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[OBE DESIGN- PHYSICS DEPARTMENT]

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PREFACE

Outcome Based Education (OBE) is the educational approach which focuses on student centric education in the context of development of personal, social, professional and knowledge (KSA) requirements in one's career and life. It is the decade ago curriculum development methodology. The educational triangle of *LEARNING-ASSESSMENT-TEACHING* is the unique nature of the OBE approach. The curriculum practices such as Competency Based Curriculum, Taylor's Model of Curriculum Development, Spadys' Curriculum principles, Blooms taxonomy and further use of assessment methodologies like, Norm-reference testing and Criterion reference testing, etc is being practiced since decades. It is also interesting to know that, globally, different countries and universities adopts the curriculum development models/approaches such as, CDIO (Conceive-Design-Implement-Operate), Evidenced Based Education, Systems' Approach, etc as the scientific and systematic approaches in curriculum design.

The authorities of Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S.) in-lieu of accreditation standards of National Assessment and Accreditation Council, decided to opt for Outcomes Based Education (OBE). As the part of the decision, different meetings, workshops and presentations were held at the campus of university.

This document is the outcome of different meetings and workshops held at university level and department level. The detailed document is designed and the existing curriculum of the department is transformed in to the framework of OBE. This is the first step towards the implementation of OBE in the department. The document will serve all stakeholders in the effective implementation of the curriculum. The OBE is continuous process for quality enhancement and it will go a long way in order to enhance the competencies and employability of the graduates/Post-graduates of the university department.

Head of Department

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OUTCOME BASED EDUCATION

Faculty of Science & Technology

Department of Physics

1. Mission:

Mission Statement

- To apply conventional and non-conventional tools to conceive physical phenomenon.
- To apply tools and techniques in the development of materials and products.
- To analyse the plant characteristics and develop new/hybrid plant.
- To conduct research based activities in Physiscs with special focus on bio-physics, applied physics, optics.
- To establish collaboration with eminent institutes and industries for enhanced learning experiences and teaching-learning process.

2. Vision:

Vision Statement

The department envisions establishing the centre for research and development in research with special application to health science, defense and industry.

The mission and vision of the organization help in preparation of strategic plan.

3. Title of the Program (s):

a. Master of Science (Physics)

4. Program Educational Objectives:

The program educational objectives (PEO) are the statement that describes the career and professional achievement after the program of studies (graduation/ post-graduation). The PEO s are driven form question no. (ii) of the Mission statement (What is the purpose of organization). The PEOs can be minimum three and maximum five.

PEO1: To have advance knowledge and apply theories and principles of physics/applied physics in the domain of industry, research and development.

PEO2: To provide the professional services to industry, research organization, institutes.

PEO3: To provide the professional consultancy and research support for the relevant organization in the domain of super specialization.

PEO4: To opt for higher education, disciplinary & multi-disciplinary research and to be a life-long learner.

PEO5: To provide, value based and ethical leadership in the professional and social life.

5. Program Outcomes:

The program outcomes (PO) are the statement of competencies/ abilities. POs are the statement that describes the knowledge and the abilities the graduate/ post-graduate will have by the end of program studies.

Programme Specific Outcomes:

a. **Domain knowledge:** Apply the knowledge of mathematics and physics fundamental, Quantum physics, electronics, spectroscopy for the solution of complex problems.
b. PSO2. **Problem Analysis:** Identify physics/optics/nuclear physics/ microprocessor/ sensor/ radiation related problems at varied complexity and analyze the same to formulate/ develop substantiated conclusion using first principles.
c. **Design Development of solutions :** Design / develop solutions for problems at varied complexity in the area Sensor Technology, industrial electronics, Materials, nano-materials, radiation technology Industrial Communication to address changing challenges put forward by market demand/ stakeholder
d. **Conduct Investigation of complex problems:** Use research-based knowledge and methods to design of experiments, analyze resulting data and interpret the same to provide valid conclusions.
e. **Modern tools:** Create, select, and apply appropriate techniques, resources, and microprocessor and relevant IT tools including prediction and modeling to complex scientific solutions related activities with clear understanding of the limitations
f. **The citizenship and society:** Apply broad understanding of ethical and professional skill in scientific applications in the context of global, economic, environmental and societal realities while encompassing relevant contemporary issues.
g. **Environment and sustainability**: Apply broad understanding of impact of electronics technology in a global, economic, environmental and societal context and demonstrate the knowledge of, and need for sustainable development.
h. **Ethics:** Apply ability to develop sustainable practical solutions for electronics technology related problems within positive professional and ethical boundaries.

i. **Project management and finance**: Demonstrate knowledge and understanding of the first principles of Nano-technology, sensor technology, nuclear physics, radiation, and spectroscopy and apply these to one's own work as a member and leader in a team, to complete project in any environment.

j. **Life-long learning**: Recognize the need for lifelong learning and have the ability to engage in independent and life-long learning in the broadest context of technological change.

