DEPARTMENTAL HANDBOOK

DEPARTMENT OF PHYSICS

JANUARY 1, 2020

1. INTRODUCTION

The Department of Physics offers a four-year undergraduate programme of study leading to the award of B.Sc. degree in Physics, and a four-year undergraduate programme of study leading to the award of B.Sc. degree in Physics.

Physics being a fundamental Science provides the basis for creative work in many areas of modern Science and Technology and an excellent background for several areas of professional study. In addition, several areas of gainful employment are also open to graduates of Theoretical and Applied Physics in government, education, research, management, banks and other industries.

The degree programme in Physics is designed to equip and prepare the students for professional work in Physics and other science-related fields while allowing them the flexibility of concentrating their study in areas of special interest to them, particularly with respect to the fourth year of the programme.

The Department offer courses in Physics for students in the Faculty of Education with Physics as a major or minor teaching subject. It also run service courses for other Departments of the College of Medical Sciences, the Faculty of Agriculture, Forestry, Wildlife Resources Management, Faculty of Basic Medical Sciences, the Faculty of Biological Sciences, the Faculty of Dentistry, Pharmacy, and some Departments in the Faculty of Physical Sciences, and the Faculty of Engineering and Technology.

In addition, the Department also runs programmes leading to the award of a B.Sc. degrees in Applied Geophysics Physics and Electronics (formerly called Electronics and Computer Technology).

The Department also runs programmes leading to the award of a Post-Graduate Diploma in Physics, M.Sc. and Ph.D. degrees in various branches of Physics.

1.1 History of Physics Department

1.2 Movement to the Permanent Site

The Department of Physics was initially housed in the block opposite the present Faculty of Social Sciences building with some of the staff sharing offices with those of Mathematics and Chemistry Departments in the complex now housing the Faculty of Agriculture, adjacent to the Chinua Achebe Arts Theatre.

In the 1978/79 session, the entire Physics Department and Departmental offices with the staff in the Maths complex, moved to the block behind the present Faculty of Agriculture. It was in the same session that work began in earnest at the permanent site buildings. The Department finally moved into its present permanent site in the middle of the 1997/98 session under the headship of Prof. E. E. Okwueze.

1.3 Headship of the Department

Chief B. E. Bassey, a senior lecturer, was appointed the pioneer Acting Head of Department by the Vice-Chancellor of the University of Nigeria, Nsukka, on October 1973. He saw to the overall development of the Department and the recruitment of additional staff until march 31, 1978, when Prof.. Sullivan took over the leadership of the Department as a substantive Head of Department.

Professor Sullivan served in that capacity until March 23, 1980, when he left the country and the Headship reverted to Chief Bassey. The leadership stayed that way until March 31, 1986 when Prof. R. Gupta was appointed the second substantive Head of Department.

Prof. Gupta handed over the office to Dr. (later Prof.) E. W. Mbipom, a Reader then, to act as the Head of Department in April 1988. Prof. Mbipom held office until 30th August, 1988 and while proceeding on sabbatical leave to France, he handed over the office as Acting Head of Department to Dr. (now Prof.) A. I. Menkiti, then a Senior Lecturer.

Prof. Menkiti was Acting Head of department until 1991/92 academic session when he became a Professor and was appointed the third substantive Head of Department and the first Nigerian substantive Head of Department. He handed over the leadership of the Department to Dr. (later Prof.) E. E. Okwueze, then a Reader as Head of Department in August, 1996.

Prof. Okwueze handed over to Dr. (now Prof.) E. J. Uwah, then a reader, in October, 1998. Dr. E. J. Uwah, became a Professor and substantive Head of Department in March, 1990, a position he occupied till 2001. Prof. E. J. Uwah handed over the baton of leadership to Dr. (Prof.) A. B. Udoimuk (then a Senior Lecturer) who acted as Head of Department until 2003, when Dr. (now Prof.) M. U. Onuu (then a Senior Lecturer) took over. Dr. M. U. Onuu handed over to Dr. O. N. Etim (a Senior Lecturer) in 2005. Dr. O. N. Etim handed over to Dr. (now Prof.) S. O. Udo in 2007. Dr. Udo in turn handed over to Dr. (now Prof.) I. O. Akpan (then a Senior Lecturer) in 2009. In October, 2011, Dr. I. O. Akpan handed over to Dr. (now Prof.) V. I. M. Obianwu. In 2013, Dr. Obianwu in turn handed over to Dr. (now Prof.). Anthony A. Okiwelu who subsequently handed over to Dr. (now Prof.) Anthony E. Akpan in 2015. In October 2017, Dr. (now Prof) R.C. Okoro, the present HOD, was appointed as Acting Head of Department.

1.4 Philosophy, Vision and Objectives of the Programme

1.4.1 Philosophy of the Programme

The B.Sc. (Hons) degree in Physics is conceived on the premise that:

(i) it will serve as a vehicle for serious academic learning and research geared towards development from the basic theory of Physics to the beneficial applications of that theory to society, industry and government;

(ii) it will provide a strong desire to achieve a high level of professionalism and entrepreneurship while maintaining good academic background that will grow into a valuable industry-university relationship.

During lectures, emphasis is placed on identifying and understanding the principles of Physics, while the laboratory practical courses are designed to enhance the understanding of the theoretical concepts which in turn enables and paves the way to technological advancement and other applications of Physics.

1.4.2 Vision

Our vision is to be an internationally recognized Centre of Excellence in Research, Training, and Character Molding necessary for providing students with a cutting-edge knowledge base, while promoting creativity, good citizenship, effective communication, and analytical skills needed in serving humanity as educators, scientists, innovators etc.

1.1 Objectives of the Programme

The objectives of the Physics Programme are to:

(i) develop a curriculum that covers all the contemporary theories and applications of the main aspects of Physics.

(ii) give laboratory training that makes the students familiar with the principles and methods of scientific decision making, measurement of physical quantities, design, perform, record and analyse results of experiments, as well as appreciate the of various types of experimental errors.

(iii) equip students with adequate and relevant mathematical tools needed for solving problems in physics and its related sub-disciplines.

(iv) equip students with rudimentary computer programming skills that will serve as a foundation for them to later become experts in the use of computers (software and hardware) in solving problems in physics and other areas such as the rapidly advancing information and communication technology.

(v) train students in basic workshops practice so that they acquire the competence in the design, fabrication and repair of some basic mechanical and electronic devices and equipment.

(vi) produce graduates that would fill the manpower needs in the appropriate areas of the national economy, including renewable energy (e.g. the fossil fuel industry) and non-renewable energy and power (e.g. solar, hydro, wind, nuclear, etc.) and communication sectors for sustainable development with some entrepreneurship urge and skill.

(vii) produce excellent trainable graduates for further academic work in the teaching and application of concepts in physics and related disciplines.

(viii) expose the students to modern state-of-the-art technology and industrial practice through the Students Industrial Work Experience Scheme (SIWES), and

(ix) expose the Department and the Faculty to the outside World through its academic output and research breakthroughs so as to attract adequate funding and to accommodate students desirous of studying core physics.

(x) train students on the basic principles and practices, and challenges inherent in environmental physics industries so as to serve as informed regulators of physical environment for government agencies and contribute in physics based environmental impact assessment of projects, including helping in environmental education of private and public agencies.

2. Admissions and Departmental Requirements

2.1 Admission Requirements

There are three modes of admission into the Undergraduate Degree Programme of Physics. These are:

I. A 3-Year Programme by Direct Entry

The minimum entry requirement for Direct Entry are passes in A-Level or its equivalent (JUPEB, IJMB, NCE, ND) in Physics and either Chemistry or Mathematics, plus SSCE/NECO/GCE O/L passes at Credit level in Physics, English Language, Mathematics, Chemistry/Biology and one science subjects.

II. A 4-Year Programme through the Unified Tertiary Matriculation Examinations (UTME)

The minimum admission requirements through UTME include Credit passes in NECO/SSCE/NABTEB/GCE O/L in Five subjects (at not more than two sittings). The subjects must include Physics, English Language, Mathematics, Chemistry/Biology, and any other science subject.

It should be noted that candidates for admission through UTME mode are expected to have passed the UTME organised by the Joint Admission and

Matriculation Board (JAMB) in four subjects namely; **English**, **Language**, **Mathematics**, **Physics**, **and Chemistry/Biology**.

III. Admission through Pre-Degree

The third mode of admission into the 4- year Programme, is through a successful completion of the **Pre-degree** Programme of the University of Calabar. Admission requirements into the Pre-Degree programme include five O/L passes at credit level in SSCE/NECO/GCE/NABTEB in not more than two sittings in English Language, Mathematics, Physics, Chemistry, and Biology. Candidates are also expected to show evidence of having attempted the UTME.

2.2 The Course System and Departmental Requirements

2.2.1 The Course System

Instructions shall be by course work. The Department operates a course unit system in a 2-semester academic year for the B.Sc. (Hons) degree. The distribution of courses at the various levels shall be as follows:

Level	Course Numbers
100	101-199
200	201-299
300	301-399
400	401-499

Each course is given a **course code**. This course code shall be the course number prefixed by a three-letter departmental designation, e.g. PHY 111, PHY 152, etc. The first digit designates the academic level of the course, the second designates the general area of physics the course is taken from, while the last digit designates the semester the course is taken. For instance, PHY 111 and PHY 152 are courses taken at the 100 – Level in the Department of Physics in the first and second semesters respectively.

All courses are quantified into credits units. One course credit unit is defined as
(a) a series of one-hour lectures or tutorials per semester;
(b) a series of three-hour periods of laboratory or field work per semester OR
(c) an equivalent amount of other assigned study or practical experience or a combination of these.

A student is credited with the prescribed number of credits in a course only if he/she scores the minimum pass mark of 40% in the overall assessment of that course. Except for credit-carrying Industrial Training programmes all courses shall be assigned 1, 2, 3, and 4 credits units only.

2.2.2 Departmental Requirements

Students are normally required to take all the approved courses and register for not less than 15 units and not more than 24 units in each semester. The student is required to consult with his/her Departmental Academic Adviser before he/her formally register any course(s).

The approved courses credit units/hours both UTME and Direct Entry students are distributed as follows:

S/N	COURSE(S)	CREDIT UNITS	
		UTME	DIRECT ENTRY
1	General Studies	18	18
2	Physics	102	94
3	Mathematics	8	4

4	Chemistry	4	-
5	Biology	4	-
6	Statistics	2	2
7	Computer Science	8	4
8	Library and Information Science	2	2
9	Geophysics	2	2
TOTAL		**150**	**126**

To be eligible for a single Honours B.Sc. Degree in Physics, a student is required pass all the prescribed courses and obtain a minimum of **120 credit units**, **90** of which must come from core physics courses for the 4-year Programme, and **82** for the case of the 3-year Programme. In other words, a student shall not be awarded a degree if he/she fails more than 12 (twelve) credit units (from the core courses) at the end of the maximum number academic sessions approved by the University senate for him/her.

3. REGISTRATION

3.1 Registration in the Department

A student is required to register at the beginning of each semester for all the courses he/she intends to offer that semester. To be duly registered a student should log on to *www.unicalexams.edu.ng* in any cybercafé and register for courses within the stipulated time. Such courses will be checked and reviewed by the student's academic adviser who will in turn advice the student on what to do next. Any student who cannot register for courses within the stipulated time will be advised to apply to Senate for suspension of studies for the academic session. The maximum number of credit units allowed per semester is 24. However, final year students may be allowed (after Senate approval) to register up to 27 credit units each semester.

Students are to register **for all failed courses first** before registering for new courses each semester. Any failed course that is not registered is recorded as a mandatory **F** for that student. A student is allowed only three attempts (except for GSS courses) to pass any course after which he/she carries an "F" grade in that course if he/she fails it the third time. The GSS courses, however, can be taken 'n' times until the student passes the courses EXCEPT if the student has exhausted his/her RESIDENCY REQUIREMENT in which case the STUDENT SHALL NOT BE AWARDED A DEGREE. All results in all the attempts are used in calculating the CGPA**.**

3.2 Residency Requirement

A student has a maximum of six years to complete a four-year programme of study or five years for a three-year programme of study, else he/she will be advised to withdraw from the University without a degree.

