic Fields, Time Varying E and B Fields, Adiabatic Invariants: First, Second and Third Adiabatic Invariants.	**7**
Unit IV	Definition of plasma, concept of temperature, Debye Shielding, Plasma Parameters, Applications of plasma Physics. Relation of Plasma Physics to ordinary electromagnetics, Classical treatment of Magnetic Materials and Dielectric. Dielectric constant of Plasma. Fluid equations of motion, Equation of continuity, equation of state, Fluid drifts parallel and perpendicular o magnetic field.	**8**
Unit V	Plasma Oscillations, Electron Plasma Wave, Ion waves, Plasma Approximation, Electrostatic electron oscillations perpendicular to B, Electrostatic Ion waves perpendicular to B, Electromagnetic wave without magnetic field, Electromagnetic waves perpendicular and parallel to static magnetic field B0.	**8**
Unit VI	Cutoffs and resonances, Whistler mode and Faraday rotation. Hydro magnetic Waves: Magneto sonic and Alfven Waves, CMA Diagram. Reflection of radio waves from ionosphere, effect of collision on reflection, Appleton- Hartee Formula and Propagation through Ionosphere and Magnetosphere.	**8**

REFERENCE BOOKS:

1. Introduction to Electrodynamics by David J. Griffiths, Publisher: PHI Learning (2009)
2. Electrodynamics: J. D. Jackson.
3. Electrodynamics: Gupta Kumar Singh, Pragati Prakashan.
4. Electricity and magnetism: Mahajan and Rangawala Tata Mc Graw Hill,New York.
5. Electrodynamics: Laud New Age Publication.
6. Introduction to Plasma Physics: Francis Chen, Plenum Press.
7. Fundamentals of Plasma Physics: Bitten Court, Pergamon Press.
8. Plasma Physics: Plasma State of Matter, S. N. Sen. Prgati Prakashan.

DSE IV (i): CONDENSED MATTER PHYSICS-II

Theory: 3 hours per week (3 Credits) **External Marks: 60**

Internal Marks: 40

COURSE OUTCOMES [COS]:

After successfully completing the course, student will have the understanding of:

1. Defects in solids and effect of point defect on structural, electrical & optical properties of solids.
2. Dislocations in crystals and stress fields inside the crystals.
3. Possible slip systems in FCC and BCC crystals, stacking faults in crystals and experimental methods to observe such defects in crystals.
4. Theories explaining electron-electron interaction in metals.
5. Concept of screening in interacting electron systems.
6. Structural and electrical properties of disordered materials.

Unit	Content	Hours
Unit-I	Point Defects: Types of point defects, concentration of point defects, description of point defect within the frame work of band model, diffusion and ionic conduction, recombination process of imperfection, optical transitions at imperfections.	**6**
Unit-II	Dislocations in crystals: concept of slip, stress field of screw and edge dislocations, elastic energy of dislocations, Cross slip, climbs and jogs in dislocation, forces on and between dislocations, Frank Read Source of dislocation multiplication.	**8**
Unit-III	Slip systems and dislocation reactions in FCC metals, partial dislocations, Thompson Tetrahedron , Slip systems and dislocation reactions in BCC metals. Stacking faults in close packed structures. Experimental methods of observing dislocation and stacking fault.	**6**
Unit-IV	Electron-electron interaction in lattice: Hartee & Hartee-Fock approximation for interacting electron systems, correlation energy, application of Hartee-Fock approximation for estimation of electron energy in metals	**6**
Unit-V	Concept of screening in interacting electron system, Thomas-Fermi and Lindhard Theory of screening, Friedel Sum Rule and Oscillations. Landau Fermi Liquid Theory for interacting electron system and concept of quasiparticles.	**8**
Unit-VI	Beyond the crystalline state: ordered and substitutional disordered alloys, liquid crystalline state- Nematic Phase and Cholesteric Phase, Smectic Phase and Columnar Phase. Introduction to electroactive polymers. Biopolymers: Introduction, types, synthesis and applications.	**6**

REFERENCE BOOKS:

1. Introduction to Dislocations, Derek Hull and D J Bacon, Butter worth Heinemann.
2. Introduction to Solid-State Theory, Otfried Madelung, Springer.
3. Solid State Physics, N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd,2009).
4. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).
5. Physics of Condensed Matter by Prasanta K. Misra (Elsevier Publication)