6. Course- Program outcome Matrix:

The Program Outcomes are developed through the curriculum (curricular/co-curricular-extra-curricular activities). The program outcomes are attained through the course implementation. As an educator, one must know, ***"to which POs his/her course in contributing?"***. So that one can design the learning experiences, select teaching method and design the tool for assessment. Hence, establishing the Corse-PO matrix is essential step in the OBE. The course-program outcomes matrix indicates the co-relation between the courses and program outcomes. The CO-PO matrix is the map of list of courses contributing to the development of respective POs.

The **C0-PO MATRIX** is provided in the below table.

COURSE TITLE [Ist & IInd Year)	**A**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**
Mathematical Methods in Physics PHYC-111	√	√	√				√	√		
Classical Mechanics PHYC-112	√	√		√					√	√
Quantum Mechanics PHYC-113	√	√	√	√	√			√		√
Statistical Mechanics PHYC-114	√			√	√	√				√
Research Methodology	√	√	√				√	√		

PHYF-115										
Lab course 1 (General Physics) PHYL- 121	√	√		√					√	√
Lab course 2 (Computational Physics based on PHYC -111, 112, 113 and114) PHYL- 122	√	√	√	√	√			√		√
Foundation Course in Electronics (Linear and Digital Electronics) PHYF-211	√			√	√	√				√
Foundation Course in Spectroscopy (Atomic and Molecular Physics) PHYF-212			√	√	√					√
Foundation Course in Nuclear Physics (General Nuclear Physics) PHYF-213		√	√		√			√	√	
Foundation Course in Condensed Matter Physics	√	√		√		√	√	√		√

(General Condensed Matter Physics) PHYF-214										
Lab course 3 (Condensed Matter Physics + Nuclear Physics+ Spectroscopy) PHYL-221			√	√	√					√
Lab course 4 (Electronics + Computational Physics) PHYL-222		√	√		√			√	√	
Review of literature for Research Project PHYR-231	√	√		√		√	√	√		√
Formulation of Topic of Research Project PHYR-232	√	√	√				√	√		
Methods of Theoretical Physics PHYF-311	√	√		√					√	√
Generic Electives 1 (A1/ B1/ C1/ D1) PHYE-312	√	√	√	√	√			√		√
Generic Electives 2 (	√	√	√				√	√		

A2/ B2/ C2/ D2) PHYE-313										
Generic Electives 3 (A3/ B3/ C3/ D3/ E3 / F3/G3/H3) PHYE-314	√	√		√					√	√
Lab course 5 (Based on Electives A1/ B1/ C1/ D1) PHYL-321	√	√	√	√	√			√		√
Lab course 6 (Based on Electives A2/ B2/ C2/ D2) PHYL-322	√			√	√	√				√
Research Project Part I (Experimental Work) PHYR-331	√	√	√				√	√		
Research Project Part II (Organization of Results) PHYR-332	√	√		√					√	√
Generic Electives 4 (A4/ B4/ C4/ D4) PHYE-411	√	√	√	√	√			√		√
Generic Electives 5 (A5/ B5/ C5/ D5) PHYE-412	√			√	√	√				√
Generic Electives 6 (	√	√	√				√	√		

A6/ B6/ C6/ D6) (Research Oriented) PHYE-413										
Service Course of Department of Physics (from other Departments) OELE-101	√	√		√					√	√
Lab course 7 (Based on Electives A4,A5/ B4,B5/ C4,C5/ D4,D5) PHYL-421	√	√	√				√	√		
Research Project Part III (Interpretation of Results) PHYR-431	√	√		√					√	√
Research Project Part IV (Dissertation and Presentation) PHYR-432	√	√	√	√	√			√		√

7. Course Outcomes (for all courses):

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There can be 5 to 7 course outcomes of any course. These are to be written in the specific terms and not in general. The list of Course Outcomes is the part of ***Annexure-C*** attached herewith.

8. Set Target levels for Attainment of Course Outcomes:

The course outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment are measured/calculated. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

9. Set Target level for Attainment of Program Outcomes:

The program outcome attainment is assessed in order to track the graduates' performance w.r.t target level of performance. The CO-PO attainment is the tool used for continuous improvement in the graduates' abilities through appropriate learning & teaching strategies. In order to assess students' performance with respect to abilities (at the end of course teaching/by the end of program) the course outcome attainment and program outcome attainment is measured/calculated. The program outcome attainment is governed by curricular, co-curricular and extra-curricular activities including the stakeholders' participation. The direct method and indirect method is adopted to calculate the PO attainment. The direct method implies the attainment by course outcomes contributing to respective program outcomes. And indirect method is the satisfaction/feed-back survey of stakeholders. In order to calculate the program outcome attainment, the course outcome attainment is calculated. Prior to that, the course-program outcome mapping is done.