3.3 Registration in the University Library

All bona-fide students of the University are entitled to make use of the University's main Library. Every student must register with the University Library. Students can borrow books and use books for a period of not more than two weeks. Fines are always charged if the books are not returned on or before the stipulated date. There is a Departmental Library, reading rooms and open spaces with benches for students in the Department to continue with their studies when they do not have classes to attend.

3.4 Registration at Medical Centre

The University of Calabar Medical Centre has highly qualified staff to take care of students' medical and related problems. They consult, treat and advice on all health matters. It is cheaper and more convenient to use the services provided by the centre. It

is then advisable that every student registers with the University Medical Centre as soon as he/she registers with the University.

4. EXAMINATION REGULATIONS

4.1 Conduct of Examinations

The University runs a semester system. There are two semesters in one academic year and one semester is approximately 16 weeks. Out of these, about 12 weeks are reserved for teaching while the other 4 weeks are for registration and examinations.

At the end of each semester, the students are given an organized examination in each course. The score obtained in the examination together with the continuous assessment score form the final score in any given course.

4.2 Admission to an Examination

The University regulation provides that in order to be admitted to an examination, a student must have been registered for that course. He/she must also have satisfied all University and Faculty requirements regarding registration, the performance of all assignments related to courses taught, class attendance and the payment of all approved school fees/charges.

4.3 Examination Venue/Time-Table

Under the regulation, it is the responsibility of each student to ensure that he/she is registered for all the required courses and to ascertain the dates, time and venues of the examinations from the published University/Faculty/Departmental Examination Time-Table for all courses registered.

After the commencement of any semester exams, any further changes in the Date, Time and Venue of any Course-Exam should be disregard by students EXCEPT such a change is signed or counter-signed by the Head of the Department offering such a course.

4.4 Reporting for Examination

A student is normally expected to be at the examination room at least 30 minutes before the prescribed time for the examination. A student is also expected to come to the examination hall with his own writing materials and calculating aids except the answer booklet or sheet, which shall be given to the student by the Department in the examination venue.

A student can be admitted into the examination hall up to 30 minutes after the start of the examination but he cannot be granted extra time. If a student arrives at the examination later than 30 minutes after the start of the examination, the invigilator may at his discretion admit him into the examination hall if satisfied that the student has a good reason for his lateness. If the student is admitted despite being late for the exam, NO EXTRA TIME shall be given to the student.

4.5 Identification of Candidate

Every student must show evidence of registration for the course and produce an authentic University of Calabar identity card for he/she to be allowed entry into every examination. The card(s) must be prominently displayed on the desk for inspection by the invigilator during the examination.

4.6 Leaving the Examination Room

No student shall be allowed to leave the examination room during the first hour of an examination except in the event of emergency. In the event of a candidate taking ill, the invigilator must complete the appropriate form and send the sick person along

with an examination attendant to Medical Centre. The student must hand over his script and question paper to the invigilator before leaving the exam room.

A student who leaves the examination room shall not be re-admitted unless throughout the period of his absence, he has been continually under the supervision of an invigilator or person duly authorised by him/her.

4.7 Examination Misconduct

There are different forms of examination misconducts. These can be grouped into two:

Group A:

The following shall constitute misconduct involving students:

a) Copying from another student or a student permitting some other student(s) to copy his/her work.
b) Copying from another student without his/her knowledge.
c) Communicating with any other student(s) except with the invigilator when essential.
d) Coming into the examination hall/room when the examination is in progress.
e) Impersonation or use of "mercenary" for examinations.
f) Smuggling question paper(s) and/or answer booklets/sheets out of or into the examination hall.
g) Preparation and use of extraneous materials.
h) Coming into the examination hall with write-ups on any part of the body, money, dresses and any other materials.
i) Reading of lecture notes, textbooks and so on inside or outside (on the pretext of going to the toilet) during the examination hour.
j) Failure to submit answer scripts at the end of examination.
k) Causing any sort of disturbance during the examination.
l) Using or browsing with mobile phones or any other electronic devices in the examination room.

Group B:

The following shall constitute misconduct involving staff:

a) Direct or indirect leakage of examination questions to student(s).
b) Helping student(s) to answer questions during an examination.
c) Change of marks by a course lecturer in order to pass or victimise a student.
d) Allowing or aiding a student to substitute freshly prepared answer scripts for the ones used during the examination.
e) Conscious alteration of grades/raw scores by an examination officer, typist, head of department, etc, in order to help or victimize a student.
f) Initiating or requesting for correction of an approved result/grade based on false claims.
g) Withholding or destruction of scripts or grade in order to enable a student qualify for a special supplementary examination.
h) Writing of thesis or project report for a student by an academic staff.

Examination misconduct is a very serious offence and a student found guilty of the offence may be rusticated or expelled from the university depending on the nature of his/her offence. Students are therefore advised to attend all lectures regularly and work hard for their examination in order to avoid the temptation of getting involved in examination misconduct.

4.8 How to Handle Examination Misconduct

Any form of examination misconduct shall be reported immediately in writing to the Head of Department (through the Examinations Officer) for necessary action. An

invigilator must try and collect a written statement from any student involved in examination misconduct before he/she leaves the hall.

All reported cases of examination misconduct shall be referred directly to the Senate Examinations Misconduct Committee (SEMC) by the Head of Department with all evidence and written report of the misconduct incidence. The SEMC shall then carry out their independent investigation where both the students involved in the exam misconduct and the invigilators are invited to appear. The decision of the SEMC is sent to SENATE for a final decision. If found guilty, the punishment ranges from obtaining an "F" grade in the course, suspension from the University for ONE or TWO sessions, to outright expulsion from the University depending on the gravity of the particular exam misconduct committed.

4.9 Absence from Examination

No student can be excused from taking whole or part of any examination except on the strength of a Medical Certificate supplied or certified by the Director of University Medical Services that he/she was unfit to take the examination. In such a case an application for a **supplementary exam** supported by evidence shall be submitted to the Head of Department/Departmental Board of Examiners by the affected student. The Head/Board (if satisfied) shall make appropriate recommendation to the Vice-Chancellor/Senate for approval. The decision of the Vice Chancellor/Senate shall be final.

4.10 Supplementary Examination

Based on section (4.9) above, a supplementary examination shall only be granted by the University Senate to any student that missed an examination for reasons acceptable to Senate. The supplementary examination, unless otherwise ruled by Senate, will normally take place during the next available opportunity.

5. ASSESSMENT POLICY AND EXAMINATION RESULTS

5.1 Assessment Policy

There are two modes of assessing all courses taught during a semester are examined at the end of that semester. Candidates are credited with the number of units assigned to the courses' examination which they have passed. The pass mark for each course is 40%. However, all courses are subject to a dual examination system under which the **Continuous Assessmen**t (class assignments, periodic tests, etc.) accounts for 30% of the total score for the course. The marks scored through such Continuous Assessment do not constitute more than 30% of the total marks for the course except in practical courses which may be 50%.

The format of examinations consists of:

(i) Written examinations

(ii) Practical examinations, and, in certain practical courses, oral examinations may be administered.

The end-of-semester examination in that course accounts for the balance of 70%. External examiners from another University, participates in the moderation of the 400 level examinations. The overall results are determined in accordance with the general regulations governing the award of the degree.

Examination results are published after each session as soon as they are approved by Senate. Only approved results are published.

Under the present regulation, a Lecturer is required to release/publish the grades obtained by students in any course(s) he/she taught in a given semester provided that such scores/grades have been presented to and approved by the Departmental Board of Examiners. These scores/grades are also forwarded to the office of the Deputy Vice

Chancellor (Academics) by the Head of Department. The sessional result which is a prepared SPREAD-SHEET of the GRADES in all the courses registered and taken by all the students in a given class/year can only be published after approval by the Senate of the University. These are published as letter grades.

It is illegal to publish or make use of any session's results that have not been approved by Senate.

5.2 Grading System for all Examinations

The approved examination letter grades and their corresponding range of examination scores, grade point, and description are as shown in Table 3.

TABLE 3: Approved Examination Letter Grades and their Corresponding Range of Examination Scores, Grade Point, And Description

Range of Exam Score	Letter Grade	Grade Point	Description
70 – 100	A	5.00	Excellent
60 – 69	B	4.00	Very Good
50 – 59	C	3.00	Good
45 – 49	D	2.00	Fair
40 – 44	E	1.00	Pass
0 – 39	F	0.00	Fail

A student is deemed to pass an examination if he/she scores a grade of E or above. A student who does not take an examination in a course that he/she is duly registered for without a reason acceptable to the University Senate shall earn a mandatory "F" grade for the course.

5.3 Calculation of Results

If a student scores a 'D' grade in PHY 111 which is a 2-credit unit course, the grade point for PHY 111 is the points for the grade of D (which is 2) times the credit units of PHY 111 (which is 2) i.e. 2 x 2 = 4 grade points.

If a student scores the following grades at the end of year one, the procedure for the computation of the Grade Point Average (GPA) is as shown in Table 4.

Table 4: Calculation of Grade Point Average

COURSE CODE	CREDIT UNITS	GRADE	GRADE POINT
PHY 111	2	C	$2\times3=6$
PHY 141	2	C	$2\times3=6$
PHY 181	1	F	$1\times0=0$
MTH 111	2	F	$1\times0=0$
CHM 101	2	A	$2\times5=10$
BIO 111	2	D	$2\times2=4$
CSC 101	2	B	$2\times4=8$
GSS 101	2	C	$2\times3=6$
GSS 131	2	B	$2\times4=8$
GSS 141	2	D	$2\times2=4$
LIS 161	2	E	$2\times1=2$
PHY 152	2	E	$2\times1=2$
PHY 182	1	A	$2\times5=10$
MTH 132	2	E	$2\times1=1$
CHM 102	2	D	$2\times2=4$
BIO 112	2	D	$2\times2=4$
CSC 102	2	C	$2\times3=6$
GSS 102	2	C	$2\times3=6$

GSS 112	2	C	$2\times3=6$
GSS 122	2	A	$2\times5=10$
GSS 142	2	D	$2\times2=4$
TOTAL	**40**		**107**

Total Points = 107
Total Credit Units = 40
Grade Point Average (GPA) = 107/40 = 2.68

So, the student's GPA at the end of year ONE is 2.68 which is the same as his/her CGPA for year one.

5.3.1 Probation and Withdrawal

- A student who fails up to 15 credit units at the end of the session BUT obtains a CGPA of up to 1.50 and above shall be PLACED ON PROBATION.
- A student who fails up to 15 credit units at the end of the session and obtains a CGPA of less than 1.50 shall be asked to WITHDRAW OR CHANGE PROGRAMME.
- A student who fails more than 15 credit units at the end of the session shall be asked to WITHDRAW FROM THE UNIVERSITY.

A student on probation in any particular year is not allowed to register for any new course(s) where a pass grade has already been gained. He/she must register only for failed course(s). At the end of the probation year, a student is allowed to continue in the programme if his/her CGPA is 1.50 or higher, otherwise the student is asked to WITHDRAW from the University.

5.3.2 Probation Result

A student whose sessional year one result is as shown below is to go on probation at the end of year one:

First Semester

Course Code	Credit Units	Grade	Grade Point
PHY 111	2	C	6
PHY 141	1	F	0
PHY 181	2	F	0
MTH 111	2	F	0
CHM 101	2	B	8
BIO 111	2	F	0
CSC 101	2	C	6
GSS 101	2	C	6
GSS 131	2	C	6
GSS 141	2	D	4
LIS 161	2	C	6
TOTAL	**21**		**42**

Second Semester

Course Code	Credit Units	Grade	Grade Point
PHY 152	2	C	6
PHY 182	1	C	3
MTH 132	2	E	2
CHM 102	2	F	0
BIO 112	2	F	0

CSC	102	2	E	2
GSS	102	2	F	0
GSS	112	2	E	2
GSS	122	2	F	0
GSS	142	2	D	4
	TOTAL	**19**		**19**

The CGPA of this student is 1.53 (61/40), which is more than 1.50, but since he/she has failed courses totalling up to 15 credit units he/she goes on probation.

