SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

Syllabus

of

Undergraduate (Honours) Programme

in

Bachelor of Computer Applications (BCA)

(AICTE Approved)

Introduced from 2024-25 admissions onwards

Prepared by

Board of Studies in Computer Science

Sacred Heart College, Thevara, Kochi.

BOARD OF STUDIES IN COMPUTER SCIENCE
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA, KOCHI, KERALA

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1. INTRODUCTION

The National Education Policy (NEP) 2020 envisages the revision of the Choice Based Credit System (CBCS) for instilling innovation and flexibility. It emphasizes on promoting interdisciplinary studies, introducing new subjects, and providing flexibility in courses and fresh opportunities for students. It also envisages setting up of facilitative norms for issues, such as credit transfer, equivalence etc., and a criterion-based grading system that assesses student achievement based on the learning goals for each programme.

The NEP document suggests several transformative initiatives in higher education. These include:

- Introduction of holistic and multidisciplinary undergraduate education that would help develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, ethical and moral - in an integrated manner; soft skills, such as complex problem solving, critical thinking, creative thinking, communication skills; and rigorous specialization in a chosen field (s) of learning.
- Adoption of flexible curricular structures in order to enable creative combinations of disciplinary areas for study in multidisciplinary contexts in addition to rigorous specialization in a subject.
- Undergraduate degree programmes of either 3 or 4-year duration.
- The students are getting a chance to determine his/her own semester-wise academic load and will be allowed to learn at his/her pace, to the extent possible.
- Increase in the number of choices of courses available to students and the students are getting an opportunity to choose the courses of their interest from all disciplines.
- Multidisciplinary and holistic education with emphasizes on research, skill development and higher order thinking,
- Promotion of innovation and employability of the student.
- Flexibility for the students to move from one institution to another as per their choice.
- Flexibility to switch to alternative modes of learning (offline, ODL, and online learning, and hybrid modes of learning).

About the Programme

A student admitted to the programme will be awarded a degree as per the regulations given in Chapter 2. The proposed pathways are as follows:

i) BCA Degree
ii) BCA (Honours)
iii) BCA (Honours with Research)

Specializations

Students will have the option to select one of the following specializations

1. Mobile applications and Cloud Technology
2. Data Science.

Major Highlights of this Programme are listed below:

A **Bachelor of Computer Applications (BCA) with specializations** significantly enhances the program's value by aligning academic learning with current industry needs.

- **Industry-Relevant Skills Development:** Specializations such as Mobile Applications & Cloud Technology or Data Science focus on in-demand technologies, ensuring students gain practical skills directly applicable in today's job market. This program also emphasizes hands-on training, real-world projects, internships, and lab sessions.
- **Focused Career Pathways:** Specializations help students streamline their career goals early by building expertise in a specific area, making them more competitive for targeted roles like App Developer, Cloud Engineer, Data Analyst, Machine Learning Engineer, and so on.
- **Enhanced Employability:** Employers often prefer candidates with specialized knowledge over generalists. A BCA with a specialization makes graduates more job-ready with hands-on project experience, certifications, and domain-specific tools.

Higher Studies options:
On successful completion of Bachelor of Computer Applications, students can join Masters Programmes in Data Science, Artificial Intelligence, Data Analytics, MCA, Computer Science. They can also complete certifications on AWS/Azure/ GCP certifications. Google Associate Android Developer, Flutter, react Native Developer Certifications, Docker, Kubernetes, Jenkins (for cloud + DevOps)

Career Opportunities:
BCA degree opens up a wide range of career opportunities in both technical and non-technical domains.

BCA (Mobile Applications and Cloud technology) provides the core technical roles such as

1. Mobile Applications Developer.
2. Cloud Solutions Architect (Entry Level)
3. Cloud Engineer
4. Full Stack Developer
5. DevOps Engineer (Junior Level)
6. Software Engineer/ Programmer Analyst
7. Cloud Support Associate
8. Cloud Security Analyst
9. Mobile UI/UX Designer
10. Mobile Game Developer

BCA (Data Science) graduates will have the following opportunities:

1. Data Analyst
2. Data Scientist(Junior Level/Entry Level)
3. Business Intelligence Analyst
4. Machine Learning Engineer
5. Data Engineer
6. Big Data Analyst

Outcome Based Education (OBE)

Undergraduate courses in Computer Science follow the Outcome-based Education (OBE) framework. OBE is a system where all the parts and aspects of education are focused on the outcomes of the course. The students take up courses with a certain goal of developing skills or gaining knowledge and they have to complete the goal by end of the course. Outcome-based education affirms teachers as facilitators, rather than lecturers. In this model, teachers guide the students and encourage them to develop their knowledge and skills. The undergraduate courses at the Department of Computer Science Sacred Heart College (Autonomous), Thevara provides a learning approach in which students develop analytical ability and critical thinking and research acumen over different situations.