The set target level is the set benchmark to ensure the continuous improvements in the learners/ graduates' performance.

10. Course Attainment Levels:

a. CO attainment is defined/set at three levels;
b. The CO attainment is based on end term examination assessment and internal assessment;
c. The Co attainment is defined at three levels in ascending order-
    i. e.g. For end term and internal examination;
    ii. LEVEL-1: 0% TO 10%
    iii. LEVEL-2: 10 %(+) TO 20%

iv. LEVEL-3: 20 %(+) TO 30%
v. Target Level- CO Attainment Value: 2 (>1 & <2)

d. The target level is set (e.g. Level-2). It indicates that, the current target is level-2 (>1<2); 10%(+) to 20% students score more than class average. The CO attainment is measured and the results are obtained. Based on the results of attainment, the corrective measures/remedial action are taken.
e. CO Attainment= 80% (Attainment level in end term examination) + 20% (Attainment level in internal examination).

11.Program attainment Level:

a. PO attainment is defined at five levels in ascending order;
b. The PO attainment is based on the average attainment level of corresponding courses (Direct Method) and feed-back survey (Indirect method);
c. The PO attainment levels are defined / set as stated below;
    i. Level-1: Greater than 0.5 and less than 1.0 (0.5>1)- Poor
    ii. Level-2: 1.0>1.5-Average
    iii. Level-3: 1.5>2.0-Good
    iv. Level-4: 2.0>2.5-Very Good
    v. Level-5: 2.5>3.0 -Excellent
d. The PO attainment target level is set/defined (say, Level-2). It implies that, the department is aiming at minimum level-2 (Average) in the performance of abilities by the graduates. Based upon the results of attainment, the remedial measures are taken;
e. PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

12. The Results of CO Attainment:

For Example:

COURSE CODE/TITLE: PHYC-113 Quantum Mechanics

For Academic Year - 2016 – 17

e.g. For end term and internal examination;

i. LEVEL-1: 0% TO 10%
ii. LEVEL-2: 10 %(+) TO 20%
iii. LEVEL-3: 20 %(+) TO 30%
iv. Target Level- CO Attainment value : 2 (>1 & <2)

Average Marks in External examination: 31.70

% Students score more than 31.70 is 3.15% i.e. Levl-1

Average Marks in Internal examination= 4.46

% Students score more than 4.46 is 22.38%, i.e. Level-3

A (CO) PHYC-113= 80% (1) +20(3)

=0.8+0.6

= 1.4 i.e.Level-2

Hence, the attainment level is Level-2 and the set target level is Level-2 and therefore the CO is fully attained.

Table No. 1.0: CO Attainment Level

LEVEL-1: 0% TO 10%
LEVEL-2: 10 %(+) TO 20%
LEVEL-3: 20 %(+) TO 30%

Target Level- CO Attainment Value: 2 (>1 & <2)

Course Title	**CO Attainment Value**	**Target Attainment Level**	**Fully Attained/ Not attained**	**Remedial Measures**
Mathematical Methods in Physics	1.2	2	Fully Attained	
Classical Mechanics	1.2	2	Fully Attained	
Quantum Mechanics	1.4	2	Fully Attained	
Statistical Mechanics	1.4	2	Fully Attained	
Research Methodology	1.4	2	Fully Attained	
Lab course 1 (General Physics)	1	2	Not attained	Assignments, Tutorials, Exercise & Remedial coaching
Lab course 2 (Computational Physics based on PHYC -111, 112, 113 and114)	1	2	Not attained	
Foundation Course in Electronics (Linear and Digital Electronics)	1	2	Not attained	

Foundation Course in Spectroscopy (Atomic and Molecular Physics)	1	2	Not attained	
Foundation Course in Nuclear Physics (General Nuclear Physics)	1	2	Not attained	
Foundation Course in Condensed Matter Physics (General Condensed Matter Physics)	1.2	2	Fully Attained	
Lab course 3 (Condensed Matter Physics + Nuclear Physics+ Spectroscopy)	1	2	Not attained	Assignments, Tutorials, Exercise & Remedial coaching
Lab course 4 (Electronics + Computational Physics)	1	2	Not attained	
Review of literature for Research Project	1	2	Not attained	
Formulation of Topic of Research Project	1	2	Not attained	
General Condensed Matter Physics	1.2	2	Fully Attained	
General Nuclear Physics	1	2	Not attained	Assignments, Tutorials, Exercise & Remedial coaching
Special Paper: 1 (A1/B1/C1/D1)	1.2	2	Fully Attained	
Special Paper : 2 (A2/B2/C2/D2)	1.2	2	Fully Attained	
Practical 5 - Lab Course (A1/B1/C1/D1)	1	2	Not attained	Assignments, Tutorials, Exercise & Remedial coaching
Practical 6 - Lab Course (A2/B2/C2/D2)	1	2	Not attained	
Tutorials (T) and Seminars (SM)	1	2	Not attained	

