UNIVERSITY OF LAGOS
FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS
INFORMATION HANDBOOK
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UNIVERSITY OF LAGOS, NIGERIA

CONTENTS

OUR VISION

The Vision of the Department of Physics, University of Lagos, is to become one of the greatest centres for the study of Physics worldwide; to be named among the very best.

OUR MISSION

The Mission of the Department of Physics is to train the manpower for the dissemination of the knowledge of the subject of Physics at both the secondary and tertiary level through the well trained graduates of the Department, as well as provide highly skilled manpower for the industry, both locally and in all other parts of the world. In addition we provide graduates that can compete favourably with any other set of Physics graduates in the world of scientific research.

CORE VALUES

The Department of Physics is a world-class academic department with the following ethical values:

- Display highest levels of competence and professionalism in academic and research with integrity and respect.
- Sensitivity to staff and student welfare.
- Advancement of indigenous knowledge and technologies that will inspire innovative solutions to the society's challenges.
- Provide access to our programmes and services for all those who wish to pursue their aspirations in basic and applied physics.

THE UNIVERSITY OF LAGOS

The University of Lagos (popularly known as UNILAG) is a Federal Government University with the main campus located at Akoka, Yaba, and a College of Medicine at Idi-Araba, Lagos State, in southwestern Nigeria.

The University was founded in 1962 by an Act of the Federal Parliament in 1962. The main campus is largely surrounded by the scenic view of the Lagos Lagoon, located on 802 acres ($3.25km^2$) of land in Akoka, northeastern Yaba, Lagos State. The University is made up of nine Faculties which offer undergraduate programmes in Arts, Social Sciences, Science, Environmental Science, Pharmacy, Law, Engineering, Business Administration, Education, and Medicine.

There are also Masters and Doctoral Degree programmes in most of the Faculty Programmes. There are two centres in the University, namely the centre for Human Rights and the centre for African, Regional Integration and Border land studies. The Distance Learning Institute (DLI) of the University offers Diploma and Degree programmes in Accounting, Business Administration, Science Education and Library Information Sciences.

The development of the University was planned to take place in three phases. The first phase began in October 1962 with the establishment of the Faculty of Business and Social Studies, the Faculty of Law, and Medical School which was conceived at the outset as an autonomous unit of the University linked with a Teaching Hospital (LUTH). The second phase began in October 1964 with the establishment of the Faculty of Engineering, the School of African and Asian Studies, Humanities, Biological Sciences, Mathematical and Physical sciences, College of Education, Continuing Education Centre (CEC), the Institute of Mass Communication and the Comparative Education Study and Adaptation Centre (CESAC). The third phase of the University development was interrupted by a crisis in 1965 followed by the national crisis (civil war) of 1967- 1970. In April 1967, the Medical School officially became the College of Medicine while the Faculty of Business and Social Studies was divided into the school of Administration and the School of Social Studies.

By October 1971, the University comprised two faculties, namely, Engineering and Law, several schools, including Environmental Design, two Colleges, namely, Medicine and Education, three Institutes, including Computer Sciences and Child Health, and two centers, CEC and CESAC. In an attempt to maximize the utilization of available manpower and further encourage interdisciplinary cooperation, teaching units of the University were restructured between 1972 and 1975. By 1976, new faculties emerged from the existing school in addition to Faculties of Engineering and Law which were not affected by the general structural change. The Faculties are: Arts, Business Administration, Environmental Design, Science and Social Sciences. The College of Education became the Faculty of Education while the College of Medicine retained its name and autonomy.

The first Vice Chancellor of the University was Prof. Eni Njoku, who was at the helm of affairs between 1962 and 1965. The second Vice- Chancellor was Professor Saburi Biobaku between 1965 and 1971. The first convocation of the university was done in 1968. Professor Ade Ajayi was the third Vice-Chancellor between 1972 and 1978, while the fourth Vice-Chancellor was Professor Kwaku Adadevoh. Professor Akin Adesola, the fifth Vice-Chancellor, completed the Senate House Complex in 1984 and built the second Access Road, 2001 Hostel, etc. The incumbent Vice-Chancellor of the University is Professor Oluwatoyin T. Ogundipe.

THE MISSION & VISION OF THE UNIVERSITY OF LAGOS

Mission - To provide a conducive teaching, learning, research and Development where staff and students will interact and Compete effectively with counterparts both in International terms of intellectual competence and zeal to add to our world.

Vision - To be a top class institution for the pursuit of excellence in knowledge through learning and research as well as in character and service to humanity

The slogan of the UNIVERSITY OF LAGOS is: “The University of First Choice and Nation’s Pride.”

PRINCIPAL OFFICERS OF THE UNIVERSITY

Visitor
His Excellency
Muhammadu Buhari, GCFR
President of the Federal Republic of Nigeria

Chancellor
His Royal Eminence Alhaji (Dr.)
Abubakar Ibn Umar Garba El-Kanemi, CFR

Pro-Chancellor and Chairman of Governing Council
Dr. Wale Babalakin, SAN, OFR

Vice-Chancellor
Professor Oluwatoyin T. Ogundipe
B.Sc. MSc. Ph.D (Ife), M.B.A (Lagos), FLS (Lon.), FAS

Deputy Vice-Chancellor (Management Services)
Professor Ben E.A. Oghojafor
B.Sc. MSc. Ph.D (Lagos), FAMN, FNIM, FNIMN, FCIA

Deputy Vice- Chancellor (Development services
Professor Folashade T. Ogunsola
MBChB (Ife), MSc. (Lagos), Ph.D (Cardiff), FMCPath, FWACP, FAS

Deputy Vice-Chancellor (Academic & Research)
Professor Oluwole B. Familoni
B.Sc., M.Phil, Ph.D. (Lagos), C.Chem FRSC, FCSN, FICCON, MIPAN

Registrar & Secretary to Council
Oladejo Azeez, Esq
B.Sc., M.Sc., LLB (Lagos), LLM (Wits), B.L, MNIM, MNIPR

Bursar
Mr. Lekan Lawal
B.Sc. (OOU), M.Sc. (Leeds, UK), FCS, FCIB, FCTI, FCA

University Librarian
Dr (Mrs) Yetunde Abosede Zaid
B.A, (Ogun State Univ.) MLS (Ibadan); Ph.D. (Ibadan), CLN

THE FACULTY OF SCIENCE

The Faculty of Science was established in October 1964. At inception, the Faculty consisted of two schools: the School of Biological Sciences and the School of Mathematical and Physical Sciences. In October 1967, the two schools became autonomous teaching units, each with its own Dean and Board of Studies but worked closely in running the B.Sc (Ed) programme. The two schools along with the Institute of Computer Science were finally merged together in October 1973 to give birth to the present Faculty of Science. From the beginning, the faculty organized its three-year degree programme by subjects. First year students took three subjects. Students in second year took two whilst third year students took one or two subjects.

In October 1974, senate approved a new degree programme structure based on course units. In 1982, the Faculty of science started an integrated four - year degree programme for the award of a Bachelor (Hons) degree in a single science subject. This structure was considered necessary to have a broad-based programme which exposes every student to as many subjects as possible. The distribution and concentration requirements for the Bachelor's degree are well spelt out in the regulations. For the award of a B.Sc (Hons.) degree, a minimum number of units of courses from 100 level to 400 or 500 level must be passed. Details of selection of courses are given in the Faculty regulations as well as in the guidelines for an Honours degree in a particular subject. A major advantage of this new degree system is its inherent flexibility because students make progress at their own pace as the university does not engage in the old degree system whereby a student will pass and move to the higher class or fail and repeat the whole year. In this new system, once a student has satisfied a minimum pass level to remain in the University, he or she can still remain as a full time student with some compulsory or elective courses that must be repeated in the following session. The maximum number of courses that can be repeated or taken again by a student per semester or session are also specified.

Other features of the new degree programme are the introduction of Faculty courses (FSC courses) which are compulsory courses to be passed by a student before the end of the degree programme. The importance of these faculty courses is to ensure that every student in the Faculty of Science or other students from other faculties have a minimum exposure to some basic science courses.

The final award of the B.Sc degree in the Faculty of Science is based on the assessment of all courses taken from 100 level to 400 level or 500 level together with a compulsory continuous assessment. There are eleven Departments in the Faculty of Science, namely Chemistry, Physics, Zoology, Marine Science, Mathematics, Computer Sciences, Biochemistry, Botany, Microbiology, Cell Biology and Genetics, and Geosciences.

The Dean is the academic and administrative head of the faculty and he is being assisted by the sub-Dean who is an academic staff. The Dean and the sub-Dean are being assisted by the faculty Officer who is a non academic staff in the everyday administration of the Faculty. Another principal officer of the faculty is the Faculty Examination Officer who is also an academic staff that organizes and arranges for all Faculty examinations. Other staffs in the Dean's Office are the Assistant Registrar and the Confidential Secretary.

AIMS AND OBJECTIVES OF THE FACULTY

The aims and objectives of the Faculty on all academic and professional programmes are:

(1) To provide its students an intellectual environment favourable to the study of science.
(ii) To help students become scientifically informed and responsible members of society.
(iii) To produce graduates who are proficient in the various branches of science.
(iv) To cooperate with the Faculty of Education in training teachers.
(v) To produce graduates who will become well equipped to translate scientific knowledge into technology.
(vi) To prepare students for post-graduate work or study in the field of science and related applied fields.

AVAILABLE UNDERGRADUATE PROGRAMMES IN THE FACULTY

Admission to any B.Sc degree programme in the faculty could be through:

(i) H.S.C. or G.C.E A - Level or Diploma (UNILAG) or equivalent for a three-year B.Sc. programme
(ii) WAEC, NECO or G.C.E O' Level or equivalent for students who have successfully passed the Unified Tertiary Matriculation Examination (UTME) on a four-year B.Sc programme.
(iii) Admission through any programme in (i) & (ii) above could lead to the award of:
  (a) Bachelor of Science in Biochemistry
  (b) Bachelor of Science in Botany
  (c) Bachelor of Science in Applied Botany (Environmental Botany and Palynology)
  (d) Bachelor of Science in Applied Botany (Ethnobotany)
  (e) Bachelor of Science in Applied Botany (Horticulture)
  (f) Bachelor of Science in Cell Biology and Genetics
  (g) Bachelor of Science in Chemistry
  (h) Bachelor of Science in Industrial Chemistry
  (i) Bachelor of Science in Computer Science
  (j) Bachelor of Science in Fisheries
  (k) Bachelor of Science in Geology
  (l) Bachelor of Science in Geophysics
  (m) Bachelor of Science in Mathematics
  (n) Bachelor of Science in Mathematics/Statistics
  (o) Bachelor of Science in Industrial Mathematics (Applied and Computational Mathematics)
  (p) Bachelor of Science in Industrial Mathematics (Mathematics and Computer Science)
  (q) Bachelor of Science in Industrial Mathematics (Mathematics and Economics)
  (r) Bachelor of Science in Industrial Mathematics (Mathematics and actuarial Science)
  (s) Bachelor of Science in Marine Biology
  (t) Bachelor of Science in Microbiology
  (u) Bachelor of Science in Physics
  (v) Bachelor of Science in Applied Physics (Electronics)
  (w) Bachelor of Science in Applied Physics (Energy Physics)
  (x) Bachelor of Science in Zoology
  (y) Bachelor of Science in Statistics

DEPARTMENT OF PHYSICS

HISTORICAL BACKGROUND

The Department of Physics is one of the foundation departments in the School of Mathematical and Physical Sciences that was established in October 1964. It was one of the two schools in the then Faculty of Science. The pioneering head of department was Professor O. Awe. Other pioneering members of staff include, Dr. A. Mohan, Professor E.O. Olatunji, Professor J.E.A. Osemeikhian, who were later Heads of Department after the tenure of Professor Awe. The Department produced the B.Sc. Honours Degree in Physics at inception in 1966. The Senate approved a new degree structure based on course units in 1974, and in 1978 the Department started a four-year program in Applied Physics with Options in Electronics, and Geophysics. B.Sc. Applied Physics (Geophysics option) was moved to Department of Geosciences in 2009. The Senate approved a new B.Sc. degree in Applied Physics (Energy Physics Option) in 2016.

The Department currently offers courses in the following areas:

B.Sc (Honours) Pure Physics
B.Sc (Honours) Applied Physics (Electronics)
B.Sc (Honours) Applied Physics (Energy Physics)

AIMS AND OBJECTIVES OF THE DEGREE PROGRAM

The aim of the degree program is to produce highly competent graduates who are versatile in all the basic and applied areas of Physics with high innovations and creative skills to be self-employed. The Physics programme will expose students to a well-structured training that meets the manpower needs in various fields including the industries, the energy sector, communication companies, engineering and the sciences.

BACHELOR OF SCIENCE DEGREE IN PHYSICS AND APPLIED PHYSICS PROGRAMME [B.Sc. (HONS) PHYSICS, B.Sc. (HONS) APPLIED PHYSICS (ELECTRONICS) & B.Sc. (HONS) APPLIED PHYSICS (ENERGY PHYSICS)]

The Programme Philosophy and Objectives

Philosophy

The overall philosophy of degree programmes in the Faculty of Science is to produce graduates with fully integrated science knowledge so that they can have a sound background required to fully understand the theoretical base of the faculty programmes.
Physics as a basic science is the foundation of all industrial technology. The degree programmes are designed to inculcate broad-based knowledge in basic and applied physics leading to a variety of careers in the public and private sectors and advanced study and research so that graduates will have self-fulfillment, professional advancement and a significant and meaningful contribution to the national economy of the country.

Physics is the fundamental science on which all technologies and innovations rest. Since modern industry is driven by technology, which itself is ever growing, the role of physics in the training and development of relevant manpower for the Nigerian industry cannot be over emphasized. The development of technical manpower for today's industry requires, not only the ability to make use of tools but also a proper understanding of the fundamental processes. Only this can guarantee a technical workforce that is capable of rising above routine to confront the challenges of improvement via innovation.

Objectives

The objective of this programme are to:

(i) provide balanced training in the fields of basic Physics, which are considered most relevant to human and material development in contemporary Nigeria, and

(ii) produce appropriate manpower for the economic development of the Nation.

Admission Requirements:

There are two modes of entry into the B.Sc. (Hons) Physics, B.Sc. (Hons) Applied Physics (Electronics) and B.Sc. (Hons) Applied Physics (Energy Physics) viz: University Matriculation Examination (UME), and Direct Entry. Each mode has its own entry requirements.

i) *University Tertiary Matriculation Examinations (UTME) Admission*

Holders of SSCE or equivalent with Five 'O' level Credit passes in English, Mathematics, Physics, Chemistry and Further Mathematics will enter the programme at 100 level. University Matriculation Examination (UME) subjects are: English, Physics, Chemistry and Mathematics. Candidates that enter the programme through this mode will spend a minimum of 4 years.

ii) *DIRECT ENTRY Mode of Entry*

Holders of Foundation Diploma in Physics of this University with a GPA of not less than 2.50 will enter the programme at 200 Level. Holders of GCE or Cambridge A' level certificates with pass in at least Mathematics and Physics will also enter the programme at 200 level. Anybody coming into the Department through Direct Entry must have basic qualification consisting of Mathematics, Further Mathematics, English, Physics and Chemistry.