In the probation year, the student then registers for the failed courses only and obtained the following results;

First Semester

Course Code	Credit Units	Grade	Grade Point
PHY 141	2	F	0
PHY 181	1	D	2
MTH 111	2	C	6
BIO 111	2	E	2
TOTAL	**7**		**10**

Second Semester

Course Code	Credit Units	Grade	Grade Point
CHM 102	2	D	4
BIO 112	2	D	4
GSS 102	2	E	2
GSS 122	2	E	2
TOTAL	**8**		**12**

Here, his or her GPA for these 8 courses is 1.47 (22/15). To determine whether or not the student can continue in the programme, there is need to calculate the CGPA. All courses taken during the first attempt and all courses attempted (both failed and passed) in the probation year are used for the calculation of CGPA. For the above, we have the following for the probation results.

First Semester (Year One)

Course Code	Credit Units	Grade	Grade Point
PHY 111	2	C	6
PHY 141	1	F	0
PHY 181	2	F	0
MTH 111	2	F	0
CHM 101	2	B	8
BIO 111	2	F	0
CSC 101	2	C	6
GSS 101	2	C	6
GSS 131	2	C	6
GSS 141	2	D	4
LIS 161	2	C	6
TOTAL	**21**		**42**

First Semester (Probation)

Course Code	Credit Units	Grade	Grade Point
PHY 141	2	F	0
PHY 181	1	D	2
MTH 111	2	C	6
BIO 111	2	E	2
TOTAL	**7**		**10**

Second Semester (Year One)

Course Code	Credit Units	Grade	Grade Point
PHY 152	2	C	6
PHY 182	1	C	3
MTH 132	2	E	2
CHM 102	2	F	0
BIO 112	2	F	0
CSC 102	2	E	2
GSS 102	2	F	0
GSS 112	2	E	2
GSS 122	2	F	0
GSS 142	2	D	4
TOTAL	**19**		**19**

Second Semester (Probation)

Course Code	Credit Units	Grade	Grade Point
CHM 102	2	D	4
BIO 112	2	D	4
GSS 102	2	E	2
GSS 122	2	E	2
TOTAL	**8**		**12**

The Total Grade Points for the First and Probation Years = 61 + 22 = 83
Total Credit Units = 40 + 15 = 55
CGPA = 83/55 = 1.51

The student's CGPA after the probation year is more than 1.50 and the Total Credit Units for the course(s) failed is just 2 (i.e., less than 15), hence he has passed and can continue with his studies.

NOTE:
CGPA is the Total Grade Point scored from the beginning of the programme divided by the Total Credit Units. It is NOT the arithmetic average of the GPA scored at different levels of the programme.

5.4 Appeals Concerning Examination Results

i. A student may have reasons to disagree with a grade awarded to him/her on a particular course. If he/she believes that he/she is awarded a wrong grade, he/she may appeal to the Registrar for reassessment of his/her examination scripts on payment of a fee as prescribed by the University. He/she cannot appeal for remarking of scripts belonging to another student. A group appeal for remarking of scripts involved in a particular course examination cannot be entertained. The regulation provides that for an appeal to be valid, notice in writing of such an appeal must be lodged with the Registrar within four weeks after Senate has approved the relevant result.

ii. Application for remarking when submitted shall be sent by the Registrar to the Dean of Faculty concerned, who will find an internal assessor to be used. Only when there is a problem would an external assessor be used. Efforts shall be made to minimize reassessment cases and students shall not be made to know who the assessors are.

iii. When sending scripts to assessors for reassessment, the composition shall be as follows:
   a. Some scripts from the highest scoring students and some scripts from the lowest scoring candidates in the course.
   b. A couple of scripts whose scores are around the petitioners score.
   c. The Petitioners script.
   d. Marking scheme used to assess the scripts by the lecturer.

e. There shall be an no indication to the assessor, which script belongs to the petitioner.

iv. After the reassessment, only the scripts of the petitioner would be affected by any change in grade, while the external assessor shall be paid a fee prescribed by the Senate. Final year students' scripts shall not be reassessed because it is for this purpose that external examiners are appointed. The result of the reassessment shall carry the comments and signature(s) of the assessor(s).

v. If a reassessment exercise results in favour of the student, i.e., requires a change in letter grades, such a result shall be presented to the Senate for approval and change of the earlier recorded grade. In this scenario, the appeal fee shall be refunded to the student.

vi. If the result of the reassessment exercise is not in favour of the student, the result shall be sent to the Registrar for onward communication to the student concerned.

vii. If the result indicates a major change in the grade for the course following the reassessment, the lecturer(s) who taught the course and graded the scripts shall be asked to explain to Senate why the major change occurred.

viii. However, it should be noted that Senate shall not encourage frivolous change(s) in grades already approved by it.

5.5 Suspension of Studies

A student may be granted suspension of studies for a period not exceeding two years by the University Senate. Request for suspension of studies must be in writing to the Senate through the Head of Department, and the Dean of Faculty.

5.6 Procedure for Reporting of Grievances by Students

The University of Calabar seriously frowns at all cases involving physical, psychological and emotional student-student, staff-student, and student-staff violations of the rights and privileges of students and staff. These include, but not limited to, sexual harassment, slapping, extortion, intimidation, monetary, demands for grades, intimidation through verbal and physical abuses, etc.

Any student who feels that his/her rights have been infringed upon by a staff is strongly encouraged at all times to follow the official procedure in channelling his/her grievances to the appropriate authorities for prompt action. The official channel for reporting such grievances is for the affected student to personally put his/her complaint in writing and submits same to the Head of Department or the Head, Student's Right Committee of the University. On receiving the such complaints, the Head of Department will set up an ad hoc Committee to look into the matter and report back to him as soon as possible. Where the affected student is not satisfied with the decision of the Department, he/she is free to report the matter to higher authorities. Some Principal Officers in the University (e.g. the Vice Chancellor, Deputy Vice Chancellor-Academic, Dean of Student's Affairs, Dean of the Faculty of Physical Sciences) do encourage students with such complaints to forward their complaints directly to their offices.

Finally, students can also channel such grievances through the Leadership of their students' Representative at Departmental, Faculty, and University levels. The University does not encourage group complaints.

5.7 Classification of Degrees

The classification of degree is based on the Cumulative Grade Point Average

(CGPA) system:

CGPA	Class of Degree
4.50 – 5.00	First Class
3.50 – 4.49	2nd Class Upper
2.40 – 3.49	2nd Class Lower
1.50 – 2.39	3rd Class
0.00 – 1.49	Fail

6.0 Departmental Responsibility

6.1 Examination Officer

The Examination Officer is usually an academic staff not below the rank of Lecturer I. The Department nominates the candidate for the Vice Chancellor's approval. The Examination Officer is directly responsible the Head of Department, acting as the Departmental Chief Examination Officer.

The duties of the Examinations Officer include:

a) Making adequate arrangements for the examinations e.g. venue, invigilation, etc.
b) Preparation of results sheets for duly registered students of the Department.
c) Any other duties as may be directed by the Head of Department or Departmental Board of Examiners.

6.2 Academic Adviser

Students at each level of study are assigned at least one academic staff as Academic Adviser to:

- Assist students with course registration, i.e. provide guidance in course selection in keeping with students' interest, values and capability.
- Advise them on academic, career and personal issues by identifying the educational and career options appropriate for each student and assist with analysis of each option, including possible outcome and their implications.
- Monitor the academic progress of students.
- Identify pressing academic needs of students and look into the academic problems the students might be encountering with a view to proffering solutions to them.
- Interpret and explain university policies and procedures, participate in the preparation for orientation and present academic information to new students.

7.0 Departmental Students' Association

The Department has a student Association called the National Association of Physics Students (NAPS). A Staff Adviser is attached to the Association to counsel, moderate and guide the activities of NAPS through its Executive Committee. Similar students Association exists at the Faculty and University levels. All students are enjoined to register and participate in the activities of these Associations.

8.0 Relevant Terms to Note

i. **Course:** A course is an aggregate (unit) of teaching, evaluation and examination offered by a particular Department under an approved title, e.g., PHY 141 – Geometrical Optics.

Note: A course may be designated core, compulsory/required, elective or optional by a Department or Faculty, if need be.

ii. **A Core Course:** This is a compulsory requirement for graduation. It is a course a student must offer and obtain a pass grade before he/she can be awarded a degree in the Discipline (Department); e.g. a student cannot carry an "F" in a core course and graduate.

iii. A Required or Compulsory Course: is a course a student must offer in the Department. The student is normally expected to obtain a pass mark in the course, but if however, a student has exhausted the maximum opportunity of getting a pass grade (in the course) the student may be allowed to carry 'F' in the course and graduate.

iv. **An Elective Course:** This is a course a student might be advised to offer. It could be a course within the Department or outside the Department or Faculty in a cognate area (i.e. in another discipline). An elective course could be required or optional.

v. **An Optional Course:** This is a complementary course a student might be advised to offer within the Department. An optional course could be offered for two reasons viz. (a) as a prescribed course to enable the student to complete the total number of credit hours required for graduation and (b) as a course required by the student out of "professional" interest. This is possible under the present NUC minimum (and maximum) academic standard requirements.

vi. **Course Work:** Comprises the total of teaching and practical, tests and examinations that are taken into account when assessing a student's performance towards the award of a Degree or Diploma.

vii. **Course Code**: This is an alphanumeric name that is used to identify a course. A course code also gives insight as to the semester the course is taken, the level at which first attempt could be made on the course and the Department or programme offering the course.

viii. **Credit Hours:** each one-hour lecture or tutorial that a class meets during a week. Thus, a class that meet three hours a week will normally be assigned three credit hour per semester. A three hour Laboratory, studio or theatre practical class shall normally be equivalent to one credit hour.

ix. **A Repeat Examination:** This is an examination which the student is required to take after repeating the course as result of failing previous examination.

x. **Supplementary Examination:** An examination (not normally scheduled one) given to a student who has been excused by the Senate on grounds acceptable to it.

xi. **Repeating Failed Course Unit(s):** A student is allowed to repeat the failed course unit(s) at the next available opportunity provided that the total number of credit units during the semester does not exceed 24. Senate directs that all students must first register previously failed courses before registering new courses.

xii. **Carry-over Course Unit(s):** A carry-over course is one that a student ought to have registered for in a particular year of study but could not do so to avoid exceeding the recommended 24 credit units limit for total credit load per semester.

xiii. **Minimum Credit Load:** students are required to register a minimum of 36 credit units per year or 18 credit units per semester and a maximum of 24 credit units per semester. In exceptional cases, a final year student may be

allowed to register up to a maximum of 27 credit units per semester only on approval by Senate or the Chairman of Senate on behalf of the Senate.

xiv. **Grade Point Average (GPA):** The performance of a student in any semester is reported on the basis of the Grade Point Average. This is the average of weighted grade points earned in the courses taken during the semester. In the University of Calabar, the Grade Point Average of students are calculated only after the second semester results have been computed. In other words, Grade Point Averages are computed for an academic session and not per semester. The Grade Point Average is obtained by multiplying the grade point attained in each course by the number of credit units assigned to that course and then summing these up and dividing by the total number of credit units taken for the two semesters.

xv. **Cumulative Grade Point Average (CGPA)**: The cumulative Grade Point Average (CGPA) is the average of the weighted of sessions completed by the student. It is an indication of the student's overall performance as at the last count of sessions completed in the training programme. In the first year of studies, the GPA is often the same as the CGPA, but as from the second year onwards, the GPA and the CGPA are often different.

