FEDERAL UNIVERSITY, KASHERE

FACULTY OF SCIENCE

Department of Mathematics and Computer Science

B.Sc. Computer Science & Mathematics Programmes

STUDENT HANDBOOK
2015

FORWARD

I am delighted to put in the 1st edition of the *Students' Handbook* of Department of Mathematics and Computer Science. I am equally happy to welcome our dear students, fresh and returning to our department of the many reasons why Computer Science and Mathematics are of worth study, none surpassed that of their applications in real life situation.

The objective of the publication of this Handbook, is to disseminate information to students in the department on the history of the programmes offered in the department, its organizational structure, philosophy, mission, vision, aim and objectives, admission requirements, workload per level, grading system, graduation requirements, results computation as well as its course structures (Curricula).

Students are therefore strongly advised to read this Handbook carefully so that he/she becomes conversant with the workings of the department and other relevant information that will lead to achieve his/her objectives. There may be other rules and academic regulations of specific nature not covered by this Handbook. Such rules are important as those contained in the *University Student Handbook,* 2013.

I wish to add that any comment for improvement of this Handbook will always be welcomed.

I also wish you God's blessing and protection throughout your study period in this department and the University at large.

DR. P .B. Zirra (MNCS, MCPN, MTRCN, AMNIM, MIEEE)
Head of Department

(A) LIST OF STAFF, QUALIFICATION, RANK AND STATUS

S/N	Name of Staff	Rank/Designation Salary Scale, Date of first appointment	FULL TIME	Qualification, date obtained and Specialization, membership of professional association and number of publications
1	Dr. P. B. Zirra	Senior Lecturer,	Full Time	NCE Math/Phy (Hong,1987); B. Tech. Comp. Sc. (ATBU,1994); MBA Finance (Unimaid, 2001); M.Tech Comp. Sc. (ATBU,2006); Diploma Theology (KBC,2010) PhD Comp. Sc. (MAUTECH, 2012). CPN, NCS, MTRCN, ANIM.
2	Prof. Mshelia I Bello	Professor	Visiting	B.Sc. Maths (Unimaid, 1990); M.Sc. Maths (ATBU 1994); PhD. Maths (ATBU 2003). MAN, NMS.
3	Prof. G.M. Wajiga	Professor	Visiting	B.Sc. Maths (Zaria,1979); M.Sc. OR (Aston, 1983); PhD Comp. Sc. (ATBU, 2000).
4	Dr. Ibrahim Isah Adamu	Reader,	Visiting	B.sc. Maths (1989 FUTY); M.Sc. Maths (1993,UNIBEN); PhD. Maths (2012, ATBU). NMS.
5	Dr. Adamu Wakili	Senior Lecturer	Visiting	B.Sc. Maths (ABU,1997); M.Sc. (OR) (Uni Ibadan, 2000); PhD (LP) (ATBU, 2013). MNS, MAN.

6	Dr. N.V. Blamah	Senior Lecturer	Visiting	B. Tech Comp.Sc. (ATBU, 2008); M.Tech Comp. Sc. (ATBU,2004); PhD. Comp. Sc. (FUTY, 2009). ICIS, CPN, IRDI.
7	Dr. Sabo Hamma	Reader	Visiting	B.Sc. Maths (Unijos 1994); PGDE (2007) NTI; PGDM(2001) M.Sc. Maths (Unijos 2000); PhD. Maths (ATBU, 2007). MAN, NMS, TRC
8	Dr. M. Y Adamu	Reader	Visiting	B.Sc. Maths (Unimaid, 1997); M.Sc. Maths (ATBU, 2005); PhD. Maths (ATBU, 2012). NMS, MAN.
9	Dr. B. Souley	Professor	Visiting	B. Tech. Comp. Sc. (ATBU,1995); M.Sc. Comp. Sc. (ATBU,1998); PhD. Comp. Sc. (ATBU,2003). NCS,CPN,IEEE,ACM
10	Dr. A. Musa	Senior Lecturer	Visiting	B.sc. Maths (BUK,1998); M.Sc. Maths (ABU, 2006); PhD. Maths (ABU 2013). MAN, NAMP, NMS

11	Dr. Bashir Ali	Senior Lecturer	Visiting	B.Sc. Maths (Unima,1996); M.Sc. Maths (Unijos, 1996); PhD. Maths (Unijos, 2010). MAN, NMS
12	Dr. Baha Yusuf Benson	Senior Lecturer	Visiting	B.Tech. Comp. Sc. (ATBU, 2000); M.Sc. Comp. Sc. (ABU, 2008); PhD. Comp. Sc. (MATECT,2012), Publication – 6
13	Faisal Suleiman Ishaq	Assistant Lecturer	Full Time	B.Sc. Comp Eng (BUK 2010), M.Sc. Comp Eng (MUK 2014).
14	Terrang Abubakar Umar	Lecturer II	Full Time	NCE(Coll., of Edu., Hong, 1993); B.Sc. Maths (ASU,2008); M.Sc. Maths (ASU,2013
15	Muhammed Bello	Lecturer II	Full Time	B.Sc. Maths (UDU,2005); Dip. In Aeronautical Telecom.(NCA, 2010); M.Sc. Maths (ATBU, 2014).
16	Usman Abubakar Jauro	Assistant Lecturer	Full Time	B.Sc. Info. Tech (MU 2012) M.Sc. Info. Tech (MU 2013).
17	Simon Yusuf Enoch	Assistant Lecturer	Full Time	B.Sc. Comp.(Uni Ibd,2007); M.Sc. Comp. Sc. (ASU 2011). NCS, SDIWC,NIM
18	Abdulmuaymin Sanusi A.	Assistant Lecturer	Full Time	B.Sc. Statistic (Usmanu D.U, 2008); M.Sc. Statistic (UDU, 2013).
19	Surajo Ibrahim Isah	Assistant Lecturer	Full Time	B.Sc. Maths (BUK, 2009); PGDE Maths (2010): M.Sc. Maths (YUI, 2014).
20	Joel J.Taura	Assistant Lecturer	Full Time	B.Sc. Maths (ABU,2000); PGDE(Gashua,2007); M.Sc. Maths (ABU, 2011).
21	Auwal Abdullahi	Assistant Lecturer	Full Time	B.Sc. Maths (Unijos,2011); M.Sc. Maths (Unimaid, 2007).
22	Yahaya Bala Zakariyau	Assistant Lecturer	Full Time	B.Sc. Comp. Sc. (ASU,2008); M.Sc. Comp. Sc. (ASU, 2014).
23	Nuraini	Graduate	Full	B.Tech. Comp. Sc. ATBU,

	Abdulganiyi	Assistant	Time	2010).
24	Babayo Mohd Abdullahi	Graduate Assistant	Full Time	B.Sc. Maths (GSU, 2009).
25	Adamu Mustapha Umar	Graduate Assistant	Full Time	NCE. Maths/Geo (2001); B.Sc. Maths (BUK, 2010).
26	Mohammed Bappah Mohd	Assistant Lecturer	Full Time	B.Tech. Sta (MAUTECH,2011); M.Sc. Sta. (Unibadan, 2015).
27	Muhammad Lawan Jibrin	Graduate Assistant	Full Time	B.Sc. Comp. Sc. (BUK 2010).
28	Adamu Habu Adamu	Graduate Assistant	Full Time	B.Tech. Comp. Sc. (ATBU, 2010);
29	Philip Simon	Graduate Assistant	Full Time	B.Sc. Comp. Sc. (GSU, 2011).
30	Muhammed Besiru Jibrin	Graduate Assistant	Full Time	B.Sc. Comp. Sc. (KSU, 2008).

(B) TECHNOLONICAL/LABORATORY STAFF

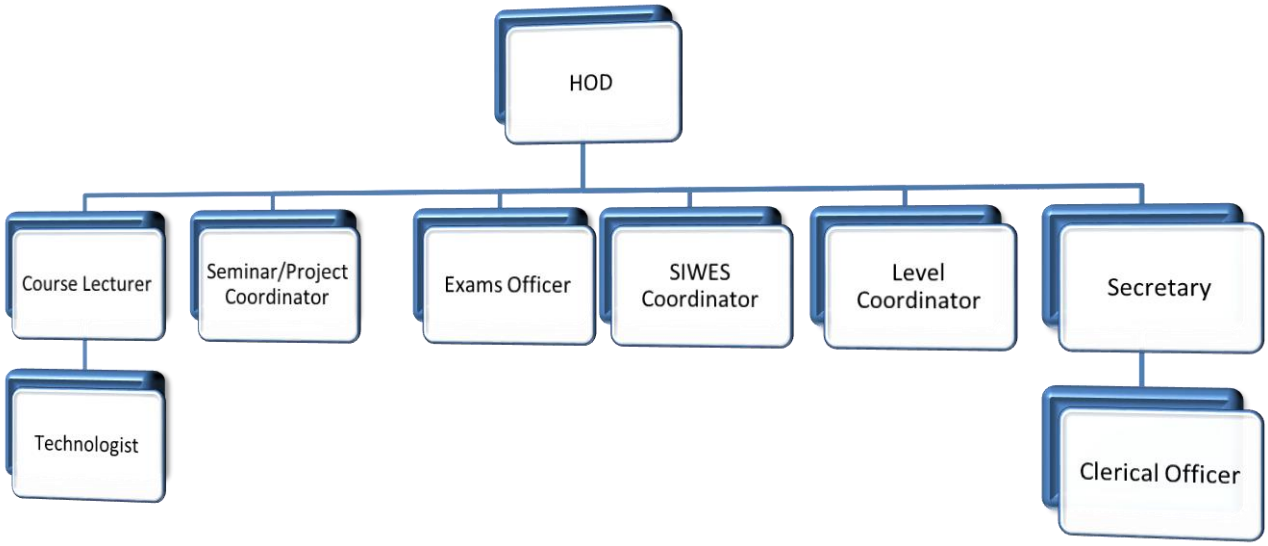
Name	**Rank/Designation Date of first Appointment**	**Qualification Date obtained Membership of Professional Association**
Adamu Mohd Mangadu	Lab Computer Assistant	Advance Cert. (FCE Gombe , 2012), ND Computer Studies (Institute of Comp. Bauchi, 2005);
Imrana Abdulmumini	Computer Operator	Cert. in Computer (Global Computer Institute, 2011)

(C) ADMINISTRATIVE STAFF

Name	**Rank/Designation Date of first Appointment**	**Qualification Date obtained Membership of Professional Association**
Asabe Mamman	Con-Sec. IV CONTISS 4, 2013.	Cert. (KCTI, 2002) Diploma in Secretarial Studies(CABS Potiskum, 2008)
Usman Mohammed	Computer Operator, CONTISS 4, 2012.	ND (Prof. Iya Abubakar 2011), Advance Cert. (ETF Gombe, 2013).