Numerical Methods in Physics	1	2	Not attained	
Special Paper : 3 (A3/B3/C3/D3)	1	2	Not attained	
Special Paper: 4 (A4/B4/C4/D4)	1	2	Not attained	
Elective Paper (E1/E4/E6/E7)	1	2	Not attained	
Practical - Lab Course	1	2	Not attained	
Project	1	2	Not attained	
Tutorials (T) and Seminars (SM)	1	2	Not attained	

13.The Results of PO Attainment:

FOR EXAMPLE:

PO NO.: j

(Note: Refer point No. 11 above which describes the attainment level and set target attainment level)

PO Attainment= 80% (Average attainment level by direct method) + 20% (Average attainment level by indirect method).

A (PO) j = 80% (1.2+1.4+1.4+ 1+1+1+1+1.2+1+1+1.2+1+1.2+1+1+1+1+1+1+1+1)/21 +20% (1.08)

=80% (1.08) + 20% (1.08)

= 1.08 i.e. Level-2. The Target Level is Level-2.

Hence, PO is attained.

Table No. 2.0 PO Attainment Level

PO/PSO number	PO Attainment Value	Target Attainment level	Fully attained/ Not Attained	Remedial Measures
A	1.09	2	Fully attained	Not Applicable
b	1.08	2	Fully attained	
c	1.08	2	Fully attained	
d	1.08	2	Fully attained	
e	1.06	2	Fully attained	
f	1.10	2	Fully attained	
g	1.11	2	Fully attained	
h	1.08	2	Fully attained	
i	1.07	2	Fully attained	
j	1.08	2	Fully attained	

14. Planned Actions for Course Attainment:

The courses having attainment level less than Level-2 shall be addressed by conducting remedial measures such as Assignments, tutorials, exercise and remedial coaching.

15.Planned Actions for Program Outcome Attainment:

Not Applicable.

ANNEXURE-B

RESULTS OF CO-PO ATTAINMENT

COURSE TITLE	A	B	c	d	e	f	g	h	i	j
Mathematical Methods in Physics PHYC-111	1.2	1.2	1.2				1.2	1.2		
Classical Mechanics PHYC-112	1.2	1.2		1.2					1.2	1.2
Quantum Mechanics PHYC-113	1.4	1.4	1.4	1.4	1.4			1.4		1.4
Statistical Mechanics PHYC-114	1.4			1.4	1.4	1.4				1.4
Research Methodology PHYF-115	1.4	1.4	1.4				1.4	1.4		
Lab course 1 (General Physics) PHYL- 121	1	1		1					1	1
Lab course 2 (Computational Physics based on PHYC -111, 112, 113 and114) PHYL- 122	1	1	1	1	1			1		1
Foundation Course in Electronics (Linear and Digital Electronics) PHYF-211	1			1	1	1				1
Foundation Course in Spectroscopy (Atomic and			1	1	1					1

Molecular Physics) PHYF-212										
Foundation Course in Nuclear Physics (General Nuclear Physics) PHYF-213		1	1		1			1	1	
Foundation Course in Condensed Matter Physics (General Condensed Matter Physics) PHYF-214	1.2	1.2		1.2		1.2	1.2	1.2		1.2
Lab course 3 (Condensed Matter Physics + Nuclear Physics+ Spectroscopy) PHYL-221			1	1	1					1
Lab course 4 (Electronics + Computational Physics) PHYL-222		1	1		1			1	1	
Review of literature for Research Project PHYR-231	1	1		1		1	1	1		1
Formulation of Topic of Research Project PHYR-232	1	1	1				1	1		
Methods of Theoretical Physics PHYF-311	1.2	1.2		1.2					1.2	1.2
Generic Electives 1 (A1/	1	1	1	1	1			1		1

B1/ C1/ D1) PHYE-312										
Generic Electives 2 (A2/ B2/ C2/ D2) PHYE-313	1.2	1.2	1.2				1.2	1.2		
Generic Electives 3 (A3/ B3/ C3/ D3/ E3 / F3/G3/H3) PHYE-314	1.2	1.2	1.2	1.2					1.2	1.2
Lab course 5 (Based on Electives A1/ B1/ C1/ D1) PHYL-321	1	1	1	1	1			1		1
Lab course 6 (Based on Electives A2/ B2/ C2/ D2) PHYL-322	1			1	1	1				1
Research Project Part I (Experimental Work) PHYR-331	1	1	1				1	1		
Research Project Part II (Organization of Results) PHYR-332	1	1		1					1	1
Generic Electives 4 (A4/ B4/ C4/ D4) PHYE-411	1	1	1	1	1			1		1
Generic Electives 5 (A5/ B5/ C5/ D5) PHYE-412	1			1	1	1				1
Generic Electives 6 (A6/	1	1	1				1	1		