LIST OF STAFF IN PHYSICS DEPARTMENT

ACADEMIC STAFF

S/NO	NAME OF STAFF	RANK	QUALIFICATION	AREA OF SPECIALIZATION
1.	Adeloye, A.B.	Professor	B.Sc. (Hons) M.Sc.Ph.D. (Ibadan)	Theoretical Physics
2.	Njah, A.N.	Professor	B.Sc. (Hons) (Jos), M.Sc., Ph.D. (Ibadan) PGD (Comp. Sc.) Abeokuta	Theoretical Physics
3.	Oyeyemi, E.O.	Professor & Head	B.Sc. (Hons) (Ilorin) M.Sc. (Lagos), PGD (Comp. Sc.) (Lagos) Ph. D. (Rhodes)	Ionospheric Physics & Radio Wave Propagation
4.	Olusola, O.I.	Assoc. Professor	B.Sc. (Hons) Ilorin M.Sc. (Lagos) Ph.D. Abeokuta	Theoretical Physics
5.	Ozebo, V.C.	Assoc. Professor	B.Sc. (Hons), (Lagos) M.Sc. Ph.D. (Ibadan)	Solid Earth Physics
6.	Akala, A.O.	Assoc. Professor	B.Tech. (Hons) (FUTA) M.Sc. Ph.D. (Lagos)	Ionospheric Physics & Radio Wave Propagation
7.	Oyebola,O.O.	Senior Lecturer	B.Sc. (Hons) M.Sc. (Lagos) M.Sc. (Central Michigan), Ph.D. (Hampton)	Solid State Physics/Optical Spectroscopy, Electronics
8.	Bolaji, O.S.	Senior Lecturer	B. Tech. (Hons), M.Tech. (FUTA), Ph.D. Ilorin	Ionospheric Physics & Radio Wave Propagation
9.	Olopade, M.A.	Senior Lecturer	B.Sc. (Hons) Physics, M.Sc. Ph.D. (Ibadan)	Solid State Physics
10.	Olatinsu, O.B.	Senior Lecturer	B.Sc. (Hons) M.Sc., Ph.D. (Lagos)	Geophysics
11.	Erusafe, N.E.	Senior Lecturer	B.Sc. (Hons) M.Sc., Ph.D. (Lagos)	Solar Energy Physics
13.	Oduah, U.I.	Senior Lecturer	B.Sc. Sc. Tech, M.Sc., Ph.D.(Unizik)	Physics Electronics
14.	Ogungbemi, K.I.	Lecturer I	B.Sc. (Hons) (Ilorin) M.Sc. (Lagos), Ph. D. (Washington DC)	Radiation Health Physics
15.	Ojo, K.S.	Lecturer I	B.Sc. (Hons), M.Sc., Ph.D. (Abeokuta)	Theoretical Physics
16.	Obot, N.I.	Lecturer I	B.Sc. (Hons) (Calabar), M.Sc. Ph.D. (Lagos)	Solar Energy Physics
17.	Odeyemi, O.O.	Lecturer I	B.Sc. (Hons) (Abeokuta) M.Sc., Ph.D. (Ilorin)	Ionospheric Physics & Radio Wave Propagation
18	Ojo, O. L.	Lecturer I	B.Sc. (Hons) (Akure), M.Sc. (Ibadan), Ph.D. (Akure)	Communication and Lower atmospheric Physics
17.	Olugbon, B. (Ms.)	Lecturer II	B.Sc. (Hons) (O.A.U), M.Sc. Ph.D. (Lagos).	Ionospheric Physics & Radio Wave Propagation
19.	Humphrey, I.	Lecturer II	B.Sc. (Hons) (Akure) M.Sc., Ph.D. (Lagos)	Solar Energy Physics
20.	Adedokun, M.B. (Mrs.)	Lecturer II	B.Sc. (Hons) (Jos) M.Sc. (Ibadan), Ph. D (Lagos)	Radiation/Health Physics (Applied Nuclear Physics)
21.	Ilori, O.G.	Assistant Lecturer	B.Sc. (Hons), M.Sc. (Lagos)	Solar Energy Physics
22.	Adedeji, M.A.	Assistant Lecturer	B.Sc. (Hons), (Lagos), M.Sc. (London)	Solid State Physics
23.	Adeniyi, O.A	Assistant Lecturer	B.Sc. (Hons) (Lagos) M.Sc.	
24.	Chukwubueze, I.U. (Miss)	Assistant Lecturer	B.Sc. (Hons), M.Sc. (Lagos)	Ionospheric Physics & Radio Wave Propagation
25.	Aina, K.A.	Assistant Lecturer	B.Sc. (Hons) (Lagos)	
26.	Folarin. S.T.	Assistant Lecturer	B.Sc. (Hons) (Lagos)	

TECHNICAL STAFF

S/NO	NAME OF STAFF	DESIGNATION	QUALIFICATION
1	Mr. J.A. Ashaolu	Chief Technologist	Fin. Dip. Physics/Elect (Lagos), Dip. In Comp.
2	Mr. M.O. Omotayo	Chief Technologist	HND, PGD.
3	Mr. A.S. Babatunde	Assistant Chief Technologist	HND (Bida)
4	Mr. A.O. Oluwatade	Assistant Chief Technologist	Final Diploma (Unilag)
5	Mr. I.A. Raheem	Principal Technical Officer	NCE (Tech)(Akoka), B.Ed.) (Nsukka), M.Ed. Ilorin
6	Mr. A.M. Owoseni	Principal Technical Officer	OND (Mech. Engr.) (Yaba Tech)
7	Mrs. M.S. Omoniyi	Senior Technologist	B. Tech. (Akure)
8	Mr. K.M. Adekunle	Senior Technologist	B. Tech. (Akure)
9	Mr. S.O. Olawale	Senior Technologist	B. Tech. (LAUTECH))
10	Mr. H.E. Yusuf	Senior Technologist	B.Sc. (Abeokuta)
11	Mr. O.Atanda	Technologist I	OND, HND (Kwara Poly)
12	Mr. E.A. Babalola	Lab. Superintendent	OND (LASPOTECH)
13	Mr. O.D. Ademiju	Higher Technical Officer	OND (Yabatech)
14	Mr A.A. Ademoye	Senior Lab. Supervisor	WASC. (Lab Tech)
15	Ms. O.I. Emmanuel	Lab. Assistant I	WASC
16	Mr. T.B. Ibitoye	Lab. Attendant I	SSCE

ADMINISTRATIVE STAFF

S/NO	NAME OF STAFF	DESIGNATION	QUALIFICATION
1	Mrs. Oni, T. E.	Personal Assistant to the H.O.D.	B.Sc. (Lagos),
2	Mrs. C.A. Abaleke	Principal Data Processing Officer	B.A. Ed. (French) (Unilag)
3	Mrs. O.O. Quadri	Admin Assistant II	B.Sc. (Hons) Lagos.
4	Mrs. Olawoyin, S.A.	Administrative Assistant II	SSCE
5	Mr. A.O. Enemari	Driver	SSCE

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Selected Publications:

Adewale, A.O., Oyeyemi, E.O., **Adeloye, A.B**., Ngwira, C.M., Athieno, (2011). Responses of equatorial F-region to different geomagnetic storms observed by GPS in the African sector. *J. Geophys. Res*., **116**, A12319, doi:10.1029/2011JA016998.

Adewale, A.O., Oyeyemi, E.O., **Adeloye, A.B**., Mitchell, C.N., Julian, R., Cilliers, P. (2012). A study of L-band scintillations and total electron content at Lagos, Nigeria. *Radio Science*, **47**, RS2011, doi:10.1029/2011RS004846.

AKALA A. O**.**, A. B. RABIU, E. O. SOMOYE, E. O. OYEYEMI, AND **A. B. ADELOYE** (2013). The Response of African equatorial GPS-TEC to intense geomagnetic storms during the ascending phase of solar cycle 24, *J.Atmos. Solar-Terrestr. Phys.*, doi/10.1016/j.jastp.2013.02.006, **98**, 50 – 62.

Oyeyemi, E.O., Adewale, A.O., **Adeloye, A.B**., Akala, A.O. Comparison between IRI-2001 predictions and observed measurements of hmF2 over three high latitude stations during different solar activity periods. *J. Atmos. Sol. Terr. Phys*. **72**, 676-684, 2010.

Adewale, A O, E O Oyeyemi, J O Adeniyi, **A B Adeloye**, O A Oladipo. Comparison of total electron content predicted using the IRI-2007 model with GPS observations over Lagos, Nigeria. *Indian Journal of Radio and Space Physics*, Vol 40, 21-25, 2011.

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Research Interests: Theoretical Physics (Nonlinear Dynamics and Chaos)
Professional Associations: NAMP, NIP, CPS, AIP

Selected Publications:

Vincent U. E., Kenfack A., **Njah A. N.** and Akinlade O. (2006): Bifurcation and chaos in coupled ratchets exhibiting synchronized dynamics. ***Physical Review E***. **72**; 056213, Published by American Physical Society (APS). Availlable online at http://pre.aps.org/abstract/PRE/v72/i5/e056213 DOI: 10.1103/PhysRevE.72.056213

Njah A. N. and Sunday O. D. (2009): Generalization on the chaos control of 4-D chaotic systems using recursive backstepping nonlinear controller. ***Chaos, Solitons and Fractals***. **41**; 2371-2376, Published by Elsevier - Science Direct. Available online at www.elsevier.com/locate/chaos doi:10.1016/j.chaos.2008.09.008

Njah A. N. (2009): Synchronization via active control of identical and nonidentical Φ6 chaotic oscillators with external excitation. ***Journal of Sound and Vibration*** 322-332, Published by Elsevier - Science Direct. Available online at www.elsevier.com/locate/jsvi doi:10.1016/j.jsv.2009.07.015

Njah A. N., Ojo K. S., Adebayo G. A. and Obawole A. O. (2010): Generalized control and synchronization of chaos in RCL-shunted Josephson junction using backstepping design. ***Physica C***. **470**; 558-564, Published by Elsevier – Science Direct. Available online at www.elsevier.com/locate/physc doi:10.1016/j.physc.2010.05.009

Vincent U. E., **Njah A. N.** and Laoye J. A. (2007): Controlling chaos and deterministic directed transport in inertia ratchets using backstepping control. ***Physica D***. **231**; 130-136. Published by Elsevier - Science Direct. Available online at www.elsevier.com/locate/physd doi:10.1016/j.physd.2007.04.003

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Professional Associations: International Reference Ionosphere (IRI); Nigerian Institute of Physics (NIP), American Geophysical Union (AGU), Committee on Space Research (COSPAR)

Selected Recent Publications:

Bolaji, O. S., **Oyeyemi, E. O**., Owolabi, O. P., Yamazaki, Y., Rabiu, A. B., Okoh, D., Fujimoto, A., Amory-Mazaudier, C., Seemala, G. K., Yoshikawa, A., and Onanuga, O. K., (2016). Solar quiet current response in the African sector due to a 2009 sudden Stratospheric warming event, *J. Geophys. Res. Space Physics*, 121, doi:10.1002/2016JA022857

Bolaji O.S., **E.O. Oyeyemi**, A.O. Adewale, Q. Wu, D. Okoh, P.H. Doherty, R.O. Kaka, M. Abbas, C. Owolabi, P.A. Jidele (2017), Assessment of IRI-2012, NeQuick-2 and IRI-Plas 2015 models with observed equatorial ionization anomaly in Africa during 2009 sudden stratospheric warming event, *J. Atmos. Sol. Terr. Phys., 164, 203-214.*

Amaechi, P. O., **E. O. Oyeyemi**, A. O. Akala (2018), Geomagnetic storm effects on the occurrences of ionospheric irregularities over the African equatorial/low-latitude region, *Adv. Space Res., 61, 2074 – 2090.*

Nsikan I.Obot, Michael A.C.Chendo, **Elijah O.Oyeyemi** (2018), Downward longwave radiation categories in Nigeria, *Dynamics of Atmospheres and Oceans*, Volume 83, Pages 122-134

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Akala A.O, **E.O Oyeyemi**, O.A Arowolo, P.H Doherty(2019), Characterization of GPS and EGNOS amplitude scintillations over the African equatorial/low-latitude region, *Adv. Space Res.*, 63, (9), 3062-3075.

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Research Interests: Computational/Theoretical Physics
Professional Associations: Nigerian Institute of Physics, American Institute of Physics
Selected Publications:

Olusola, I. O., Njah, A. N., Vincent, U. E. and Ahmed, A, (2011).: Chaos Control and Synchronization in Generalized Lorenz Systems with fully Uncertain Parameters, J. Nig. Assoc. of Mathematical Physics **19**: 7 – 14.

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C. R. Hens, **Olasunkanmi I. Olusola**, Pinaki Pal, and Syamal K. Dana, (2013). Oscillation death in diffusively coupled oscillators by local repulsive link. PHYSICAL REVIEW E **88**, 034902.

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Selected Publications:

1. Ozebo, V.C., Ikuemonisan, F,E, (2019) Evaluation of Allowable Bearing Capacity of Ayila Soil, South-West Nigeria. *JASEM* **23**(4) 624 – 625

2. S.A. Ojo, O.B. Olatinsu, V.C. Ozebo (2018) Rock type based Poroperm and Continuous Predictions in a Tight Gas Formation. *Ife Journal of Sciences* 20(1): 15-31
3. S.A. Ojo, V.C Ozebo, I.O. Olusola, O.B. Olatinsu (2018): Continuous Permeability Predictions in Heterogeneous Reservoirs using Vshale and microstructure calibrated free-fluid models (a combined study of Niger Delta field and the Tight Gas sandstone of the southern North Sea). *Arabian Journal of Geosciences* 11 (17): 527 1 -13.
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5. **Ozebo, V.C**., Ogunsanwo, F.O., Adebayo, G.A. and Adeniran, O.J (2013): Analysis and Interpretation of the Ibuji Spring Magnetic Anomaly Using the Mellin Transform. ***Central European Journal of Geosciences*** 5(1) 2013 43-52
DOI: 102478/313533-012-0116-9 http://rd.springer,com/journal/13533/1/page/1

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Selected Publications:

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SELECTED PUBLICATIONS:

O. O. Oyebola, and A. Sieradzan. Characterization of Dendrimers for Photonic Applications. *Journal of Sci. Res. Dev*. 2013. **14**: 106 – 111.

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1. Charles Owolabi, Jiuhou Lei, **O.S. Bolaji,** OluwaseyiJimoh, HaibingRuan, Na Li, XiaojuanNiu and Akimasa Yoshikawa **(2019)** Investigation on the variability of the geomagnetic daily current during sudden stratospheric warmings, J. Geophys. Res., doi: 10.1029/2019JA026667.

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Olopade M.A and Sanusi Y.K.(2008) "Solar Radiation Characteristics and Performance of Photovoltaic Modules in a Tropical Station," Journal Sci. Res.Dev.,2008/2009, vol.11,100-109.

Adewale A.O., **Olopade M.A**., Oyeyemi E.O., and Alege G.O" Diurnal and Seasonal Variations of Radio Refractivity over Akure, Nigeria" , International Journal of Physical Sciences, 4(2), 80-88, 2009.

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M.A. Olopade, O.O. Oyebola, B.S. Adeleke **, "**Investigation of some materials as buffer layer in copper zinc tin sulphide (Cu_2ZnSnS_4) solar cells by SCAPS-1D", Advances in Applied Science Research, 2012, 3 (6): 3396-3400.

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Selected Publications:

(1) **Olatinsu, O.B.**, Oyedele, K.F., and Ige-Adeyeye, A. A. (2019). Electrical resistivity mapping as a tool for post-reclamation assessment of subsurface condition at a sand-filled site in Lagos, southwest Nigeria. *SN Applied Sciences*, 1:24. https://doi.org/10.1007/s42452-018-0028-5.

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(4) **Olatinsu, O.B**., Olorode, D.O., Josh, M., Clennell, B., and Esteban, L. (2017). Frequency-dependent electrical characterization of rock types from Ewekoro, Eastern Dahomey Basin, Nigeria. *Current Science*, 113(2), 253-263. DOI:10.18520/cs/v113/i02/253-263.

(5) **Olatinsu, O.B**., Olorode, D.O., Clennell, B., Esteban, L. and Josh, M. (2017). Lithotype characterizations by Nuclear Magnetic Resonance (NMR): A case study on limestone and associated rocks from the eastern Dahomey Basin, Nigeria. *Journal of African Earth Sciences*, 129, 701-712. https://doi.org/10.1016/j.jafrearsci.2017.02.005.

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Selected Publications

1. Nald E. Erusiafe, Michael A. C. Chendo (2016) C**orrelation of daily sunshine fraction with global solar radiation***International Renewable Energy Conference (IRECON2016). Godfrey Okoye University, Enugu. August 2016.*

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Selected Publications:

1. Oduah, U.I. and Wu, Y., 2016. Advanced Photodetector Chip. *IEEE Sensors Journal*, *16*(14), pp.5610-5617.
2. Oduah, U.I. and Yang, W., 2017. Effective Control of Auger Recombination in Silicon Solar Cell. *Electroscope Journal*, *9*(9), pp.35-44.
3. Oduah, U. and Yang, W., 2017. A Bioelectronic PIN Diode Chip for Improved Efficiency Using Magnetosomes of Magnetotactic Bacteria. *Electroscope Journal*, *8*(8), pp.1-7.
4. Oduah U.I., Dairo O.S. and Onokpite G.W., 2017. An Improved Light-Source for a Neonate Heliotherapy Device. *FUW Trends in Science and Technology Journal.*1A(l.2). pp. 290-294. (www.ftstjournal.com).
5. Oduah U.I., Onukpite G.W., and Dairo O.S., 2017. Development of an improved vehicle speed tracking device. *FUW Trends in Science and Technology Journal*. 2(18) pp. 350-354. (www.ftstjournal.com).

REGISTERED SCIENTIFIC PATENTS IN NIGERIA (DR. ODUAH, UZOMA IFEANYI – LEAD INVENTOR)

* February 2018, Vehicular Road Advanced Electronic Flood Level Caution Device (RP: NG/P/2018/14).
* June 2019, Road Vehicle Blackbox Surveillance Security Device (RP: NG/P/2019/101).
* June 2019, New Product Unveiler (RP: NG/P/2019/102).
* June 2019, Solar Powered Neonate Phototherapy Device Station (RP: NG/P/2019/99).