ORGANIZATIONAL STRUCTURE OF THE DEPARTMENT

The structure below shows the typically hierarchical arrangement of line of authority, communications, rights and duties of the Department of Mathematics and Computer Science, Federal University, Kashere.



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1.0 HISTORICAL BACKGROUND OF THE DEPARTMENT

The Department of Mathematics and Computer Science enjoys the historical privilege of being one of the foundation Departments of the Federal University, Kashere established in August 2012 with two programmes (B.Sc. Computer Science and B. Sc. Mathematics) under the leadership of Mr. Yusuf Simon Enoch as the Ag. Head of Department. The programmes took up with seven (7) permanent academic staff (3 in Mathematics and 4 in Computer Science) and twenty four (24) students (7 in Mathematics and 17 in Computer Science) in 2011/2012 Academic Session. Today the Department has a total number of one hundred and fifteen (115) students as per 2014/15 Academic Session. Also since then staff were added to improve the staff strength and quality of the programmes. At the moment the Department has a total number of nineteen (19) tenure academic staff (7-on study fellowship and 12 on ground) excluding visiting lectures, two (2) administrative staff and two (2) laboratory staff. In March 2014, Dr. P. B. Zirra a Senior Lecturer was appointed as the Head of Department.

2.0 VISION

2.1 B. Sc. Computer Science Programme

To reinforce, extend, and diversify our strengths in interdisciplinary innovation and collaboration while striving to become recognized for addressing critical, scientifically important problems through education and research in Computer Science.

2.2 B. Sc. Mathematics Programme

The Department of Mathematics aspires to be globally recognized as a centre of excellence for interdisciplinary - research and teaching. The Programme will promote a comprehensive, innovative and dynamic learning environment that meets the changing needs of student population.

3.0 MISSION

3.1 B. Sc. Computer Science Programme

The Computer Science Programme of Mathematics and Computer Science Department strives for excellence in creating, applying and imparting knowledge in Computer Science and Engineering through comprehensive educational programs,

research in collaboration with industry and government, dissemination through scholarly publications, and service to professional societies, the communities and the world at large.

3.2 B. Sc. Mathematics Programme

The Programme mission is to provide students with rigorous training that enables them to develop reasoning and analytical skills and pursue graduate degrees for service to the communities and the world at large.

4.0 PHILOSOPHY

4.1 B. Sc. Computer Science Programme

The Computer Science Programme is particularly designed to produce quality graduates who are practically oriented so as to provide the much needed solutions to problems in any field of Education, Science, Engineering, Business, Banking, Healthcare, Agriculture etc.

4.2 B. Sc. Mathematics Programme

The training of Mathematics should involve broad strategy of human resource development with its broader goals of social and political modernization. Rigorous training and research in mathematics is what makes the acquisition of solid foundation knowledge of the application of mathematics to the society. That is the knowledge which nurtures confidence, zeal and capacity for analytical problem solving and potential for research in the modern scientific age

5.0 AIM AND OBJECTIVES

5.1 B. Sc. Computer Science Programme

The aim of this programme is to produce highly quality Computer Science graduates with the range of knowledge and skills to be able to impact positively and provide solutions to problems in various fields of Human endeavour locally and internationally. The specification objectives are:

i. To provide a broad and balanced foundation in Computer Science knowledge and practical skills.
ii. To prepare students for further graduate studies in the field of Computer Science.
iii. To reinforce, extend, and diversify students' strengths in interdisciplinary innovation and collaboration.

iv. To produce graduates with the ability and expertise to conduct and lead research in all aspect of Computer Science which will be in turn beneficial to the economic, social and scientific needs of people

v. To provide quality undergraduate and graduate education in both the theoretical and practical aspect of Engineering, Electronics, Information theory, Logic, human behaviour and train students to effectively apply this education to solve real-world problems thus amplifying their potential for lifelong high-quality careers.

vi. To develop and offer dynamic programs in Computer Science that will prepare students to be self-reliant and job creators.

vii. To produce Computer Science graduates that will compete favourably with their contemporaries in the labour market and the worlds at large.

5.2 B. Sc. Mathematics Programme

The aim of this programme is to produce graduates with the abilities of tackling mathematical and computational problems of the society and the world community at large, through the acquisition of the solid foundation knowledge of the mathematical sciences.

The objectives are:

i. To develop in the students the enabling capacity to develop mathematical models to solutions to various scientific and socioeconomic problems.

ii. To produce mathematics graduates that will compete favourably with their contemporaries in the labour market in Nigeria and the world at large.

iii. To widen the knowledge base and enhance the capacity of students to address the general mathematical problems of the pure and applied sciences.

iv. To prepare students intellectually to pursue postgraduate research studies in all areas of mathematics and related fields.

v. To produce graduate that are self-reliant and job creators.

6.0 COURSE ASSESSMENT

Each course is assessed by a continuous assessment which includes assignments, tests, practical and end of semester examination.

(a) The practically based courses are assessed according to the following distribution:

- Practical: 20%

- Assignment and Test: 20%
- End of Semester Examination: 60%
- Total Weighting for the course: 100%

(b) The non- practically based courses are assessed according to the following distribution:

- Assignment and Continuous Assessment Test : 40%
- End of Semester Examination: 60%
- Total Weighting for the course: 100%

7.0 ADMISSION / ENTRY REQUIREMENT

7.1 B. Sc. Computer Science Programme

a) U.T.M.E. Applicants: Five ordinary level passes at credit level in English**,** Mathematics, Physics, Chemistry and Biology in not more than two (2) sittings. In addition, applicants are expected to sit for the relevant **U.T. M.E.** subjects and obtain the minimum cut off points as may be specified from time to time by the Joint Admission and Matriculation Board (JAMB).

b) **Direct Entry (D.E.) Applicants:** The D.E. applicants are expected to have the following:

i. Five ordinary level passes at credit level in English**,** Mathematics, Physics, Chemistry and Biology in not more than two (2) sittings.

ii. National Diploma/NCE (not professional) in Computer Science with Upper Credit or I.J.M.B. in relevant subjects (Mathematics and Physics as core and any other one from Chemistry, Biology or Geography) with the minimum of ten (10) points.

7.2 B. Sc. Mathematics Programme

a) U.T.M.E. Applicants: Five ordinary level passes at credit level in English**,** Mathematics, Physics, Chemistry and Biology in not more than two (2) sittings. In addition, applicants are expected to sit for the relevant **U.T.M.E.** subjects and obtain the minimum cut off points as may be specified from time to time by the Joint Admission and Matriculation Board (JAMB).

b) Direct Entry (D.E.) Applicants: The D.E. applicants are expected to have the following:

i. Five ordinary level passes at credit level in English**,** Mathematics, Physics, Chemistry and Biology in not more than two (2) sittings.

ii. National Diploma/NCE (not professional) in Mathematics/Computer Science with Upper Credit or I.J.M.B. in relevant subjects (Mathematics and Physics as core and any other one from Chemistry, Biology or Geography) with the minimum of ten (10) points.

8.0 GRADING SYSTEM

Students' academic work shall be graded at the end of every semester using the following letter grades

Letter	Grade	Marking Scale (%)	Grade Points
A	70 –100	Excellent	5 Points
B	60 – 69	Very Good	4 Points
C	50 – 59	Good	3 Points
D	45 –49	Average	2 Points
F	0 – 44	Fail	0 Point

9.0 EXAMINATION

Course Credit System: The department has adopted the Course Credit System in computing results of students' performance. It is a quantitative system of organization of the curriculum in which the subject areas are split into examinable unit courses that are assigned weights or Credit Units (e.g. 1 Unit, 2 Units, 3 Units, etc) and for which credits are earned after passing them. The course (Core, general and elective) are arranged in progressive order of difficulty or in levels of academic progress e.g. Level 1 or 100 Level or Year 1 donated as 1201, 1301, 1402, etc; Level 2 or 200 Level or Year 2 designated as 2301, 2301, 2202, etc. the first digit represents the level, the second digit represents the credit unit, the third and fourth digits represent the serialization of the course.

Credit: Is generally a 'Value' used to measure a students work load in terms of learning time required to complete course units, resulting in learning outcomes. The number of credits awarded to a leaner is determined by Credit Value or Credit Points assigned to a particular course.

Course: A course is essentially a constituent of a 'Program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a

certain level. A 'Course' in simple terms corresponds to the word 'subject' use in many Universities.

Core Courses: These are compulsory courses that each student must register for and pass them before graduating.

General Courses: These are compulsory Courses offered by all students at a particular level and must pass them before graduating.

Elective Courses: These are optional (not compulsory) courses designed for the student to make up the minimum credit units for registration.

Credit Unit (CU): This is a measure of the 'Workload' of a learner and is an index of student-teacher contact hours per week per semester e.g. 1 credit unit means one hour of lecture or tutorial etc per week per semester.

Grade Point (GP): The grade point derives from the actual percentage, raw score for a given course; the raw score is converted into a letter grade and hence the grade point. Each grade, except 'Inc' and 'Pnd' is assigned a Grade Point as follows:

Raw score	70-100	60-69	50-49	45-49	40-44	0-39
Letter Grade	A	B	C	D	E	F
Grade Point	5	4	3	2	1	0

Credit Point (CP): The credit is the product of the credit units of the course and the grad point. For example if a student obtains C in a 2 credit units course then his/her credit point is *2 x 3 = 6.*

Total Credit Unit Registered (TCUR): This represents the total number of credit units registered by a student in any given semester.

Total Credit Unit Earned (TCUE): This represents the number credit units for which a student has sat for in examination and passed in a semester.

Weight Grade Point (WGP): The sum of Product of Credit Units and Grades Points (i.e.$\mathrm{WGP} = \sum \mathrm{CU\ X\ GP}$).

Grade Point Average (GPA): Performance in any semester is reported in Grade Point Average. This is the average of weighted grade points earned in the courses

taken during the semester. The grade point average is obtained in each course by the number of credit units assigned to that course and then summing them up and dividing by the number of credit units taken for the semester.

$$GPA = \frac{\text{Sum of Credit Units for a Course corresponding GP gain}}{\text{Sum of Credits Registered}}$$

Suppose a 100-Level student in Computer Science has the following results for a session.