B6/ C6/ D6) (Research Oriented) PHYE-413										
Service Course of Department of Physics (from other Departments) OELE-101	1	1		1					1	1
Lab course 7 (Based on Electives A4,A5/ B4,B5/ C4,C5/ D4,D5) PHYL-421	1	1	1				1	1		
Research Project Part III (Interpretation of Results) PHYR-431	1	1		1					1	1
Research Project Part IV (Dissertation and Presentation) PHYR-432	1	1	1	1	1			1		1
PO ATTAINMENT	**1.09**	**1.08**	**1.08**	**1.08**	**1.06**	**1.10**	**1.11**	**1.08**	**1.07**	**1.08**

ANNEXURE-C
COURSE OUTCOMES

Course Structure:

Semester I (Core and Foundation Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	Credits
PHYC-111	Mathematical Methods in Physics	4 hours	100	4
PHYC-112	Classical Mechanics	4 hours	100	4
PHYC-113	Quantum Mechanics	4 hours	100	4
PHYC-114	Statistical Mechanics	4 hours	100	4
PHYF-115	Research Methodology	1 hours	30	1
COM-100	***Constitution of India***	***2 hours***	***50***	***2***
PHYL- 121	Lab course 1 (General Physics)	4 hours	50	2
PHYL- 122	Lab course 2 (Computational Physics based on PHYC -111, 112, 113 and114)	4 hours	50	2

Total Credits for Semester I : 23 (Theory : 19 ; Laboratory : 04)				
Semester II (Foundation Courses)				
PHYF-211	Foundation Course in Electronics (Linear and Digital Electronics)	4 hours	100	4
PHYF-212	Foundation Course in Spectroscopy (Atomic and Molecular Physics)	4 hours	100	4
PHYF-213	Foundation Course in Nuclear Physics (General Nuclear Physics)	4 hours	100	4
PHYF-214	Foundation Course in Condensed Matter Physics (General Condensed Matter Physics)	4 hours	100	4
PHYL-221	Lab course 3 (Condensed Matter Physics + Nuclear Physics+ Spectroscopy)	4 hours	50	2
PHYL-222	Lab course 4 (Electronics + Computational Physics)	4 hours	50	2
PHYR-231	Review of literature for Research Project	4 hours	50	2
PHYR-232	Formulation of Topic of Research Project	4 hours	50	2
Total Credits for Semester II : 24 (Theory : 16 ; Laboratory : 04 ; Research Project : 04)				
Semester III (Foundation and Generic Elective Courses)				
PHYF-311	Methods of Theoretical Physics	4 hours	100	4

PHYE-312	Generic Electives 1 (A1/ B1/ C1/ D1)	4 hours	100	4
PHYE-313	Generic Electives 2 (A2/ B2/ C2/ D2)	4 hours	100	4
PHYE-314	Generic Electives 3 (A3/ B3/ C3/ D3/ E3 / F3/G3/H3)	4 hours	100	4
PHYL-321	Lab course 5 (Based on Electives A1/ B1/ C1/ D1) Lab course 6 (Based on Electives A2/ B2/ C2/ D2)	6 hours	50	3
PHYR-331	Research Project Part I (Experimental Work) + Research Project Part (Organization of Results)	12 hours	100	10
Total Credits for Semester III : 29 (Theory : 16 ; Laboratory : 03 ; Research Project : 10)				
Semester IV (Generic and Open Elective Courses)				
PHYE-411	Generic Electives 4 (A4/ B4/ C4/ D4)	4 hours	100	4
PHYE-412	Generic Electives 5 (A5/ B5/ C5/ D5)	4 hours	100	4
PHYE-413	Generic Electives 6 (A6/ B6/ C6/ D6) (Research Oriented)	4 hours	100	4
OELE-101	Service Course of Department of Physics (from other Departments)	4 hours	100	4
PHYL-421	Lab course 7	6 hours	50	3

	(Based on Electives A4,A5/ B4,B5/ C4,C5/ D4,D5)			
PHYR-431	Research Project Part II (Interpretation of Results) + (Dissertation and Presentation)	6 hours	100	10
Total Credits for Semester IV : 29 (Theory : 16 ; Laboratory : 03 ; Research Project : 10)				
Total Credits : 105 (Sem I : 23 + Sem II : 24 : Sem III : 29+ Sem IV : 29)				