Programme Outcomes:

The Undergraduate Programme Outcomes (POs) are as follows:

PO 1: Critical thinking and Analytical reasoning

- Critical thinking guides the assessment and judgment of information, while analytical reasoning involves specific methods for analysis and conclusion drawing. It includes the ability to assess evidence, identify assumptions, formulate coherent arguments, understand complex relationships, and evaluate practices and theories critically. Additionally, critical sensibility involves self-awareness and reflection on personal and societal experiences.

PO 2: Scientific reasoning and Problem solving

- Capacity to interpret and draw conclusions from data, critically evaluate ideas and evidence with an open-minded perspective; ability to apply learned competencies to solve unfamiliar problems and apply knowledge to real-life situations, avoiding mere replication of curriculum content.

PO 3: Effective communication and leadership skill

- Proficiency in expressing thoughts verbally and non-verbally, utilizing appropriate communication media. Confidently sharing ideas, active listening, analytical reading and writing and presenting complex information clearly to diverse groups. Effective teamwork and leadership skills, including setting direction, inspiring vision, building and motivating teams, and guiding them efficiently towards common goals.

PO 4: Social consciousness and responsible citizenship

- Social consciousness involves an empathetic and informed perspective, extending beyond personal concerns to embrace a responsibility for the collective good in nation-building. It includes reflecting on the impact of research on conventional practices and a clear understanding of societal needs for inclusive and sustainable development.

Responsible citizens contribute positively through civic engagement, environmental stewardship, and a commitment to social justice, abiding by laws and working for the advancement of society.

PO 5: Equity, Inclusiveness and Sustainability

- Promoting equity, inclusiveness, sustainability, and diversity appreciation. Developing ethical and moral reasoning with values of unity, secularism, and national integration for dignified citizenship. Understanding and appreciating diversity, managing differences, and using an inclusive approach. Emphasizing creating environments where diverse individuals feel valued, addressing present needs without compromising future generations' ability to meet their own needs, considering environmental, economic, and social factors.

PO 6: Moral and Ethical Reasoning

- Possessing the capacity to embody moral and ethical values in personal conduct, articulating positions and arguments on ethical matters from diverse perspectives, and consistently applying ethical practices in all endeavours. Proficient in recognizing and addressing ethical issues pertinent to one's work, steadfastly steering clear of any unethical behaviour.

PO 7: Networking and Collaboration

- Cultivating networking skills in education entails establishing meaningful professional connections and relationships among educators, administrators, and stakeholders. It also involves fostering cooperative efforts among individuals, institutions, and research organizations within the educational realm. These practices are indispensable for nurturing a supportive, innovative, and dynamic learning environment.

PO 8: Lifelong Learning

- Cultivating the ability to continually acquire knowledge and skills, including the art of "learning how to learn," becomes paramount for lifelong learning. This self-paced and self-directed approach serves personal development, aligns with economic, social, and cultural objectives, and facilitates adaptation to evolving workplace demands through skill development and reskilling. It equips individuals with competencies and insights, allowing them to adeptly respond to society's changing landscape and enhance their overall quality of life. Lifelong learning extends beyond formal education, embracing diverse informal and non-traditional learning experiences.

2. Regulations for Bachelor in Computer Applications(Honours) Programmes

PREAMBLE

Sacred Heart College (Autonomous), Thevara, Kochi is a grant-in-aid private college affiliated to Mahatma Gandhi University, Kottayam, Kerala. The College was established in 1944 as a higher educational institute for men on the basis of the minority rights. It started admitting girls in 1975 and currently serves all sections of the society without any discrimination of caste or creed.

The College was granted Autonomous Status by the University Grants Commission (UGC) in 2014.

Vision and Mission of the Institution

The vision of the College aims at the formation of holistic individuals who would champion the cause of justice, love, truth and peace. To this effect, Sacred Heart College envisions the **"Fashioning of an enlightened society founded on a relentless pursuit of excellence, a secular outlook on life, a thirst for moral values as well as an unflinching faith in God."** It seeks the creation of a world, guided by divine wisdom, governed by moral principles, inclusive by secular outlook and united by the principle of equity.