FIRST SEMESTER						
Course	MTH1201	MTH1203	MTH1205	CSC1201	STA 1201	GST 1201
Credit Units (CU)	2	2	2	2	2	2
Raw Score	50	60	70	45	38	40
Grade	C	B	A	D	F	E
GP	3	4	5	2	0	1
GPxCU	6	8	10	4	0	2
$GPA = \frac{(6+8+10+4+0+2)}{12} = \frac{30}{12} = 2.5$						

Cumulative Grade Point Average (CGPA): This is the up to date average of the grade points earned by the student in a program of study. It is an indication of the student's overall performance at any point in the training program. To compute the CGPA, the total grade points multiplied by the respective credit points for all the semesters are added and then divided by the total number of credit units for all courses registered by the students.

$$\text{i.e. } \mathbf{CGPA} = \frac{\text{Total Credit Units Earned for the session}}{\text{Total Credit Units Registered for the session}} = \frac{TCUE_1 + TCUE_2}{TCUR_1 + TCUR_2}$$

Where $TCUE_1$ and $TCUE_2$ are Earned points for first and second semesters, $TCUR_1$ and $TCUR_2$ are registered credit units for first and second semesters respectively. This calculation is carried out up to the final year from which the average of the CGPAs will determine the class of degree.

Since the minimum pas mark of a course is 40% corresponding to GP of 1.00, the minimum CGPA of 1.00 is required for graduation. An example of how the above mentioned terms are used in calculating CGPA is given in tables below for a 100 Level Computer Science as an illustration.

Computation of CGPA (example)

- **a.** Total Credit Units Registered (TCUR)
- **b.** Total Credit Units Earned (TCUE)
- **c.** Total Weight Grade Point (TWGP)

SECOND SEMESTER						
Course	MTH1202	MTH1204	MTH1206	STA1202	GST1202	GST1204
Credit Units (CU)	2	2	2	2	2	2
Raw Score	55	60	63	45	56	60
Grade	C	B	B	D	C	B
GP	3	4	4	2	3	4
GPxCU	6	8	8	4	6	8

$$GPA = \frac{(6+8+8+4+6+8)}{12} = \frac{40}{12} = 3.33$$

$$The\ CGPA = \frac{TCUE_1+TCUE_2}{TCUR_1+TCUR_2} = \frac{(6+8+10+4+0+2)+(6+8+8+4+6+8)}{12 \quad + \quad 12} = \frac{30+40}{12+12} = \frac{70}{24} = 2.917$$

Cumulative

TCUR	TCUE	TWGP	CGPA
12+12=24	10+12=22	30+40=70	70/24=2.917

Therefore the CGPA for that level = 2.917

Instructions to Candidates on Examination

a) A candidate must arrive at the examination Hall 30 minutes before the commencement of the examination.

b) A candidates who arrives late for any examination shall not be allowed extra time.

c) No candidate shall remove a question paper from the examination room without the consent of the Chief Invigilator.

d) In case a candidate has to leave the examination room temporarily he/she shall be accompanied by an invigilator or security personnel.

e) No candidate shall be allowed to enter an examination room later than 30 minutes after the start of an examination session. However any candidate who seeks entry into the examination room after the first 30 minutes may be allowed to do so by the Chief Invigilator but such cases shall be reported in writing to the Examination Committee.

f) No candidate is allowed to leave the examination Hall 30 minutes to the end of the examination.

g) No candidate shall take into an examination room or have in his/her possession during an examination any book or paper, printed or written documents, whether relevant to the examination or not, unless specifically authorised to do so. An invigilator has authority to confiscate any such documents or items.

i) A candidate shall not directly or indirectly;

i. Give assistance to any candidate.
ii. Accept any assistance from any other candidate during the examination.

j) A candidate shall not remove from an examination room any papers used or unused, except the question paper and such books or papers, if any, as he/she was authorized by the invigilator to take into the examination room. The invigilator will indicate occasions when question papers may not be taken out of the examination room.

k) A candidate shall not be allowed during an examination to communicate in any way with any other candidate, nor shall he/she leave his/her seat except with the consent of an invigilator. Should the candidate act in such a way as to disturb or inconvenience other candidates he/she shall be warned and if he/she persists he/she may, at the directive of the chief invigilator, be expelled from that examination room.

l) A candidate shall comply with all instructions to candidates set out on the examination answer booklet or other examination materials supplied to him/her, and shall comply with directives given by the invigilator.

m) A candidate shall not write on any paper other than the answer booklet of the examination except when indicated. All rough work must be done in the answer booklet and crossed out neatly. Supplementary answer sheets, even if they contain only rough work, must be tied inside the main answer booklets and handed in.

n) When leaving the examination room, a candidate shall not leave his/her written work on the desk but he/she shall hand it over to the invigilator. Candidates are responsible for the proper return of their written work.

o) Smoking, chewing and eating shall not be permitted in examination rooms during examination session.

p) Any candidate involved in examination misconduct must complete the misconduct form or write a statement as demanded by the invigilator stating

clearly his/her level of involvement. Such a report should be signed by the candidate and dated.

q) Candidates who have been requested by an invigilator to change their seats must comply with the directive.

r) All candidates must ensure that they have signed in and out on the Attendance List when their scripts are submitted to the invigilator at the end of each examination.

10.0 STUDENT ACADEMIC WORKLOAD

All full-time students shall take a minimum of 15 credit units and a maximum of 24 credit units per semester. A student may apply to take less or more than the limit through the Faculty Board for Senate's consideration.

11.0 ACADEMIC PROBATION

A student shall be placed on Academic Probation if he/she fails to maintain a minimum CGPA of 1.50 at the end of the session. The probationary status of a student shall be reversed if the student maintains a CGPA of at least 1.50 in any subsequent semester after the first year.

The responsibility to reverse the probationary status rests with the student.

A preliminary notice of poor academic standing shall be given to a student in writing by the University.

12.0 TEACHING AND LEARNING

We use a wide range of teaching methods to suit the content and aims of each course unit:

a. **Fieldwork**: Students undertake directed work and independent research projects to develop observation, experimental design and data collection skills.
b. **Tutorials**: regular sessions with an advisor and small group of students develop your oral and written communication, it, team working and problem-solving skills whilst exploring topics related to your degree discipline.
c. **Lectures**: delivered to audiences ranging from 20 to 500 students using technology such as power point.
d. **E-learning**: our virtual learning environment provides learning resources on demand (discussion boards, quizzes) to enhance and support lecture based units.

e. **Practical**: undertake modern experimental techniques to develop laboratory, experimental design, and data analysis skills.
f. **Seminars**: examine and debate topical areas of research to develop the students' critical thinking and communication skills.
g. **Projects**: carry out an independent research project which could be lab-based or in a number of other formats for example planning a new bioscience enterprise or an education project.

13.0 WITHDRAWAL FOR ACADEMIC FAILURE (WAF)

A student shall be required to withdraw for academic failure if he/she at the end of any session fails to maintain a CGPA of at least 1.50. However, this rule shall not apply to the first year students.

However, a student in his/her final year of study who fails to make a minimum CGPA of 1.50 may be allowed to register for courses in the final year. Such student who fails to make a minimum CGPA of 1.50 in the concession year shall be asked to withdraw from the University.

14.0 DURATION OF PROGRAMME

Expected duration for UTME candidates shall be four years, while that of DE shall be three years.

15.0 RESIDENCY PERIOD

The residency period for a UTME candidate to graduate is six years, while it is five years for DE candidates.

16.0 GRADUATION REQUIREMENTS FOR BACHELOR'S DEGREE

In order to qualify for the Bachelor's Degree in Computer Science of this Department, students must attain:

i. A passing grade in supervised Student Industrial Work Experience Scheme, (SIWES) where applicable;
ii. A minimum of CGPA of 1.50;
i. A minimum of 156 (B.Sc. Computer Science) or 162 (B.Sc. Mathematics) and 114 (B.Sc. Computer Science) or 117 (B.Sc. Mathematics) units including SIWES for UTME and DE admission respectively. A transfer student must earn a minimum of 112 units and

iv. A passing grade is required in all compulsory courses. A student may take some Elective courses to meet graduation requirement.

17.0 FINAL CLASSIFICATION OF DEGREE

For the purpose of final classification of degree, a student should have achieved the following CGPA at the end of 159 or more units.

CGPA		CLASS OF DEGREE
4.50 – 5.00	-	First Class
3.50 – 4.49	-	Second Class (upper Division)
2.40 – 3-49	-	Second Class (Lower Division)
1.50 – 2.39	-	Third Class

18.0 SUMMARY OF CREDIT LOAD DISTRIBUTION BY SEMESTER AND LEVEL

18.1 B.Sc. Computer Science

LEVEL	SEMESTER		TOTAL CREDIT
	FIRST	SECOND	
100	24	20	44
200	23	22/24(D.E)	45/47
300	24	6	30
400	17	20	37
TOTAL	**U.T.M.E**		**156**
	D.E		**114**

18.2 B.Sc. Mathematics

LEVEL	SEMESTER		TOTAL CREDIT
	FIRST	SECOND	
100	24	20	44
200	23	20/22(D.E)	43/45
300	24	6	30
400	21	21	42
TOTAL	**U.T.M.E**		**162**
	D.E		**117**

19.0 COURSE CODING/NUMBERING/DESCRIPTION

Each course offered in Computer Science has as its prefix the letter CSC which indicates a Computer Science Course. The letter CSC is followed by a four digit numbers; the first digit indicates the level to which the course belongs, second the credit unit/ units and the last two digits indicates the serialization of the course in any given semester – an odd number indicates a first semester course whereas an even number indicates a second semester course.