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Selected Publications:

"Effect of Varying Discharge Current on Optogalvanic Waveforms Associated with the Neon Transition at 640.2 nm," **Kayode I. Ogungbemi** and P. Misra. Proceeding of the NSBP:35th Annual Day of Scientific lectures and 31st Annual meeting, 2008 Joint Annual Conference of the NSBP and NSHP;AIP Conference proceedings Vol.1140;pp168 -177 (2009)

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2. **K. S. Ojo**, A. B. Adeloye, A. O. Busari. Switching Tracking Control and Synchronization of Four-Scroll Hyperchaotic Systems.Journal of Applied Nonlinear Dynamics 7(4), 329-335 (2018)
3. AhlemGasria, Adel Ouannas, **Kayode S. Ojo**, Viet-Thanh Pham. Coexistence of generalized synchronization and inversegeneralized synchronization between chaotic andhyperchaotic systems. Nonlinear Analysis: Modelling and Control, Vol. 23, No. 4, 583–598, 2018
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1. **Obot N.I**. and Chendo M.A.C. (2010).Sizing of a Standalone Photovoltaic System Using Rules of Thump. Nigeria Journal of Solar Energy 20, 84-89.

2. **Obot N. I**.,Chendo M.A.C., Udo S. O., and Ewona I. O. (2010). Evaluation of rainfall trends in Nigeria for 30 years (1978-2007). International Journal of Physical Sciences Vol. 5(14), 2217 – 2222.

3. **Obot N.I**., Emberga T.T.Ishola K.S. (2011). 22 years characterized trends of rainfall in Abeokuta Nigeria. Research Journal of Applied Sciences. Vol.6, Issue 4, 264 – 271. Doi:3923/rjasci.2011.264.271

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O.L Ojo , M.O Ajewole , A.T Adediji , J.S Ojo **(2014)** " Microwave Anomalous propagation conditions in the first 100-m Altitude in a tropical Location*" Journal of Microwave Power and Electromagnetic Energy, 48 (2) Pp.131-137.*

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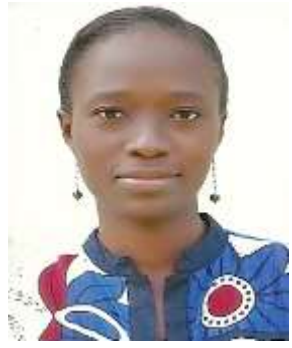

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Selected Publications:

Oyeyemi, E.O., Adewale, A.O**.**, Adeloye, A.B., **Olugbon, B**. (2013). An evaluation of the IRI-2007 storm time model at low latitude stations. *Advances in Space Research* **52**, 1737–1747.

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Selected Publications:

1. Potentials of Waste Vegetable Oil for Biodiesel in Nigeria Names of Journal: British Journal for Applied Science and Technology
   Authors: Humphrey, Ibifubara [1]*, Nsikan I. Obot[2], Michael A.C. Chendo[3]
   Date of publication: July 7th, 2014.

2. Comparative Studies on Some Edible Oils for Biodiesel Production in Nigeria
   Names of Journal: British Biotechnology Journal
   Authors: Humphrey, Ibifubara [1]*, Nsikan I. Obot[2], Michael A.C. Chendo[3]
   Date of publication: December 18th, 2014.

3. Prospects of non-edible oil for Biodiesel production in Nigeria
   Conference presentation: National Solar Energy Forum and Exhibition
   Organizers: Solar Energy Society of Nigeria (SESN)
   Reiz Continental Hotel, Abuja FCT, Nigeria. Date: 6th -7th May, 2015,

4. Utilization of Some Non-Edible Oil for Biodiesel Production
   Name of Journal: Nigeria Journal of Pure & Applied Physics, Vol. 6, No. 1, pages 40 – 45, 2015
   Authors: Humphrey, Ibifubara [1*], Nsikan I. Obot[2], Michael A.C. Chendo[3]

5. Effects of monochromatic light on the growth of Oedogonium species for production
   Name of Journal: Trends in Industrial Biotechnology Research (TIBR), Volume 2, Pages 1-10
   Authors: Humphrey, Ibifubara[1]*, Nsikan I. Obot[2], Michael A.C. Chendo[2], Abdulahi, N. Njah[3] and Lovinson M. Ogunliyi[5]. Date of publication: July, 2018.

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Selected Publications:

1. Ibitoye A.Z., Nwoye E.O., Saseyi A.O.,AdeneyeS.O.,Adedokun M.B.and Aweda M. A., (2019).Evaluation of Temperature Distributions During Microwave Ablation of Ex Vivo Bovine Liver Using Two Types of Antennas.Nigerian *Journal of Pure and Applied Sceince*.**32**(1), 3297-3306.
2. AdedokunM.B., Aweda M.A., Maleka, P.P., Obed R.I., Ogungbemi K.I. and ibitoyeA.Z.(2019). Natural Radioactivity Contents in Commonly Consumed Vegetables Cultivated through Surface Water Irrigation in Lagos State, Nigeria.*Journal of Radiation Research and Applied Sciences*, **12**(1), 147-156.
3. Adedokun M.B., Aweda M.A., OgungbemiK.I. and ibitoyeA.Z., 2018. Assessment of Naturally Occurring Radionuclides in Irrigation Water from Selected Vegetable Farms in Lagos. *Ife Journal of Science*,**20** (3), 607- 615.
4. A.O. Adewale, E.O. Oyeyemi, A.B. Adeloye, **M.B. Adedokun** (2013). Ionospheric effects of geomagnetic storms at Hobart and comparisons with IRI model predictions. *Journal of Sci. Res. Dev*. **14**: 98 – 105.

SIMPLY TITLES

1. Evaluation of Temperature Distributions During Microwave Ablation of Ex Vivo Bovine Liver Using Two Types of Antennas. Nigerian.
2. Natural Radioactivity Contents in Commonly Consumed Vegetables Cultivated through Surface Water Irrigation in Lagos State, Nigeria.
3. Assessment of Naturally Occurring Radionuclides in Irrigation Water from Selected Vegetable Farms in Lagos

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Selected Publications:

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Selected Publications: Nil

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Professional Associations:

Selected Publications:
Aina A. and Wallin S. (2017). "Multisequence algorithm for coarse-grained biomolecular simulations: Exploring the sequence-structure relationship of proteins", J. Chem. Phys. 147 (9), 095102-1-9 http://doi.org/10.1063/1.498693

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Selected Publications: Nil

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Selected Publication:
Oduah, U.I, & Folarin, S.T. (2019). "Development of a Handheld Scanner for Completion of Surgery in a Hospital Theater", *Nigeria Research Journal of Engineering and Environmental Sciences*, 4 (1).

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OFFICERS OF THE DEPARTMENT (2019/2020 Session)

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Chairman, Departmental Postgraduate Programmes Committee	Dr. O.I. Olusola
Coordinator, SIWES and Accreditation Committee	Dr. U.I. Oduah
Final Year (400 Level) Project Coordinator	Dr. V.C. Ozebo
Vice-Chairperson, Courses and Seminar	Dr. O.I. Olusola
Chairman, Departmental Consultancy Committee	Prof. A.B. Adeloye
Departmental Examination and Time Table Office	Dr. M.A. Olopade
Departmental Results Officer	Dr. B.O. Olatinsu
Undergraduate Admission and NEEDS Assessment Coordinator	Dr (Mrs). M.B. Adedokun
Department Academic Secretary	Dr. I. Humphrey
Coordinator, Foundation Programme	Dr. M.A. Olopade

Course Advisers (2019/2020 Session):

100 Level	
200 Level	Dr. O.B. Olatinsu & Prof. E.O.Oyeyemi
300 Level	Dr. O.O. Odeyemi & Dr. A.O. Adewale
400 Level	Mr. O.G. Ilori & Mr. M. Adedeji
400 Level	Dr. A.O. Akala & Dr. I. Humphrey

UNDERGRADUATE PROGRAMME

Bachelor of Science in Physics, Applied Physics (Electronics) and Applied Physics (Energy Physics)

The structure of the 4-year programme in Physics as is being currently run is as follows:

100 Level: Physical courses, Fundamental Courses in Physics, Chemistry, Mathematics and General Studies
200 Level: Core Courses in Physics and Mathematics
300 Level: First Semester: Core Courses in Physics
300 Level: Second Semester: Industrial Training
400 Level: Specialized courses in Physics and Final-year project

COURSE STRUCTURE

B.Sc.(Hons.) Physics

100 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
FSC111	Introductory Biology	C	3
FSC112	Introductory Chemistry I	C	3
FSC113	Introductory Computer Science	C	3
FSC114	Introductory Mathematics	C	3
FSC115	Introductory Physics I	C	3
GST 102	Philosophy, Logic & Philosophy of Science	C	2
GST 105	Use of English	C	2
Total Units of Compulsory Courses			**19**
Total Units of Available Elective Courses			**0**

100 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 121	Introductory Physics II	C	3
PHS 122	Introductory Physics III	C	3
PHS 123	Introductory Practical Physics	C	2
MAT 121	Algebra and Coordinate Geometry	C	3
MAT 122	Calculus	C	3
STA 121	Statistics for Scientists	C	3
GST 103	Nigerian People's History & Culture	C	2
MAT 123	Mechanics	E	3
CHM 121	Introductory Chemistry II	E	3
Total Units of Compulsory Courses			**19**
Total Units of Available Elective Courses			**6**

200 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 201	General African Studies I	C	2
FRE139	French for Science Students I	C	2
PHS 211	Classical Mechanics I	C	2
PHS 213	Electricity and Magnetism	C	2
PHS 214	Modern Physics 1	C	2
PHS 216	Electronics I	C	2
PHS 218	Experimental Physics IA	C	1
MAT 231	Real Analysis I	C	3
PHS 212	Geophysics I	E	2
MAT 233	Mathematical Methods I	E	3
Total Units of Compulsory Courses			**16**
Total Units of Available Elective Courses			**5**

200 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
FRE164	French for Science Students II	C	2
PHS 222	Thermal physics	C	2
PHS 225	Oscillations and Waves	C	2
PHS 227	Optics	C	2
PHS 229	Theoretical Physics I	C	2
PHS 228	Experimental Physics IB	C	2
SIW 200	SIWES I	C	3
PHS 223	Introductory Astrophysics	E	2

PHS 226	Workshop Practice	E	2
STA 222	Statistical Methods	E	2
MAT 222	Linear Algebra I	E	2
MAT 223	Mathematical Methods II	E	3
CSC 227	Intro. To Information Processing	E	3
Total Units of Compulsory Courses			**15**
Total Units of Available Elective Courses			**14**

300 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 307	Entrepreneurship & Corporate Governance	C	2
PHS 331	Classical Mechanics II	C	2
PHS 313	Electrodynamics I	C	2
PHS 316	Electronics II	C	2
PHS 317	Mathematical Physics I	C	2
PHS 312	Quantum Mechanics I	C	2
PHS 318	Experimental Physics IIA	C	1
PHS 319	Solid State Physics I	C	2
FSC 311	History & Philosophy of Science	C	2
MAT 331	Complex Analysis I	E	3
Total Units of Compulsory Courses			**17**
Total Units of Available Elective Courses			**3**

300 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 320	Special Relativity	C	2
PHS 324	Modern Physics II	C	2
PHS 325	Physical Optics	C	2
PHS 327	Theoretical Physics II	C	2
PHS 323	Energy Physics	C	2
PHS 329	Statistical Physics I	C	2
PHS 328	Experimental Physics II B	C	1
SIW 300	SIWES II	C	3
PHS 326	Geophysics II	E	2
Total Units of Compulsory Courses			**16**
Total Units of Available Elective Courses			**2**

400 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 410	General Relativity	E	2
PHS 411	Computational Physics	C	2
PHS 412	Statistical Physics II	C	2
PHS 413	Modern Optics	E	2
PHS 414	Lower Atmospheric Physics	E	2
PHS 415	Nuclear Physics	E	2
PHS 416	Plasma Physics	E	2
PHS 417	Communication Electronics	E	2
PHS 418	Experimental Physics III	C	1
PHS 419	Elementary Particle Physics	E	2
Total Units of Compulsory Courses			**5**
Total Units of Available Elective Courses			**14**

400 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 420	Quantum Mechanics II	C	3
PHS 429	Electrodynamics II	C	2
PHS 488	Project	C	4
APH 421	Applied Electronic III	E	2
PHS 423	Ionospheric Physics	E	2
PHS 424	Solid State Physics II	E	2
PHS 442	Modern Astrophysics	E	2
PHS 441	X-Ray Crystallography	E	2
PHS 425	Digital Electronics	E	2
PHS 426	Optoelectronics	E	2
PHS 427	Mathematical Physics II	C	2
PHS 428	Entrepreneurship for Physicists	E	2
Total Units of Compulsory Courses			**11**
Total Units of Available Elective Courses			**16**

Summary of number of units compulsory and elective courses to be taken/available at each level for B.Sc. (Hons) Physics

	First Semester		Second Semester			
Level	Units of Compulsory courses	Units of Elective courses	Units of Compulsory courses	Units of Elective courses	Total units of Compulsory courses	Total units of Elective courses
100	19	0	19	6	38	6
200	16	5	15	14	31	19
300	17	3	16	2	33	5
400	5	14	11	16	16	30
					118	60

B.Sc. (Hons) Applied Physics (Electronics)

100 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 102	Philosophy, Logic & Philosophy of Science	C	2
GST 105	Use of English	C	2
FSC 111	Introductory Biology	C	3
FSC112	Introductory Chemistry I	C	3
FSC 113	Introductory Computer science	C	3
FSC 114	Introductory Mathematics	C	3
FSC 115	Introductory Physics 1	C	3
TOTAL Units compulsory courses			19
Total Units of Available Elective Courses			**0**

100 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 121	Introductory Physics II	C	3
PHS 122	Introductory Physics III	C	3
PHS 123	Introductory Practical Physics	C	2
MAT 121	Algebra and Coordinate Geometry	C	3
MAT 122	Calculus	C	3
MAT 123	Mechanics	E	3
STA 121	Statistics for Scientists	C	3

GST 103	Nigerian People's History & Culture	C	2
CHM 121	Introductory Chemistry II	E	3
Total Units Compulsory Courses			**19**
Total Units Elective Courses			**6**

200 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 201	General African Studies I	C	2
FRE 139	French for Science Students I	C	2
PHS 211	Classical Mechanics I	C	2
PHS 213	Electricity and Magnetism	C	2
PHS 214	Modern Physics 1	C	2
PHS 216	Electronics I	C	3
PHS 218	Experimental Physics IA	C	**1**
MAT 231	Real Analysis I	C	3
MAT 233	Mathematical Methods I	E	3
EEG 211	Fundamentals of Electrical Engineering I	E	2
EEG 231	Fundamentals of Electrical Engineering I Lab	E	1
Total Units Compulsory Courses			**17**
Total Units Elective Courses			**6**

200 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
FRE 164	French for Science Students II	C	2
PHS 222	Thermal physics	C	2
PHS 225	Oscillations and Waves	C	2
PHS 227	Optics	C	2
PHS 229	Theoretical Physics I	C	2
PHS 228	Experimental Physics IB	C	**1**
PHS 226	Workshop Practice	E	2
EEG 222	Fundamentals of Electrical Engineering II	C	2
EEG 220	Fundamentals of Electrical Engineering II Laboratory	C	1
SIW 200	SIWES I	C	3
MAT 223	Mathematical Methods II	E	3
STA 222	Statistical Methods	E	2
CSC 227	Intro. To Information Processing	E	3
Total Units Compulsory Courses			**17**
Total Units Elective Courses			**10**

300 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 307	Entrepreneurship & Corporate Governance	C	2
PHS 331	Classical Mechanics II	E	2
PHS 313	Electrodynamics I	C	2
PHS 316	Electronics II	C	2
PHS 317	Mathematical Physics I	C	2
PHS 319	Solid State Physics I	C	2
PHS 312	Quantum Mechanics I	C	2
PHS 318	Experimental Physics IIA	C	1
MAT 311	Complex Analysis I	E	3
FSC 311	History & Philosophy of Science	C	2
EEG 317	Instrumentation & Measurement I	E	2
Total Units Compulsory Courses			**15**

Total Units Elective Courses	**7**

300 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 320	Special Relativity	C	2
PHS 324	Modern Physics II	C	2
PHS 325	Physical Optics	C	2
PHS 323	Energy Physics	C	2
PHS 329	Statistical Physics I	C	2
PHS 328	Experimental Physics II B	C	1
APH 321	Electronics Laboratory	C	2
SIW 300	SIWES II	C	3
Total Units Compulsory Courses			**16**
Total Units Elective Courses			**0**

400 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 412	Statistical Physics II	C	2
PHS 415	Nuclear Physics	E	**2**
PHS 411	Computational Physics	E	2
PHS 413	Modern Optics	E	2
PHS 414	Lower Atmospheric Physics	E	2
PHS 417	Communication Electronics	E	2
PHS 418	Experimental Physics III	C	1
PHS 416	Plasma Physics	E	**2**
EEG 417	Active Network	E	**2**
Total Units Compulsory Courses			**3**
Total Units Elective Courses			**14**