6. Polymer Physics, Gedde U.W. (Chapman and Hall) Introduction To Polymer Physics by M. Doi , Translated by H. See, Oxford University Press.
7. Polymer Physics, 1st Edition Oxford University Press

DSE IV (ii): PHOTONICS- II

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon the successful completion of this course the student will

1. Understand details about optical fiber, their classification, fabrication techniques and applications.
2. Understand optical communications, optical transmitters, optical receivers, system design and performance.
3. Understand fundamentals of optical amplifiers, dispersion compensation and optical signal processing.
4. Understand about optical devices, optical modulators, optical transducers, optical switches, optical logic gates, photonic circuits, and optical sensors.
5. Understand design, working and applications of optoelectronic devices like light emitting diodes (LED's), Diode lasers, fiber lasers and wave division multiplexing network optical devices.

Unit	Content	Hours
Unit I	Optical fibers: Classification, total internal reflections, Goos Hanchen shifts, Analysis of optical wave guides, ray and wave optics, characteristic equation of step index fiber, modes and their cut-off frequencies, single and multimode fibers, linearly polarized modes, power distribution.	7
Unit II	Graded index fiber, propagation constant, leaky modes, power profiles, dispersions, impulse response, types of couplings, Birefringent effects, polarization maintaining fibers, Fabrication techniques, Photonic crystal fiber.	8
Unit III	Optical Communications: Optical transmitters, Optical receivers, system design and performance, coherent and multi-channel light wave systems, optical amplifiers, dispersion compensation, Optical signal processing.	8
Unit IV	Optical devices: Optical modulators, Optical Transducers, Optical switches, All optical logic gates, Photonic circuits, Optically integrated devices.	8
Unit V	Optoelectronic devices: Wide bandgap semiconductors, light emitting diodes (LED's), Diode lasers, fiber lasers	7
Unit VI	Other optical devices: Optical sensors. Wave division multiplexing network optical devices, Advances in waveguides and waveguide devices, Plasmonic waveguides.	7

TEXT BOOKS:

1. Ajoy Ghatak and K Thyagarajan, "Introduction to fiber optics," Cambridge University Press (1999).
2. G P Agarwal, "Fiber-Optic Communication systems (second edition),"
3. Pallab Bhattacharya, "Semiconductor Optoelectronic devices," Prentice Hall (1996).
4. Shun Lien Chuang, "Physics of Optoelectronic Devices," Wiley Series in Pure and Applied Optics, John Wiley & Sons Ltd. (1995).
5. S. O Kasap, "Optoelectronics and Photonics: Principles and Practices," Pearson Education (2001).
6. F G Smith, T A King and D Wilkins, "Optics and Photonics: An Introduction," John Wiley & Sons, Ltd, San Francisco, USA, (2007).

1. Joseph W Goodman, "Introduction to Fourier Optics," McGraw-Hill.

REFERENCE BOOKS:

1. Keigo Iizuka, "Elements of PHOTONICS Vol. 1 (In free space and special media) and 2 (for fiber and integrated optics)," Wiley Series in Pure and Applied Optics.

2. Born and Wolf, “Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light,” Cambridge University Press.
3. Hand Book/Optics, Vol. 1-IV, Optical Society of India, McGraw Hill. Page 15

Weblink to Equivalent MOOC on SWAYAM if relevant:

1. https://onlinecourses.nptel.ac.in/noc20_ph07/preview
2. https://onlinecourses.nptel.ac.in/noc20_ee79/preview

DSE IV (iii): DIGITAL TECHNIQUES-II

Theory: 3 hours per week (3 Credits) **External Marks: 60**
Internal Marks: 40

COURSE OUTCOMES [COS]:

Upon the successful completion of this course the student will be able to:

1. To get the knowledge of design of sequential and non-sequential circuits such registers, counters, sequence detector etc.
2. To get the idea about industrial programming conceptual learning to design digital circuits.
3. Secure first hand idea about CPU, Registers, Internal buses, Timer Controller Unit in Intel 8051 Microcontroller.
4. Learn microcontroller and its architecture, pin diagram, timing diagram, instruction set.
5. Learn organization of 8051 microcontroller, to analyse Instruction Sets and its basic Programming.
6. Learn organization of 8051 microcontroller for its interfacing with instruments in daily life.