19.1 B. Sc. Computer Science

100 LEVEL First semester

Code	Course Title	CU	P/req	L	T	P
MTH1301	General Mathematics I: Algebra and Trigonometry	3		3	1	
MTH1303	General Maths III: Vectors, Geometry and Dynamics	3		3	1	
CSC1301	Introduction to Computer Science	3		3	1	3
CSC 1203	IT Essentials: PC Hardware & Software	2		2	1	2
PHY 1311	Gen. Physics I (Mechanics, Thermal Physics and Waves)	3				
PHY 1171	General Physics Laboratory I	1				
CHM 1301	General Chemistry I	3				
BIO 1301	General Biology	3				
GST 1201	Communication in English I	2				
GST 1105	Introduction to Service – Learning I	1				
Total		24				

Second semester

Code	Course Title	CU	P/req	L	T	P
CSC 1302	Introduction to Problem Solving	3		3	1	3
MTH1302	General Mathematics II: Calculus	3		3	1	
STA 1202	Introductory Statistics	2		2	1	
STA 1304	Statistical Inference	3		3	1	
PHY 1322	Gen. Physics II (Electricity, Magnetism and Modern Phy.)	3				
PHY 1172	General Physics Laboratory II	1				
GST 1202	Communication in English II	2				
GST 1204	Use of library, studies skills and ICT	2				
GST 1106	Introduction to Service – Learning II	1				
Total		**20**				

200 LEVEL **First semester**

- Core courses

Code	Course Title	CU	Prerequisite	L	T	P
CSC 2301	Computer Programming I: Java	3	CSC 1301, CSC 1302	3	1	3
CSC 2303	Data Management I	3		3	1	3
CSC 2305	Operating System I	3		3	1	3
CSC2207	Computer Hardware	2	CSC 1203	2	1	2
CSC 2309	Discrete Structure	3			1	
MTH 2301	Mathematical Methods I	3				
MTH 2205	Linear Algebra I	2				
GST 2201	Nigerian People and Culture	2				
GST 2203	Entrepreneurship and Innovation I	2				
Total		**23**				

Second semester **Core courses**

Code	Course Title	CU	Prerequisite	L	T	P
CSC 2302	Computer Programming II: C++	3	CSC 1302	3	1	3
CSC 2304	Fundamentals of Data Structures	3	CSC 1302	3	1	3
CSC 2306	Foundation of Sequential Programming	3		3	1	3
CSC 2308	Internet Technology	3		3	1	3
MTH 2308	Introduction to Numerical Analysis I	3				
PHY 2342	Electric circuit and electronics	3				
GST 2202	Logic, Philosophy and Human Existence	2				
GST 2208	Peace Studies and Conflict Resolution	2				
*GST 1204	Use of Library, Study Skills and ICT	2				
	Total	**22/24**				

**Note: ***GST 1204 – Use of Library, Study Skills and ICT is for Direct Entry Students only

300 LEVEL First semester

- **Core courses**

Code	Course Title	U	Prerequisite	L	T	P
CSC 3301	Structured Programming	3	CSC 2301, CSC 2302	3	1	3
CSC 3303	Algorithm and Complexity Analysis	3	CSC 2304	3	1	3
CSC 3305	Data Management II	3	CSC 2303	3	1	3
CSC 3307	System Analysis and Design	3		3	1	3
CSC 3109	Survey of Computing in IT Industries	1				
CSC3315	Object Oriented Programming	3	CSC 2301, CSC 2302	3	1	3
CSC 3317	Computational Science and Numerical Methods	3		3	1	3
CSC 3319	Operating System II	3	CSC 2305	3	1	3
GST 3201	Enterprise Business Creation and Growth II	2				
Total		**24**				

Second semester

Code	Course Title	U	Prerequisite
CSC 3699	Students Industrial Work Experience Scheme (SIWES)	6	
Total		**6**	

400 LEVEL First semester

- **Core courses**

Code	Course Title	U	Prerequisite	L	T	P
CSC 4301	Software Engineering	3	CSC 3307	3	1	3
CSC 4303	Net-Centric Computing	3	CSC 2308	3	1	3
CSC 4305	Computer Architecture and Organization	3	CSC 1203, CSC 2207	3	1	3
CSC 4307	Compiler Construction	3		3	1	3
CSC 4309	Computer Networks and Communications	3		3	1	3
CSC 4211	Research Methods in Computing Sciences	2		2	1	2
Total		**17**				

Second semester

- **Core courses**

Code	Course Title	U	Prerequisite	L	T	P
CSC 4202	Human Computer Interface	2		2	1	2
CSC 4204	Formal Methods and Software Developments	2		2	1	2
CSC 4406	Survey and Organization of Programming Languages	4	CSC 3315, CSC 3301	4	1	3
CSC 4308	Artificial Intelligence	3		3	1	3
CSC 4699	Project	6				
Total		**17**				

- **Elective courses:** A minimum of 3 credit units from the following:

CSC 4310	Project Management	3 Units
CSC 4312	Operations Research	3 Units
CSC 4314	Optimization Techniques	3 Units
CSC 4315	Computer System performance	3 Units
CSC 4316	Computer Graphics and Visualization	3 Units
CSC 4317	Distributed Computing system	3 Units
CSC 4319	Formal models of computation	3 Units
CSC 4318	Computer Simulation	3 Units
CSC 4220	Computer Security and Privacy	2 Units

COURSE DESCRIPTIONS

CSC 1301: Introduction to Computer Science: (3 Units)

Status - Core

Overview of the discipline of computer Science; General Structure of a computer system; Historical development of Computer system; Generation of Computer systems; Computer Operations, Internal structure of computer Hardware, Characteristics of computer, micro computer technology, computer number system, computer arithmetic, computer data representation schemes, low and high languages, source and object programs, translators, storage, manipulations and retrieval of data. Internet and its facilities, basic file processing concepts. Introduction to Program development, flow charts and algorithms using BASIC fundamentals.

CSC 1302: Introduction to Problem Solving: (3 Units)

Pre-requisite – CSC 1301

Status - Core

Problem solving strategies, Role of algorithms in problem solving process, implementations strategies, concepts and properties of algorithm. Program: Development; Flow charts and algorithms; Program Objects. Operators, expression and assignment, conditional statement, Boolean expression, scope of identifier, lifetime of variable, Arrays. Student are expected to translate their algorithm, pseudocode, flowchart to VB language. Laboratory exercise using Visual Basic

CSC 1203: IT Essentials: PC Hardware and Software

Status - Core

Overview of information technology, Character User interface (with reference to MSDOS), Computer Installation, requirements, computer assembly step – by – step, basis of preventive maintenance and troubleshooting, operating system capabilities, identification and description of main components of laptops and portable devices and their basic maintenance. Basic preventive maintenance of printers and scanners. Fundamentals of networks: definition, types, technologies and importance. Replacement or upgrading personal computer components.

CSC 2301: Computer programming I: Java (3 Units)

Pre-requisite – CSC 1301, CSC 1302

Status - Core

Algorithm development, designing, coding, debugging and documentation programmes using techniques of a good programming language style, programming language and programming algorithm development.Creating, compiling and executing program, Anatomy of Application Program: comments, reserved words, modifiers, statements, blocks, classes, methods etc Primitive data types and operations, Control Statement, Methods, objects and classes. Arrays and vectors, String manipulations, creating user interface. Laboratory exercise using programminglanguage(Java) to implement variety of programs.

CSC 2303: Data Management I (3 units)

Status - Core

Introduction to DBMS Technology, Information storage & retrieval, Information management applications, Information capture and representation, analysis and indexing, search, retrieval, information privacy; integrity, security; scalability, efficiency and effectiveness. File processing.

Introduction to database systems: Components of database systems, DBMS functions, Database architecture and data independence, Entity Relational Model – concept and practice, interpretation and representation of case scenarios using ER tools. Use of database query language – forms and standard, DDL, DML and DCL command. Laboratory exercise using Structured Query Language.

CSC 2305: Operating System I (3 Units)

Status - Core

Overview of O/S: Definition, Role and Purpose, Types of operating Systems; real time (single – user/multi user), timesharing, functionality mechanisms to support Client – Server models, hand-held devices, concurrent programming batch vesus time sharing, multi processing systems; the supervisor, resources allocation and deallocation, interrupt and interrupt handling, momory organization, virtual momory& virtual machine, remote jobe entry, Design Issues influences of security, networking, multimedia, Windows. CPU Scheduling, Process Management, O/S Principles: Structuring methods Abstraction, Concepts of APIS device organization interrupts. Laboratory exercise using a microcomputer operating system, e.g. Windows, Linux

CSC 2207: Computer Hardware: (2 Units)

Status - Core

Computer circuits; diode arrays, PLAs, etc, Integrated circuits fabrication process. Use of MSI, LSI and VLSI IC hardware design. Primary and Secondary memories; core memory, etc. Magnetic devices; disks, tapes, video disks etc.Peripheral devices; printers, CRT's, keyboards, character recognition.Operational amplifiers; Analog-to-digital and digital-to-analog converter.Analog Computers: channels and interrupts.

CSC 2302: Computer Programming II using C++ (3 Units)

Pre-requisite – CSC 2301

Status - Core

Principles of good programming, structured programming concept, Introduction: History of C and C++. Basic structure of a C++ program: Generic form , Header files, Define constants, Main, Local variables, Basic input/output statements, Simple program. Variables, data types, and expressions. Program control, Arrays: One dimensional arrays, Multi dimensional arrays, String manipulation functions, Pointers. Debugging and testing, string processing, internal searching and sorting, recursion.Creating user interface and Object Linking and Embedded (OLE). Laboratory exercise using C++ programming language to implement variety of programs.

CSC 2304: Fundamentals of data Structures (3 Units)

Pre – requisite – CSC 2301, CSC 2302

Status - Core

Data Structure and representation, Basic data types. Relations between algorithm and data structure, linear data structure, Arrays, linear linked list, stacks and heap allocation, queues, tree structures, non-linear data structure applications. Graph, binary trees, transversal algorithm, multi-linked structure.Dynamic storage allocation and storage management. Searching and sorting algorithms. Symbols tables and hashing.Higher level language data-handing facilities.Implementation Strategies for stack, queues, trees. Run time Storage management; Pointers and References.Records Strings and String processing, Data representation in memory.

CSC 2309: Discrete Structure: (3 Units)

Basic set Theory: Basic definitions, Relations, Equivalence Relations Partition, Ordered Sets. Boolean Algebra& lattices, Logic, Graph Theory, Matrices; Integer and Real and matrices, Boolean Matrices, Path matrices. Adjacency matrices. Application to counting, Discrete probability Generating functions.

CSC 2306: Foundations of Sequential Program: (3 Units)

Pre – requisite – CSC 2301

Status - Core

The relationship between High-level languages and the Computer Architecture that underlies their implementation; fundamentals of compilation of computer programs to machine-executable code.The functional components of computer (CPU, memory, I/O) and their interactions.Representation of data in a computer; its manipulation at the machine-language level and in high-level languages.Assembly language and the manipulation of an assembler.Overall structure of a compiler and the functions of its components.Purpose and functions of linkers and loaders.Specification and recognition of regular languages and their use in lexical analysis; lexical analysis tools.Specification and parsing of context-free language; parsing tools.Semantic analysis and code generation for procedural languages.

CSC 2308: Internet Technology: (3 Units)

Status – Core

Pre-requisite - CSC 2301, **CSC 1301**, **CSC 2303**.

WWW: Definition, history and fundamental concepts. HTML: Document structure, images, maps, table, frames and forms. HTTP, TCP/IP, URL's server technology. JavaScript: Syntax, DOM, Form processing, common tasks. Style sheets: fundamentals CSS formatting, CSS positioning and standard. DHTML: Dynamic techniques, proprietary techniques. Web design and usability: principle of navigation, usability, style grids and standard. Multimedia: Audio, animation, multimedia server and protocol technology. Web programming-Introduction to PHP – SQL – Connecting Databases using ODBC – files – forms – images – Imap object.Web development tools: Editors, site management tools. Laboratory exercise and group project on web development to meet the needs of the society (service learning).