List of Generic Elective Courses for Semester III

Sr. No.	Code	Name of Course	Semester
		A: Electronics ; B : Spectroscopy	

		C : Nuclear Physics D : Condensed Matter Physics	
1	A1	8086 Microprocessor and Interfacing	III
2	B1	Atomic Spectroscopy	III
3	C1	Radioactivity and Nuclear Decay	III
4	D1	Crystallography	III
5	A2	Microwaves	III
6	B2	Molecular Spectroscopy	III
7	C2	Nuclear Reactions	III
8	D2	Electrical Properties of Solids and Superconductivity	III
9	A3	Industrial Electronics	III
10	B3	Modern Trends in Spectroscopy	III
11	C3	Reactor Physics	III
12	D3	Physics of Nanomaterials	III
13	E3	X-Ray Diffraction	III
14	F3	Thin Film and Vacuum Technology	III
15	G3	Nuclear Spectroscopy	III
16	H3	Micro Electro Mechanical System (MEMS)	III
List of Generic Elective Courses for Semester IV			
1	A4	Fundamentals of Sensors	IV
2	B4	Applied Spectroscopy	IV

3	C4	Particle Physics, Nuclear forces and Cosmic rays	IV
4	D4	Magnetic Materials and Superfluidity	IV
5	A5	8051- Microcontroller	IV
6	B5	Lasers, Nonlinear Optical mixing and Spectroscopic Phenomena	IV
7	C5	Radiation Measurements And Nuclear Dosimetry	IV
8	D5	Material Synthesis and Characterization	IV
9	A6	Advanced Sensor Technology	IV
10	B6	X-ray Spectroscopy	IV
11	C6	Nuclear Fission, Fusion and Neutron Physics	IV
12	D6	Ferromagnetism	IV

PHYC-111 : Mathematical Methods in Physics

- Apply the basic elements of complex mathematical analysis, including the integral theorems, obtain the residues of a complex function and to use the residue theorem to evaluate definite integrals
- Solve ordinary differential equations of second order that are common in the physical sciences.
- Expand a function in terms of a Fourier series, with knowledge of the conditions for the validity of the series expansion.
- Apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics, use Fourier transforms as an aid for analyzing experimental data.
- Solve partial differential equations of second order by use of standard methods like separation of variables, series expansion (Fourier series) and integral transforms.
- Solve some simple classical variational problems.

PHYC-112: Classical Mechanics

- Describe the physical principle behind the derivation of Lagrange and Hamilton's equations, and the advantages of these formulations,
- Relate symmetries to conservation laws in physical systems, and apply these concepts to practical situations,
- Demonstrate and practice different problem-solving strategies within mechanical physics and assess which of these strategies is most useful for a given problem,
- Ex[plain the fundamental principles of the special theory of relativity,
- Describe the intricacies of moving-reference frames and rigid-body motion

PHYC-113 : Quantum Mechanics

- Describe the concept that quantum states live in a vector space;
- Describe the meaning of measurement;
- Relate the abstract formulation to wave and matrix mechanics;
- Explainperturbation theory, level splitting, and radiative transitions;
- Explain the relation between conservation laws and symmetries;
- Describe the role of angular momentum in atomic and nuclear physics;
- solve quantum mechanics problems;
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations

PHYC-114 Statistical Mechanics

- Apply statistics to various modern discoveries ranging from Ohm's law to quantum Hall effect to Bose Einstein condensates – optical molasses.
- Describe the fundamental idea behind various phenomena in condensed matter physics.
- Solve the problems

PHYF-115 : Research Methodology

- Conduct systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
- Design a research approach for a specific research issue of their choice.
- Select a suitable analytical method for a specific research approach.
- Demonstrate a good understanding of how to write a research report.
- Critically assess published quantitative research with regard to the statistical methods and approaches adopted

PHYF-211 : Foundation Course in Electronics (Linear and Digital Electronics)

- Describe the general method for analyzing and predicting the performance of operational amplifiers and related integrated circuits.
- Design realistic circuits to perform specified operations.
- Select available devices for intended operations.

PHYF-212 : Foundation Course in Spectroscopy (Atomic and Molecular Physics)

- Explain the basic concept and principles of Atomic- and Molecular Physics
- Describe the modern experimental tools of Atomic- and Molecular Physics job prospects.

PHYF-213: Foundation Course in Nuclear Physics (General Nuclear Physics)

- Apply general considerations of Nuclear physics to atomic and nuclear system; make general orders of magnitude of estimation of physical effects.
- Explain interaction of gamma radiation with matter;
- Explain the working principle of accelerators and radiation detector.