Unit	Content	Hours
Unit-I	**Counter:** Asynchronous and synchronous counter, UP/Down counter, BCD counter **Register:** SISO, SIPO, PISO, PIPO shift register, Bidirectional Shift register, Universal shift register, Shift register as Ring counter and shift counter.	**7**
Unit-II	**D/A converters**: Type of D/A converter, Modes of operations, BCD-Input D/A Converters, Integrated Circuit D/A Converters, D/A Converters as a Multiplier,	**7**
Unit-III	**A/D converters**: D/A converter as a multiplier, Divider, programmable integrator, low frequency function generator and digitally controlled filter.	**7**
Unit-IV	**8051 Microcontroller:** Microprocessor versus microcontroller, Microcontroller Architecture and Pin diagram, Inside a microcontroller, Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM), Special-Function Registers (SFRs), A/D converters, I/O Ports, Counter/Timers, applications of microcontrollers	**8**
Unit-V	**Addressing modes of 8051 microcontroller:** Immediate addressing mode, Register addressing mode, Direct Addressing Mode, Register indirect addressing Mode, Indexed Addressing Mode, Implied Addressing Mode **Instruction sets of 8051 microcontroller:** Arithmetic Instructions, Branch Instructions, Data Transfer Instructions, Logic Instructions	**8**
Unit-VI	**8051 Microcontroller Programming:** 8-bit and 16-bit Addition, Subtraction, Multiplication and Division programs using internal as well as external memory of 8051 microcontroller. **Concept of Interfacing:** Interfacing of 8051 microcontroller with Peripheral Devices like LEDs and Seven-Segment Displays	**8**

REFERENCE BOOKS:

1. Digital Electronics Principles, Devices and Applications by Anil K. Maini (2007), John Wiley & Sons Ltd.
2. Fundamental of Digital Circuits by A. Anand Kumar (2016), PHI leaning private Ltd
3. Digital Logic and Computer Design by M. Morris Mano (2016), Pearson India Education Services Pvt. Ltd
4. Digital Logic Circuit by A. P. Godase and D. A. Godse (2007), Technical Publication
5. Digital Electronics: Theory and Experiments by Virendra Kumar (2015), New Age International Publishers

6. Practical Digital Electronics by N. P. Cook (2003), Prentice-Hall, USA
7. Arithmetic and Logic in Computer Systems by M. Lu (2004), John Wiley & Sons, USA.
8. The 8051 microcontroller by I. Scott Mackenzie and Raphael C.-W. Phan, Pearson Education International
9. The 89051 microcontroller Architecture, Programming and applications by Keneth J. Ayala, West Publishing company New York
10. The 8051 microcontroller and embedded systems by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, Pearson Prentice Hall, New Jersey

LABORATORY COURSE I (DSC X AND DSC XI)

Practical: 6 hours per week (3 Credits) **External Marks: 50**
Internal Marks: 50

(Note: Student should perform at least ten experiments from Lab on DSC- X and Lab on DSC- XI)

Lab on DSC X: NUCLEAR AND PARTICLE PHYSICS

COURSE OUTCOMES [COS]:

List of Experiments:

1. Study of the characteristics of G.M. Counter.
2. To determine dead time of GM counter.
3. To verify random nature of radioactivity using GM counter.
4. To study range of beta particle in Al.

Lab on DSC XI: OPERATIONAL AMPLIFIER AND LINEAR INTEGRATED CIRCUITS

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. To conduct experiment to determine the characteristic parameters of Op-Amp.
2. To design the Op-Amp as Amplifier, adder, subtractor, differentiator & integrator
3. To design test the OP-Amp as oscillators and filters.
4. Design and study of Linear IC"s as VCO and function generator.