CSC 2312: Theory of Computation: (3 Units)

Status - elective

Finite Automata, Turning machine, Recursively enumerable sets, Halting problem, computation and Decidable. Predicate logic validity problem, Deduction, Herbands procedure, Robinson's resolution rule. Program verification; formal semantics.Chomsky hierarchy, regular, context sensitive and unrestricted grammars, characterization closure properties, algorithms and limitations.Models of computation, universal machines.Unsolvable problems, Church's thesis, Digital arguments.Reductibility, complexity classes.

CSC 3301: Structured Programming: (3 Units)

Pre-requisite – CSC 2301, CSC 2302

Status - Core

Structured Programming elements, structured design principles, abstraction modularity, stepwise refinement, structured design techniques. Teaching of a structured programming language, e.g. C++/JAVA.Laboratory exercises using the programming language.

CSC 3305: Data Management II: (3 Units)

Pre-requisite – CSC 2303

Status - Core

Relational Databases, Mapping conceptual schema to relational Schema; Database Query languages (SQL), Normalization, concept of functional dependencies & multi – valued dependencies.Transaction processing; Concurrency Control, Distributed databases.create Database, select database, create tables, drop tables, insert records, update records, delete records, WHERE clause, Like clause, sorting data. Laboratory exercise.

CSC 3303: Algorithms and Complexity Analysis: (3 Units)

Pre-requisite – CSC 2306

Status - Core

Basic algorithmic analysis: Asymptotic analysis of Upper and average complexity bounds; standard complexity classes time and space tradeoffs in algorithms analysis recursive algorithms.

Algorithmic Strategies: Fundamental computing algorithms; Numerical algorithms, sequential and binary search algorithms, Binary Search trees, Hash tables, graphs & its representation.

CSC 3307: Systems Analysis and Design: (3 Units)

Status - Core

System Concept; System Development Life Cycle, project identification and selection; system requirements analysis and feasibility study.

Analysis: Fact gathering Techniques, data flow diagrams, Process description, data modelling.

System Design: Structured charts, form designs, Security, automated Tools for design. Analysis techniques and tools e.g. Jackson System Development (JSD) techniques etc. HIPO Charts. Business system design; procurement, site preparation, system installation, system testing, system conversion; system project, report writing and presentation; system documentation; post installation evaluation; compilation of a real life systems analysis team project to provide experience in applying the principles and techniques presented above.

CSC 3109: Survey of Computing in IT Industries: (1 Units)

Status - Core

Students will be introduced to computing practices in industries through visitations to selected IT sections of governmental and non-governmental organisations. There will be no end of semester examinations for this course but students are to write and defend report after the visitation, which shall be used for the semester assessment and grading.

CSC 3315: Object – Oriented Programming (3 Units)

Pre-requisite: CSC 2301, CSC 2302

Status - Core

Basic OOP concepts; Classes, Objects, inheritance, polymorphism, Data Abstraction, Tools for developing, Compiling, interpreting and debugging, Java Programs, Java Syntax and data objects, operators. Central flow constructs, objects and classes programming, Arrays, methods, Exceptions handling, Applets and the Abstract, File input and output, Connection to database from java, Persistence, Window Toolkit, Laboratory exercise in an OOP language(Java). Student are to develop programs (e.g. student records, staff payroll, supermarket inventory system, etc) using the concept of OOP and Database connectivity.

CSC 3317: Computational Science and Numerical Methods: (3 Units)

Status - Core

An introduction to Scientific Computing using Matlab/Octave covering the fundamental programming concepts (data types, abstraction, control structures, I/O, modules) and demonstrating the use of Matlab/Octave to solve scientific computing problems from a variety of disciplines including physics, chemistry, biology, computer science, and mathematics. Topics to be covered include plotting, curve fitting, image processing, optimization, integration, differentiation, statistical analysis, ODE solving, and simulation.

CSC 3319: Operating System II: (3 Units)

Pre-requisite – CSC 2305

Status - Core

Concurrency: States and State diagram Structures, Dispatching and context switching; interrupts; Concurrent execution; mutual exclusion problem and some solution Deadlock; Models and mechanisms (Semaphores, monitors etc.). Producer – consumer Problems & Synchronization, P & V operations, resource protection. Multiprocessor issues. Scheduling & dispatching, Memory Management: Overlays, Swapping and Partitions, Paging and Segmentation Placement & replacement policies, working sets and Trashing, caching.

CSC 3699: Students Industrial Work Experience Scheme: (6 Units)

Pre-requisite – CSC 3109

Status - Core

Students are to undergo a six (6) months industrial training in an IT related firms. A technical report which will be defended by the students in form of a seminar must be submitted at the end of the exercise. Students' reports will be presented in a seminar.

CSC 4301: Software Engineering: (3 Units)

Pre-requisite – CSC 3307

Status - Core

Introduction, organization of software projects: project models, software project life cycle, Software Design: Software architecture, Design patterns, O.O. analysis & Design, Design for re-use. Using APIS: API programming Class browsers and related tools, Component based computing. Software tools and Environment: Requirements analysis and design modelingTools, Testing Tools, Tool integration mechanisms, Use of CASE tools - UML and UML extension.

CSC 4303: Net-Centric Computing: (3 Units)

Pre-requisite – CSC 2308

Status - Core

Distributed Computing, Mobile & Wireless computing, Network Security; Client/Server Computing (using the web), building Web Applications.

CSC 4305: Computer Architecture and Organization (3 Units)

Pre-requisite – CSC 1207

Status - Core

Fundamental building blocks, logic expressive immunization, sum of product forms. Register transfer notation, Physical considerations. Data representation, and number bases, Fixed and Floating point systems, representation memory systems organization and architecture.

Memory system, general; characteristics of memory operation, (Technology-magnetic recording semi-conductor memory, coupled devices, magnetic bubble).Memory addressing, memory hierarchy, virtual memory control systems, Hardware control, micro programmed control, Asynchronous control, i/c control. Introduction to the methodology of fault tolerant computing.

CSC 4307: Compiler Construction: (3 Units)

Pre-requisite – CSC 3307

Status - Core

Review of compilers, assemblers and interpreters, structure and functional aspects of a typical compiler, syntax semantics and pragmatics, functional relationship between lexical analysis, expression analysis and code generation. Internal form of course programme. Error detection and recovery. Grammars and languages: the parsing problem. The scanner. Grammar and language recognizers, Top down and bottom-up, L-R grammars and analysers, construction of LR table, organization of symbol tables. Code generation and optimization. Use of a standard compiler as a working vehicle. Laboratory exercises leading to the production of major parts of a compiler for an actual programming language.

CSC 4309: Computer Networks and Communication: (3 Units)

Status – Core

Introduction, wares, Fourier analysis, measure of communication, channel characteristics, transmission media, noise and distortion, modulation and demodulation, multiplexing, TDM FDM and FCM Parallel and serial transmission (synchronous Vs asynchronous).TCP/IP

modelBus structures and loop systems, computer network Examples and design consideration, data switching principles broadcast techniques, network structure for packet switching, protocols, description of network e.g. ARPANET, etc.

CSC 4211: Research Methods in Computer Science: (2 Units)

Status - Core

Introduction and overview of the research in computing, the nature of Computer science research, what makes good research in computing science,searching for information on www and libraries, information gathering, Reading and understanding research paper, reviewing Research literatures, Technical writing, referencing, bibliographies, Presentation skills, written and oral, Choosing or proposing a project, Project planning, tools and techniques for planning, Project conduct, time management, risk management, team working, Commercial and economic considerations in IT research and IT industry.Review of legal, ethical, social and professional (LSEP) issues including data protection and standards.

CSC 4202: Human Computer Interface (HCI) (2 Units)

Status - Core

Foundations of HCI, Why is HCI needed? Human information processing and human error models of the user and interaction, Principles of GUI, GUI toolkits; Human centered software evaluation and development; GUI design, guidelines, standards, metrics and programming. Usability issues and the world wide web.

CSC 4304: Formal Methods and Software Developments (3 Units)

Pre –requisite – CSC 4301

Status - Core

Paradigms of software development traditional and automation-based software engineering processes. Cases tools and programming support environments. Specification and prototype: formal specification versus prototype; specification methods (SADT, HOOD, VDM, Z,..), Abstract data types: algebraic specification; semantic, completion and consistency, object oriented system.

CSC 4406: Survey and Organization of Programming Languages: (3 Units)

Pre-requisite – CSC 2301, CSC 2302, CSC 3301

Status - Core

Overview of programming languages: History of programming languages, Brief survey of programming paradigms (Procedural languages, Object-oriented languages, Functional languages, Declarative – non algorithmic languages, Scripting languages), the effects of scale on programming methodology; language description: Syntactic Structure (Expression notations, abstract Syntax Tress, Lexical Syntax, Grammars for Expressions, Variant of Grammars), Language Semantics (Information semantics, Overview of formal semantics, Denotation semantics, Axiomatic semantics, Operational semantic); Declarations and types: The concept of types, Declaration models (binding, visibility, scope and lifetime), Overview of type-checking, Garbage collection; Abstraction mechanisms; Procedures, function, and iterations as abstraction mechanisms, Parameterization mechanisms (reference vs. value), Activation records and storage management. Type parameters and parameterized types. Modules in programming languages; Object oriented language paradigm; Functional and logic language paradigms.

Organization of programming Language: Language definition structure. Data types and structures, Review of basic data types, including lists and tress, control structure and data flow, run-time consideration, interpretative languages, lexical analysis and parsing.

CSC 4308: Artificiel Intelligence: (3 Units)

Status - Core

Introduction to Artificial Intelligence, Search control, Games trees, understanding natural languages, knowledge representation, expert systems, pattern recognition. Laboratory Exercise in AI language e.g. LISP/Prolog.

CSC 4310: Project Management: (3 Units)

Status - elective

Team Management, project scheduling, Software measurement and estimation techniques, risk analysis, Software quality assurance, Software Configuration Management, Project Management tools.

CSC 4312: Operations Research: (3 Units)
Status - elective

Phases of operations Research study. Classification of operations research models, linear; Dynamic and integer programming.Decision Theory. Inventory Models, Critical Path Analysis and project Controls.

CSC 4315: Computer System Performance: (3 Units)

Status - elective

Measurement techniques, simulation techniques; workload characterization, performance evaluation in selection problems, performance evaluation in design problems, evaluation of programme performance.

CSC 3318: Computer Graphics and Visualization: (3 Units)

Status – elective

Hardware aspect, plotters microfilm, plotters display, graphics tablets, light pens, other graphical input aids Facsimile and its problems Refresh display refresh huggers, changing images, light pen interaction. Two and three dimensional transformation, perspective clipping algorithms. Hidden line removal bolded surface removal. Warmock's method, shading, data reduction for graphical input. Introduction to hand writing and character recognition. Curve synthesis and fitting Contouring. Ring structures versus doubly linked lists. Hierarchical Structures. Data structure: Organization for interceptive graphics.