400 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 420	Quantum Mechanics II	C	3
PHS 429	Electrodynamics II	C	2
PHS 424	Solid State Physics II	E	2
PHS 488	Project	C	4
APH 421	Applied Electronics III	C	2
PHS 423	Ionospheric Physics	E	2
PHS 425	Digital Electronics	C	2
PHS 426	Optoelectronics	E	2
PHS 427	Mathematical Physics II	E	2
PHS 428	Entrepreneurship for Physicists	E	2
Total Units Compulsory Courses			**13**
Total Units Elective Courses			**10**

Summary of number of units compulsory and elective courses to be taken/available at each level for B.Sc. (Hons) Applied Physics (Electronics Option)

	First Semester		Second Semester			
Level	Units of Compulsory courses	Units of Elective courses	Units of Compulsory courses	Units of Elective courses	Total units of Compulsory courses	Total units of Elective courses
100	19	0	19	6	38	6
200	17	6	17	10	34	16
300	15	7	16	0	31	7
400	3	14	13	10	16	24
					119	53

B.Sc. (Hons) Applied Physics (Energy Physics Option)

100 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 102	Philosophy, Logic & Philosophy of Science	C	2
GST 105	Use of English	C	2
FSC 111	Introductory Biology	C	3
FSC112	Introductory Chemistry I	C	3
FSC 113	Introductory Computer science	C	3
FSC 114	Introductory Mathematics	C	3
FSC 115	Introductory Physics 1	C	3
TOTAL Units compulsory courses			19
Total Units of Available Elective Courses			**0**

100 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 121	Introductory Physics II	C	3
PHS 122	Introductory Physics III	C	3
PHS 123	Introductory Practical Physics	C	2
MAT 121	Algebra and Coordinate Geometry	C	3
MAT 122	Calculus	C	3
MAT 123	Mechanics	E	3
STA 121	Statistics for Scientists	C	3
GST 103	Nigerian People's History & Culture	C	2
CHM 121	Introductory Chemistry II	E	3
Total Units Compulsory Courses			**19**
Total Units Elective Courses			**6**

200 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 201	General African Studies I	C	2
FRE139	French for Science Students I	C	2
PHS 211	Classical Mechanics I	C	2
PHS 213	Electricity and Magnetism	C	2
PHS 214	Modern Physics 1	C	2
PHS 216	Electronics I	C	2
PHS 218	Experimental Physics IA	C	1
APH 231	Energy and Environment	C	1
MAT 231	Real Analysis I	C	3
MAT 233	Mathematical Methods I	E	3
CSC 211	Software Workshop (Object oriented Programming) II	E	3

Total Units of Compulsory Courses	**17**
Total Units of Available Elective Courses	**6**

200 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
FRE164	French for Science Students II	C	2
PHS 222	Thermal physics	C	2
PHS 225	Oscillations and Waves	C	2
PHS 227	Optics	C	2
PHS 229	Theoretical Physics I	C	2
PHS 228	Experimental Physics IB	C	1
PHS 226	Workshop Practice	E	2
STA 222	Statistical Methods	E	2
MAT 222	Linear Algebra I	E	2
MAT 223	Mathematical Methods II	E	3
CSC 227	Intro. To Information Processing	E	3
APH 241	Renewable Energy I	C	2
SIW 200	SIWES I	C	3
Total Units of Compulsory Courses			**16**
Total Units of Available Elective Courses			**12**

300 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
GST 307	Entrepreneurship & Corporate Governance	C	2
PHS 331	Classical Mechanics II	C	2
PHS 313	Electrodynamics I	C	2
PHS 316	Electronics II	C	2
PHS 317	Mathematical Physics I	C	2
PHS 312	Quantum Mechanics I	C	2
PHS 318	Experimental Physics IIA	C	1
PHS 319	Solid State Physics I	C	2
APH 331	Renewable Energy II	C	2
FSC 311	History & Philosophy of Science	C	2
MAT 331	Complex Analysis I	E	3
Total Units of Compulsory Courses			**19**
Total Units of Available Elective Courses			**3**

300 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 320	Special Relativity	C	2
PHS 323	Energy Physics	C	2
PHS 324	Modern Physics II	C	2
PHS 325	Physical Optics	C	2
PHS 328	Experimental Physics II B	C	1
PHS 329	Statistical Physics I	C	2
CSC 322	A Modern Programming Language	E	3
SIW 300	SIWES II	C	3
Total Units of Compulsory Courses			**14**
Total Units of Available Elective Courses			**3**

400 LEVEL – 1st Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 411	Computational Physics	C	2

PHS 412	Statistical Physics II	C	2
PHS 413	Modern Optics	E	2
PHS 414	Lower Atmospheric Physics	E	2
PHS 415	Nuclear Physics	E	2
PHS 416	Plasma Physics	E	2
PHS 418	Experimental Physics III	C	1
APH 431	Renewable Energy III	E	2
APH 432	Special Topics in Conventional Energy	E	2
APH 433	Reliabliliy and Maintainability of Power Systems	E	2
Total Units of Compulsory Courses			**5**
Total Units of Available Elective Courses			**14**

400 LEVEL – 2nd Semester			
Course Code	**Course Title**	**Status**	**Units**
PHS 420	Quantum Mechanics II	C	3
PHS 429	Electrodynamics II	C	2
PHS 488	Project	C	4
PHS 423	Ionospheric Physics	E	2
PHS 424	Solid State Physics II	E	2
PHS 425	Digital Electronics	E	2
PHS 426	Optoelectronics	E	2
PHS 427	Mathematical Physics II	E	2
PHS 428	Entrepreneurship for Physicists	E	2
APH 421	Applied Electronic III	E	2
APH 441	Nuclear Reactor Physics	E	2
APH 442	Special Topics in Renewable Energy	E	2
APH 443	Energy Efficient Building	E	2
PAH 444	Radiation Effects and Protection	E	2
Total Units of Compulsory Courses			**9**
Total Units of Available Elective Courses			**20**

Summary of number of units compulsory and elective courses to be taken/available at each level for B.Sc. (Hons) Applied Physics (Energy Physics Option)

	First Semester		Second Semester			
Level	Units of Compulsory courses	Units of Elective courses	Units of Compulsory courses	Units of Elective courses	Total units of Compulsory courses	Total units of Elective courses
100	19	0	19	6	38	6
200	17	6	16	12	33	18
300	19	3	14	3	33	6
400	5	14	9	20	14	34
					118	64

SYNOPSES OF COURSES FOR UNDERGRADUATE PROGRAMME

100 LEVEL COURSES

FSC 115: INTRODUCTORY PHYSICS I **3 UNITS**

Physical quantities, standards and units. Kinematics: uniform velocity motion, uniform acceleration motion. Dynamics: Newton's laws of motion. Newton's universal law of gravitation. Work, energy, power, conservation laws. Concept of mechanical equilibrium. Centre of mass and centre of gravity. Moment of a force. Rotational motion, angular momentum and torque. Total mechanical energy; elasticity, Hooke's law, Young's shear and bulk modulus. Hydrodynamics. Molecular properties of fluids, viscosity, surface tension, adhesion, cohesion, capillarity, drops and bubbles.
Temperature and the Zeroth law of thermodynamics. Quantity of heat. Heat transfer. Gas Laws. First and second laws of thermodynamics. Application to kinetic theory of gases.

PHS 121: INTRODUCTORY PHYSICS II 3 UNITS
Geometrical Optics: Laws of reflection and refraction. Location of images. Plane and curved mirrors. Converging and diverging thin lenses. Aberrations. The eye. Optical instruments.
Simple Harmonic motion. Wave motion and wave types. Dispersion. Production of sound in strings and pipes, resonance; applications. Simple description of diffraction and interference, applications to both light and sound waves. Polarization of transverse waves.
Atomic structure. Production and properties of X-rays. Radioactivity. Photoelectric emission.

PHS 122: INTRODUCTORY PHYSICS III 3 UNITS
Electrostatics, potential and capacitance, dielectrics, production and measurement of static electricity. Current, Ohm's law, resistance and resistivity, heating, Galvanometers, Voltmeters and Ammeters.
D.C. circuits, sources of e.m.f. and currents, Kirchhoff's laws. Electrochemistry. The Earth's magnetic fields and induction. Faraday's and Lenz's Laws. Force on a current carrying conductor. Biot-Savart law. Flemmings right and left-hand rules, motors and generators.

PHS 123: INTRODUCTORY PRACTICAL PHYSICS 2 UNITS
Simple experiments illustrating the key topics covered in FSC 105, PHS 101 and PHS 102 theoretical courses.

200 LEVEL COURSES

PHS 211: CLASSICAL MECHANICS 2 UNITS
Pre-*requisite: FSC 115.*
Review of coordinate transformations. Particle kinematics and dynamics. Systems of particles, Central orbits – Keplerian case. Elementary motion of rigid bodies. Newtonian gravitation. Conservative forces and potentials. Defects of Newtonian mechanics and the essence of special relativity. Elasticity, stress, strain, static and dynamic friction, hydrodynamics irrotational flow, viscosity, surface tension.

PHS 212: GEOPHYSICS I 2 UNITS
Gravity methods: Newton's gravitation; applications. Instruments: gravimeters; Zero-length spring. Densities: rocks and ores. Magnetic methods: definitions; concepts. Geomagnetism; origin; properties of rocks. Gravity and magnetic field survey; instruments data processing: interpretations. Field work. The earth, internal structure and construction.

PHS 213: ELECTRICITY AND MAGNETISM 2 UNITS
Pre-requisite: PHS 122.
Electrostatics: Method of images. D.C. Network analysis and circuit theories. R-C and L-C circuits, transient time constants. A. C. circuits; inductance capacitance, transformers; eddy currents; hysteresis. Sinusoidal waveforms: r.m.s. and peak values; maximum power theorem. Q-factor of RLC circuits. Filters. Dielectric media, piezoelectricity.

PHS 214: MODERN PHYSICS I **2 UNITS**

Pre-requisite: PHS 121.

The electron: discovery and properties. Atomic structure. Photoelectric effect. X-Ray spectra. Mass spectra. Structure of the nucleus; nomenclature; binding energy; stability. Radioactivity: discovery and properties, radioactive series. Accelerators. Detectors.

PHS 216: ELECTRONICS I **2 UNITS**

Pre-requisite: PHS 122.

Electrons in matter, electron emission. Tube devices; structure, characteristics and applications. Semiconductors; doping, Transport phenomena in semiconductors. p-n junctions, p-n diode, diode characteristics. Transistors and applications. Semiconductor diodes: resistance; transient times; switching; capacitance. Diode types: Zener; Tunnel; LEDs. Applications in Analog and digital circuits; stabilized power packs; wave-shaping; chipping.

PHS 218: EXPERIMENTAL PHYSICS IA **1 UNIT**

Laboratory experiments based on 200 Level Physics courses: Mechanics, Optics, Heat and Electricity.

PHS 222: THERMAL PHYSICS **2 UNITS**

Pre-requisite: FSC 115.

Thermodynamic systems: Equation of State: First Law of thermodynamics: Combined First and Second Laws. Thermodynamic Potentials. Applications to simple Systems including phase transitions. Kinetic theory of gases, elementary statistical Physics.

PHS 223: INTRODUCTORY ASTROPHYSICS **2 UNITS**

Abundance and origin of the elements; formation, condensation and age of solar system; meteorites and the historical record of the solar system they preserve; comets and asteroid; the planets and their satellites; temperatures and atmospheres of planets; the origin of the Eath's lithosphere, hydrosphere, atmosphere, and biosphere. Structure, origin, evolution of stars, galaxies, planets. Physical laws applied in the study of the structures and evolution of galaxies, quasars, clusters of galaxies, and the universe at large. Stellar atmosphere.

PHS 225: OSCILLATIONS AND WAVES **2 UNITS**

Pre-requisite: PHS 121.

Wave phenomena; acoustical waves, the oscillator. Wave energy, wave types; longitudinal, transverse, standing, spherical. Wave properties; group and phase velocities; Doppler effect; diffraction, interference. Thin films. Vibrations: undamped, damped and forced vibration. Resonance, response, sharpness of response, quality factor.

PHS 226: WORKSHOP PRACTICE **2 UNITS**

First-aid in the laboratory and workshop. Selection and use of materials in common use. Soldering and welding. Gauges and indicators. Use of standard workshop machines; the lathe, the drill, the grinder and other power-operated tools, maintenance of tools. Fabrication and projects/term work.

PHS 227: OPTICS **2 UNITS**

Pre-requisite: PHS 121.

The nature of light, basic radiometry, Rays and wave fronts, Fermat's principle. Geometrical optics; image formation and location in both thin and thick lenses; principal planes, paraxial rays, ray transfer matrix and ray tracing. Imaging and imaging system design, aberrations, optical instruments.

Interference, diffraction and polarization. Introduction to Masers and lasers; holography; dispersion and scattering.

PHS 228: EXPERIMENTAL PHYSICS IB 1 UNIT
Laboratory experiments based on 200 Level Physics courses: Mechanics, Optics, Heat and Electricity.

PHS 229: THEORETICAL PHYSICS I 2 UNITS
Differential equations, multiple integration: Line, double and triple integrals, Applications in moment of inertia, centre of mass, etc., Transformation in 3-D. Partial differentiation. Matrices. Complex analysis.

APH 231: ENERGY AND THE ENVIRONMENT 1 UNIT
Energy resources: types, distribution, costs and reserves. Technologies for energy production, conversion and storage. Environmental and social impact of energy Exploitation. Energy in the future.

APH 241: RENEWABLE ENERGY I 2 UNITS
Available energy resources and consumption, Non-renewable energy resources. Evaluation of Renewable Energy resources. Energy economics (regulation and Deregulation issues). Power Deregulation in Nigeria

SIW 200: SIWES I 3 UNITS

300 LEVEL COURSES

PHS 320: SPECIAL RELATIVITY 2 UNITS
Pre-requisite: PHS 211.
Einstein postulates and Lorentz transformation; consequences of transformations of momentum and energy. Experimental verifications of special relativity. Velocity addition theorem and Doppler Effect. Electromagnetic 4 vectors, Transformation of E & H. Lorentz force.

PHS 312: QUANTUM MECHANICS I 2 UNITS
Pre-requisite: PHS 214.
Experimental basis of quantum theory; Black body radiation, and Planck's hypothesis, electron and quanta; Bohr's theory of atomic structure, de Brogue hypothesis. Operators. Postulates of Quantum Mechanics. Wave particle duality. Schrodinger equations and their solutions. Boundary conditions. Applications; one-dimensional box problem; potential well and bound sates potential barrier; the tunnel effect; atomic and molecular structures and reactions fusion and fission.

PHS 313: ELECTRODYNAMICS I 2 UNITS
Pre-requisites: PHS 213.
Electrostatics and Magnetostatics. Dielectrics; Laplace equation and boundary value problems. Method of images. Multipole expansions. Maxwell's equations and electromagnetic potentials; Maxwell's wave equation. Conservation laws.

PHS 316: ELECTRONICS II **2 UNITS**

Pre-requisite: PHS 216.

Introduction to transistors. The transistor parameters. Amplifiers. High frequency limitations. Noise. Introduction of field effect transistors. JFET, MOSPET. Applications to single stage low voltage amplifiers. Multistage amplifiers. Power amplifiers: classes A, B, C. Active and Passive Filters; Power systems; Use of transistors in stabilized power supplies.

PHS 317: MATHEMATICAL PHYSICS I **2 UNITS**

Pre-requisite: PHS 229.

Numerical and harmonic analysis. Orthogonal function expansions. The Dirac delta function. Fourier series and integral. Fourier and Laplace transforms; applications. Eigenvalue problems. Calculation of residues and application to evaluation of integrals and summation of series; applications.

PHS 318: EXPERIMENTAL PHYSICS IIA **2 UNITS**

Advanced experiment on mechanics, heat, optics and electricity

PHS 319: SOLID-STATE PHYSICS 1 **2 UNITS**

Pre-requisite: PHS 222.

Crystal structure of solids. Crystal binding. X-ray diffraction in crystals; application. Thermal properties of the crystal lattice. Elastic properties; lattice vibrations; phonons. Free-electron theory of metals. Motion of electrons in periodic fields. Hall Effect. Energy bands. Introduction to Semiconductors and Superconductors.

APH 321: ELECTRONICS LABORATORY **2 UNITS**

Specialized laboratory practical for Applied Physics (Electronics) students. Hands-on-experience on the use of electronic CAD tools, fabrication of prototype devices with industrial applications. Applications of microcontroller in modern electronics.

PHS 323: ENERGY PHYSICS **2 UNITS**

Energy and Power, principles, demands and outlook, transformation of energy and its costs. Thermal pollution. Electrical energy from fossil fuels. Hydro-electric generation. Principles and problems. Capacity, storage, reserves, efficiency and environmental effects. Electrical energy from nuclear reactors, energy in future breeder reactors, fusion power, solar power, geothermal power, tidal power etc.