List of Experiments:

1. To design and setup an inverting non inverting amplifier circuit with OP AMP 741 IC.
2. To design and setup a summing amplifier circuit with OP AMP 741 IC.
3. To design and setup a difference amplifier circuit with OPAMP IC 741 IC.
4. To design and setup a Schmitt trigger, plot the input output waveforms and measure VUT and VLT.
5. To design and setup a Differentiator circuit using OP AMP 741 IC.
6. To design and setup a Integrator circuit using OP AMP 741 IC.
7. To design and setup symmetrical and asymmetrical astable multivibrators using Opamp 741 IC.
8. To design and setup a monostable multivibrator using Op-amp 741 IC.
9. To Design and setup a RC phase shift oscillator using Op-Amp 741 IC.
10. To design and setup a Wien bridge oscillator using Op-Amp 741 IC.
11. To design and setup voltage controlled oscillator using IC 566.
12. To design and setup First order high pass & low pass Butterworth filters.
13. To design and setup Function Generator using IC 8038.
14. To design and setup D/A and A/D converter.

LABORATORY COURSE II (DSC XII and DSE IV (i)/(ii)/(iii))

Practical: 6 hours per week (3 Credits) **External Marks: 50**
Internal Marks: 50

(Note: Student should perform at least ten experiments from Lab on DSC- XII and Lab on DSE IV (i)/(ii)/(iii))

Lab on DSC XII: RADIATION AND PLASMA PHYSICS

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Understand the Dynamics of Charged Particles in Electromagnetic Fields.
2. Analyze and Measure Electromagnetic Wave Propagation and Plasma Oscillations.
3. Explore Computational Analysis of Plasma Systems and Electromagnetic Wave Propagation.

List of Experiments:

1. Study the motion of charged particles in uniform electric and magnetic fields using a cyclotron or a simple Helmholtz coil setup.
2. Use a microwave setup to observe and measure the propagation of electromagnetic waves in free space.
3. To observe plasma oscillations and measure their frequencies using an RF plasma generator.
4. To construct and analyze the CMA diagram for a given plasma system using computational tools.
5. To study the propagation of electromagnetic waves through the ionosphere and magnetosphere through simulation using computational software.
6. Apply the Appleton-Hartree formula to calculate the propagation characteristics of radio waves in the ionosphere and verify them with experimental data.

Lab on DSE IV (i): CONDENSED MATTER PHYSICS II

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Analyze and Measure Ionic Conductivity and Defect Properties in Materials.
2. Characterize Dislocations, Stacking Faults, and Stress Fields in Crystals.
3. Investigate Recombination Processes, Optical Transitions, and Transport Properties in Semiconductors.
4. Apply Computational and Experimental Techniques to Study Electron Interactions and Material Properties.
5. Characterize Liquid Crystals, Electroactive Polymers, and Biopolymers.
6. General Structural Characterization of Materials.

List of Experiments:

1. To study variation of ionic conductivity of a given sample with temperature
2. To measure dislocation density by etch-pit method.
3. To determine Poisson's ratio of glass by Cornu's method.
4. To determine the types and concentration of point defects in a crystal using X-ray diffraction (XRD) technique.
5. To measure diffusion coefficients and ionic conductivity in materials using electrochemical impedance spectroscopy (EIS) technique.
6. To study the recombination processes of defects in semiconductors using photoluminescence spectroscopy.
7. To observe slip bands and measure stress fields of screw and edge dislocations using transmission electron microscopy (TEM).
8. To study optical transitions at imperfections in crystals using absorption and emission spectroscopy.
9. To observe slip bands and measure stress fields of screw and edge dislocations using transmission electron microscopy (TEM).
10. To study stacking faults in close-packed structures using high-resolution TEM (HRTEM).
11. To apply Hartee and Hartee-Fock approximations using computational quantum chemistry software to estimate electron energy in metals.
12. To study impurity bands in semiconductors using optical and electrical characterization techniques.
13. To tudy transport properties in amorphous semiconductors using conductivity and Hall effect measurements.
14. To study hopping probability and conductivity in impurity bands using temperature-dependent conductivity measurements.
15. To study different phases of liquid crystals (nematic, cholesteric, smectic, and columnar) using polarized optical microscopy and differential scanning calorimetry (DSC).
16. To synthesize and characterize electroactive polymers using cyclic voltammetry and conductivity measurements.
17. Study the properties of biopolymers using techniques like Fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA).
18. Structural Characterization of Materials :Virtual Lab Experiments http://vlabs.iitkgp.ac.in/scm/#

Lab on DSE IV (ii): PHOTONICS II

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Analyze the Properties and Performance of Optical Fibers.
2. Investigate Magneto-Optic, Acousto-Optic, and Electro-Optic Effects.
3. Explore Fabrication and Characterization of Optical Devices.
4. Analyze Optical Waveguide Properties and Light Propagation.
5. Design and Test Optical Communication Systems and Devices.