The Mission of the Institution is to provide an environment that

- **facilitates the holistic development of the individual**
- **enables the students to play a vital role in the nation-building process and contribute to the progress of humanity**
- **disseminates knowledge even beyond the academia**
- **instils in the students a feel for the frontier disciplines, and**
- **cultivates a concern for the environment**

by setting lofty standards in the ever-evolving teacher-learner interface.

Framing of the Regulations

As part of the implementation of the National Education Policy 2020 (NEP 2020), the University Grants Commission (UGC) has issued the Curriculum and Credit Framework for Undergraduate Programmes 2023 (CCFUP) which would provide a flexible choice-based credit system, multidisciplinary approach, multiple entry and exit options, and establish three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and (c) 4-year UG Degree (Honours with Research).

The Kerala Higher Education Reforms Commission has recommended a comprehensive reform in the undergraduate curriculum for the 2023-24 academic year, adopting 4-year undergraduate

programs to bring Kerala's undergraduate education at par with well acclaimed universities across the globe.

The Kerala State Curriculum Committee for Higher Education has been constituted, and have proposed a model Kerala State Higher Education Curriculum Framework (KSHECF) for Undergraduate Education. Further, an Academic Committee and various sub committees were constituted for the implementation of the Regulations. The Academic Council of the college in its meeting held on 18th March 2024 approved the regulations, namely**: THE SACRED HEART COLLEGE (AUTONOMOUS) UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2024 {SHC-UGP (Honours)}**.

As Undergraduate Programs/Courses in computer applications and management offered through General Degree Colleges (Non-Technical Institutions) have been brought under the umbrella of AICTE to ensure coordinated development in technical and management education, we need separate regulations for these programmes.
Based on the model curriculum prepared by the AICTE and the Mahatma Gandhi University regulations, we have drafted a regulation for the Bachelor in Computer Applications(BCA) programme, namely: **THE SACRED HEART COLLEGE (AUTONOMOUS) REGULATIONS FOR BACHELOR IN COMPUTER APPLICATIONS(HONOURS) PROGRAMMES**

Short Title and Commencement

i. These Regulations may be called THE SACRED HEART COLLEGE (AUTONOMOUS) REGULATIONS FOR BACHELOR IN COMPUTER APPLICATIONS(HONOURS) PROGRAMMES 2024. Shortly, the Regulations may be called as 'BCA Regulations'
ii. These Regulations will come into effect from the academic year 2024-2025 and will have prospective effect.

Scope and Application

iii. These Regulations shall apply to all BCA(Honours) programmes conducted by THE SACRED HEART COLLEGE (AUTONOMOUS) for the admissions commencing in the academic year 2024-2025.
iv. Every programme conducted under these regulations shall be monitored by an Academic Committee comprising members nominated by the Principal.

Definitions

Unless used in a context otherwise specified,

i. College means THE SACRED HEART COLLEGE (Autonomous) Thevara, a grant-in-aid private college affiliated to Mahatma Gandhi University, Kottayam, Kerala.
ii. 'University' means the MAHATMA GANDHI University which is the affiliating University of Sacred Heart College (Autonomous).
iii. FYUGP means Four Year Undergraduate Programme.
iv. Academic Year: Two consecutive (one odd and one even) semesters followed by a vacation in one academic year.

v. Academic Coordinator/Nodal Officer: Academic Coordinator/Nodal Officer is a faculty nominated by the college council to coordinate the effective conduct of the FYUGP including Continuous Comprehensive Assessment (CCA) undertaken by various departments within the college. She/ he/ they shall be the convenor for the College Level Academic Committee.

vi. Academic Week: A unit of five working days in which the distribution of work is organized, with at least five contact hours of one-hour duration on each day.

vii. Academic Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week in a semester. It is defined both in terms of student efforts and teacher's efforts. A course which includes one hour of lecture or tutorial or minimum 2 hours of lab work/ practical work/ field work per week is given one credit hour. Accordingly, one credit is equivalent to one hour of lecture or tutorial or two hours of lab work/ practical work/ field work/ practicum and learner engagement in terms of course related activities (such as seminars preparation, submitting assignments, group discussion, recognized club-related activities etc.) per week. Generally, a one credit course in a semester should be designed for 15 hours Lecture/ tutorials or 30 hours of practical/ field work/ practicum and 30 hours' learner engagement.