PHS 324: MODERN PHYSICS II **2 UNITS**

Pre-requisite: PHS 214.

Properties of atomic orbits. Optical spectra of the hydrogen atom. Spontaneous and stimulated emissions (Lasers and Masers). Spectra of alkali metals. Quantum effects. Vector model of the atom: L-S and J-J couplings. Bohr magneton. Space quantization. Stern-Gerlach Experiment. Zeeman Effect. Hyperfine structure, Isotopes and nuclear spin. Nuclear spin number. Pauli's exclusion principle, molecular spectroscopy; rotation, vibration, X-ray spectra. Applications to chemistry Frank - Gordon principle. Microwave methods. Resonance phenomena, ESR, NMR. Optical pumping and Mossbauer scattering.

PHS 325: PHYSICAL OPTICS **2 UNITS**

Pre-requisites: PHS 225.

Electromagnetic waves. Complex representation of waves. Superposition of waves. Interference of two or more light beams. Young's double slit experiment, Michelson interferometer, Fabry-Perot interferometer. Coherence. Interference by division of amplitude. Interferometry, Fraunhoffer

diffraction, Fresnel diffraction, diffraction gratings. Polarization of light and its matrix; Jones vectors. Double refraction: quarter and half-wave plates. Optical activity. Modern wave optics. Laser beams. Holography. Optical filtering, Magneto-optics and electro-optics. Lasers, Gaussian beams, holography. Fourier methods in optics.

PHS 326: GEOPHYSICS II **2 UNITS**

Pre-requisite: PHS 212

Seismic methods: Elastic properties of rocks. Wave propagation in elastic media. Refraction and Reflection. Seismic: horizontal and inclined multiple interface; instrumentation; field procedures. Velocity analysis. Methods of processing and interpretation. Application in oil and water prospecting. Electrical methods.

SIW 300: SIWES II **3 UNITS**

PHS 327: THEORETICAL PHYSICS II **2 UNITS**

Integral equations: Volterra's equations of second kind, solution of Volterra's equation of second kind, Solution of Volterra's equation of first kind, method of resolvent kernels, Abel equation, Fredholm's integral equations, Fredholm's singular equations, Eigenvalues and eigenfunctions, Fredholm's theorems, Special integrals: Error integrals, sine integrals, cosine integrals, Laplace integrals, Bessel's integral, Tensor analysis and calculus: N-dimensional space, contravariant and covariant vector, higher rank tensors, Symmetric and skew-symmetric tensors, addition and subtraction of tensors, multiplication of tensors, Contraction of tensors, inner product of tensors, quotient law, conjugate tensors, the metric tensor, Conjugate of metric tensors, length of a curve, associate tensors, Christoffel symbols, transformation laws of Christoffel symbols, Covariant differentiation of vectors, intrinsic derivatives, curvature tensor, Riemann-Christoffel tensor, Riemann 4-space.

PHS 328: EXPERIMENTAL PHYSICS IIB **2 UNITS**

Advanced experiment on mechanics, heat, optics and electricity

PHS 329: STATISTICAL PHYSICS I **2UNITS**

*Pre-requisite: PHS 222.*Introduction to probability, statistical mechanics, and thermodynamics. Random variables, joint and conditional probability densities, and functions of random variables. Concepts of macroscopic variables and thermodynamic equilibrium, fundamental assumption of statistical mechanics, micro-canonical and canonical ensembles. First, second and third laws of thermodynamics. Applications physical phenomena such as magnetism, polyatomic gases, thermal radiation, electrons in solids, and noise in electronic devices.

PHS 331: CLASSICAL MECHANICS II **2 UNITS**

Pre-requisite: PHS 211.

Degrees of freedom and generalized coordinates: constraints, Lagrange's formulation of mechanics; applications. The calculus of variations and the principle of least action; geodesics. Hamilton's formulation of mechanics; applications. Invariance and conservation laws. Two-body central force problems; moving frames of reference. Forced and coupled oscillations; normal modes. Rigid body motion.

APH 331: RENEWABLE ENERGY II **2 UNITS**

Pre-requisite: APH 231.

Operating principles and applications of emerging technological solutions to the energy demands of the world. The scale of global energy usage and requirements for possible solutions. Basic physics and chemistry of solar cells, fuel cells, and batteries. Performance issues, including economics, from the ideal device to the installed system. The renewable energy resource base, its conversion to useful forms, and practical methods of energy storage. Geothermal, wind, solar, biomass, and tidal energies; resource extraction and its consequences.

400 LEVEL COURSES

PHS 410: GENERAL RELATIVITY **2 UNITS**

Pre-requisite: PHS 320.

Fundamentals of tensor transformations, Geometrical concept of gravitation, weak field approximation, gravitational field equations in free space. Schwarzschild solution, cosmological models.

PHS 411: COMPUTATIONAL PHYSICS **2 UNITS**

Use of numerical methods in physics, various methods of numerical differentiation and integration. Numerical solutions of differential and partial differential equations of interest in physics. Statistical analysis of data.

PHS 412: STATISTICAL PHSYCIS II **2 UNITS**

Pre-requisite: PHS 329.

Basic concepts of statistical mechanics; microscopic basis of mechanics and applications to macroscopic systems. Probability distribution for classical and quantum systems. Micro-canonical, canonical and grand canonical partition-functions and associated thermodynamics potentials. Applications: non-interacting Bose and Fermi gases; mean field theories for real gases, binary mixtures, magnetic systems, polymer solutions; phase and reaction equilibria, critical phenomena. Fluctuations, correlation functions and susceptibilities, and Kubo formulae. Evolution of distribution functions. Maxwell-Boltzmann distribution. The perfect quantal gas; Bose-Einstein, Fermi-Dirac distributions, The Blackbody, Bose-Einstein condensation.

PHS 413: MODERN OPTICS **2 UNITS**

Pre-requisites: Nil.

Integrated optics, Nonlinear optics, propagation of light in material media (including crystals), quantum theory of light, optical spectra, lasers, holography. Application of ray matrix to laser resonator. Various applications of lasers, etc.

PHS 414: LOWER ATMOSPHERE PHYSICS **2 UNITS**

Atmospheric composition and structure. Thermodynamics of water vapour and air. Hydrostatic stability and convection; tephigrams; gradients and winds. Radiation in the atmosphere; absorption, scattering. Absorption spectra: electronic, vibrational, rotational; lines and bands, Broadening processes; pressure/collision; Doppler. Radiometric quantities; definitions and measurements.

PHS 415: NUCLEAR PHYSICS 2UNITS

Basic Nuclear concepts; nuclear structure; nuclear size, nuclear masses, nuclear forces; nucleon scattering; nuclear models. Energy spectra of alpha and beta decays. Fermi theory of beta decay; emission; internal conversion. Nuclear reactions. Interaction of nuclear radiation with matter.

PHS 416: PLASMA PHYSICS 2 UNITS

Orbits of individual particles, Boltzmann equation, Magneto-hydrodynamics, confinement of plasma research and industrial applications.

PHS 417: COMMUNICATION ELECTRONICS 2 UNITS

Pre-requisite: PHS 316

High input impedance circuits. High frequency oscillators. Modulation and detection. Amplitude Modulation: Square law modulator and detector, Switching modulator, envelope detector, double sideband suppressed carrier (DSBSC) modulation, generation of balanced modulator, ring modulation, coherent detector of DSBSC waves, double-balanced modulator. Single sideband modulation (SSB) and demodulator. Vestigial sideband modulation. (VSB), Frequency Modulated (FM) Systems.

PHS 418: EXPERIMENTAL PHYSICS III 1 UNIT

Instrumentation: oscilloscope, networks differentiation & integration, superposition and Thevenin's theorem, transistors, semiconductor diode characterization, Op-Amp, electrical pulses, transmission lines, photoelectric effect: determination of h, earth resistance, mini projects.

PHS 419: ELEMENTARY PARTICLE PHYSICS 2 UNITS

Pre-requisite: PHS 324

Elementary particles: types, conservation laws, particle classification. Strong, gravitational, electromagnetic and weak interactions. Particle resonances. Symmetry models SU(2), SU(3). Quarks.

PHS 420: QUANTUM MECHANICS II 3 UNITS

Pre-requisite: PHS 312.

Harmonic oscillators. Three-dimensional spherically symmetric potentials. Angular momentum and spin of atomic and nuclear particles. Dirac Notation. Multi-electron atoms. Perturbation theory (time-independent and time-dependent), variational method, WKB and Born-Oppenheimer approximations. Applications to atomic and molecular systems. Scattering theory, elastic potential scattering. Green's function and method of partial waves, Applications.

PHS 423: IONOSPHERIC PHYSICS 2 UNITS

The sun and formation of ionized layers, formation and Structure of D, E, and F layers of the ionosphere, Vertical and Oblique propagation of radio waves in the ionosphere, ionospheric absorption and fading, ionospheric disturbances.

PHS 424: SOLID STATE PHYSICS II 2 UNITS

Pre-requisite: PHS 319.

Dielectric properties. Magnetism; Paramagnetism, diamagnetism, ferromagnetism and anti-ferromagnetism; magnetic resonance, imperfections in solids. Semiconductor theory and superconductivity.

PHS 425: DIGITAL ELECTRONICS 2 UNITS

Pre-requisite: PHS 316.

Logic expressions and their simplifications: De Morgan's Laws. Implementing Logic expressions using logic gates; Karnaugh maps. Logic families and their generic properties: RTL, DTL, TIL, HTL, BCL, CTL, CMOS; Analysis of wiring schematic of typical SSI chips; 741, 7404, 74121, 555. Decoder/ multiplexer. Coder. Read only memory (ROM). Sequential digital systems; 1-bit memory, flip-flops shift register, counters A/D, D/A, Converters. Displays. Computer interface systems.

PHS 426: OPTOELECTRONICS 2 UNITS

Pre-requisites: Nil.

Modulation of light; optical activity electro and magneto optic effects and devices: Faraday effect, Kerr effect. Acousto-optic effect. Laser: concepts; optical pumping; feedback; population inversion; Classes: doped, gas, liquid, semiconductor. Display devices and photo-electrons; luminescence; photoluminescence; photo-conductive detectors. Fibre optics and communication concepts; Fibre optical waveguides: concepts; Fibre optical waveguides; planar dielectric waveguide; intermodal dispersion. Losses in fibres. Integrated optics.

PHS 427: MATHEMATICAL PHYSICS II 2 UNITS

Pre-requisite: PHS 317.

Partial differential equations, solutions of boundary value problems of p.d.e by various methods (separation of variables, integral transforms, etc), Green function, Convolution. Sturm Liouville theory, uniqueness of solutions. Calculus of residues and applications to evaluations of integrals and summation series. Application to various physical situation which may include electromagnetic theory, quantum theory and diffusion equation. Introduction to Nonlinear dynamics: Nonlinear ODE and PDE.

PHS 428: ENTREPRENEURSHIP FOR PHYSICISTS 2 UNITS

Understanding entrepreneurship: the entrepreneur and the entrepreneurial process. The potential of physicists and engineers to contribute as entrepreneurs. Steps required to research the potential for a new venture opportunity. Concept of IP Generation and protection. Steps involved in turning an invention into a product.

Obtaining sufficient financial literacy and knowledge to write a business plan. Steps required in setting up a new venture. "Soft skills" for success in a business environment. Resource available to up-coming entrepreneurs.

PHS 429: ELECTRODYNAMICS II 2 UNITS

Pre-requisite: PHS 313.

Maxwell's equations, Electromagnetic waves in different media, Scalar and vector potentials, Gauge transformations, Continuity equation, Poynting's theorem, Propagation of plane waves in unbounded isotropic media, reflection, refraction. Transmission lines, wave guides and resonant circuits. Radiation from an oscillating dipole. Radiation from moving charges.

PHS 488: PROJECTS 4 UNITS

Each student is expected to undertake a project

PHS 441: X-RAY CHRYTALOGRAPHY 2 UNITS

Crystal morphology, crystal optics, classification of crystal polarization. Interference and dispersion in crystals. X-ray diffraction. Applications in research and industry.

PHS 442: MODERN ASTROPHYSICS 2 UNITS

Pre-requisite: PHS 223.

Applications of Physics (Newtonian, statistical and quantum mechanics) to fundamental processes that occur in celestial objects. Includes main-sequence stars, collapsed stars (white dwarfs, neutron stars, and black holes), pulsar, supernovae, the interstellar medium, galaxies. Optional topics are active galaxies, quasars and cosmology.

APH 421: APPLIED ELECTRONICS III **2 UNITS**

Pre-requisites PHS 316

Pulse generation. Timing circuits. Wave shaping circuits. Generation of sinusoidal wave forms; bistable; mono-comparator, multi-vibrators. Industrial electronic applications. Microwave circuits.

APH 432: SPECIAL TOPICS IN CONVENTIONAL ENERGY **2 UNITS**

APH 433: RELIABILITY AND MAINTAINABILITY OF POWER SYSTEM **2 UNITS**

Measurement tracking and feedback mechanism, total quality management, risk management. Introduction to reliability, maintainability, availability. Elementary reliability theory. Application to power system and electronic components. Test characteristics of electrical and electronic components. Types of faults. Designing for higher reliability. Packaging, mounting, ventilation. Protection from humidity, dust. Quality control techniques. Verification and validation, measurement.

APH 441: NUCLEAR REACTOR PHYSICS **2 UNITS**

Pre-requisite: Nil.

Introduction to Nuclear reactor Physics:

Neutron Physics, Flux cross sections. Thermalisation, fundamentals of thermonuclear reactions, nuclear reactions-Homogeneous and Heterogeneous Nuclear reactions- Operation and Control. Reactor Parameters and Control Reactor Parameters and Critical Sizes. Reactor Kinetics.

APH 442: SPECIAL TOPICS IN RNEWABLE ENERGY **2 UNITS**

APH 443: ENERGY EFFICIENT BUILDINGS (POWER GENERATION AND UTILIZATION) **2 UNITS**

Energy systems for commercial and institutional buildings, with a focus on energy Efficient design. Knowledge and skills required in the development of low-energy Buildings that provide high quality environments. Analysis and design. Thermal analysis of building envelope, heating and cooling requirements, HVAC, and building integrated PV systems. Emphasis is on residential passive solar design and solar water heating. Renewable and efficient electric power systems emp

APH 444: RADIATION EFFECTS AND hasizing analysis and sizing of photovoltaic arrays and wind turbines. Basic electric power generation, transmission and distribution, distributed generation, combined heat and power, fuel cells. End user demand, including lighting and other uses of electricity. Energy utilization for agricultural purposes. Rural electrification.

PROTECTION **2 UNITS**

A review of the interaction of radiation with matter. Radiation effects in chemical and biological systems, biological response. Radiation dosimetry, theory and practice. Principles of radiation protection; shielding of nuclear installations; shielding design and safety standards. Radioactive waste management and radiological emergencies.