CSC 4317: Distributed Computing Systems: (3 Units)

Status - elective

Introduction: Definitions, Motivation; Communication Mechanisms: Communication protocols, RPC, RMI, Stream Oriented Communication; Synchronization: Global State, Election, Distributed Mutual Exclusion, Distributed Transactions; Naming: Generic Schemes, DNS, Naming and Localization; Replication and Coherence: Consistency Models and Protocols; Fault Tolerance: Group Communication, two and Thee phase Commit. Check pointing; Security; Access Control, Key Management, Cryptography; Distributed File Systems: NFS, Coda etc.

CSC 4318: Computer Simulations (3 Units)

Status - elective

Basic Definitions and uses, Simulation process, Some basic statistic Distributions Theory, Model and Simulation. Queues; Basic components, Kendal notation, Queuing rules, Little's Law, Queuing networks, Special/types of queues. Stochastic Processes; Discrete state and continuous state processes, Markov processes, Birth-death process, Poisson Processes. Random Numbers; types of Random Number Exercises.

CSC 4319: Formal Models of Computation (3 Units)

Status - elective

Automata Theory: Roles of models in computation finite state Automata, Push-down Automata, Formal Grammars, Parsing, Relative Powers of formal models. Basic computability: Turing machines, Universal Turing-Machines, Church's thesis, solvability and Decidability.

CSC 4220: Computer Security and Privacy(2 Units)

Status - elective

Introduction to Computer Security and privacy issues in various aspects of computing: meaning, comparing security with privacy; types of threats and attacks; methods of defense. Program Security: secure program; nonmalicious program errors; malicious code; control against program threats. Operating System security: methods of protection; access control, user authentication, Network Security, Database Security and privacy. Physical security, economic security, legal and ethical issues.

CSC 4699: Project (6 Units)

Pre – requisite - CSC 4311

Status - Core

Students should embark on work that will lead to substantial software development under the supervision of a member of staff in the field of Computer Science. It will spread over both semesters.

19.2 B. Sc. Mathematics

100 LEVEL: First Semester

Code	Course Title	CU	P/req	L	T	P
MTH1301	General Mathematics I: Algebra and Trigonometry	3		3	1	
MTH1303	General Mathematics III: Vectors, Geometry and Dynamics	3		3	1	
CSC1301	Introduction to Computer Science	3				
CSC 1203	IT Essentials: PC Hardware & Software	2				
PHY 1311	General Physics I (Mechanics, Thermal Physics and Waves)	3				
PHY 1171	General Physics Laboratory I	1				
CHM 1301	General Chemistry I	3				
BIO 1301	General Biology	3				
GST 1201	Communication in English I	2				
GST 1105	Introduction to Service – Learning I	1				
Total		24				

100 LEVEL: Second Semester

Code	Course Title	CU	P/req	L	T	P
CSC 1302	Introduction to Problem Solving	3				
MTH1302	General Mathematics II: Calculus	3		3	1	
STA 1202	Introductory Statistics	2		2	1	
STA 1304	Statistical Inference	3		3	1	
PHY 1322	Gen. Physics II (Electricity, Magnetism and Modern Phy.)	3				
PHY 1172	General Physics Laboratory II	1				
GST 1202	Communication in English II	2				
GST 1204	Use of library, Studies skills and ICT	2				
GST 1106	Introduction to Service – Learning II	1				
Total		**20**				

200 LEVEL: First Semester
Core courses

Code	Course Title	CU	Prerequisite	L	T	P
MTH2301	Mathematical Methods I	3	MTH1302	3	1	
MTH2303	Sets Logic and Algebra	3	MTH 1301	3	1	
MTH2205	Linear Algebra I	2		2	1	
MTH2307	Real Analysis I	3	MTH1301	3	1	
MTH 2309	Vector and Tensor Analysis	3		3	1	
CSC2301	Computer Programming I: Java	3				
STA2201	Probability I	2	STA1202	2	1	
GST 2201	Nigerian People and Culture	2				
GST2203	Entrepreneurship and Innovation I	2				
Total		**23**				

200 LEVEL: Second Semester
Core courses

Code	Course Title	CU	Prerequisite	L	T	P
MTH2302	Ordinary Differential Equations I	3	MTH1302	3	1	
MTH2204	Linear Algebra II	2		2	1	
MTH2306	Real Analysis II	3	MTH1301	2	1	
MTH2308	Introduction to Numerical Analysis I	3		3	1	3
CSC2302	Computer Programming II: C++	3				
STA 2202	Probability II	2	STA1202	2	1	
GST 2202	Logic, Philosophy and Human Existence	2				
GST 2208	Peace Studies and Conflict Resolution	2				
***GST 1204**	Use of Library, Study Skills and ICT	2				
Total		**20/22**				

Note: *GST 1204 – is only for Direct Entry Students (D.E)

300 LEVEL: First Semester

- **Core courses**

Code	Course Title	CU	Prerequisite	L	T	P
MTH3301	Mathematical Methods II	3	MTH2301	3	1	
MTH3303	Metric Space and Topology	3	MTH2307	3	1	
MTH3305	Abstract Algebra I	3	MTH2303	3	1	
MTH3307	Complex Analysis I	3	MTH1304	3	1	
MTH3209	Ordinary Differential Equation II	2	MTH2301	3	1	
MTH3211	Introduction to Mathematical Modeling	2	MTH1303	2	1	2
MTH3313	Numerical Analysis II	3	MTH2310	3	1	
MTH 3315	Discrete Mathematics	3		3	1	
GST 3201	Enterprise Business Creation and Growth II	2				
Total		**24**				

300 LEVEL: Second Semester

Code	Course Title	CU
MTH3699	Students Industrial Work Experience Scheme	6
Total		**6**

400 LEVEL: First Semester

Core courses

Code	Course Title	CU	Prerequisite	L	T	P
MTH4301	Theory of Ordinary Differential Equations	3	MTH3309	3	1	
MTH4303	General Topology	3	MTH3303	3	1	
MTH4305	Theory of Finite Groups	3	MTH3305	3	1	
MTH4307	Functional Analysis	3	MTH2306	3	1	
MTH4309	Hydrodynamics I	3	MTH2301,MTH3301	3	1	
MTH4311	Number Theory	3	MTH 2303	3	1	
MTH4317	Abstract Algebra II	3	MTH 3305	3	1	
Total		**21**				

400 LEVEL: Second Semester

Core Courses

Code	Course Title	CU	Prerequisite	L	T	P
MTH4699	Project	6	MTH3699			
MTH4302	Theory Partial Differential Equations	3	MTH2302,MTH3309	3	1	
MTH4304	Lebesgue Measure and Integration	3	MTH2306,MTH2307	3	1	
MTH 4306	Representation of finite groups	3	MTH 3305	3	1	
MTH 4312	Complex Analysis II	3	MTH 3307	3	1	
Total		**18**				

Elective courses: a minimum of 3 credit units should be selected from first semester or second semester

400 LEVEL: ***First Semester***

Code	Course Title	CU	Prerequisite
MTH4313	Analytical Dynamics	3	MTH 2308/ MTH 3301
MTH4315	Quantum Mechanics	3	MTH 2308/ MTH 3301

400 LEVEL: ***Second Semester***

Code	Course Title	CU	Prerequisite
MTH4308	Fluid Dynamics	3	MTH2308/ MTH3301
MTH4310	Mathematical Methods III		MTH3301
MTH4314	Measure Theory	3	MTH2306
MTH4316	Abstract Algebra III	3	MTH3305
MTH4318	Introduction to Operations Research	3	MTH 2301

COURSE DESCRIPTIONS

MTH 1301: **General Mathematics I: Algebra and Trigonometry (3 Units)**
Status: *Core*
Prerequisite: *O/Level Mathematics*

Elementary set theory, subsets, union, intersection, complements, venn diagrams. Real numbers; integers, rational and irrational numbers, mathematic I, induction real sequences and series, theory of quadratic equations, binomial theorem. Complex numbers; algebra of complex numbers; the Argand Diagram. Re Moivre's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formalae.

MTH 1302: **General Mathematics II: Calculus (3 Units)**
Status: *Core*

Calculus: Function of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation. Extreme curve sketching; Integration as an inverse of differentiation. Methods of integration, Definite integrals. Application to areas, volumes.

MTH 1303: General Mathematics III: Vectors, Geometry and Dynamics (3 Units)

Status: *Core*
Prerequisite: *O/Level Mathematics*

Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, Scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normals. Elementary Mathematics IV. Impact of two smooth sphere, and of a sphere on a smooth sphere.

STA 1202: Introductory Statistics (2 Units)
Prerequisite: O/*Level Mathematics*

Nature of statistics, its definition, importance and limitations, types of statistical data, the primary and secondary data, methods of collecting primary data, graphical and diagrammatic representations of data, the frequency distribution, nature of frequency curves, characteristics of a frequency distribution, central tendency, dispersion, skewness and kurtosis along with their measures, essential requisites of an ideal measure, simple motions of probability, theory of attributes.

STA 1304: Statistical Inference (3 Units)
Prerequisite: *O/Level Mathematics*

Population and samples. Random sampling Distribution, estimation (Point and interval) and Tests of hypotheses concerning population mean and proportion (one and two large sample cases). Regression and Correlation. Elementary time series analysis.

200 LEVEL

MTH 2301: Mathematical Methods I (3 Units)
Prerequisite: *MTH 1302*

Applications of Calculus: Revision of different techniques of differentiation, successive differentiation, Leibniz's theorem, Taylor and Maclaurin series Curvature, definite integrals. Methods of integration, reduction formulae.
Differential Equations: Concept of differential equations. First order ordinary differential equations of the forms; variable separable, homogeneous, exact and linear. Second order ordinary linear differential equations with constant coefficients, auxiliary equation, and cases of auxiliary equations having distinct, equal, and complex roots, complementary functions and particular integrals in connection with non-homogeneous equations. Uses of the operator D = d/dx and the method of undetermined coefficients for calculating particular integrals, differential equations of Euler's type of second order.

MTH 2302: Ordinary Differential Equation I (3 Units)
Status: *Core*
Prerequisite: *MTH 1302*

Derivation of differential equations from primitive, geometry, physics etc. order and degree of differential equation. Techniques for solving first and second order linear and non – linear equations. Solutions of systems of first order linear equations. Finite linear difference equations. Application to geometry and physics.
Solutions of systems of two linear differential equations, Second order Ordinary Linear Differential Equations with variable coefficients; reduction of order, variation of parameters.