6. STAFF LIST

6.1 Academic Staff

6.1.1 Full-Time

6.1.2 Part-Time

6.2 Non-Teaching Staff

6.2.1 Technologists and Laboratory Attendants

6.2.2 Administrative/Secretarial Staff

7. COURSE CONTENTS AND DESCRIPTION

7.1 Course Contents

YEAR ONE – FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS

1	PHY 111	GENERAL PHYSICS (MECHANICS AND THERMAL PHYSICS	2
2	PHY 141	VIBRATIONS, WAVES AND OPTICS	2
3	PHY 181	GENERAL PHYSICS LABORATORY I	1
4	MTH 111	ALGEBRA & TRIGONOMETRY	2
5	CHM 101	GENERAL CHEMISTRY I	2
6	BIO 111	GENERAL BIOLOGY I	2
7	CSC 101	INTRODUCTION TO COMPUTER SCIENCE I	2
8	GSS 101	USE OF ENGLISH & COMMUNICATION SKILLS I	2
9	GSS 131	HISTORY & PHILOSOPHY OF SCIENCE	2
10	GSS 141	ANTI-CORRUPTION STUDIES I	2
11	LIS 161	INTRODUCTION TO LIBRARY & INFORMATION SCIENCE	2
		TOTAL	**21**

YEAR ONE – SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 152	ELECTRICITY, MAGNETISM AND MODERN PHYSICS	2
2	PHY 182	GENERAL PHYSICS LABORATORY II	1
3	MTH 132	CALCULUS & ANALYTIC GEOMETRY	2
4	CHM 102	GENERAL CHEMISTRY II	2
5	BIO 112	GENERAL BIOLOGY II	2
6	CSC 102	INTRODUCTION TO COMPUTER SCIENCE II	2
7	GSS 102	USE OF ENGLISH & COMMUNICATION SKILLS II	2
8	GSS 112	CITIZENSHIP EDUCATION	2
9	GSS 122	PHILOSOPHY & LOGIC	2
10	GSS 142	ANTI-CORRUPTION STUDIES II	2
		TOTAL	**19**

YEAR TWO – FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 231	THERMAL PHYSICS	3
2	PHY 251	ELECTROMAGNETICS	3

3	PHY 271	INTRODUCTION TO SPACE SCIENCE	2
4	PHY 281	EXPERIMENTAL PHYSICS I	1
5	GPH 201	INTRODUCTION TO EARTH PHYSICS	2
6	MTH 201	ADVANCE MATHEMATICS I	2
7	STA 201	STATISTICS FOR PHYSICAL SCIENCES	2
8	CSC 201	INTRODUCTION TO COMPUTER PROGRAMMING I	2
		TOTAL	**17**

YEAR TWO – SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 212	ANALYTICAL MECHANICS I	3
2	PHY 242	WAVES, SOUND AND OPTICS	3
3	PHY 262	ELECTRIC CIRCUITS & ELECTRONICS	2
4	PHY 272	ELEMENTARY MODERN PHYSICS	3
5	PHY 282	EXPERIMENTAL PHYSICS II	1
6	MTH 202	ADVANCED MATHEMATICS II	2
7	CSC 202	INTRODUCTION TO COMPUTER PROGRAMMING II	2
8	GST 202	ENTREPRENEURSHIP DEVELOPMENT SKILLS (THEORY)	2
		TOTAL	**18**

YEAR TWO – FIRST SEMESTER – DIRECT ENTRY

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 231	THERMAL PHYSICS	3
2	PHY 251	ELECTROMAGNETICS	3
3	PHY 271	INTRODUCTION TO SPACE SCIENCE	3
4	GPH 201	INTRODUCTION TO EARTH PHYSICS	2
5	PHY 281	EXPERIMENTAL PHYSICS I	1
6	CSC 201	INTRODUCTION TO COMPUTER PROGRAMMING I	2
7	MTH 201	ADVANCED MATHEMATICS I	2
8	STA 201	STATISTICS FOR PHYSICAL SCIENCES	2
9	GSS 101	USE OF ENGLISH AND COMMUNICATION SKILLS	2
10	GSS 131	HISTORY AND PHILOSOPHY OF SCIENCE	2
11	LIS 161	INTRODUCTION TO LIBRARY & INFORMATION SCIENCE	2
		TOTAL	**24**

YEAR TWO – SECOND SEMESTER – DIRECT ENTRY

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 212	ANALYTICAL MECHANICS I	3
2	PHY 242	WAVE, SOUND AND OPTICS	3
3	PHY 262	ELECTRIC CIRCUITS AND ELECTRONICS	2
4	PHY 272	ELEMENTARY MODERN PHYSICS	3
5	PHY 282	EXPERIMENTAL PHYSICS II	1
6	CSC 202	INTRODUCTION TO COMPUTER PROGRAMMING II	2

7	MTH 202	ADVANCED MATHEMATICS II	2
8	GST 202	ENTREPRENEURSHIP DEVELOPMENT SKILLS (THEORY)	2
9	GSS 102	USE OF ENGLISH AND COMMUNICATION SKILLS II	2
10	GSS 112	CITIZENSHIP EDUCATION	2
11	GSS 122	PHILOSOPHY AND LOGIC	2
		TOTAL	**24**

YEAR THREE – FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 301	WORKSHOP PRACTICE I	1
2	PHY 311	ANALYTICAL MECHANICS II	3
3	PHY 321	MATHEMATICAL METHODS I	3
4	PHY 331	STATISTICAL AND THERMAL PHYSICS	3
5	PHY 341	QUANTUM PHYSICS	3
6	PHY 351	ELECTROMAGNETISM	3
7	PHY 361	ELECTRONICS I	2
8	PHY 371	INTRODUCTION TO ATMOSPHERIC PHYSICS	2
9	PHY 381	EXPERIMENTAL PHYSICS III	1
		TOTAL	**21**

YEAR THREE – SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 302	WORKSHOP PRACTICE II	1
2	PHY 322	MATHEMATICAL METHODS II	3
3	PHY 342	ELECTROMAGNETIC WAVES & OPTICS	3
4	PHY 352	SOLID STATE PHYSICS I	3
5	PHY 372	INTRODUCTION TO NUCLEAR PHYSICS	3
6	PHY 382	EXPERIMENTAL PHYSICS IV	1
7	PHY 362	ELECTRONICS II	2
8	PHY 306	ENERGY & ENVIRONMENTAL STUDIES	2
9	GST 302	ENTREPRENEURSHIP TRADE SKILL DEVELOPMENT (PRACTICAL)	2
		TOTAL	**20**

YEAR THREE – FIRST SEMESTER – DIRECT ENTRY

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 301	WORKSHOP PRACTICE I	1
2	PHY 311	ANALYTICAL MECHANICS II	3
3	PHY 321	MATHEMATICAL METHODS I	3
4	PHY 331	STASTICAL AND THERMAL PHYSICS	3
5	PHY 341	QUANTUM PHYSICS	3

6	PHY 351	ELECTROMAGNETISM	3
7	PHY 361	ELECTRONICS I	2
8	PHY 381	EXPERIMENTAL PHYSICS III	1
9	PHY 371	INTRODUCTION TO ATMOSPHERIC PHYSICS	2
10	GSS 141	ANTI-CORRUPTION STUDIES I	2
		TOTAL	**23**

YEAR THREE – SECOND SEMESTER – DIRECT ENTRY

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 302	WORKSHOP PRACTICE II	1
2	PHY 322	MATHEMATICAL METHODS II	3
3	PHY 342	ELECTROMAGNETIC WAVES & OPTICS	3
4	PHY 352	SOLID STATE PHYSICS I	3
5	PHY 382	EXPERIMENTAL PHYSICS IV	1
6	PHY 372	INTRODUCTION TO NUCLEAR PHYSICS	3
7	PHY 362	ELECTRONICS II	2
8	PHY 306	ENERGY & ENVIRONMENTAL STUDIES	2
9	GST 302	ENTREPRENEURSHIP TRADE SKILL DEVELOPMENT (PRACTICAL)	2
10	GSS 142	ANTI-CORRUPTION STUDIES II	2
		TOTAL	**22**

YEAR FOUR – FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 401	SEMINAR	2
2	PHY 411	QUANTUM MECHANICS I	3
3	PHY 421	COMPUTATIONAL PHYSICS	3
4	PHY 451	SOLID STATE PHYSICS II	3
5	PHY 461	MATERIALS SCIENCE I	2
6	PHY 481	EXPERIMENTAL PHYSICS V	1
7	PHY……	ELECTIVE I	3
8	PHY……	ELECTIVE II	3
		TOTAL	**20**

YEAR FOUR – SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 402	PROJECT	4
2	PHY 412	QUANTUM MECHANICS II	3
3	PHY 422	ATOMIC AND MOLECULAR SPECTROSCOPY	3
4	PHY 432	STATISTICAL MECHANICS	3

5	PHY 462	MATERIALS SCIENCE II	2
6	PHY 482	EXPERIMENTAL PHYSICS VI	1
7	PHY……	ELECTIVE III	3
		TOTAL	**19**

1st SEMESTER ELECTIVES

1. **NUCLEAR PHYSICS OPTION**

   PHY 471 Nuclear and Particle Physics I
   PHY 473 Introduction to Reactor Physics

2. **ASTRONOMY OPTION**

   PHY 441 Stellar Structure and Evolution
   PHY 443 Galaxies

3. **ATMOSPHERIC PHYSICS OPTION**

   PHY 493 Aeronomy
   PHY 495 Introduction to Atmospheric Electricity and Cloud Physics

4. **MEDICAL PHYSICS OPTION**

   PHY 475 Radiation Instruments
   PHY 471 Nuclear and Particle Physics I

5. **GEOPHYSICS OPTION**

   PHY 491 Advanced Physics of Earth's Interior
   GPH 311 Principles and Practice of Geophysics

6. **THEORETICAL PHYSICS OPTION**

   PHY 413 Topics in Mathematical Physics
   PHY 415 General Theory of Relativity

7. **BIOPHYSICS OPTION**
   PHY 477 Biophysics I

2nd SEMESTER ELECTIVES

1. **GEOPHYSICS OPTION**

   PHY 472 Engineering Geophysics

2. **MEDICAL PHYSICS OPTION**

   PHY 416 Medical Nuclear Physics

3. **ATMOSPHERIC PHYSICS OPTION**

PHY 494 Meteorology

4. ASTRONOMY OPTION

PHY 442 Modern Cosmology and High Energy Astrophysics

5. NUCLEAR PHYSICS OPTION

PHY 472 Nuclear and Particle Physics II

6. THEORETICAL PHYSICS OPTION

PHY 418 Introductory Quantum Field Theory

7. BIOPHYSICS OPTION

PHY 478 Biophysics II

7.2 Course Description

FIRST SEMESTER

100 LEVEL

PHY 111 General Physics I (Mechanics and Thermal Physics) (2 UNITS)

Mechanics

Space and Time; Physical Quantities, Units, Dimensions, and Vectors; Kinematics in One, Two, and Three Dimensions; Newton's Laws of Motion; Circular Motion; Applications of Newton's Laws; Work, Energy and Power; Momentum and Collisions; Static Equilibrium and Elasticity; Universal Gravitation; Fluid Mechanics.

Thermal Physics

Temperature, Thermal Equilibrium and the Zeroth Law of Thermodynamics; Thermometry; Thermal Expansion; Quantity of Heat (Specific Heat, Molar Heat Capacity); Calorimetry and Phase Changes; Heat Transfer Mechanisms (Conduction, Convection Radiation, Radiation and Absorption, Applications of Radiation, Radiation, Climate and Climate Change); Thermal Properties of Matter (Equations of State, Molecular Properties of Matter, Kinetic Molecular Model of an Ideal Gas, Heat Capacities, Molecular Speeds, Phases of Matter; The First Law of Thermodynamics; Second Law of Thermodynamics

PHY 141 Vibrations, Waves and Optics (2 UNITS)

Oscillatory Motion

Description of Oscillatory Motion; Simple Harmonic Motion/Oscillators; Comparing Simple Harmonic Motion with Uniform Circular Motion; The Physical Pendulum; Damped, Forced Oscillations and Resonance**;**

Waves and Acoustics

Mechanical Waves; Sound and Hearing.

The Nature and Propagation of Light

The Nature of Light; Measurements of the Speed of Light (*Roemer's Method, Fizeau's Method*, etc.); Reflection and Refraction; Total Internal Reflection; Dispersion; Polarization; Scattering of Light; Huygens Principle.