APH 442: SPECIAL TOPICS IN RENEWABLE ENERGY **2 UNITS**

WORK PLAN FOR OFFERED COURSES

COURSE TITLE: INTRODUCTORY PHYSICS I
COURSE CODE: FSC 115 **UNITS: 3**

WEEK	TOPICS
1	Registration of students
2	Introductory class: Classification of physical quantities, Definition of standards and units
3	Kinematics as a branch of mechanics; terms used in describing motion – distance/displacement, speed/velocity, uniform velocity motion, uniform acceleration motion.
4	Dynamics as a branch of mechanics: Newton's first law of motion, Newton's second law of motion and Newton's third law of motion
5	Newton's universal law of gravitation. Concept of work, energy, power. Application of conservation laws.
6	Concept of mechanical equilibrium. Centre of mass and centre of gravity. Moment of a force about a point
7	Description of rotational motion. Definition of angular momentum and torque. Conservation of mechanical energy
8	Elasticity of an elastic material. Statement of Hooke's law. Experimental explanation of Hooke's law. Stress and Strain. Young's, shear and bulk modulus.
9	Hydrodynamics. Molecular properties of fluids, viscosity, surface tension, adhesion, cohesion, capillarity, drops and bubbles.
10	INCOURSE ASSESSMENTS
11	Temperature and the Zeroth law of thermodynamics.
12	Quantity of heat. Heat transfer. Gas Laws
13	First and second laws of thermodynamics. Application to kinetic theory of gases
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: INTRODUCTORY PHYSICS II
COURSE CODE: PHS121 **UNITS: 3**

WEEK	TOPICS
1	Registration of students
2	Introductory class: Geometrical Optics: Laws of reflection and refraction. How to locate images in plane and curved mirrors
3	Converging and diverging thin lenses, thin lens equation, combination of lenses, lensmaker's equation, magnification of images
4	Aberrations of lenses and mirrors; correction
5	The human eye; corrective lenses Optical instruments: magnifying glass, telescopes, compound microscope.
6	Simple Harmonic motion, energy in simple harmonic oscillator, SHM related to uniform circular motion, simple pendulum, physical pendulum and torsion pendulum
7	Damped harmonic motion, forced oscillations and resonance
8	Wave motion and wave types. Dispersion of waves.
9	Production of sound in strings and pipes, standing waves and resonance; applications.
10	INCOURSE ASSESSMENTS
11	Simple description of diffraction and interference, applications to both light and sound waves, Polarization of transverse waves.
12	Atomic structure, de Broglie's hypothesis. Production and properties of X-rays.
13	Radioactivity. Photon theory, Photoelectric emission.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: INTRODUCTORY PHYSICS III
COURSE CODE: PHS122 **UNITS: 3**

WEEK	TOPICS
1	Registration of students
2	Static electricity; Electric charge and its conservation, electric charge in atoms, insulators and conductors
3	Coulomb's law, the electric field; electric field calculations for continuous charge distributions, electric fields and conductors, motion of a charged particle in an electric field
4	Electric potential energy and Potential difference. Capacitors: determination of capacitance, capacitors in series and parallel, energy stored in capacitors.
5	Dielectrics, molecular description of dielectrics, production and measurement of static electricity.
6	Electric current, Ohm's law: resistance, resistors and resistivity, electric power, power in household circuits
7	Measuring instruments: Galvanometers, Voltmeters and Ammeters
8	D.C. circuits: sources of emf, terminal voltage and currents, resistors in series and in parallel, Kirchhoff's laws.
9	Series and parallel emfs; battery charging, circuits containing resistors and capacitor (RC circuits), Electrochemistry.
10	INCOURSE ASSESSMENTS
11	Magnets and magnetic fields, the Earth's magnetic fields and induction, electric currents produce magnetic fields, Faraday's and Lenz's Laws.
12	Force on an electric current carrying conductor in a magnetic field, force on an electric charge moving in a magnetic field, Biot-Savart law
13	Torque on a current loop, magnetic dipole moment, Flemmings right and left-hand rules, motors and generators
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: INTRODUCTORY PRACTICAL PHYSICS
COURSE CODE: PHS123 **UNITS: 2**

WEEK	TOPICS
1	Lab Registration of students
2	Data manipulation and measurement of density
3	Forces in equilibrium
4	The simple pendulum
5	The spiral spring/Hooke's law
6	Coefficients of static and dynamic friction
7	Cantilever
8	Bifilar suspension
9	The compound pendulum
10	Moment of inertia
11	Determination of refractive index of a glass prism
12	Determination of focal length of a concave/convex lens; simple and compound microscope
13	E.M.F.s and internal resistance of cells, ohms law and resistivity
14	REVISION/Alternative to practical
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: CLASSICAL MECHANIC I

COURSE CODE: PHS211 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Review of coordinate transformations, scalar and vector quantities, vector notation, scalar or dot product, vector product
3	Particle kinematics; vector kinematics, projectile motion, circular motion
4	Dynamics, composition of concurrent forces, composition of parallel forces, torque; Newton's laws of motion, motion of a particle, frictional forces, work, energy and power
5	Dynamics of a system of particles, motion of the center of mass of a system of particles, equilibrium of a particle, kinetic energy of a system of particles
6	Conservation of energy of a system of particles, Central orbits – Keplerian case.
7	Elementary motion of rigid bodies
8	Newtonian gravitation
9	Conservative forces and potentials, conservation of energy of a particle
10	INCOURSE ASSESSMENTS
11	Rectilinear motion under conservative force, non-conservative forces, reduced mass
12	Defects of Newtonian mechanics
13	Special relativity, Lorentz transformation, transformation of velocities, consequences of the Lorentz transformation; length contraction, time dilation
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: THERMAL PHYSICS
COURSE CODE: PHS222 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Macroscopic and microscopic points of view, scope of thermodynamics, thermal equilibrium, temperature concept, measurement of temperature, thermometers.
3	Simple thermodynamic systems: thermodynamic equilibrium, *PV* diagram for a pure substance, $P\theta$ diagram for a pure substance, $PV\theta$ surface
4	Equation of state, differential changes of state, mathematical theorems
5	Work, Quasi-Static process, work of a hydrostatic system, *PV* diagram, work in Quasi-Static processes
6	Heat and the first law of thermodynamics: work and heat, adiabatic work, internal-energy function, mathematical formulation of the first law of thermodynamics
7	Differential form of the first law of thermodynamics, heat capacity and its measurement, equations for a hydrostatic system
8	Ideal gases: equation of state of a gas, internal energy of a gas, ideal gas, experimental determination of heat capacities
9	Conversion of work into heat, and vice versa, stirling engine, steam engine, Kelvin-Planck statement of the second law of thermodynamics
10	INCOURSE ASSESSMENTS
11	The refrigerator, equivalence of Kelvin-Planck and Clausius statements
12	Thermodynamic Potentials, concept of entropy, enthalpy, the Helmholtz and Gibbs functions, Maxwell's relations, the *TdS* equations
13	Applications to simple Systems including phase transitions, first-order transition; Clapeyron's equation, fusion, vaporization, sublimation
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ELECTRICITY AND MAGNETISM
COURSE CODE: PHS213 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Electrostatics: Coulomb's law, electric field, electric flux, electric potential, Gauss' law (integral and differential forms)
3	Ohm's law and relationships between electrical quantities, direction of current flow, polarity and voltage, comparison of circuit current directions from DC and AC sources
4	Series circuits: Resistance in series circuits, voltage in series circuits, Kirchhoff's voltage law, power in series circuits
5	Parallel circuits: Definition and characteristics of a parallel circuit, voltage in parallel circuits, current in parallel circuits, Kirchhoff's current law, resistance in parallel circuits
6	Series-parallel circuits: total resistance in series-parallel circuits, current in series-parallel circuits, voltage in series-parallel circuits, power in series-parallel circuits
7	Basic network theorems: maximum power transfer theorem, superposition theorem, thevenin's theorem, norton's theorem
8	Inductance, inductive reactance in AC, RL circuits in AC, fundamental analysis of series RL circuits, fundamental analysis of parallel RL circuits
9	Capacitance, capacitive reactance in AC, RC circuits in AC, RLC circuit analysis,
10	INCOURSE ASSESSMENTS
11	Transformers; eddy currents; hysteresis
12	Series and parallel resonance: X_L and X_C and frequency, series resonance characteristics, the resonant frequency formula, parallel resonance characteristics, parallel resonance formula, Q-factor of RLC circuits.
13	Sinusoidal waveforms: r.m.s. and peak values; maximum power theorem.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: MODERN PHYSICS I

COURSE CODE: PHS214 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	The electron: discovery and properties
3	Atomic structure: the nuclear atom, electron orbits, atomic spectra, the Bohr atom
4	Energy levels and spectra, correspondence principle, nuclear motion
5	Atomic excitation, the laser, Rutherford scattering
6	Particle properties of waves: elementary waves, blackbody radiation
7	Photoelectric effect, quantum theory of light, thermionic emission
8	X-rays: X-ray diffraction, Bragg's analysis, Compton effect, pair production, photon absorption, photons and gravity, gravity red shift
9	Structure of the nucleus; nomenclature, nuclear composition, nuclear properties, stable nuclear
10	INCOURSE ASSESSMENTS
11	Binding energy, liquid-drop model, shell model, meson theory of nuclear forces
12	Radioactivity: discovery and properties, radioactive decay, Half-life, radioactive series, alpha decay, beta decay, gamma decay
13	Nuclear reactions, nuclear fission, nuclear reactors, Accelerators. Detectors.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: OSCILLATIONS AND WAVES
COURSE CODE: PHS225 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Simple and damped simple harmonic motion of mechanical and electrical oscillators, vector representation of simple harmonic motion, heavy damping, critical damping, amplitude decay
3	The forced oscillator: electrical and mechanical impedance, transient and steady state behavior of a forced oscillator, variation of displacement and velocity with frequency of driving force
4	Coupled oscillations: spring coupled pendulums, normal coordinates and normal modes of vibration, inductance coupling of electrical oscillators
5	Transverse wave motion: particle and phase velocities, the wave equation, transverse waves on a string, the string as a forced oscillator
6	Characteristic impedance of a string, reflexion and transmission of transverse waves at a boundary, impedance matching
7	Energy in a normal mode of oscillation, wave groups, group velocity, dispersion, wave group of many components, bandwidth theorem
8	Longitudinal waves: Wave equation, sound waves in gases, energy distribution in sound waves, intensity, specific acoustic impedance
9	Longitudinal waves in a periodic structure, reflexion and transmission of sound waves at a boundary
10	INCOURSE ASSESSMENTS
11	Waves on transmission lines: ideal transmission line, wave equation-velocity of voltage and current waves, characteristic impedance
12	Reflexion at end of terminated line, standing waves in short circuited line, real transmission line with energy loses, propagation constant, attenuation coefficient
13	Doppler effect; diffraction. Thin films.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ELECTRONICS I
COURSE CODE: PHS216 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Electrons in matter, electron emmison, electric current, E.M.F., P.D. and voltage, resistance and Ohm's law
3	Meters and measurement, potential divider, electric power, alternating power
4	Resistors, capacitors, inductors, CR and LR circuits
5	LCR circuits, transformers, switches
6	Transducers: microphones, loudspeakers, headphones and earpieces, digital displays, cathode ray tube, relays and reed switches, electric motors
7	Semiconductor materials, Diodes and diode circuits: P-N junction diodes
8	Digital displays: Light-emitting diode (LED) display, filament display, gas discharge display (GDD), fluorescent vacuum display, liquid crystal display (LCD)
9	Rectifier diodes, switching diodes, zener diodes, optoelectronic diodes
10	INCOURSE ASSESSMENTS
11	Relays, relay circuits and reed switches
12	Electric motors: D.C electric motors, A.C. electric motors
13	Applications in Analog and digital circuits; stabilized power packs; wave-shaping; chipping.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: OPTICS
COURSE CODE: PHS227 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	The nature and propagation of light: wave fronts and rays, Huygen's principle, atmospheric refraction
3	Reflection and refraction at plane surfaces, the laws of reflection and refraction, ray treatment of reflection and refraction
4	Fermat's principle of least time, reflection of a spherical wave at a plane surface, images in plane mirrors, virtual and real images
5	Refraction of a spherical wave at a plane surface, total internal reflection, reflection prisms
6	Refraction by a plane parallel plate, refraction by a prism, dispersion, direct-vision and achromatic prisms
7	Refraction at a spherical surface, reflection at a spherical surface, lateral magnification, focal points and focal lengths
8	Lenses: the simple lens in air, principal points and focal lengths, the thin lens, images as objects, thick lens optics, compound lenses
9	Polarization: reflection and refraction of linearly polarized light, polarization by reflection, double refraction, polarization by double refraction
10	INCOURSE ASSESSMENTS
11	Interference: interference in thin films, nonreflecting films, Newton's rings, standing waves, Michelson interferometer, double slit interference, Young's experiment
12	Diffraction: diffraction by a slit, the plane diffraction grating, the concave grating, diffraction of X-rays by a crystal
13	Masers and lasers; holography; dispersion and scattering.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: INTRODUCTORY ASTROPHYSICS
COURSE CODE: PHS223 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Representative topics include abundance and origin of the elements
3	Formation, condensation, and age of the solar system
4	Formation and age of the meteorites
5	The historical record of the solar system the meteorites preserve
6	Comets and asteroids
7	The planets and their satellites
8	Temperatures and atmospheres of the planets
9	The origin of the Earth's lithosphere
10	INCOURSE ASSESSMENTS
11	The origin of the Earth's hydrosphere
12	The origin of the Earth’s atmosphere, and biosphere
13	Physical laws are applied in the study of the structures and evolution of galaxies, quasars, clusters of galaxies, and the universe at large.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: THEORETICAL PHYSICS I
COURSE CODE: PHS229 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Differential equations: Ordinary differential equations, method of separation of variables, conversion to separable form, exact differential, Bernoulli's equation
3	Clairaut's equation, Lagrange's equation, homogeneous equations, non-homogeneous equations
4	Incomplete differential equations, linear differential equations, homogeneous linear equations with constant coefficients
5	Non-homogeneous linear equations with constant coefficients, second-order homogeneous equations with variable coefficients, Cauchy-Euler equation
6	Multiple integration: double integral
7	Partial differentiation: linear PDE of order one, linear PDE of order two, particular solutions, particular integrals for some functions
8	Cauchy type equations, linear PDE of order two, canonical forms, linear PDE of order one, D'Alemberts method, fourier method
9	Matrices: arithmetics of matrices, properties of symmetric matrices, calculus of matrices, orthogonal matrices, minors and cofactors, adjoint and reciprocal matrices, inverse of a matric
10	INCOURSE ASSESSMENTS
11	Hermitian and skew-Hermitian matrices, rank of a matrix, solution to linear algebraic equations, homogeneous and non-homogeneous systems, systems of linear differential equations
12	Complex analysis: algebra of complex numbers, complex conjugate, vector representation of complex numbers, cube roots of unity
13	Euler's formula, DeMoivre's theorem, analytic function, the Cauchy-Riemann's equations in polar coordinates, integration of analytic functions
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: EXPERIMENTAL PHYSICS IA
COURSE CODE: PHS218 **UNITS: 1**

WEEK	TOPICS
1	Registration of students
2	Introduction to practical
3	Alternative to practical
4	Error analysis & significant figures
5	Hooke's law
6	Young's modulus by cantilever
7	Coefficient of friction
8	Rigid body rotation
9	Moment of inertia
10	INCOURSE ASSESSMENTS
11	Young's modulus by cantilever I
12	Young's modulus by cantilever II
13	Young's modulus by cantilever
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: EXPERIMENTAL PHYSICS IA
COURSE CODE: PHS228 **UNITS: 1**