MTH 2303: Sets Logic and Algebra (3 Units)
Prerequisite: *MTH 1301/ MTH 1304*

Introduction to the language and concepts of modern Mathematics. Topics include; Basic set theory: mappings, relations, equivalence and other relations, Cartesian products. Binary logic, methods of proof. Binary operations. Algebraic structures, semigroups, rings, integral domains fields. Homeomaphics. Number systems; properties of integers, rationals, real and complex numbers.

MTH 2204: Linear Algebra II (2 Units)
Prerequisite: *MTH 1301/MTH 1304*

Linear Mappings and Matrices: General linear transformation of n-dimensional into m-dimensional space, matrix representation of a linear map, similar matrices and change of basis. Eigenvalue and eigenvectors. Characteristic polynomial and characteristic equation. Caley-Hamilton theorem. Orthogonal diagonalisation
Canonical Forms: Primary decomposition theorem, Triangular Jordan and Rational forms for linear operator (square matrices). Quadratic and bilinear forms.

MTH 2205: Linear Algebra I (2 Units)
Status: *Core*
Prerequisite: *MTH 1301*

Vector Spaces: Basic definitions and examples of vector spaces. Subspaces, linear dependence and independence. Bases, dimension of a vector space. Homomorphism and quotient space. Direct sum, Dual spaces.
Matrices: Definition, types of matrices, algebra of matrices, matrix as a sum of symmetric and skew symmetric matrices. Elementary operations of matrices and echelon form, equivalent matrices. Inverse of a matrix.
Systems of linear equations and matrices: Systems of m linear equations in n unknowns and their solutions. Gaussian elimination by pivot method and matrix representation. Solution of the system using Gaussian elimination and Gauss-Jordan reduction.
Determinants: Definition, evaluation of determinants, cofactor expansion, inverse of a non-singular matrix, solution of systems of linear equations using Cramer's rule.

MTH 2306: Real Analysis II (3 Units)
Status: *Core*
Prerequisites: *MTH 1301*

Real Functions of one Variable: Limits of functions. Improper limits (limits at $+\infty$ and $-\infty$). Algebraic operations on limits of functions, Continuity of functions on sets and related results, Uniform continuity.
Derivatives: derivative of functions derivative of composition of functions. Higher order derivatives. Algebraic operations on derivatives of functions. Differentiability and some related results. Rolle's and Mean value theorems, Taylor's formula, L'Hospital's rule, local and global extrema, saddle points, monotonicity, geometrical interpretations.
Riemann Integration: Partition of an interval, refinement, Riemann sums, Riemann integrals, uniqueness of Riemann integral, Darbouxintegral of a real valued function, relation between Riemann and Darboux integrals.

MTH 2307: Real Analysis I (3 Units)
Status: *Core*
Prerequisites: *MTH 1301*

Preliminaries: Properties of real numbers, algebraic and topological properties, identity theorem, density theorem for Q and R Ordering and properties.
Boundedness: Boundedness and related simple results.
Relations and Functions: Cartesian products of sets.
Relations: equivalence relations, equivalence classes.
Functions: injective, surjective, bijective, inverse, composition of functions, monotone functions, graph of functions, algebraic operations on functions.
Sequences and series of Real Numbers: Sequences of real numbers, subsequences, bounded and unbounded sequences.
Limit of a sequence; limit superior and limit inferior, improper limits. Algebraic operations on sequences and their limits; Monotone sequences and properties.Cauchy sequences and related results.
Series of real numbers: partial sums, convergence, absolute and conditional convergences.
Convergence tests: comparison, ratio, Ra'abe, De-Morgan and Betrand, logarithmic, Cauchy root test. Cauchy condition for the convergence of series, rearrangement of series.

MTH 2308: Introduction to Numerical Analysis I (3 Units)

Status: *Core*
Prerequisite: *MTH 1302*

Accuracy in Numerical Calculations: Types of errors and their sources, error accumulation in different operations.
Solution of Equations: Numerical solutions of Algebraic and transcendental equations.
Finite Differences: Difference operators and Difference table, separation of symbols.

Interpolation: Interpolation formulae for equal and unequal intervals, Central Difference Formulae, Numerical Differentiation, Numerical Integration, Summation of Series.

MTH 2309: Vector and Tensor Analysis (2 Units)
Prerequisite: *O/Level Mathematics*

Vectors: Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar multiplication, linear independence and dependence of vectors. Scalar and vector products of vectors. Differentiation and integration of vectors w.r.t a scalar variable.
Tensor products of vector spaces. Tensor algebra.Symmetry. Gartesiantensers.

STA 2201: Probability I (2 Units)
Prerequisites: *STA 1202*
Status: *Core*

Various definitions of probability, Baye's theorem, and concepts of probability function, probability density function, cumulative probability density function and moment generating function, univariate probability distributions such as Bernouli distribution, Binomial and Poisson distribution, geometric distributions, negative binomial distribution, hypergeometric distribution, Poisson and geometric distributions.

STA 2202: **Probability II (2 Units)**
Prerequisites: *STA 2201*

Univariate continuous probability distributions such as Normal, Uniform, exponential, beta and gamma distributions, various properties of these distributions, fitting of normal distribution. Concept of Bi-variate probability distribution, joint, marginal and conditional probability distribution. The multiple and partial regression and correlation (for 3 variables case only).

300 LEVEL
MTH 3301: Mathematical Methods II (3 Units)
Status: *Core*
Prerequisites: *MTH 2301*

Vector Fields: Revision of definitions and elementary results related to vectors; gradient, divergence and curl in different co-ordinate systems. Multiple integrals; areas and volumes, Surface and Line integrals; Stokes theorem, Divergence theorem.Green's theorem.

Fourier Series: Definition, computation of Fourier coefficients, expansions of evenand odd functions, change of period, half period expansion, Fourier transform.

Laplace Transform: Definition, elementary formulae, convolution theorem, application of solutions of ordinary differential equations.

MTH 3303: Metric Space and Topology (3 Units)
Prerequisite: *MTH 2307*

Sets, matrics, and examples. Open spheres (or balls). Open sets and neighbourhoods. Closed sets. Interior, exterior, frontier, limit points and closure of a set. Dense subsets and separable space. Convergence in metric space homeomorphisms. Continuity and compactness, connectedness. Baire's category theorem.

MTH 3305: Abstract Algebra I (3 Units)
Status: *Core*
Prerequisite: *MTH 2303*

Group: definition, examples including permutation grounds. Subgroups, cosets.Legranges theorem and applications.Cyclic groups. Rings: definition examples including Z, Zn, rings of polynomials and matrices. Integral domains, fields. Polynomial rings, factorization. Euclidean algorithm for polynomials H.C.F. and L.C.M. of polynomials.Groups , Algorithms and Programming.

MTH 3307: Complex Analysis I (3 Units)
Status: *Core*
Prerequisite: *MTH1304*

Sequences and Series of Complex Numbers: Definition of sequences and series of complex numbers, properties of convergence, uniform and absolute convergence of sequences of complex numbers. Algebraic operations on limits of sequences.
Limit, Continuity and Differentiability of Complex Functions: Definition of Complex function. Properties of continuous complex functions. Limit of a complex function and its properties. Continuity of a complex function. Differentiation of a complex function. Analytic and entire functions. Laplace and Cauchy-Riemann equations. Elementary functions (exponential, trigonometric, logarithmic, rational, power and hyperbolic functions) Harmonic functions.
Complex Integration: Definition and properties of complex integration. Cauchy integral theorem, Cauchy formulae. Contour integration: Integration of complex functions along a continuously differentiable arc, along a piece wise, differentiable arc and along a rectifiable arc. Cauchy-Goursat theorem

MTH 3209: Ordinary Differential Equation II (2 Units)
Status: *Core*
Prerequisite: *MTH 2301*

Ordinary differential equations: linear dependence, wronskian, reduction order, variation of parameters, series solution about ordinary and regular points. Special functions: Gamma, Beta, Bessel, Lengendre's and Hyper-geometric functions.
Partial Differentiation: Real valued functions of two and three variables. Partial derivatives, chain rule, Jacobian, Extrema, Lagrange's multipliers.

MTH 3211: Introduction to Mathematical Modelling (2 Units)
Status: *Core*
Prerequisite: *MTH 1303*

Methodology of model building; identification, formulation and solution of problems, cause-effect diagrams. Equation types: Algebraic, ordinary differential, partial differential, difference, integral and functional equations. Application of mathematical models to pluprical, biological, social and behavioural sciences.

MTH 3313: Numerical Analysis II (3 Units)
Status: Core
Prerequisite: *MTH 2310*

Solution of simultaneous equations and other linear system of equations: Eigenvalues and Eigenvectors.
Numerical solutions of ordinary differential equations: Euler's, Picard's, Taylor's and Runge-Kutta methods, predictor – corrector method, Introduction to numerical solution of partial differential equations.

MTH 3315: Discrete Mathematics (3 Units)
Status: *Elective*
Prerequisite: *MTH 2303*

Group and subgroups; Group Axioms, permutation Group, Cosets, Graph; directed and undirected graphs, subgroups, cycles, connectivity, Application (flow Charts) and state transition graphs; lattices and Boolean Algebra, Finite fields: Mini polynomials. Irreducible polynomials, polynomial roots, Application (error correction codes, sequences generators).

MTH 3319: Real Analysis III (3 Units)
Status: *Elective*
Prerequisite: *MTH 2306*

Uniform Convergence of Sequences and Series of Functions: Pointwise and uniform convergences, Cauchy's general principle of uniform convergence, test for uniform convergence; Mn -test, Weistrass M-test, Abel's test, Dirichlet's test. Uniform convergence and continuity, Dini's theorem. Integrability of uniform limit of a uniformly convergence series of integrable functions, term by term integration. Uniform convergence and differentiability.Weierstrass's continuous non-differentiable function.Uniform convergence of power series.
Functions of Bounded Variation and their Properties: Variation function of a function of bounded variation, Jordan's theorem.
Riemann – Stieltjes Integral: Stieltjes integral and its various generalizations, conditions of integrability, integration by parts. First mean value theorem, second mean value theorem. Differentiation under the integral sign.

MTH 3699 : **Students Industrial Work Experience Scheme (SIWES) – (6 Units)**
Status: *Core*

It is a six-month practical training course to be undertaken by each student in an industry after the completion of the first semester of 300 level. The scheme is called Students Industrial Work Experience Scheme (SIWES). At the end of the training the students are required to submit a report about what he / she has learnt during this practical industrial training.

400 LEVEL

MTH 4301: Theory of Ordinary Differential Equations (3 Units)
Status: *Core*
Prerequisite : *MTH 3309*

Differential equations: existence and uniqueness theorems dependence of solution on initial data and parameters. Properties of solutions. Sturm comparison and Sonin – Polya theorems. Linear and non – linear systems. Floguet's theory and stability theory, integral equations: classification, volterra and fredlhom types Neumann series. Fredholm alternative for degenerate Hilbert – Schmidt kernels. Reduction of ordinary differential equations to integral equations. Symmetric kernels, eigen function expansion with application.