viii. Academic Bank of Credits (ABC): An academic service mechanism as a digital/ virtual entity established and managed by Government of India to facilitate the learner to become its academic account holder and facilitating seamless learner mobility, between or within degree-granting Higher Education Institutions (HEIs) through a formal system of credit recognition, credit accumulation, credit transfers and credit redemption to promote distributed and flexible process of teaching and learning. This will facilitate the learner to choose their own learning path to attain a Degree/ Diploma/ Certificate, working on the principle of multiple entry and exit, keeping to the doctrine of anytime, anywhere, and any level of learning.

ix. Credit Accumulation: The facility created by ABC in the Academic Credit Bank Account (ABA) opened by the learner across the country in order to transfer and consolidate the credits earned by them by undergoing courses in any of the eligible HEIs.

x. Credit Recognition: The credits earned through eligible/ partnering HEIs and transferred directly to the ABC by the HEIs concerned.

xi. Credit Redemption: The process of commuting the accrued credits in the ABC of the learner for the purpose of fulfilling the credits requirements for the award of various degrees. Total credits necessary to fulfil the criteria to get a degree shall be debited and deleted from the account concerned upon collecting a degree by the learner.

xii. Credit Transfer: The mechanism by which the eligible HEIs registered with ABC are able to receive or provide prescribed credits to individual's registered with ABA in adherence to the UGC credit norms for the course(s) registered by the learner in any HEIs within India.

xiii. Credit Cap: Maximum number of credits that a student can take per semester, which is restricted to 30.

xiv. Continuous Comprehensive Assessment (CCA): The mechanism of evaluating the learner by the course faculty at the institutional level.

xv. End Semester Evaluation (ESE): The mechanism of evaluating the learner at the end of each semester.

xvi. Audit Course: a course that the learner can register without earning credits, and is not mandatory for completing a programme. The student has the option not to take part in the CCA and ESE of the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is eligible for a pass in that course, without any credit (zero-credit).

xvii. Courses: refer to the papers which are taught and evaluated within a programme, which include lectures, tutorials, laboratory work, studio activity, field work, project work, vocational training, viva, seminars, term papers, presentations, assignments, self-study, group discussion, internship, etc., or a combination of some of these elements.

xviii. Choice Based Credit System (CBCS) means the system wherein students have the option to select courses from the prescribed list of courses.

xix. College-level Academic Committee: It is a committee constituted for the FYUGP at the college level comprising the Principal as the Chairperson, the Academic Co-ordinator/ Nodal Officer as its convenor.

xx. Academic Co-ordinator/ Nodal Officer: A senior faculty member nominated by the college council.

xxi. Course Faculty: A faculty member nominated by the Head of the Department shall be in charge of offering a particular course in a particular semester of FYUGP.

xxii. Department means any teaching department in a college offering a course of study approved by the College as per the regulations of the college and it includes a Department, Centre, or School of Teaching and Research conducted directly by the College.

xxiii. Board of Studies (BoS) means the academic body duly constituted to frame the syllabus of each department.

xxiv. Senior Faculty Advisor (SFA) is a faculty nominated by a Department Council to co-ordinate all the necessary work related to FYUGP undertaken in that department, including the continuous comprehensive assessment.

xxv. Department Council means the body of all teachers of a department in a college.

xxvi. Faculty Adviser (FA) means a teacher from the parent department nominated by the Department Council to advise students in academic matters.

xxvii. Graduate Attributes means the qualities and characteristics to be obtained by the graduates of a programme of study at the College, which include the learning outcomes related to the disciplinary areas in the chosen field of learning and generic learning outcomes. The College will specify graduate attributes for its programmes.

xxviii. Programme means the entire duration of the educational process including the evaluation leading to the award of a degree.

xxix. Programme Pathway: Combination of courses that can be chosen by a student that give options to pursue interesting and unconventional combinations of courses drawn from different disciplinary areas, like the sciences and the social sciences/ humanities.

xxx. Regulatory Body means University Grants Commission (UGC), All India Council for Technical Education (AICTE), National Assessment and Accreditation Council (NAAC) and National Board of Accreditation (NBA) etc.

xxxi. Signature Courses: Signature courses are the specialized Discipline Specific Elective courses or skill-based courses designed and offered by the regular/ ad hoc/ visiting/ emeritus/ adjunct faculty member of a particular college with the prior recommendation of the BoS and the approval of Academic Council of the College.

xxxii. Letter Grade or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F, and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on their performance in various examinations. The Letter grade that corresponds to a range of CGPA.

xxxiii. Grade Point: Each letter grade is assigned a 'Grade point' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in each course. Grade Point means point given to a letter grade on 10-point scale.

xxxiv. Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxv. Credit Point (CP) of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: $CP = G \times C$

xxxvi. Cumulative Grade Point Average (CGPA) is the value obtained by dividing the sum of credit points in all the semesters earned by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to two decimal places.

xxxvii. Grade Card means the printed record of students' performance, awarded to them.