Geometrical Optics (Reflection and Refraction at Plane Surface, Reflection and Refraction at Spherical Surface, Thin Lenses, Lens Aberrations, Cameras; The Human Eye, The Simple Magnifier, Microscopes, Telescopes.

PHY 181 General Laboratory Physics I (1 UNIT)

This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques will be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, PHY 102, and PHY 111, PHY 141 and PHY 152.

LEVEL 200

PHY 231 Thermal Physics (3 UNITS)

Pre-requisites – PHY 152 AND MTH 111 & 132

Foundations of Classical Thermodynamics including the Zeroth Law, and Definition of Temperature; The First Law; Work, Heat and Internal Energy; Isothermal and Adiabatic Processes; Carnot Cycles and the Second Law; Entropy and Irreversibility; Thermodynamic Potentials and the Maxwell Relations; Applications; Qualitative Discussion of Phase Transitions; Third Law of Thermodynamics; Molar Specific Heat Capacities; Ideal and Real gases; Elementary Kinetic Theory of Gases including Boltzmann Counting, Maxwell- Boltzmann Law of Distribution of Velocities, Simple Applications of the Distribution Law; Transport and Thermal Diffusion.

PHY 251 Electromagnetics (3 UNITS)

Pre-requisites: PHY 111 AND MTH 102

Electric Charge and Electric Fields; Gauss Law; Electric Potential; Capacitance and Dielectrics; Currents, Resistance, and Electromotive Force; Direct-Current Circuits; Magnetic Fields; Electromagnetic Induction; Inductance; Alternating Current.

PHY 271 Introduction to Space Science (2 UNITS)

Introduction to Astronomy and Astrophysics; Satellite Communication; Introduction to Atmospheric Science; Space Environment; Spacecraft Systems and Dynamics; Aero/Astrodynamics Engineering; Cosmology; Origin of the Universe and Life; Space Law and Business Development

GPH 201 Introduction to Earth Physics (2 UNITS)

The Earth's History – Historical Developments and Scope of Earth's Physics; Monistic and Dualistic Hypothesis for the Origin of the Solar System; Kepler's Laws of Planetary Motion; Planets and Satellites of the Earth's System and the Characteristics. Structural Units of the Continental Crust Active and Passive Margins; Cratons and Orogens. The

Earth's Interior, Seismicity, and Earthquake Zones. The Nature of the Gravity Field of the Earth. The Measurement of Gravity and Figure of the Earth; Shape and Size of the Earth; International Gravity Formula and Rotation of the Earth. The Earth's Magnetic Field – Reversal of the Earth's Magnetism and the Geomagnetic Timescale. Rock Magnetism, Polar Wandering, Plate Motions and Regional Structures – Causes of Geodynamic Process, Geodynamic Models, Continental Drift, Ocean Floor Spreading, Plate Tectonics, and its Geological Implications, New Global Tectonics and Plate Margin Process, Benioff Zones, Ocean Ridges, Evolution of Triple Junction, Trenches, and Islands Arcs, Hot Spots, Geodynamics of the Continental Drift. Heat Flow and Geothermometry.

PHY 281 Experimental Physics I (1 UNIT)

Pre-requisites: PHY 181/182

This Laboratory consists of: Graphical Handling of Data, Error Evaluation and Analysis; and Experiments on: Coefficient of Friction; Newton's Second Law of Motion (Atwood Machine); Centripetal Acceleration; Conservation of Energy; Moment of Inertia and Rotational Energy; Determination of Coefficient of Viscosity of Oil (Stokes's Method); Determination of the Viscosity of Water by Capillary Flow; Surface Tension by the Method of Capillary Rise.

LEVEL 300

PHY 301 Workshop Practice I (1 UNITS)

Mechanical Workshop Practice: Safety, Tools, Bench Work, Marking Out, Drilling, Cutting, Machine Tools, Lathe, Drilling Machine, Shaping Machine Parts, Operation and Accessories. Metal Joining, Nuts, Bolts, Brazing, Soldering, Welding, Drawings, Projects).

PHY 311 Analytical Mechanics II (3 UNITS)

Pre-requisites: PHY 111&PHY 212

Degrees of Freedom; Constraints; Generalized Coordinates; Lagrange's Formulation of Mechanics; Hamilton's Formulation of Mechanics; Applications. Invariance and Conservation Laws; Oscillatory Systems (including Damped, Forced and Coupled Oscillations), Normal Modes.

PHY 321 Mathematical Methods I (3 UNITS)

Pre-requisites: MTH 201& MTH 202

Review of Preliminary Algebra, Calculus, Complex numbers and Hyperbolic; Functions, Series and Limits, Partial Differentiation, Multiple Integrals Line, Surface and Volume Integrals, Vector Algebra, and Vector Calculus; Matrices and Vector Spaces; Normal Modes; Fourier Series; Integral Transforms; Ordinary Differential Equations; Special Functions.

PHY 331 STATISTICAL AND THERMAL PHYSICS (3 UNITS)

Pre-requisite – PHY 111 & PHY 231

Basic Concepts of Statistical Mechanics; Microscopic Basis of Thermodynamics and Applications to Macroscopic Systems; Condensed States; Phase Transformations; Quantum Distributions; Elementary Kinetic Theory of Transport Processes; Fluctuation Phenomena. Applications.

PHY 341 Quantum Physics (3 UNITS)

Pre-requisite – PHY 152 & PHY 272

Historical/Experimental Origins of Quantum Theory; Bohr's Quantization of Angular Momentum, and its Application to the Hydrogen atom; Wave Properties of Matter; Consequences of de Broglie's Concepts; The Heisenberg's Uncertainty Principle; Schrodinger's Theory of Quantum Mechanics; Solution of Schrodinger's Equation for Different Potentials; Physical interpretation of the Wave Function; Operators in Quantum Mechanics; Expectation values; Postulates of Quantum Mechanics; Transition probability; The Harmonic Oscillator; Quantum Theory of the Hydrogen Atom ; Quantum Numbers and their interpretation; Electron Spin; Quantum Operators.

PHY 351 Electromagnetism (3 UNITS)

Pre-requisites: PHY 152 AND MTH 202

Electrostatics and Magnetostatics (Charge Configuration, Coulomb's Law and Electric Field Intensity, Electrostatic Potential Field, Gauss's Law, Dielectrics, Laplace's and Poisson's Equations and Boundary Value Problems, Image Theory, Electric Current and Conservation of Charge, The Biot-Savart Law & Magnetic Field Intensity, Ampere's Circuital Law, Ampere's Law in Point Form (Maxwell's Equation); Multipole Expansions; Maxwell's Equations and the Displacement Current
Lorentz Covariance and Special Relativity

PHY 361 ELECTRONICS I (2 UNITS)

Pre-requites: PHY 262

Network Topology (Loop and Mesh Analysis, Nodal Analysis); Network Theorems (Superposition, Maximum Power Transfer, Reciprocity, Thevenin's, Norton's, Rosen's, Star-Delta Transformations, Equivalence); Sinusoidal Circuits (RLC Circuits and Characteristics, Wave-Shaping Circuits and R-C Filters, Applications); Semiconductor Devices (Transistors (Bipolar and FET); Tunnel diodes (Applications in Amplification and Oscillation, Voltage Regulation, Signal Modulation and Detection); Elements of Logic Circuits (Logic Gates and their Applications in Computing).

PHY 371 INTRODUCTION TO ATMOSPHERIC PHYSICS (2 UNITS)

Detailed Treatment of Atmospheric Variables (Pressure, Temperature, etc.) – Their Variations in Time and Space; Moisture Variables – Mixing Ratio, Specific Humidity, etc. Pressure Systems; Pressure Gradients and Coriolis Force; Atmospheric Motion – Geostrophic, Gradient and Thermal Wind. Lapse Rates – Environment, Dry and Wet Adiabatic Lapse Rates; The Effects of Latent Heat Release; Types and Characteristics of Atmospheric Stability.

Relationship between Lapse Rates, Stability and Clouds. Types of Clouds and their Classification. Types of Precipitation associated with /clouds. Scales of Motion in the Atmosphere. Air Masses and Source regions. Air Masses affecting Tropical and Temperate Regions. ITD and ITCZ. The Polar Front and Fronted Slopes. Life Cycles of Frontal Depress. Atmospheric Optics with Applications to Rainbow. Halo and other Optical Phenomena. Transparency of Atmosphere and Visual Range.

The Universe: Galaxies, Stars and the Sun. The Solar System: Gravitation; the Planets; the Moons, comets and Meteors. The Sun: Solar Atmosphere; Activity Regions; Sunspots, Solar Flares, Solar Wind. Solar Radiation and the Earth's Atmosphere. Ions. Frontal Cross-Sections. Introduction to Divergence and Vorticity.

PHY 381 EXPERIMENTAL PHYSICS III (1 UNIT)

Pre-requisites: PHY 281/282

This Laboratory consists of experiments involving:
The use of Advanced Instruments (e.g. Photometer, Telescopes, Oscilloscopes, etc.); Verification Conservation of Linear Momentum (Elastic Scattering Method;) Investigation of the Moment of a Couple; Calibration of a Thermocouple and the Determination of the Melting Point of Naphthalene; Determination of the Wavelength of Sodium Lamp using a Diffraction Grating; Determination of the Polarising angle for the Glass Prism Surface and Refractive Index of the Material using Brewster's Law $\tan\phi = \mu$; Investigation of the Charging and Discharging of a Capacitor; Determination of the Resonance Frequency of an LC Circuit;

LEVEL 400

PHY 401 SUPERVISED INDIVIDUAL RESEARCH (SEMINAR) (2 UNITS)

The course offers students the opportunity to do research in contemporary physics and under the supervision of staff. A detailed report on the research is presented by the student when the seminar and/or project is completed.

PHY 411 QUANTUM MECHANICS I (3 UNITS)

Pre-requisites: PHY 321, PHY 341, PHY 371, PHY 322, MTH 202

Principles of Quantum Theory: Linear vector spaces, Operators in Hilbert space, Hermitian and unitary operators, Projection operators and Tensor Products, The trace and Determinant of an Operator.The Postulates of Quantum Mechanics. The Pictures of Quantum Mechanics: Schrodinger Picture, Heisenberg Picture, The Interaction Picture. Mixed Quantum States and Density Operator: Mixed States, Decoherence, Imperfect Measurements. Composite Systems and Entanglement: Composite Systems, Quantum Entanglement, Quantum Teleportation. Evolution of Open Quantum Systems. Rotations and Addition of Angular Momenta: Rotations in Classical Physics, Rotations in Quantum Mechanics. Addition of Angular Momenta (Addition of Two Angular Momenta: General Formalism; Calculation of Clebsch - Gordon Coefficients; Coupling of Orbital and Spin Angular Momenta; Addition of More than Two Angular Momenta; Rotation Matrices for Coupling Two Angular Momenta; Isospin)

PHY 421 COMPUTATIONAL PHYSICS (3 UNITS)

Pre-requisites: MTH 201, MTH 202, PHY 321, PHY 322

Modelling and Computing; Errors in Numerical Computation; Roots of Equations; Linear Algebraic Equations; Numerical Methods for Matrices; Optimization; Curve Fitting; Numerical Differentiation; Numerical Integration; Ordinary Differential Equations; Partial Differential Equations.

PHY 451 SOLID STATE PHYSICS II (3 UNITS)

Pre-requisite: PHY 352

Magnetic Properties of Materials: The Phenomenon of Magnetism; Magnetic Interactions of Many-Electron Systems, Magnetic Properties of Insulators and Metals; Magnetic Permeability and Susceptibility; Magnetization; Bohr Magneton; Electron Spin and Magnetic Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Anti-Ferromagnetism, Magnetic Resonance.