MTH 4302: Partial Differential Equations (3 Units)
Status: *Core*
Prerequisite: *MTH 2302/MTH 3309*

Basic concepts. Theory and solutions of first and second order linear equations; wave, heat and Laplace equations in Cartesian and polar coordinates, classifications, characteristics, canonical forms. Cauchy problems.Elliptic equations; Laplace and Poisson formulae, solution in cylindrical, polar and spherical coordinates.Hyperbolic and parabolic equations.Green's function, harmonic function, properties.

MTH 4303: General Topology I (3 Units)
Status: *Core*
Prerequisite: *MTH 3303*

Topological Spaces: Definition and examples of topological spaces, open and closed sets, neighborhoods, limits (cluster) points, interior and closure of a set, boundary, coarser and finer topologies, Bases and Subbasis. Subspaces of Topological spaces. Product topology. Quotient topology.First and second countable spaces. Separable spaces. Separation axioms. Topology of metric spaces. Convergence of sequence in a topological space, pointwise and uniform convergence, limit of functions at given points. Limit of functions in first countable Hausdorff spaces.
Continuous mappings: Continuity in metric spaces, Open and closed mappings, Homeomorprohism. Topological invariants.
Connectedness: Union, product, closure of connected sets Intervals as connected subsets of the real line. Image of connected sets under continuous mappings.Connected components.

MTH 4304: Lebesgue Measure and Integration (3 Units)
Status: *Core*
Prerequisite: *MTH 2307/MTH 2306*

Lebesgue measure; measurable and non-measurable sets. Measurable functions. Lebesgue integral: Integration of non-negative functions, the general integral convergence theorems.

MTH 4305: Theory of Finite Groups (3 Units)
Status: *Core*
Prerequisite: *MTH 3305*

Arithmetic Structures of groups: Definition and example of p-groups. Sylow p-subgroup, Sylow's theorems (proofs and applications).Determination of all groups of low order, up to order 15.
Isomomorphism theorems: First, second and third isomorphism theorems, Free groups, Groups of automorphisms. Group action on a set.Burnside lemma.Structure theory of Abelian groups. Free Abelian groups.
Normal Structure of groups: Composition series, derived series, Jordan – Hölder theorem. Soluble and Nilpotent groups. Groups, Algorithms and Programming.

MTH 4306: Representation Theory of Finite Groups (3 Units)
Status: *Core*
Prerequisite: *MTH 3305*

Introduction: Historical background. Types of representations, permutations, automophism and matrix (principle, linear and faithful), equivalent representations, G – submodules, G – homomorphisms.
Reducible representation: Reducibility and G – submodules, irreducibility, Maschke's theorem. Complete reducibility and direct sum of G – submodules. Canonical decomposition of representations. The regular representation.The Schur's Lemma.The commutant algebra. Tensor products of matrices. The group algebra (KG).Decomposition of the regular representations. Number of inequivalent irreducible representations of a group is equal to the number of the distinct conjugacy classes. Lifting process, induced representation.
Character Theory: Definition and elementary properties of characters, class function, orthogonality relations, character relations of the first and second kind. Linear characters, irreducible characters. The character table, induced characters, lifted characters. Groups, Algorithms and Programming.

MTH 4307: **Functional Analysis (3 Units)**
Status: *Core*
Prerequisite: *MTH 2306*

Metric Spaces: Separability, Completeness and compactness, contraction mapping theorem. Arzela – Ascoli lemma.Stone-Weierstrass theorem.

Normed Spaces: Linear spaces, Norm function, Normed Linear boundedness principle. Open mapping and closed graph.
Hilbert Spaces: Definition and examples of Inner product spaces and Hilbert spaces, projection theorem, Riez representation theorem.

MTH 4308: Fluid Dynamics (3 Units)
Status: *Elective*
Prerequisite: *MTH 2308/ MTH 3301*

Real and Ideal fluids.Differentiation following the motion of fluid particles. Equations of motion and continuity for incompressible invisoid fluids. Velocity potentials and Stoke's Stream functions. Berboulli's equation with application to flow along curved paths. Kinetic energy. Sources, links, doubles in 2-and-3-dimensions, limiting streamlines. Images and rigid planes.

MTH 4309 : **Hydrodynamics (3 Units)**
Status: *Core*
Prerequisite: *MTH 2301/ MTH 3301*

Kinematics of Fluids: Lagrangian and Eulerian methods of treating motion of fluids. Steady and unsteady flows. Streamlines. Resolution of fluid motion into translation, rotation and deformation.Irrotational motion.Velocity potential. Fluid acceleration in Eulerian method.Acceleration components in Cartesian cylindrical and spherical polar coordinates. The significance of the operator D/Dt. V. condition for a boundary surface.
Conservation of Mass: Principle of conservation of mass of a fluid element. Equation of continuity in Cartesian, cylindrical and spherical polar coordinates. The Laplacian equation $V^2 = 0$ for steady, irrotational and incompressible flows. The concepts of stream function for steady two-dimensional, incompressible flows. Cauchy-Riemann relations and the complex potential $w = \phi + i\psi$. Equation of streamlines as ψ = constant. Circulation.
Equations of Motion: Euler's dynamical equations. Lagrange's integration of Euler's equations (so called Bernoulli's equation) Bernoulli's equation for (I) steady incompressible flows, and (ii) steady, compressible adiabatic flows.
Irrotational Motion in Two Dimensions: Introduction. Boundary conditions for a moving cylinder. Flow due to translation motion of a right circular cylinder.

MTH 4310 : **Mathematical Methods III (3 Units)**
Status: *Elective*
Prerequisite: *MTH 3301*

Calculus of variation: Lagrange's functional and associated density. Necessary condition for a weak relative extremum. Hamilton's principles. Lagrenge's equations and geodesic problems. The Du Bois-Raymond equation and corner conditions. Variable end-points and related theorems. Sufficients conditions for a minimum. Isoperimeric problems variational integral transforms. Laplace, Fourier and Hankel transforms. Complex variable methods convolution theorems.Application to solution of differential equations.

MTH 4311: Number Theory (3 Units)
Status: *Core*
Prerequisite: *MTH 3303*

Division and Factorization properties for positive integer multiplicative arithmetical functions, Euler's φ-function, Themobius function μ. Linear congruences, residue sets (mod m). Euler's theorem.Fermat's theorem. Chinese Remainder theorem. The ring Z_m of residue classes (mod m). Mobius function.
Algebraic congruences, primitive roots, indices with respect to a primitive root.
Quadratic and high power residues.The Legendre and Jacobi symbols. Gauss Law of quadratic reciprocity. Representative of integers by binary quadratic forms.
Diophantine equation like ax +by =c, $x^2 + y^2 = z^2$, $x^4 + y^4 = z^4$, e.t.c.

MTH 4312: Complex Analysis II (3 Units)
Status: *Elective*
Prerequisite: *MTH 3307*

Taylor and Laurent series expansions. Isolated singularities and residue.The residue theorem and some of its consequences. Maximum modulus principle. Argument principle. Rouche theorem. The fundamental theorem of algebra.Principle of analytic continuation. Morera's theorem. Cauchy-Liouville theorem. Conformal and bilinear mappings. Multiple-valued functions and Riemann surfaces.

MTH 4313: Analytical Dynamics (3 Units)
Status: *Elective*
Prerequisite: *MTH 3308/ MTH 3301*

Integrals: The meaning of integrals, Jacobi's integral. Noetherian forms and moment integral.
Stability: Definition and variational equation, indirect and direct methods of Lyapunov. Applications.
Celestial Problems: Central force problem, Apsidal, The n-body problem, the 2-body problem. Impulsive motion. Fundamental EQUATION. Impulsive motion theorem, Lagrange's equations of impulsive motion.

MTH 4314 – Measure Theory (3 Units)
Status: *Elective*
Prerequisite: *MTH 2306*

Differentiation and Integration: Derivatives, Weierstrass's non-differentiable function. Vitali's theorem, Differentiability of monotone functions and functions of bounded variation. A general version of the fundamental theorem of calculus.Absolute continuity.Jordan decomposition theorem, Random – Nikydom theorem.
L^PSpace: The inequalities of Schwartz, Holder and Minkowski, The completeness of L^P space. Abstract integration, L^P spaces.
Multiple Integral (With emphasis on double Integral):Genralization of Lebesgue measure and integral on R^n. Fubini's theorem.Tonelli's theorem.

MTH 4315 – Quantum Mechanics (3 Units)
Status: *Elective*
Prerequisite: *MTH 2301/ MTH 3301*

Experimental observations. Bohr's model of the atom and classical quantization. Uncertainty and complementary principles. Hermitian operators. Eigenvalues and eigenvectors. The commutation relation $[x,y]=ih/2\pi$. Schrödinger equation. One-dimensional square-well potential, infinite barriers. Differential equation and operator methods for linear harmonic oscillator.3-dimensional central potentials, hydrogen atoms. Differential and scattering cross-sections. Laboratory and centre of mass frames. Partial wave analysis of the scattering amplitude.

MTH 4316 : **Abstract Algebra III (3 Units)**
Status: *Elective*
Prerequisite: *MTH 3305*

Theory of ideals in commutative rings. Noetherian rings. Principal ideal domains, Euclidean Rings. Product and Quotient of ideals. Prime ideals. Factorization of ideals. Theory of polynomial ideals. Algebra manifolds, zeros of a prime ideal dimension. Modules over a commutative unitary ring. Sub modules, factor modules, Homomorphism, kernel. cokernel. Factorization of homomorphism. Jordan-Holder theorem, length of a module, Exact sequences. Generators, free modules, projective and injective modules, tensor products, flat modules.

MTH 4317: Abstract Algebra II (3 Units)
Status: *Elective*
Prerequisite: *MTH 3305*

Normal subgroups and quotient groups. Monomorphic isomorphism theorems. Cayley's theorems. Direct products. Groups of small order. Froup acting on sets. Sylow theorems. Ideal and quotient rings. P.I.D. 8, U.F.D ' Seuclides rings. Irreducibility; Field extensions, degree of an extension, minimum polynomial. Algebraic and transcendental extensions. Straight edged and compass constructions.

MTH 4318 – Introduction to Operation Research (3 Units)
Status: *Elective*
Prerequisite: *MTH 2301*

Phases of operations Research study. Classification of operations research models, linear; Dynamic and integer programming. Decision Theory. Inventory Models, Critical Path Analysis and project Controls.

MTH 4699: Project (6 Units)
Status: *Core*

Students should embark on substantial project under the supervision of a member of staff in the field of Mathematics. It will spread over both semesters.