PHYF-214: Foundation Course in Condensed Matter Physics (General Condensed Matter Physics)

- Investigates different classes of materials -metals, ceramics, electronic materials.
- Establish based on investigation, the relationships between the underlying structure and the processing, properties, and performance of the materials.
- Identify research opportunities in the domain.are offered as scientists and technologists, etc in national and international institutions.

PHYF-311 : Methods in Theoretical Physics

- Apply analytical tools including formal methods in classical and quantum physics
- Write communicate information and conclusions in written and verbal formats on core ideas in Theoretical Physics
- Evaluate complex problems and formulate solutions, indentifying the role of theory, hypothesis and experiment in the scientific method
- Apply computers to the solution of problems in theoretical physics
- Plan, carry out and report a theoretical physics based investigation
- Apply classical and quantum theoretical techniques in research

PHYE-312 – Elective 1 (A1): 8086 Microprocessor and Interfacing

- Microprocessor architecture, physical configuration of memory, logical configuration of memory, microprocessor programming and interfacing.
- Describe the types of interface.
- Design the interface for the given problems.
- Conduct Industrial automation using 8086 interfacing and programming.

PHYE-312 – Elective 1 (B1) : Atomic Spectroscopy:

- Describe the concept of the photon, however, emerged from experimentation with **thermal radiation**,
- Verify the quantized nature of electromagnetic radiation.
- Describe experimentation with visible light .
- Describe various aspects of atomic spectroscopic analysis relevant to research and industry.
- Describe the systems and solve chemical problems
- Describe basic concepts of instrumentation, data acquisition and data processing.

PHYE-312 – Elective 1 (C1) : Radioactivity and Nuclear Decay:

- Describe the uses of radioactivity in determining age of earth, mountains, etc.
- Explain various nuclear decay that is beneficial in radio physics / Chemistry and in the field of medical (Treating the cancer patients).
- Identify the skills required to handle the technology.

PHYE-312 – Elective 1 (D1) : Crystallography :

- Explain basic/fundamental crystallographic concepts
- Extort the relevant information from a crystallographic paper'
- Find specific tools for solution of a given crystallographic problem.

PHYE-313 – Elective 2 (A2) : Microwaves

- Apply electromagnetic theory to calculations regarding waveguides and transmission lines
- Describe, analyze and design of simple microwave circuits and devices
- Describe and coarsely design common systems such as radar and microwave transmission links-

- Describe common devices such as microwave vacuum tubes, high-speed transistors and ferrite devices-
- Handle microwave equipment and make measurements.

PHYE-313 – Elective 2 (B2): Molecular Spectroscopy

- Analyze the uv-visible spectra of diatomic molecules, and determine their structure
- Analyze the Raman spectra of molecules, and determine their structure
- Demonstrate spectroscopy techniques in solving problem.

PHYE-313 – Elective 2 (C2) : Nuclear Reactions and Nuclear Energy

- Use basic concepts of nuclear physics.
- Describe the basic principles of the most common nuclear physics applications in the society: nuclear energy, radiation therapy and nuclear medicine
- Use nuclear data bases available on Internet to search for information about the properties of nuclides
- Analyze/search and explain the different applications of nuclear physics.

PHYE-313 – Elective 2 (D2) : Electrical Properties of Solids and Superconductivity

- describe different theories of superconductivity
- describe the basic properties of superconductors;
- explain type-I and type-II superconductivity based on thermodynamic calculations of the Gibbs free energy for a superconductor
- apply fundamental knowledge of superconductors to applications of superconductivity in technology and the research laboratory;

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PHYE-314 – Electives 3 (A3): Industrial Electronics:

- Describe different types power semiconductor devices and their switching characteristics.
- Explain types of operations.
- Describe types of power converters.
- Describe types, constructing and working principle of dc converters.

PHYE- 314 – Electives 3 (B3) : Modern Trends in Spectroscopy

a) Analyze the molecular spectra.
b) Analyze the FTIR spectra of thin film and molecules and determine their structure.
c) Analyze the NMR spectra of molecules, and determine their structure

PHYE-314 – Electives 3 (C3) : Reactor Physics

- Describe the basic and advance concepts of Reactor Physics
- Explain the applications of Reactor Physics

PHYE-314 – Electives 3 (D3) : Physics of Nanomaterials

- Describe the techniques to synthesize nanomaterials
- Explain the nanoscale properties of nanomaterials;
- Describe the process of changing macroscopic properties via molecular level engineering and nanoscale manipulation;
- Explain the nanotechnology principles and applications.

PHYE-314 – Electives 3 (E3) : X ray Diffraction

- Perform basic calculations relating to crystal planes, lattice parameters and sample characteristics.
- Setup data collection strategies and collect data on both a single crystal and powder samples.
- Process data, solve/refine and interpret a single crystal structure.
- Use various crystallographic databases.
- Describe solid-state matter in terms of crystallinity and bonding.
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PHYE-314 – Electives 3 (F3) : Thin film and Vacuum Technology

- Describe the thin film coating processes.
- Implement building, validating, operating, maintaining, and troubleshooting vacuum-based equipment
- Use of this equipment and processes supported by this technology.