List of Experiments:

1. To determine numerical aperture of given optical fiber.
2. Determination of bending loss in multi mode fibers.
3. Magneto optic effect: To determine the angle of rotation as a function of mean flux density using different wavelengths of light and to calculate the corresponding Verdet's constant in each case.
4. Acousto optic effects: Study of density and elasticity in various liquids.
5. To study Pockel's effect.
6. To study Sculpting of plastic optical fiber tip.
7. To fabricate all optical fiber beam splitter.
8. Study of Second Harmonic Generation in crystals.
9. Pulsed laser deposition of thin films. (Demo)
10. Microlithography using High power Nd:YAG laser. (Demo)
11. To measure the Goos-Hanchen shift using a setup with a laser, beam splitter, and detectors.
12. To study wave propagation in optical waveguides using a He-Ne laser and to measure mode patterns and attenuation.
13. To identify and measure the modes and their cut-off frequencies in a single-mode and multimode fiber using an optical spectrum analyzer.
14. To measure the power distribution across different modes in a fiber using a power meter and mode scrambler.
15. To study the propagation characteristics in graded index fibers and measure the propagation constant using an optical time-domain reflectometer (OTDR).
16. To measure chromatic and modal dispersion in optical fibers using a pulse generator and an oscilloscope.
17. To study coupling techniques (butt-coupling, lens-coupling) and measure coupling efficiency between fibers and other optical components.
18. To characterize photonic crystal fibers and observe light guiding mechanisms using a tunable laser source.
19. To design and test an optical transmitter and receiver system using LEDs or laser diodes and photodetectors.
20. To study electro-optic modulators (e.g., Mach-Zehnder modulator) by measuring modulation depth and frequency response.
21. Study the working of optical transducers and measure their sensitivity and linearity.
22. To design and test optical switches and logic gates using nonlinear optical effects or photonic devices.
23. To study wide bandgap semiconductor materials (e.g., GaN) using techniques like photoluminescence or electrical characterization.
24. To measure the I-V characteristics, emission spectrum, and efficiency of different types of LEDs.
25. To study diode lasers and fiber lasers by measuring their output power, spectrum, and threshold current.

Lab on DSE IV (iii): DIGITAL TECHNIQUES-II

COURSE OUTCOMES [COS]:

The student, after successful completion of the course, will be able to

1. Design and Implement Digital Logic Circuits.
2. Develop and Test Programs for Arithmetic Operations Using 8051 Microcontroller.
3. Implement Memory Operations and Factorial Calculation Using 8051 Microcontroller.

List of Experiments:

1. Realization of 3-bit counter as a sequential circuit and Mod-N counter design
2. Design and testing of Ring counter/ Johnson counter
3. Design and testing of Monostable and Astable multivibrators using 555 timer
4. Suppose two 8-bit data bytes are stored in memory locations 7001H and 7002H. Write a program to add these two bytes from external memory locations using 8051 microcontroller and store the result in memory location 7003H of the external memory
5. Suppose two 8-bit data bytes are stored in memory locations 7001H and 7002H. Write a program to subtract these two bytes from external memory locations using 8051 microcontroller and store the result in memory location 7003H of the external memory
6. Using 8051 microcontroller, write an assembly language program to add two 16-bit numbers
7. Using 8051 microcontroller, write an assembly language program to subtract two 16-bit numbers
8. Using 8051 microcontroller, write an assembly language program to multiply two 8-bit numbers
9. Using 8051 microcontroller, write an assembly language program to divide two 8-bit numbers
10. Using 8051 microcontroller, write an assembly language program to exchange five bytes between source block and destination block in internal memory. Assume source block address is 20H and destination block address is 30H.
11. Using 8051 microcontroller, write an assembly language program to exchange five bytes between source block and destination block in external memory. Assume source block address is 7001H and destination block address is 7011H.
12. Using 8051 microcontroller, write an assembly language program to find factorial of an 8-bit number