Semiconductors: Maxima and Minima of Energy Band; Metal, Insulator, and Semiconductor; Basics of Semiconductor (Band Gap); Electrons and Holes; Intrinsic Semiconductor; Doped Semiconductor; Basic Equations used in Semiconductors (Diffusion, Maxwell, and Continuity Equations); Diode; Thermoelectric Effects; Semi-metals; Superlattices; Semiconductor Devices.
Fermi Surfaces and Metals: Reduced and Periodic Zone Schemes; Electron, Hole and Open Orbits; Calculation of Energy Bands (Tight Binding Approximation, Wigner-Seitz, Cohesive and Pseudopotential Methods); Experimental Methods in Fermi Surface Studies (Quantization of Orbits in a Magnetic Field, De Haas-van Alphen Effect, Extremal Orbits, Magnetic Breakdown).
Superconductivity: Experimental Overview (Occurrence, Destruction by Magnetic Fields, Meissner Effect, Heat Capacity, Energy Gap, Microwave and Infrared Properties, Isotope Effect); Theory of Superconductivity (Thermodynamics of the Superconducting Transition, London Equation, Coherence Length, Bardeen, Cooper and Schrieffer (BCS) Theory of Superconductivity, Type II Superconductors, Josephson Effect-Superconductors in DC and AC Fields, Quantum Tunnelling, Josephson Superconductor Tunnelling, Macroscopic Quantum Interference); High-Temperature Superconductors; Applications of Superconductivity; Superfluidity.
Plasmon, Polaritons, and Polarons: Dielectric Properties of Electron Gas, Plasmons, Electrostatic Screening, Polaritons, Electron-Electron, and Electron-Phonon Interaction, Polarons.
Introduction to Surface and Interface Physics: Surface Crystallography (Reflection of High-Energy Electron, Diffraction); Surface Electronic Structure (Work Function, Thermionic Emission, Surface States, Tangential Surface Transport); Magnetoresistance (Integral Quantum Hall Effect (IQHE), Fractional Quantized Hall Effect (FQHE)); *p-n* Junctions (Rectification, Solar Cells and Photovoltaic Detectors, Schottky Barrier); Heterostructures (n-*N* Heterojunction, Semiconductor Lasers, Light-Emitting Diodes).
Introduction to Nanostructures: Imaging Techniques for Nanostructures (Electron, Optical, Scanning Tunnelling, and Atomic Force Microscopy); Electronic Structures in 1-D Systems (1-D Sub-bands, Spectroscopy of Van Hove Singularities, Coulomb and Lattice Interactions in 1-D Metals); Electrical Transport in 1-D (Conductance Quantization and the Landauer Formula, Two Barriers in Series-Resonant Tunnelling, Incoherent Addition and Ohm's Law); Electronic Structure of 0-D Systems (Quantized Energy Levels, Semiconductor Nanocrystals, Metallic Dots, Discrete Charge States); Electrical Transport in 0-D (Coulomb Oscillations, Spin, Mott Insulators, and the Kondo Effect, Cooper Pairing in Superconducting Dots); Vibrational and Thermal Properties of Nanostructures (Quantized Vibrational Modes, Transverse Vibrations, Heat Capacity and Thermal Transport).
Non-Crystalline Solids: Diffraction Pattern, Glasses, Amorphous Ferromagnets and Semiconductors, Low Energy Excitations of Amorphous Solids, Fibre Optics.

PHY 461 MATERIALS SCIENCE I (2 UNITS)
Metals and Microstructure: Crystallography and Metallic Alloys (iron-based, copper-based, nickel-based, aluminium-based, titanium-based); Equilibrium Constitution and Phase Diagrams; Steels (carbon steel and alloy steel), Nucleation and Growth.
Mechanical Properties: Elastic Deformation; Elastic Moduli (Young's, Bulk, and Shear Moduli); Inelastic Deformation, Viscous Deformation, Plastic Deformation, Bonding in Atoms, Packing of Atoms in Solids, Dislocations and Yielding in Crystals,

Compression, Yield Strength, Tensile Strength, Ductility, Fast Fracture, Brittle Fracture, Toughness, Fatigue Failure, Creep Deformation

Semiconductor Processing: Purification, Crystal Growth, Crystal Doping, Slice Preparation, Epitaxial Growth, Integrated Circuit Processing, Photolithography, Impurity Diffusion, Junction Formation, Ion Implantation, Metallization.

PHY 481 Experimental Physics V (1 UNIT)

Pre-requisites: PHY 381/382

Simulation of Data and Analysis of Experimental Data using MATLAB and/or other Statistical Programming Packages, Investigation of Electrical Conduction In Solid Bodies; Investigation of Photoconductivity; I-V Characteristics Of Solid State Devices; Nuclear Counting Statistics; X-Ray-Spectroscopy and Moseley's Law; Alpha Particle Spectroscopy; Investigation of Microwaves; Tungsten Filament Lamp Characteristics.

FIRST SEMESTER ELECTIVES

NUCLEAR PHYSICS OPTION

PHY 471 NUCLEAR AND PARTICLE PHYSICS I (3 UNITS)

Pre-requisites: PHY 372

Nuclear Size; Nuclear forces; Nuclear Models; Alpha Decay, Beta Decay & Gamma Ray Emission; Nuclear Reactions; Charged-Particle Interactions; Neutron Interactions; Gamma Interactions; Nucleosynthesis; Applications of Nuclear Physics (Fission, Fusion, Biomedical applications, Other Applications.

PHY 473 INTRODUCTION TO REACTOR PHYSICS (3 UNITS)

Nuclear Fission; Neutron Moderation and Thermal Diffusion; Critical Size; Effect of Reflectors; Flux Flattening; Calculation of Lattice Parameters. Reactor Kinetics; Prompt Criticality Reactor Analogue Simulators; Control Rods; Reactor Instrumentation; Reactor Shielding and Safety; Control of Hazards; Effects of Irradiation on Reactor Materials.

ASTRONOMY OPTION

PHY 441 STELLAR STRUCTURE AND EVOLUTION (3 UNITS)

Hydrostatic and Thermal Equilibrium; Energy Transport; Stellar models

PHY 443 GALAXIES (3 UNITS)

Astronomical Distance Determination; Galaxy Classification; Properties of the Components of the Milky Way Galaxy, and its Local Environment; Properties of Spiral and Elliptical Galaxies; Active Galaxies; Galaxy Evolution.

ATMOSPHERIC PHYSICS OPTION

PHY 493 AERONOMY (3 UNITS)

Review of the Principles and Concepts of Kinetic Theory; Laws of Equation State, Continuity and Thermal Equilibrium; Collision and Diffusion Processes; Atmospheric Layers (Structure and Characteristics); Solar-Terrestrial Interactions; Magnetic Fields and Storms; Atmospheric Aerosols at the Lower Level

PHY 495 INTRODUCTION TO ATMOSPHERIC ELECTRICITY AND CLOUD PHYSICS (3 UNITS)

Atmospheric Electricity: Regular Diurnal Variations of the Earth's Atmospheric Electromagnetic Network, Lightning Discharges, Plasma Temperatures in Lightning.
Cloud Physics and Weather Modification: Formation, Growth and Precipitation in Clouds; Thunder Storms; Cloud Models; Use of Satellites and Weather Radar for Monitoring Cloud Development and Precipitation. Artificial Modification of Weather. Warm and Cold clouds. Fogs. Severe Storms and Precipitation; Socio-Economics of Weather Modification-Prospect for the Future.

MEDICAL PHYSICS OPTION

PHY 475 RADIATION INSTRUMENTS (3 UNITS)

Ionization Chamber; Geiger Counter; Scintillation Counter; X-ray Equipment; Solid State Detectors; Gamma-ray Cameras; Medical Imaging Devices and their Applications.

PHY 471 NUCLEAR AND PARTICLE PHYSICS I (3 UNITS)
(Same as given Above)

THEORETICAL PHYSICS OPTION

PHY 413 TOPICS IN MATHEMATICAL PHYSICS (3 UNITS)
Pre-requisites: MTH 201, MTH 202, PHY 321, PHY 322

Linear Algebra and Functional Analysis; Transformations in Linear Vector Spaces and Matrix Theory; Hilbert Space and Complete Sets of Orthogonal Functions; Special Functions of Mathematical Physics; Applications of Transform Methods to the Solution of Ordinary and Partial Differential Equations of interest in Physics and Engineering; Partial Differential Equations; Sturm-Liouville's theory-Uniqueness of solutions; Calculus of Residues and Applications to the Evaluation of Integrals and Summation of Series; Applications of Various Physical Situations, which may include – electromagnetic theory, quantum theory, diffusion phenomena.

PHY 415 GENERAL THEORY OF RELATIVITY (3 UNITS)
Pre-requisites: MTH 201, MTH 202, PHY 212, PHY 311, PHY 321, PHY 322

Newtonian Gravity and the Principle of Equivalence; The Shortest Distance between Two Points is a Straight Line; Curvilinear Coordinates; Introduction to Tensors; The Metric Tensor and a Lagrangian for Particles in Free-Fall; Curved Space; Special Relativity and Tensors; Dust, Energy, Momentum, Stress; Motion on curved Surfaces; Christoffel Symbols and Differentiation of Tensors; Evaluation of the Christoffel Symbols; Parallel Transport on the Surface of a Sphere; The Riemann Curvature; Einstein's Equations and an Introduction to the Schwarzschild Solution; Fixed and Freely-Falling Clocks, Gravitational Redshift of Light; Bending of light beams in a gravitational field; Black Hole Interiors; An Introduction to Cosmology

GEOPHYSICS OPTION

PHY 491 ADVANCED PHYSICS OF EARTH'S INTERIOR (3 UNITS)

Structure of the Earth; Conductivity; Heat Flow; Elasticity; Dynamo Theory; Magnetic Field.

GPH 311 Principles and Practice of Geophysics

Gravity and Magnetic Methods; Data Acquisition and Interpretation; Spontaneous Potential and Electrical Resistivity Methods; Concepts of Electrical Potential; Current Density and Conductivity of Rocks; Potential Distribution in a Homogeneous Earth and Apparent Resistivity; Elect-Interpretation.

BIOPHYSICS OPTION

PHY 477 Biophysics I (3 UNITS)

Ionization of Biomolecules; Thermodynamic Principles; Energy Transfer in Living Systems; Bioelectricity-Ion Channels, Action Potentials, Nerve Impulse Transmission, Study of the Electric Cell.

SECOND SEMESTER

100 LEVEL

PHY 152 Electricity, Magnetism and Modern Physics (2 UNITS)

Electricity: Electric Fields; Gauss's Law: Applications of Electrostatics; Capacitance and Dielectrics; Current and Resistance; Superconductivity; Electrical Power; Direct Current Circuits;

Magnetism: Magnetic Fields (Magnetic Fields and Forces, Magnetic Force Acting on a Current-Carrying Conductor; Torque on a Current Loop in a Uniform Magnetic Field), Electrical Meters; Motion and Applications of a Charged Particle in a Uniform Magnetic Field; The Hall Effect; Sources of the Magnetic Field; Faraday's Law; Motional emf; Lenz's Law; Induced emf and Electric Fields; Generators and Motors; Eddy Currents; Maxwell's Equations; Electromagnetic Oscillations and Waves; Inductance; Self-Inductance; RL Circuits; Energy in a Magnetic Field; Mutual Inductance (*Transformers*); Oscillations in an LC Circuit; The RLC Circuit.

Modern Physics: Relativity Theories; Structure of the Atom; Cathode Rays; X-rays; Elements of Quantum Theory; The Atomic Nucleus - Composition and Size, Nuclear Force, and Binding Energy, Radioactivity, Nuclear Reactions, Nuclear Fission and Fusion, Radiation Detection.

PHY 182 General Laboratory Physics II (1 UNIT)

This introductory course emphasizes quantitative measurements, the treatment of measurement errors, and graphical analysis. A variety of experimental techniques will be employed. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc., covered in PHY 101, PHY 102, and PHY 111, PHY 141 and PHY 152.

LEVEL 200

PHY 212 Analytical Mechanics I (3 UNITS)

Pre-requisites: PHY 111

Elements of Vector Analysis; Newtonian Mechanics (Motion of a Particle in One, Two and Three Dimensions); Systems of Particles and Collision Theory; Newtonian Gravitation; Conservative Forces and Potentials; Oscillations; Central Force Problems; Accelerated Frames of Reference; Rigid Body Dynamics; Generalized Motion; Mechanics of Continuous Media.