- Explain vacuum-based processes to create and manufacture products.

PHYE-411 – Generic Electives 4 (A4): Fundamentals of Sensors: Credits 4

- Describe the concepts of sensor
- Explain different principles of sensors
- Identify the structure and application of sensors.
- Develop sensor device for an application based on the laboratory input.
- Explain the characteristics of sensors, optical fiber and optical sensors.

PHYE-411 – Generic Electives 4 (B4) : Applied Spectroscopy

- Describe the basic principles of physics as related to the field of photonics.
- Integrate the concepts of light, geometric and wave optics and their practical applications in photonics.
- Explain the theory and practice of instrumental methods for the separation, identification and quantitative analysis of chemical substances.
- Explain structure and bonding influence the physical properties and reactivity of molecules.
- Use crystal field theory to understand the electronic and magnetic properties of transition metal complexes.
- Use symmetry to predict molecular orbital diagrams and explain electronic spectra

PHYE-411 – Generic Electives 4 (C4) : Particle Physics, Nuclear forces and Cosmic rays:

- Describe various elementary particles, their properties
- Describe the nuclear structure, their interactions,
- Describe nature and application of cosmic rays.

PHYE-411 – Generic Electives 4 (D4) : Magnetic Materials and Superfluidity

- Describe the physical origin of diamagnetism in solids.
- Describe the physical origin of paramagnetism in solids.
- Categorize the materials according to their magnetic susceptibilities
- Analyze the strong magnetization in ferromagnetic materials
- Determine the differences between ferro and ferrimagnetic substances

- Compute the experimental results by theoretical calculations.

PHYE-412 – Electives 5 (A5) : 8051- Microcontroller

- Describe the concepts and basic architecture of 8051
- Explain difference between microprocessor and micro controller
- Describe the architecture, various blocks from 8051 , ports, memory organization and various addressing modes of 8051 and various moving op-code.
- Perform the arithmetic operations and jump ranges and instructions.
- Write/develop assembly language programs of 8051
- Explain the importance of different peripheral devices & their interfacing to 8051
- Describe different types of external interfaces including LEDS, LCD, Keypad Matrix, Stepper motor & seven segment displays.

PHYE-412 – Electives 5 (B5) : Lasers, Nonlinear Optical mixing and Spectroscopic Phenomena

- Explain the basic and advance concepts of Lasers,
- Explain non-linear optical mixing and spectroscopic phenomena.
- Write the applications and uses.

PHYE-412 – Electives 5 (C5) : Radiation Measurements And Nuclear Dosimetry

- Explain the applications of nuclear techniques in industry, Agriculture and Medical safety standards required.
- Describe the using of nuclear radiations for medical disorders and diseases on human-beings, animals etc.
- Describe the use in industry like Polymers,
- Describe the process of fault finding in metal, Polymer, equipments and components, high quality welding etc

PHYE-412 – Electives 5 (D5) : Material Synthesis and Characterization

- Describe the methodology and technology for development of new materials having particular desired properties.
- Measure the mechanical strength, various structural, optical, electrical, magnetic and thermal properties are demanded from materials depending on the application.
- investigates different classes of materials -metals, ceramics, polymers, electronic materials, biomaterials-
- Explain the relationships between the underlying structure and the processing, properties, and performance of the materials.

PHYE-413 – Generic Electives 6 (A6): Advanced Sensor Technology (Research Oriented)

a) Describe sensor materials and technologies,
b) Develop sensor devices and sensor networks.

PHYE-413 – Generic Electives 6 (C6): Nuclear Fission, Fusion and Neutron Physics (Research Oriented)

- Explain nuclear fission
- Explain nuclear fusion
- Describe how the processes of fission and fusion work in nuclear weapons and in generating nuclear power
- Explain the principles of neutron physics
- Describe experimental methods in neutron physics and instrumentation and to make estimations,
- Explain the role of neutrons in the standard model of particle physics and astrophysics
- Apply the models describing the basic nucleon and nuclear properties
- Describe the properties of strong and weak interaction.
- Describe the astrophysical processes leading to nuclear synthesis
- Describe the fission and fusion processes and the basic properties of the nuclear and fusion reactors

PHYE-413 – Generic Electives 6 (D6): Renewable Energy
(Research Oriented)

- Describe different renewable energy systems.
- Describe the components, processes and specifications of the renewable energy system
- Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, Manufacturability, and sustainability.
- An ability to use the techniques, skills, and modern technological tools necessary for Technological practice.