WEEK	TOPICS
1	Registration of students
2	Error analysis
3	Wheatstone bridge
4	Modulus of rigidity Searle's method
5	Transverse vibration of strings (Melde's experiment)
6	Semiconductor diode characteristics
7	ac measurement
8	Alternative to practical
9	Prism spectrometer
10	INCOURSE ASSESSMENTS
11	Experiment with microscope
12	Deflection and vibration magnetometer
13	Surface tension by torsion balance
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: GEOPHYSICS I
COURSE CODE: PHS212 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Gravity methods: Newton's gravitation; applications.
3	Geophysical instruments: gravimeters; Zero-length spring.
4	Densities: geology of rocks and ores.
5	Concepts of magnetic methods: definitions
6	Origin of geomagnetism, measurement of geomagnetism
7	Properties of rocks, identification of rocks
8	Introduction to gravity and magnetic field survey
9	Instruments used in gravity and magnetic field survey, data processing and interpretations.
10	INCOURSE ASSESSMENTS
11	Field work
12	Field work
13	The earth, internal structure and construction.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: WORKSHOP PRACTICE
COURSE CODE: PHS226 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to workshop practice
3	First-aid in the laboratory and workshop
4	Selection and use of materials in common use
5	Soldering and welding - demonstration
6	Practical class on Soldering and welding.
7	Introduction to gauges and indicators – practical class
8	Introduction to gravity and magnetic field survey
9	Introduction to standard workshop machines, the use of the lathe, the drill, the grinder and other power-operated tools.
10	INCOURSE ASSESSMENTS
11	Maintenance of tools
12	Practical workshop assignment (Group work)
13	Practical workshop assignment (Group work)
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: CLASSICAL MECHANICS II
COURSE CODE: PHS331 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to degrees of freedom and generalized coordinates
3	The Euler-Lagrange equations, the principle of stationary action
4	Forces of constraint, change of coordinates, conservation laws: cyclic coordinates, energy conservation. Noether's theorem
5	Central forces: conservation of angular momentum, the effective potential, finding $r(t)$ and $\theta(t)$, finding $r(\theta)$, Two-body central force problems
6	Kepler's laws: calculation of $r(\theta)$, the orbits, reduced mass
7	Angular momentum: rotation about the z-axis, general motion in *x-y* plane, the parallel-axis theorem, the perpendicular-axis theorem
8	Calculating moments of inertia; Torque: point mass – fixed origin, extended mass – fixed origin, extended mass – non-fixed origin.
9	The calculus of variations and the principle of least action; geodesics.
10	INCOURSE ASSESSMENTS
11	Hamilton's formulation of mechanics and applications. Invariance and conservation laws
12	Accelerated frames of reference, translation force, centrifugal force, coriolis force, azimuthal force
13	Forced and coupled oscillations; normal modes. Rigid body motion.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: QUANTUM MECHANICS I
COURSE CODE: PHS312 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Experimental basis of quantum theory
3	Black body radiation, and Planck's formula, the photoelectric effect, electron and quanta
4	Bohr's theory of atomic structure, de Broglie's hypothesis
5	Postulates of Quantum Mechanics. Wave particle duality.
6	The Schrödinger equation, the probability interpretation and normalization, expansion of the wavefunction and finding coefficients
7	The phase of a wavefunction, operators in quantum mechanics, momentum and the uncertainty principle, the conservation of probability
8	The time independent Schrödinger equation: the free particle, bound states and 1-D scaterring, parity.
9	Boundary conditions. Applications
10	INCOURSE ASSESSMENTS
11	The solution of the harmonic oscillator in the position representation, the operator method for the harmonic oscillator
12	One-dimensional box problem; potential well and bound sates potential barrier
13	The tunnel effect; atomic and molecular structures and reactions fusion and fission.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ELECTRODYNAMICS I
COURSE CODE: PHS313 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Electrostatics: Coulomb's law, electric field, electric flux, Gauss' law and some applications of Gauss' law
3	Electrostatic potential, relation between electric field and the potential, equipotential surfaces, electrostatic energy, electric dipole in uniform and non-uniform electric field
4	Electrostatics in dielectrics, capacitors, polarization, laws of electrostatic field in the presence of dielectrics
5	Gaseous non-polar dielectrics, gaseous polar dielectrics, solid dielectrics-electrets, electric field stresses
6	Poisson and Laplace equations, boundary conditions and uniqueness theorem, solution of Laplace's equation in rectangular coordinates
7	Laplace's equation in spherical polar coordinates, Laplace's equation in cylindrical coordinates, solution of Poisson equation using Green function
8	Magnetostatics: electric current, Ohm's law-electrical conductivity, magnetic effects, the magnetic field, force on a current, Biot-Savart law
9	The law of magnetostatics, the magnetic potentials, current loops in external fields – magnetic dipole, magnetic vector potential due to a small current loop
10	INCOURSE ASSESSMENTS
11	Magnetization, magnetic field vector, magnetic susceptibility and permeability
12	Maxwell's equations and electromagnetic potentials
13	Maxwell's wave equation. Conservation laws.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: MODERN PHYSICS II
COURSE CODE: PHS324 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Properties of atomic orbits.
3	Optical spectra of the hydrogen atom
4	Spontaneous and stimulated emissions (Lasers and Masers). Spectra of alkali metals. Quantum effects
5	Vector model of the atom: L-S and J-J couplings.
6	Bohr magneton. Introduction to Space quantization.
7	Stern-Gerlach Experiment and Zeeman effect
8	Hyperfine structure, Isotopes and nuclear spin. Nuclear spin number.
9	Pauli's exclusion principle, molecular spectroscopy; rotation, vibration
10	INCOURSE ASSESSMENTS
11	X-ray spectra. Applications to chemistry Frank - Gordon principle.
12	Microwave methods. Resonance phenomena, ESR, NMR.
13	Optical pumping and Mossbauer scattering.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: PHYSICAL OPTICS
COURSE CODE: PHS325 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Complex representation of waves
3	Interference of two or more beams light: interference in thin films, nonreflecting films, Newton's rings
4	Coherence. Interference by division of amplitude. Interferemetry
5	Diffraction by a slit, the plane diffraction grating, the concave grating, diffraction of x-rays by a crystal.
6	Fraunhoffer diffraction by a circular aperture, Fresnel zones.
7	Diffraction by a circular obstacle, diffraction by a straight edge
8	Polarization: reflection and refraction of linearly polarized light, polarization by reflection, double refraction: quarter and half-wave plates.
9	Malus' law, transmission of elliptically polarized light by an analyzer, optical stress analysis.
10	INCOURSE ASSESSMENTS
11	Optical activity, the scattering of light
12	Modern wave optics. Laser beams. Holography.
13	Optical filtering, Magneto-optics and electro-optics.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ELECTRONICS II
COURSE CODE: PHS316 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to transistors, basic types of transistors, BJT Construction and operation, BJT bias voltages and currents.
3	BJT characteristic and Parameters, BJT as an Amplifier, BJT as a switch.
4	DC operating point, Voltage Divider Bias, Other Bias methods
5	BJT amplifier circuits: amplifier operation and circuit configurations (Common-Emiter, Common-Collector and Common-Base amplifiers), Transistor AC Models
6	BJT amplifier circuits: amplifier circuit configurations, classification by signal levels and class operation, analysis of BJT amplifiers.
7	Applications to single stage low voltage amplifiers, Multistage amplifiers, introduction to oscillators
8	Field-effect transistors and circuits: Junction field-effect transistors, MOS field-effect transistors
9	FET Amplifiers and Switching circuits: Common-source, Common-drain and Common-gate amplifiers.
10	INCOURSE ASSESSMENTS
11	Amplifier Frequency response: Basic concepts, the Decibel, Low frequency Amplifier Response, High frequency Amplifier Response, Total Amplifier Response.
12	Thyristors: Silicon Control Rectifier, The Diac and Triac, The Unijunction Transistor.
13	Power Amplifiers: Class A.B C, Active and Passive filters, Use of transistors in stabilized supplies
13	INCOURSE ASSESSMENTS
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: MATHEMATICAL PHYSICS I
COURSE CODE: PHS 317 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Numerical analysis: finite difference operators, shift operator, differential operators
3	Numerical interpolation, roots of equations
4	Numerical differentiation and numerical integration, curve fitting
5	System of linear equations, ordinary differential equations, systems of differential equations
6	Higher-order differential equations, partial differential equations
7	Orthogonal function expansions. Definition of Dirac delta function
8	Delta functions in three-dimensions – cylindrical and spherical coordinates,
9	Fourier series and integral
10	INCOURSE ASSESSMENTS
11	Fourier transform: Fourier transform for functions of many variables, Fourier transforms of derivatives, applications of Fourier transform
12	Laplace transform, inverse Laplace transform, applications of Laplace transform
13	Calculation of residues and application to evaluation of integrals and summation of series; applications.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: THEORETICAL PHYSICS II
COURSE CODE: PHS 327 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Integral equations: Volterra's equations of second kind, solution of Volterra's equation of second kind
3	Solution of Volterra's equation of first kind, method of resolvent kernels, Abel equation
4	Fredholm's integral equations, Fredholm's singular equations,
5	Eigenvalues and eigenfunctions, Fredholm's theorems
6	Special integrals: Error integrals, sine integrals, cosine integrals, Laplace integrals, Bessel's integral
7	Tensor analysis and calculus: N-dimensional space, contravariant and covariant vector, higher rank tensors
8	Symmetric and skew-symmetric tensors, addition and subtraction of tensors, multiplication of tensors
9	Contraction of tensors, inner product of tensors, quotient law, conjugate tensors, the metric tensor
10	INCOURSE ASSESSMENTS
11	Conjugate of metric tensors, length of a curve, associate tensors, Christoffel symbols, transformation laws of Christoffel symbols
12	Covariant differentiation of vectors, intrinsic derivatives, curvature tensor, Riemann-Christoffel tensor
13	Riemann 4-space
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: SOLID-STATE PHYSICS 1
COURSE CODE: PHS319 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Crystal structure of solids: periodic array of atoms, lattice translation vectors, basis and the crystal structure, primitive lattice cell
3	Fundamental types of lattices, two-dimensional lattice types, three-dimensional lattice types
4	Simple crystal structures, sodium chloride structures, cesium chloride structure, hexagonal close-packed structure, diamond structure, cubic zinc sulfide structure
5	Direct imaging of atomic structure, nonideal crystal structures, crystal structure data
6	Crystal binding, crystal of inert gases, Van der Waals-London interaction, repulsive interaction, equilibrium lattice constants, cohesive energy
7	Ionic crystals, metals, hydrogen bonds, atomic radii and ionic crystal radii, analysis of elastic strains
8	Elastic compliance and stiffness, elastic waves in cubic crystals
9	X-ray diffraction in crystals, diffraction of waves by crystals, scattered wave amplitude, Brillouin zones
10	INCOURSE ASSESSMENTS
11	Thermal properties of the crystal lattice
12	Elastic properties; lattice vibrations; phonons, Free-electron theory of metals.
13	Motion of electrons in periodic fields. Hall Effect. Energy bands. Semiconductors. Superconductivity.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: SPECIAL RELATIVITY
COURSE CODE: PHS320 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to special relativity, concept of general relativity
3	Frame of reference is special relativity, Einstein postulates of special relativity
4	Coordinates and the relativity of time, derivation of the Lorentz transformation, properties of the Lorentz transformation
5	Relativistic kinematics: length contradiction and the length contraction paradox, time dilation
6	The twin paradox, velocity transformation and transformation of linear acceleration
7	Relativistic particle mechanics: the conservation of four-momentun, the equivalence of mass and energy, the centre of momentum frame
8	Consequences of transformations of momentum and energy. Experimental verifications of special relativity
9	Relativistic optics: the drag effect, aberration and the visual appearance of moving objects
10	INCOURSE ASSESSMENTS
11	Velocity addition theorem and Doppler effect
12	Threshold energies, de Broglie waves, the angular momentum four-tensor
13	Electromagnetic 4 vectors, Transformation of E & H. Lorentz force.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ENERGY PHYSICS
COURSE CODE: PHS323 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Principles of energy and power, demand of energy in Nigeria
3	Transformation of energy, cost of transformation of energy
4	Concept of thermal pollution
5	Electrical energy from fossil fuels; implication and cost of energy from fossil fuels
6	Principles of hydro-electric generation, problems encountered in hydro-electric generations
7	Capacity, storage, reserves, efficiency and environmental effects of energy
8	Introduction to nuclear energy
9	Introduction to solar energy
10	INCOURSE ASSESSMENTS
11	Electrical energy from nuclear reactors, cost of building a nuclear plant, advantages and disadvantages of nuclear energy generation
12	Electrical energy from solar energy, cost of building a solar energy panel, advantages and disadvantages of solar energy generation
13	Energy in future breeder reactors, fusion power, solar power, geothermal power, tidal power etc.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: EPERIMENTAL PHYSICS II A
COURSE CODE: PHS 318 **UNIT: 1**

WEEK	TOPICS
1	Registration of students
2	Small oscillation of a simple pendulum
3	Moderate oscillations of a simple pendulum
4	Coupled pendula
5	Viscosity of fluids
6	Motion of a projectile in a resistive medium
7	Determination of convection transfer coefficient of air
8	Resistivity of electrolytes
9	Polarization by reflection
10	INCOURSE ASSESSMENT
11	Optical activity
12	Dispersion curve
13	Interference
14	REVISION
15	SEMESTER EXAMINATION
16	SEMESTER EXAMINATION

COURSE TITLE: ELECTRONIC LABORATORY
COURSE CODE: APH 321 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Experiment on lamp in series and parallel
3	Using multimeter as a continuity checker, as a voltmeter and as an ohmmeter
4	Usage of signal generator and oscilloscope
5	Silicon P-N junction diode characteristics
6	P-N junction semiconductor diode characteristics
7	Experiments on zener diode characteristics
8	Static characteristics of a NPN transistor on common-emitter configuration
9	Bridge rectifier and filter circuit
10	INCOURSE ASSESSMENTS
11	Integrated circuit (IC) voltage regulator
12	Passive differentiation and integrating circuits
13	Operational amplifier using single supply voltage
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: EPERIMENTAL PHYSICS II B
COURSE CODE: PHS 328 **UNIT: 1**

WEEK	TOPICS
1	Registration of students
2	A.C. Potentiometer
3	A.C. Bridges
4	Measurement of wavelength of red and blue light by Young's fringes
5	Measurement of wavelength of sodium light using Newton's rings
6	Michelson Interferometer
7	Measurement of thickness of foil and angle of air-wedge by interference fringes
8	Measurement of wavelength by diffraction grating
9	Measurement of thermoelectric e.m.f and variation with temperature
10	INCOURSE ASSESSMENT
11	Investigation of Laws of electromagnetic induction
12	Reactance of capacitor. Series C-R A.C. circuit
13	Reactance of Inductor. Series L-R A.C. circuit
14	REVISION
15	SEMESTER EXAMINATION
16	SEMESTER EXAMINATION

COURSE TITLE: GEOPHYSICS II
COURSE CODE: PHS326 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Elastic properties of rocks; the elastic constants, their interrelation and relations to seismic wave velocities.
3	Attenuation of seismic waves through rocks.
4	Propagation of seismic energy through bounded media.
5	Types of seismic waves.
6	Ray path in layered media, refraction and reflection at boundaries.
7	Seismometers; basic principles, geophones, hydrophones
8	Aanalogue and digital. Seismic amplifiers.
9	Seismic reflection and refraction surveys. Instrumentation. Seismograph and seismograms.
10	INCOURSE ASSESSMENTS
11	Methods of processing and interpretation. Applications in oil, mineral and water prospecting.
12	Velocity analysis.
13	Borehole Geophysics.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: STATISTICAL PHYSICS I
COURSE CODE: PHS 329 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to probability
3	Statistical mechanics, and thermodynamics
4	Random variables, joint and conditional probability densities
5	Random variables, and functions of random variables.
6	Concepts of macroscopic variables and thermodynamic equilibrium
7	Fundamental assumption of statistical mechanics
8	Micro-canonical and canonical ensembles
9	First, second and third laws of thermodynamics
10	INCOURSE ASSESSMENT
11	Applications physical phenomena such as magnetism
12	Applications physical phenomena such as polyatomic gases
13	Applications physical phenomena such as thermal radiation, electrons in solids, and noise in electronic devices.
14	Revision
15	SEMESTER EXAMINATION
16	SEMESTER EXAMINATION

COURSE TITLE: QUANTUM MECHANICS II
COURSE CODE: PHS 420 **UNITS: 3**

WEEK	TOPICS
1	Registration of students
2	The mathematical structure of quantum mechanics
3	Harmonic oscillator: the solution of the harmonic oscillator in the position representation, the operator method for harmonic oscillator
4	Number states of the harmonic oscillator, more on the action of the raising and lowering operators
5	Spherically symmetric potentials: 2-D square well, an overview of a particle in a central potential, an overview of the hydrogen atom
6	Angular momentum: the commutation relations of angular momentum, the uncertainty relations for angular momentum
7	Generalized angular momentum and the Ladder operators, matrix representations of angular momentum, coordinate representation of orbital angular momentum and the spherical harmonics
8	Spin-1/2 systems, spin of atomic and nuclear particles
9	Dirac Notation. Multielectron atoms
10	INCOURSE ASSESSMENTS
11	Schrodinger wave mechanics: Schrodinger equation, the wave function, expectation values of dynamical quantities
12	Perturbation theory, scattering theory, elastic potential scattering.
13	Green's function and method of partial waves, Applications.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: GENERAL RELATIVITY
COURSE CODE: PHS 410 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Review of Tensors I: Change of Basis
3	Fundamentals of tensor transformations
4	Geometrical concept of gravitation
5	Weak field approximation
6	Gravitational field equations in free space
7	Schwarzschild solution
8	Experimental confirmation
9	Relativistic mechanics II
10	INCOURSE ASSESSMENTS
11	Transformation of energy and momentum
12	Cosmological models
13	Applications of general relativity
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: STATISTICAL PHSYCIS
COURSE CODE: PHS412 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Basic concepts of statistical mechanics; microscopic basis of mechanics and applications to macroscopic systems.
3	Equilibrium ensembles: microcanonical distribution functions and density matrices
4	The classical ideal gas, quantum-mechanical harmonic oscillators and spin systems, Maxwell-Boltzmann distribution
5	Entropy, temperature and pressure, the energy distribution function
6	Properties of some non-interacting systems: the ideal gas, non-interacting quantum mechanical harmonic oscillators and spins
7	The canonical ensemble: the density matrix, the Maxwell distribution and the barometric pressure formula
8	The entropy of the canonical ensemble and its extremal values, thermodynamic quantities in the canonical ensemble
9	The grand canonical ensemble: systems with particle exchange, the grand canonical density matrix
10	INCOURSE ASSESSMENTS
11	Thermodynamic quantities, the grand partition function for the classical ideal gas
12	Potentials and laws of equilibrium thermodynamics
13	The perfect quantal gas; Bose-Einstein, Fermi-Dirac distributions, The Blackbody, Bose-Einstein condensation
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: ELECTRODYNAMICS II