PHY 242 Waves, Sound and Optics (3 UNITS)

Pre-requisites – PHY 141 and MTH 102

Wave phenomena: Acoustical waves, The Harmonic Oscillator, Waves on a String, Energy in Wave Motion, Longitudinal Waves, The Linear Wave Equation,

Superposition and Standing Waves in Strings and Air Columns, Standing Waves in Rods and Membranes, Group and Phase Velocity, Doppler Effect, Resonance, Beats: Interference in Time, Non-Sinusoidal Wave Patterns.
Sonics: Characteristic Impedance, Reflection, Absorption, Transmission, Pressure and Intensity, Decibels, Room Acoustics.
Physical Optics: Spherical Waves (Huygens's Principle); Interference and Diffraction; Thin Films; Crystal Diffraction; Holography; Dispersion and Scattering.
Geometrical Optics: Waves and Rays; Reflection at a Spherical Surface; Thin Lenses, Optical Lenses; Mirrors and Prisms.

PHY 262 ELECTRIC CIRCUITS & ELECTRONICS (3 UNITS)
Pre-requisite – PHY 152

DC Circuits: Circuit Theorems (Thevenin's, Norton's, Reciprocity, Superposition), Kirchhoff's Laws, DC Network Analysis, Electromagnetic Induction, Sources of EMF and Currents.
AC Circuits: Capacitance and Inductance; The Transformer; Network Analysis and Network Theorems; Various Waveforms of AC Circuits (Sinusoidal, Symmetrical, and Square), and their Characteristics; Series Circuits (RL, RC, and RLC); Root Mean Square (RMS) and Peak Values; Power; Impedance and Admittance; Q-Factor and Resonance.
Electronics: Band Theory of Electrical Conduction; Semiconductors and Insulators; Calculation of Charge Concentration in Semiconductors; Diodes (P-N Junction); PNP and NPN, Field Effect Transistor (FET), Bipolar Junction Transistor (BJT), Amplifiers, Feedback (Negative and Positive), Oscillators;

PHY 272 Elementary Modern Physics (3 UNITS)
Pre-requisite – PHY 152

Relativity Theories: The Special Theory of Relativity and an Introduction to the Theory of General Relativity.
The Atom: Structure; Models; Static Properties.
Elements of Quantum Theory: Blackbody Radiation; Electrons and Quanta; Bohr's Theory of Atomic Structure; de Broglie's Hypothesis; Heisenberg's Uncertainty Principle; Schrödinger's Equation and some of its Simple Applications.
The Atomic Nucleus: Structure; Static Properties - Composition and Size, Nuclear Force, and Binding Energy; Radioactivity, Nuclear Reactions; Nuclear Fission and Fusion; Fundamental Particles; Radiation Detection.
Introduction to Nanophysics: Definition of Nanophysical Systems; Branches of Nanoscience (Quantum Transport, Nanoelectronics, Nano-Optics, Nanofluids, Nanomagnetism and Spintronics, Carbon Nanotubes, etc.); Importance of Nanostructures; Nanowires (growth and properties); Transport Phenomena in Nanostructures; Optical Properties of Nanostructures; Magnetic and Non-Magnetic Nanocomposites; Nanofluids and Flows at Nanoscale.

PHY 282 Experimental Physics II (1 UNIT)
Pre-requisites – PHY 181/182

Verification of Boyle's law of Gases; Investigation of Due-Point and Relative Humidity of Water using Daniel's Hygrometer; Determination of the Specific Heat Capacity of Liquids and Solids by Electrical Method; Determination of Wavelength of Sodium Light with Fresnel's Biprism; Investigation of Newton's Rings; Determination of the Frequency of Tuning Forks using a Sonometer; Determination of the Velocity of Sound

in Air using a Resonance Tube; Michaelson Interferometer; Determination of the Temperature Dependence of Resistance of using a Wheatstone bridge; Investigation of Joule Heating of a Resistor.

LEVEL 300

PHY 302 Workshop Practice II (1 UNITS)

Electronic Workshop Practice: Safety, Tools, Test Equipment, Multimeters, Signal Generator, Scope: Use of these in Circuits, Colour Codes, Soldering, Circuit Symbols, Amplifiers, Rectifiers, Oscillators, Block diagrams, Use of Characteristics, Projects.

PHY 306 Energy and Environmental Studies (2 Units)

Energy and Power - Principles, Demands and Outlook; Transformation of Energy and its Costs; Thermal Pollution; Electric Energy from Fossil fuels; Hydroelectric Power Generation (Principles and Problems); Costs, Capacity, Storage, Reserves, Efficiency, and Environmental Effects of these. Electrical Energy from Nuclear Reactors (Prospects for the future through its Promises and Problems of Breeder Reactors); Fusion Power; Geothermal Power, Tidal Power, etc. (their Promises and Problems); Renewable Energy Systems (Solar, Wind and Biomass) and their Utilisation; Solar Energy Technology and its Applications for Rural Development, e.g. Solar Stills, Solar Dryers, Solar Cookers, Solar Cooling and Heating; Solar Cells and Photovoltaic Systems; Contribution of Energy Generation Processes to Environmental Pollution and Safeguards.

PHY 322 Mathematical Methods II (3 UNITS)

Pre-requisite –PHY 321

Partial Differential Equations; Calculus of Variations; Integral Equations; Functions of Complex Variables and its Applications; Tensors; Numerical Methods; Group Theory; Representation Theory; Probability Theory; Statistics.

PHY 342 Electromagnetic Waves and Optics (3 UNITS)

Pre-requisite –PHY 251, PHY 242

Maxwell's Equations in Vacuum and Electromagnetic Potentials - The Wave Equation; Propagation of Plane Waves in Various Media (dielectric, conducting media, and plasmas)-Reflection and Refraction, Polarization, Dispersion, Interference, Diffraction; Energy Conservation and Poynting's Theorem; Transmission Lines: TEM Modes; Waveguides and Resonant Cavities; Dipole Fields and Radiation: - Electric and Magnetic Dipole Radiation, Larmor's Formula; Geometrical Optics:- Interference, Coherence, Young's Fringes, Michelson Interferometer, Fabry-Perot, Rayleigh refractor meter, Diffraction, Huygens's Principle, Fraunhofer Diffraction, the Grating, Airy' Disc, Polarisation (plane and circular), Optical Activity.

PHY 352 Solid State Physics 1 (3 UNITS)

Crystal Structure and Symmetry: X-Ray Diffraction and Reciprocal Lattice; Interatomic Forces and Bonding in Solids; Elastic Properties of Solids: Point Defects; Dislocations in Crystals; Crystal Vibrations; Thermal Properties of Solids: Free Electron Fermi Gas; Band Theory of Solids; Superconductivity and Superfluidity.

PHY 362 ELECTRONICS II (2 UNITS)

Pre-requisite – PHY 361

Electronic Properties of Solids: Kinetic Theory of Gases, Crystal Lattices, X-ray Diffraction, Electrons in Metals, Electronic Theory. **Review of Energy Bands:** Semi-Conduction, Mobility, Drift, Diode Equations, Bipolar Transistors. **Electronic Devices**: Silicon-Controlled Devices, Opto-Electronics, Photo-Transistors, Iphoto Resistors, Photo-Diodes, Solar Cells, Light-Emitting Diodes. **Amplifiers:** Tuned, Stagger-tuned, Power (for audio, radio, video) Stability in Amplifiers, Noise Distortion. Operational Amplifiers and its Applications. **Oscillators:** Review of LC, RC Oscillators, Negative Resistance and Relaxation Types, Voltage-Controlled Types (PLL), Frequency Synthesizers. **Pulse Electronics:** Common Waveforms - Step, Ramp, Exponential, Ideal & Practical (Saw-Tooth, Triangular, Trapezoid). **Active Waveform Shaping Circuits**: Semi-Conductor, Switching Circuits; Pulse Transformers, Lumped and Distributed Parameter Delay Lines.

PHY 372 Introduction to Nuclear Physics (3 UNITS)
Pre-requisite – PHY 272

General Properties of Nuclei: Constituents, Charge, Size (basic methods used to determine nuclear sizes), Mass and Abundance, Nuclear Binding Energy, Nuclear Angular Momentum, Parity and Moments, Nuclear Excited States
Nuclear Forces: Properties of Nuclear Force, The Deuteron, The Exchange Force Model
Spontaneous Decay of Nuclei (alpha, beta, and gamma decay processes)
Nuclear Reactions: Basic Types (compound nucleus reactions and direct reactions); Nuclear Fission and Fusion.
Introductory Particle Physics: Fundamental Interactions and Fields, Survey of Fundamental Particles, Fermion and Bosons, The Quark Model, Properties of Quarks.

PHY 382 EXPERIMENTAL PHYSICS IV (1 UNIT)
Pre-requisites: PHY 281/282

This Laboratory consists of experiments involving:
Determination the Inductance and Inductor Self-Capacitance from Measurement of a Resonance Parallel Circuit; Investigation of Alternating Currents in LR, RC and LRC Circuits; Investigation of the Pulling Effect of an Electromagnet; Investigation of the Magnetic Field inside a Conductor; Investigation of Equipotentials and Electric Fields; Investigate Magnetic Induction in a Current-Carrying Long Straight Wire; Identification of Resistor Colour Codes and Diode Characteristics; Investigation of Bipolar Transistor Characteristics; Transistor Amplification; Phototransistor Unit; Diode Rectifier and Smoothing Circuits; Cathode Ray Oscilloscope; Pulse Handling and Wave Shaping; Determination of e/m; Investigation of the Photoelectric Effect; Electron Spin Resonance; Millikan's Oil Drop Experiment.

LEVEL 400

PHY 402 Supervised Individual Research (Project) (4 UNITS)
The course offers students the opportunity to do research in contemporary physics and under the supervision of staff. A detailed report on the research is presented by the student when the seminar and/or project is completed.

PHY 412 Quantum Mechanics II (3 UNITS)
Pre-requisites – PHY 321, PHY 322, PHY 341, PHY 411

Approximation Methods in Quantum Mechanics; Scattering Theory; Path Integrals; Space-Time Symmetries; Selected phenomena from each of atomic physics, molecular physics, solid state physics and nuclear physics are described and then interpreted using quantum mechanical models.

PHY 422 Atomic and Molecular Spectroscopy (3 UNITS)

Pre-requisite- PHY 341

The Hydrogen Atom: Atomic Gross Structure (Bohr Model); Absorption and Emission Spectra; Angular Momentum and Magnetic Moments; Spin, Spin-Orbit Coupling and Fine Structure; Total Angular Momentum; Spin-Orbit Energy; Spectroscopic Notation; Zeeman and Paschen-Back Effects; Nuclear Effects.

Radiative Transitions: Classical Theories of Radiating Dipoles; Quantum Theory of Radiative Transitions; Electric (E1) Transitions; Selection Rules for E1 Transitions, Higher Order Transitions; Radiative Lifetimes; The Width and Shape of Spectral Lines; Natural Broadening, Collisional (Pressure) Broadening; Doppler Broadening; Atoms in Solids.

The Atomic Shell Model: The Shell Model and the Periodic Table; Justification of the Shell Model; Experimental Evidence for the Shell Model; Effective Potentials and Screening; Alkali Metals.

Resonance Phenomena: ESR, NMR, Optical Pumping and Mossbauer Scattering; Microwave Methods.

Many-Electron Atoms: Helium Atom (Exchange Symmetry; Helium Wave Functions; Pauli's Exclusion Principle; Exchange Energy; Spin-Orbit Coupling in Multi-Electron Atoms; Hund's Rule, Stark Effect, Fine and Hyperfine Structure, The Frank-Condon Principle.

Molecules: The Molecular Bond; Electron Sharing; The H_2^+ Molecular Ion; The Hydrogen Molecule; Complex Molecules; Rotational Energy Levels; Vibrational Energy Levels; Electronic Spectra of Molecules.