COURSE CODE: PHS429 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Electromagnetic waves: plane waves in non-conducting media, polarization
3	Energy flux in a plane wave, radiation pressure and momentum, plane waves in a conducting medium, the skin effect
4	Electromagnetic waves in bounded media: reflection and refraction of plane waves at a plane interface
5	Total internal reflection, reflection from the surface of a metal
6	Wave guides: propagation of waves between conducting planes, waves in guides of arbitrary cross-section
7	Wave guides of rectangular cross-section, coaxial wave guide
8	Transmission lines, Resonant cavities, dielectric wave guides
9	Electromagnetic radiation: Retarded potentials, radiation from an oscillating dipole, linear antenna
10	INCOURSE ASSESSMENTS
11	Potentials for a charge in uniform motion-Lorentz formula, fields of an accelerated charge
12	Radiation from an acceleration charged particle at low velocity, radiation when the velocity and acceleration of the particles are collinear
13	Radiation from a charged particle moving in a circular orbit, electric quadrupole radiation
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: SOLID STATE PHYSICS II
COURSE CODE: PHS424 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Dielectric properties: Maxwell equations, polarization, macroscopic electric field, depolarization field, local electric field at an atom, Lorentz field
3	Dielectric constant and polarizability, electronic polarizability, classical theory of electronic polarizability
4	Diamagnetism and paramagnetism: Langevin diamagnetism equation, quantum theory of diamagnetism of mononuclear systems
5	Paramagnetism, quantum theory of paramagnetism, rare earth ions, Hund rules, iron group ions, crystal field splitting
6	Cooling by isentropic demagnetization, nuclear demagnetization, paramagnetic susceptibility of conduction electrons
7	Ferromagnetism and antiferromagnetism: ferromagnetic order, Curie point and the exchange integral, magnetization, saturation magnetization at absolute zero
8	Magnons: quantization of spin waves, thermal excitation of magnons. Neutron magnetic scattering
9	Ferrimagnetic order: Curie temperature and susceptibility of ferrimagnets, iron garnets. antiferromagnetic order: susceptibility below the Néel temperature, antiferromagnetic magnons
10	INCOURSE ASSESSMENTS
11	Ferromagnetic domains: anisotropy energy, transition region between domains, origin of domains, coercivity and hysteresis. Single domain particles: geomagnetism and biomagnetism
12	Magnetic resonance: Nuclear magnetic resonance, line width, hyperfine splitting
13	Nuclear quadrupole resonance, ferromagnetic resonance, antiferromagnetic resonance. Imperfections in solids.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: NUCLEAR PHYSICS
COURSE CODE: PHS415 **UNITS: 3**

WEEK	TOPICS
1	Registration of students
2	Properties of stable nuclei and nuclear forces: Mass number A and electric charge Z of the atomic nucleus, nuclear and nucleonic mass
3	Nuclear binding energy of all nucleons, nuclear stability, binding energy per nucleon
4	Nuclear radius, spin and magnetic moment of nucleons and nuclei, nuclear forces
5	Models of the atomic nucleus: the liquid drop model, independent particle model, shell model, generalized model of the nucleus, superfluid nucleus model
6	Energy spectra of alpha and beta decays: half-life, laws of radioactive decay, alpha decay, beta decay, Fermi theory of beta decay; emission; internal conversion
7	Nuclear gamma radiation, types of radioactivity: proton radioactivity, double-proton radioactivity, neutron radioactivity, carbon radioactivity
8	Nuclear interactions: classification of nuclear reactions, laws of conservation of electric charge and baryon number
9	Energy and momentum conservation laws, law of conservation of angular momentum, law of parity conservation, law of conservation of isotopic spin
10	INCOURSE ASSESSMENTS
11	Interaction of particles and radiation with matter: general description of the interaction of charged particles, neutrons and gamma-quanta with matter, ionization losses due to collision of charged particles,
12	Dirac monopole, elastic scattering of particles, radiation losses for electrons, synchrotron radiation, Cherenkov radiation, transition radiation
13	Interaction of neutrons with matter, interaction of gamma radiation with matter: photoeffect, scattering of gamma radiation, electron-positron pair formation
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: PLASMA PHYSIC
COURSE CODE: PHS 416 UNITS: 2 UNITS

WEEK	TOPICS
1.	Registration of students.
2.	A brief history of plasma physics, What is plasma? Basic parameters, The plasma frequency, Debye shielding . . . The plasma parameter, Collisionality, Magnetized plasmas, Plasma beta.
3.	Charged particle motion: Motion in uniform fields, Method of averaging, Guiding centre motion, Magnetic drifts
4.	Invariance of the magnetic moment, Poincar´e invariants, Adiabatic invariants, Magnetic mirrors, The Van Allen radiation belts
5.	Plasma fluid theory: Moments of the distribution function, Moments of the collision operator, Moments of the kinetic equation.
6.	Fluid equations, Entropy production, Fluid closure, The cold-plasma equations, The MHD equations, The drift equations, Closure in collisionless magnetized plasmas.
7.	Waves in cold plasmas: Plane waves in a homogeneous plasma, The cold-plasma dielectric permittivity, The cold-plasma dispersion relation, Polarization, 4.6 Cutoff and resonance.
8.	Waves in an unmagnetized plasma, Low-frequency wave propagation in a magnetized plasma, Wave propagation parallel to the magnetic field,
9.	Wave propagation perpendicular to the magnetic field, Wave propagation through an inhomogeneous plasma, Radio wave propagation through the ionosphere.
10.	INCOURSE ASSESSMENTS
11.	Magnetohydrodynamic theory: Introduction,Magnetic pressure, Flux freezing, MHD waves,
12.	The solar wind,The Parker model of the solar wind, The interplanetary magnetic field, Mass and angular momentum loss, MHD dynamo theory
13.	Applications of Magnetohydrodynamic theory
14.	REVISION
15.	SEMESTER EXAMINATIONS
16.	SEMESTER EXAMINATIONS

COURSE TITLE: ELEMENTARY PARTICLE PHYSICS
COURSE CODE: PHS419 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Atoms, Neutrons, Sizes of nuclei, Quark and Standard Models, Characterization of elementary particles, Forces of nature, Antiparticles
3	Particle Detectors: Centre-of-mass Energy, Cyclic Accelerators, Ionization Detectors, Ionization counters, Proportional Counters, Geiger-Müller Counters, Scintillation Detectors, Types of Scintillators: Photomultiplier tubes, Semiconductor Detectors. Particle Identification, Calorimeters
4	Quantum Number: Baryon Number, Lepton number, Strangeness, Isospin. Conservation Laws: Conservation of Baryon Number, Conservation of Lepton Number, Conservation of Strangeness Number, Conservation of Isospin Number
5	Violation of Quantum Numbers: Weak Interactions, Hadronic Weak Decays, Semileptonic Processes, Electromagnetic Processes
6	Leptons: Leptons Generations, Neutrinos, Leptons Universality. Quarks : Experimental Evidence for Quark Existence, Hadron spectroscopy, Lepton scattering, Jet production, Quark Generations, Quark Numbers
7	Hadrons: Quarks Flavour Independence, Quark Model Spectroscopy, Isospin Symmetry . Quark Dynamics: the Strong Interaction, Colour, Quantum Chromodynamics (QCD), The Strong Coupling Constant and Asymptotic Freedom
8	Jets and Gluons, Colour Counting, Deep Inelastic Scattering
9	Electroweak Interactions: Unified Theory of Electromagnetic and Weak Interactions, Symmetries of the Weak Interaction , $W^{\pm}$ and Z^{0} Bosons
10	INCOURSE ASSESSMENTS
11	Weak Interactions of Hadrons: Semileptonic Decays, Neutral Meson Decays, *CP* Violation, Flavour Oscillations
12	Symmetries and Groups: Group Theory, The Group *SU*(2), *SU*(2) of Isospin
13	Symmetries and Quarks: The Group *SU*(3), Quark-Antiquark States: Mesons, Three-Quark States: Baryons
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: COMMUNICATION ELECTRONICS
COURSE CODE: PHS417 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	High input impedance circuits
3	High frequency oscillators
4	Modulation and detection
5	Amplitude Modulation: Square law modulator and detector, Switching modulator, envelope detector
6	Double sideband suppressed carrier (DSBSC) modulation,
7	Generation of balanced modulator,
8	Coherent detector of DSBSC waves, double-balanced modulator.
9	Single sideband modulation (SSB) and demodulation
10	INCOURSE ASSESSMENTS
11	Ring modulation
12	Vestigial sideband modulation. (VSB),
13	Frequency Modulated (FM) Systems.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: EXPERIMENTAL PHYSICS III
COURSE CODE: PHS418 **UNIT: 1**

WEEK	TOPICS
1	Registration of students
2	Instrumentation
3	Semiconductor
4	Passive-net works
5	NPN/PNP transistor
6	OP-AMP
7	Transmission-line
8	Earth resistance investigation
9	Compound pendulum
10	INCOURSE ASSESSMENTS
11	Microscope
12	Magnetometer
13	Ohm’s law and resistivity
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: IONOSPHERIC PHYSICS
COURSE CODE: PHS423 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	The sun: the sun in white light, the sun at EUV and X-ray wavelengths, the sun at radio wavelengths, the solar cycle
3	Ionosphere: Formation of the ionosphere, observing the ionosphere, variations of the ionosphere, Structure of D, E, and F layers of the ionosphere
4	Sporadic E, the equatorial ionosphere, the polar ionosphere, the Earth's magnetic field
5	Irregularities in the F region, travelling ionospheric disturbances, thermospheric winds
6	Vertical and Oblique propagation of radio waves in the ionosphere: polarization, maximum usable frequency, the skip zone
7	Propagation modes, multipath interference, choosing the correct antenna
8	Ionospheric absorption and fading, the lowest usable frequency, the variability of the MUF
9	Ionospheric disturbance: solar flares and their effects, coronal holes and HSSWS
10	INCOURSE ASSESSMENTS
11	Sudden disappearing filaments, geomagnetic effects, UT and seasonal control of geomagnetic disturbances
12	Communication problems at low latitudes, communication problems at high latitudes
13	Ionograms and their interpretation: vertical incidence ionograms, oblique incidence ionograms
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: LOWER ATMOSPHERE PHYSICS
COURSE CODE: PHS414 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Atmospheric continuum, physical dimensions and units
3	The fundamental forces, onoinertial reference frames and apparent forces, structure of the static atmosphere
4	The basic conservation laws: total differentiation, the vectorial form of the momentum equation in rotating coordinates
5	Scale analysis of the equations in rotating coordinates, the component equations in spherical coordinates, scale analysis of the equations of motion
6	The continuity equation, thermodynamic energy equation, thermodynamics of the dry atmosphere
7	Thermodynamics of water vapour and air.
8	Hydrostatic stability and convection; tephigrams; gradients and winds
9	Radiation in the atmosphere; absorption, scattering
10	INCOURSE ASSESSMENTS
11	Absorption spectra: electronic, vibrational, rotational; lines and bands
12	Broadening processes; pressure/collision; Doppler
13	Radiometric quantities; definitions and measurements.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: X-RAY CRYSTALOGRAPHY
COURSE CODE: PHS441 **UNITS: 2**

WEEK	TOPIC
1	Nature and production of X-rays
2	Crystal diffraction
3	Crystals and crystal structures
4	Lattice, Planes and directions
5	Miller indices
6	Crystal Optics
7	Polarisation in crystals
8	Interference in crystals
9	Dispersion in crystals
10	INCOURSE ASSESSMENTS
10	Dispersion in crystals
11	X-Ray Diffraction
12	Applications in Research and Industry.
13	Applications in Research and Industry.
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: MODERN ASTROPHYSICS
COURSE CODE: PHS442 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	A review of statistical and thermodynamic equilibrium in gases
3	Transport phenomena: Boltzmann transport, conservation law, Virial theorem
4	Concept of stellar equation; hydrostatic equation, conservation of mass
5	Conservation of energy in stellar interior, equation of energy transport
6	Central pressure in a star and Virial theorem
7	Stellar temperature; minimum temperature, stellar material
8	Energy generation in stars, sources of stellar energy – main source of the possible options, energy production
9	Energy transport within stars considers the methods of transfer of thermal energy
10	INCOURSE ASSESSMENTS
11	Stellar structure and evolution, equation of radiative transport, time scale
12	Stellar material; types of materials and their abundance. Materials and stellar cycle.
13	Stellar spectra; measurement, spectral classification, H-R diagram, model atmosphere
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: DIGITAL ELECTRONICS
COURSE CODE: PHS425 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Introduction to logic expressions and their simplifications, de Morgan's laws
3	Implementing Logic expressions using logic gates, Karanaugh maps
4	Logic families and their generic properties: RTL, DTL, TIL, HTL, BCL, CTL, CMOS
5	FET digital circuits, NMOS inverters: n-Channel MOSFET, NMOS inverter transfer characteristics, Noise margin, transient analysis of NMOS inverters
6	NMOS logic circuits: NMOS NOR and NAND gates, NMOS logic circuits
7	CMOS inverter: p-Channel MOSFET, DC analysis of the CMOS inverter, power dissipation
8	CMOS logic circuits: Basic CMOS logic gates, clocked CMOS logic
9	Transmission gates: NMOS transmission gate, NMOS pass networks, CMOS transmission gate, CMOS pass networks
10	INCOURSE ASSESSMENTS
11	Analysis of wiring schematic of typical SSI chips; 741, 7404, 74121, 555. Decoder/ multiplexer. Coder
12	Read only memory (ROM). Sequential digital systems; 1-bit memory, flip-flops shift register, counters A/D, D/A, Converters
13	Displays. Computer interface systems
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: OPTOELECTRONICS
COURSE CODE: PHS426 **UNITS: 2**

WEEK	TOPICS
1	Registration of students
2	Modulation of light; optical activity electro and magneto optic effects and devices
3	Faraday effect, Kerr effect. Acousto-optic effect
4	Nonlinear optics
5	Concept of lasers, optical pumping, feedback, population inversion
6	Classes of lasers: doped, gas, liquid, semiconductor
7	Display devices and photo-electrons; luminescence; photoluminescence; photo-conductive detectors
8	Concepts of fibre optics and communication
9	Concept of fibre optical waveguides
10	INCOURSE ASSESSMENTS
11	Planar dielectric waveguide
12	Intermodal dispersion
13	Losses in fibres. Integrated optics
14	REVISION
15	SEMESTER EXAMINATIONS
16	SEMESTER EXAMINATIONS

COURSE TITLE: RELIABILITY AND MAINTAINABILITY OF POWER SYSTEM
COURSE CODE: APH 433 UNITS: 2 UNITS

WEEK	TOPICS
1.	Registration of students.
2.	Measurement tracking and feedback mechanism.
3.	Total quality management, risk management.
4.	Introduction to reliability, maintainability, availability.
5.	Elementary reliability theory. Application to power system and electronic components.
6.	Elementary reliability theory. Application to power system and electronic components (contd).
7.	Test characteristics of electrical and electronic components of power system.
8.	Types of power system faults – diagnostic techniques
9.	Designing power system for higher reliability.
10.	INCOURSE ASSESSMENTS
11.	Packaging, mounting, ventilation. Protection from humidity, dust.
12.	Quality control for power system assessment..
13.	Quality control techniques; verification and validation, measurement.
14.	REVISION
15.	SEMESTER EXAMINATIONS
16.	SEMESTER EXAMINATIONS

COURSE TITLE: NUCLEAR REACTOR PHYSICS
COURSE CODE: APH 441 UNITS: 2 UNITS

WEEK	TOPICS
1.	Registration of students.
2.	Introduction to Nuclear reactor Physics
3.	Neutron Physics..
4.	Flux cross sections.
5.	Neutron thermalisation
6.	Fundamentals of thermonuclear reactions
7.	Homogeneous and Heterogeneous Nuclear reactions.
8.	Homogeneous Nuclear reactions- Operation and Control
9.	Heterogeneous Nuclear reactions- Operation and Control
10.	INCOURSE ASSESSMENTS
11.	Reactor Parameters and Control
12.	Reactor Parameters and Critical Sizes
13.	Reactor Kinetics
14.	REVISION
15.	SEMESTER EXAMINATIONS
16.	SEMESTER EXAMINATIONS

COURSE TITLE: ENERGY EFFICIENT BUILDINGS (POWER GENERATION AND UTILIZATION)

COURSE CODE: APH 443 UNITS: 2 UNITS

WEEK	TOPICS
1.	Registration of students.
2.	Energy systems for commercial and institutional buildings, with a focus on energy Efficient design
3.	Knowledge and skills required in the development of low-energy Buildings that provide high quality environments.
4.	Analysis and design of HVAC system..
5.	Analysis and design of buildings with integrated PV systems.
6.	Residential passive solar design and solar water heating.
7.	Renewable and efficient electric power systems
8.	Analysis and sizing of photovoltaic arrays and wind turbines.
9.	Basic electric power generation, transmission and distribution
10.	INCOURSE ASSESSMENTS
11.	Distributed generation, combined heat and power, fuel cells.
12.	End user demand, including lighting and other uses of electricity.
13.	Energy utilization for agricultural purposes. Rural electrification.
14.	REVISION
15.	SEMESTER EXAMINATIONS
16.	SEMESTER EXAMINATIONS

COURSE TITLE: RADIATION EFFECTS AND PROTECTION
COURSE CODE: APH 444 UNITS: 2 UNITS

WEEK	TOPICS
1.	Registration of students.
2.	A review of the interaction of radiation with matter.
3.	Radiation effects in chemical systems
4.	Radiation effects in biological systems
5.	Biological response.to radiation exposure.
6.	Radiation dosimetry, theory and practice.
7.	Principles of radiation protection
8.	Shielding of nuclear installations
9.	shielding design and safety standards.
10.	INCOURSE ASSESSMENTS
11.	Radioactive waste
12.	Management of radioactive waste.
13.	Management and radiological emergencies
14.	REVISION
15.	SEMESTER EXAMINATIONS
16.	SEMESTER EXAMINATIONS