PHY 432 Statistical Mechanics (3 UNITS)

Review of Concepts in Thermodynamics: Equilibrium and State Quantities; Laws of Thermodynamics; Phase Transitions and Chemical Reactions; Thermodynamic Potentials;

Classical Statistics Mechanics: Number of Microstates and Entropy; Ensemble Theory and Microcanonical Ensemble; The Maxwell-Boltzmann (M-B) Distribution; The Bose-Einstein (B-E) Distribution (and its Applications to some Simple Systems); The Canonical Ensemble and its Applications; The Macrocanonical Ensemble.

Quantum Statistics: Density Operators; The Grand Canonical Ensemble and its Description of Quantum Systems; Fermi-Dirac (F-D) Distribution and some Ideal Fermi Systems (e.g. White Dwarfs, Neutron Stars, Nuclear Matter, etc.); Comparison of M-B, B-E, F-D Statistics; Ideal Bose and Fermi Gases.

Real Gases and Phase Transitions: Real Gases; Phase Transitions; Ising and Heisenberg Models.

PHY 462 MATERIALS SCIENCE II (2 UNITS)

Polymers and Composites: The generic polymers: thermoplastics, thermosets, elastomers, natural polymers, mechanical behavior of polymers, molecular structure of polymers, production, forming and joining of polymers; Composites: fibrous, particulate and foamed (how adding fibers or particles to polymers can improve their stiffness, strength and toughness; why foams are good for absorbing energy).

Ceramics and Glasses: Structure of ceramics (crystalline ceramics glassy ceramics, ceramic alloys, ceramics micro-structures); production of ceramics, production of glass, mechanical properties of ceramics (wear and erosion resistance, thermal shock, stiffness and hardness, toughness); natural ceramics (rocks and ice); Cement and concrete.

Oxidation and Corrosion: Oxidation of materials, rates of oxidation, energy of oxidation, wet oxidation, wet corrosion, friction between materials, wear of materials, abrasion, stress corrosion.

PHY 482 Experimental Physics VI (1 UNIT)
Pre-requisite- PHY 381/382

Beta Particle Spectroscopy; Hydrogen Spectrum and the Rydberg Constant; Simulated Radioactive Decay using Dice "Nuclei"; Geiger Counter Measurement of the Half-Life of ^{137}Ba; Absorption of Beta and Gamma Rays; Fourier Series Theorem; Thevenin's Network Theorem.

SECOND SEMESTER ELECTIVES

NUCLEAR PHYSICS OPTION

PHY 472 Nuclear and Particle Physics II (3 UNITS)
Pre-requisite- PHY 372, PHY 471

Nuclear Instrumentations and Radiation Detection Techniques;
Scales and Units in Particle Physics: Length, Mass and Energy.
Particle Phenomenology: (Leptons, Quarks, Hadrons).
Symmetries and Conservation Laws (Parity, Charge Conjugation); Interactions and Feynman Diagrams:
Particle Exchange: Forces and Potentials (Range of Forces, The Yukawa Potential);
Observable quantities: Cross Sections and Decay Rates, Amplitudes, Cross-sections, Unstable states;
Experimental Methods: Accelerators and Beams (DC Accelerators, AC Accelerators, Neutral and Unstable Particle Beams), Particle Detectors (Gas detectors, Scintillation Counters, Semiconductor Detectors, Particle Identification, Calorimeters), Layered detectors.
Quark Dynamics: The Strong Interaction – Colour, Quantum Chromodynamics (QCD), Heavy Quark Bound States, The Strong Coupling Constant and Asymptotic Freedom, Jets and Gluons, Colour Counting, Deep Inelastic Scattering and Nucleon Structure.
Electroweak Interactions: Charged and Neutral Currents, Symmetries of the Weak Interaction, Spin Structure of the Weak Interactions (Neutrinos, Particles with Mass: Chirality, $W^{\pm}$ and Z^{0} W, Weak interactions of Hadrons, Neutral Meson Decays (CP Violation, Flavour Oscillations), Neutral Currents and the Unified Theory
Outstanding Questions and Future Prospects: Particle Physics (The Higgs Boson, Grand Unification, Supersymmetry, Particle astrophysics); Nuclear Physics (The structure of Hadrons and Nuclei, Quark–Gluon Plasma, Astrophysics and Cosmology,

Symmetries and the Standard Model, Nuclear Medicine, Power Production and Nuclear Waste.

ASTRONOMY OPTION

PHY 442 Modern Cosmology and High Energy Astrophysics (3 UNITS)

Hubble's Law, Gravity, Luminosity and Redshift, High Energy Particles, Cosmic Rays, Solar Wind, Shock Waves, Supernovae, Neutron Stars, Pulsars, Black Holes

ATMOSPHERIC PHYSICS OPTION

PHY 494 Meteorology (3 UNITS)

Meteorological Parameters and their Measurement: Temperature, Pressure, wind etc. Weather and Climate

MEDICAL PHYSICS OPTION

PHY 416 Medical Nuclear Physics (3 UNITS)

Production of isotopes, Nuclear Scanning and Tracers, Nuclear Magnetic Resonance, Interaction of Radiation with Matter, (X-ray and Gamma rays, Thomson Scattering Photoelectric Effect, Compton Scattering, Pair Production, Attenuation.

GEOPHYSICS OPTION

PHY 414 Industrial Geophysics (3 UNITS)

Seismic, gravitational, magnetic/electrical induced polarization, Prospecting for Economic Minerals, Solutions of Civil Engineering Problems

THEORETICAL PHYSICS OPTION

PHY 418 Introductory Quantum Field Theory (3 UNITS)

Pre-requisite PHY 342, PHY 411

Photons and Electromagnetic Fields, Quantization of Electromagnetic Fields, Lagrangian Field Theory, Covariant Theory for Photons, Covariant Quantization, The S-Matrix, Klein-Gordon Field, Feynman Diagrams in Quantum Electrodynamics, Radiative Corrections, Infra-Red Divergence, Renormalisation, Spontaneous Symmetry Breaking, The Higgs Model

BIOPHYSICS OPTION

PHY 478 Biophysics II (3 UNITS)

Optics of the Eye, Photo-energy Transduction in Vision, Sound Waves Receiver and the Ear Hearing Aids, Human voice, Ultrasound/Applications, Fluid Flow and Viscosity – applications, Blood Pressure, Osmotic Pressure, Centrifugation, Surface Tension and Applications.

8. SERVICE COURSES TAUGHT BY THE DEPARTMENT TO STUDENTS IN OTHER FACULTIES OF PHYSICAL, AND COLLEGE OF MEDICAL SCIENCES

8.1 Course Contents

FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS

1	PHY 101	INTRODUCTORY PHYSICS I	2
2	PHY 181	GENERAL LABORATORY PHYSICS I	1
3	PHY 201	GENERAL PHYSICS I	2
4	PHY 281	EXPERIMENTAL PHYSICS I	1
5	PHY 291	GENERAL PHYSICS III	2

SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	CREDIT HOURS
1	PHY 102	INTRODUCTORY PHYSICS II	2
2	PHY 182	GENERAL LABORATORY PHYSICS II	1
3	PHY 202	GENERAL PHYSICS II	2
4	PHY 282	EXPERIMENTAL PHYSICS II	I

8.2 Course Description

FIRST SEMESTER

PHY 101 Introductory Physics I (2 UNITS)

Mechanics: Space and Time, Units and dimensions; Fundamental Laws of Mechanics, Statics and Dynamics; Work, Energy and Power; Conservation Laws; Elastic Properties of Matter (*Hook's Law, Young's, Shear and Bulk Moduli*); Hydrostatics (*Pressure; Buoyancy, Archimedes' Principles. Surface Tension; Adhesion, Capillarity, Drops and Bubbles*); Linear Momentum and Collisions; Static Equilibrium

Thermal Physics: Temperature and States of Matter; Thermometry; Heat and Internal Energy (*Units of Heat, The Mechanical Equivalent of Heat*); Thermal Expansion of Solids and Liquids; Specific Heat and Calorimetry; Latent Heat, Heat Transfer Mechanisms); Gas Laws of Thermodynamics; Kinetic Theory of Gases.

Waves: Propagation of a Disturbance, Sinusoidal Waves, Waves on Strings; Reflection and Transmission of Waves; Rate of Energy Transfer by Sinusoidal Waves on Strings; Speed, Periodicity, and Intensity of Sound Waves; Sound Levels (in Decibels), Loudness and Frequency; Waves in a Vibrating Air Column; Beats; The Nature of Light (*Waves and Particles*); The Ray Approximation of Light; Reflection, and Refraction; Dispersion and Prisms; Total Internal Reflection (*Fibre Optics*); Images Formation by Mirrors and Lenses; The Eye (Conditions of the Eye); Polarization of Light; Applications.

PHY 181 General Laboratory Physics I (1 UNIT)

Same as for the B.Sc. (Physics) Programme.

PHY 201 General Physics I (2 UNITS)

Mechanics: Gravitation, Kepler's Laws, Inverse Square Law Motion, Circular Orbits, Motion of Rockets and Satellites, Variation of Acceleration due to Gravity, Circular Motion, Angular Velocity, Moment of Inertia, Couples, etc.

Heat Properties of Matter: Properties of Solids -Hook's Law, Elastic Moduli; Properties of Fluids – Fluid Pressure, Bernoulli's Principle, Floating Bodies, Viscosity; Second Law of Thermodynamics, Cyclic Processes, Adiabatic Changes, Thermodynamic Equilibrium, Phase Changes.

Waves: Vibrations, Wave Motion, Resonance, Group and Phase Velocities, Doppler Effect, Black Body Radiation, Simple Optical Instruments, Interference, Young' Fringes, Diffraction.

PHY 281 Experimental Physics I (1 UNIT)
Same as for the B.Sc. (Physics) Programme.

PHY 291 General Physics III (2 UNIT)
Analytical Mechanics: Dynamics of Rigid Bodies, Rotation about a Fixed Point and a Fixed Axis.
Waves: Wave Equation in One Dimension and its Solution, Polarization Phenomenon, Optical Activities, Polarimeters.
Quantum Theory: Wave-Particle Duality, Uncertainty Principle, Wave Packets, Schrodinger Wave Equation.
Solid State Physics: Crystal Structure, Symmetry Operations, Crystal Diffraction, Conductors, Insulators, Semiconductors.

SECOND SEMESTER

PHY 102 Introductory Physics II (2 UNITS)
Electricity: Electrostatics (Electric Charges and Coulomb's Law, Electric Forces and Fields, Gauss's Law, Electric Potential, Capacitance and Dielectrics); Current and Resistance; Direct Current Circuits; Power and Energy.
Magnetism: Magnetic Fields and Forces; Electrical Meters (*Galvanometer, Ammeter, Voltmeter*); Sources of the Magnetic Field; Faraday's Law (*Faraday's Law of Induction, Some Applications of Faraday's Law*); Lenz's Law; Generators and Motors; Eddy Currents; Maxwell's Equations; Electromagnetic Oscillations and Waves; Inductance; Oscillations in an LC Circuit; The RLC Circuit**;**
Modern Physics: Relativity (*The Principle of Galilean Relativity, the Special Theory and the General Theory of Relativity*); Atomic Structure (Early and Modern Models, Size, X-rays, Cathode Rays); Elements of Quantum Theory; The Atomic Nucleus (*Static Properties - Composition and Size, Nuclear Force*, and *Binding Energy*: *Radioactivity, Nuclear Reactions, Nuclear Fission and Fusion, Radiation Detection*).

PHY 182 General Laboratory Physics II (1 UNIT)
Same as for the B.Sc. (Physics) Programme.

PHY 202 General Physics II (2 UNITS)
Electricity and Electronics: Electron Motion in Fields, Oscilloscope, Semiconductors, Vacuum Tubes and Integrated Circuits, Rectifiers, Simple Functional Circuits, Impedance Matching, Power Transfer.
Modern Physics: Electron Emission Process, Atomic Models, Quantum Numbers, Pauli's Exclusion Principle and Multi-Electron Atoms, Characteristic X-rays, Description of Alpha, Beta and Gamma Emissions.

PHY 282 EXPERIMENTAL PHYSICS II (1 UNIT)
Same as for the B.Sc. (Physics) Programme.