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Features of the BCA Regulations

i BCA is a Stand-alone programme as envisaged by AICTE, and no switching from BCA to other programmes is allowed

ii The BCA(Honours) programme is a Four year programme with exit option at the end of the third year

iii The BCA regulations provide the following options to the students

(a) Students who choose to exit after 3 years shall be awarded a degree 'Bachelor in Computer Applications (BCA) after the successful completion of the required

minimum Courses with 133 credits.

b) Students who have successfully completed the BCA degree shall be awarded the BCA(Honours) or BCA (Honours with Research) degree after the successful completion of the fourth year with the required minimum courses with 177 credits

iv Students who acquire minimum 75% marks in their graduation (upto 6th semester) are eligible for Honours with Research Programme. However if necessary, College may conduct screening test for the honours with research programme in accordance with College Regulations from time to time. Honours with research is possible only if at least two faculty members of the department are having PhD.

v. Students who have chosen the honours with research stream shall do their entire fourth year under the mentorship of a mentor (a faculty with PhD).

vi. The mentor shall prescribe suitable advanced level/capstone level courses for a minimum of 20 credits to be taken within the institutions along with the courses on research methodology, research ethics, and research topic-specific courses for a minimum of 12 credits which may be obtained either within the institution or from other recognized institutions, including online and blended modes.

vii. Students who have opted for the honours with research should successfully complete a research project under the guidance of the mentor and should submit a research report for evaluation. They need to defend successfully the research project to obtain 12 credits under a faculty member of the College. The research shall be in the Major/ allied discipline.

viii. The research outcomes of their project work may be published in peer-reviewed journals or presented at conferences or seminars or patented.

Types of Courses

The BCA programme comprises a mix of the following types of courses

(a) **Core Courses (CC)** - designed so as to enable students to gain basic knowledge in the discipline.

(b) **Discipline Specific Electives (DSE)** -designed to provide the students with an opportunity to pursue in-depth study of a particular subject or discipline and develop competency in that chosen area.

(c) **Ability Enhancement Courses (AEC)** - designed specifically to achieve competency in English and other languages (OL) as per the student's choice, with special emphasis on language and communication skills.

(d) **Multi-Disciplinary Elective (MDE)** Courses - designed as to enable the students to broaden their intellectual experience by understanding the conceptual foundations of Science, Social Sciences, Humanities, and Liberal Arts.

(e) **Skill Enhancement Courses (SEC)** - designed to enhance 21st-century workplace skills such as creativity, critical thinking, communication, and collaboration

(f) **Value Addition Courses (VAC)** - designed as to empower the students with personality development, perspective building, and self-awareness.

Internship

All students shall undergo Summer Internship or Apprenticeship in a Firm, Industry or Organization; or Training with faculty or researchers or professionals or other Higher Education Institutions (HEIs) or Research Institutions or NGOs. Students may also choose to undertake social responsibility or community engagement. Students may choose to work as research assistants or teaching assistants. Students will be provided the opportunities for internships with local industries, business organizations, agriculture, health and allied sectors, Local Government institutions (such as panchayats, municipalities), State Planning Board, State Councils/ Boards, Research Institutions, Research Labs, Library, elected representatives to the parliament/ state assembly/ panchayath, media organizations, artists, crafts persons etc. These opportunities will enable the students to actively engage with the practical aspects of their learning and to improve their employability.

Attendance

A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if he/she has acquired 75% of attendance in that particular course. A student is eligible for attendance as per the existing university and government orders which includes participation in a meeting, or events organized by the college or the university, a regularly scheduled curricular or extracurricular activity prescribed by the college or the university. Due to unavoidable or other legitimate circumstances such as illness, injury, family emergency, care-related responsibilities, bad or severe weather conditions, academic or career-related interviews students are eligible for authorized absence. Apart from this, all other eligible leaves such as all other eligible leaves such as maternity leave, and menstrual leave shall also be treated as authorized absences. The condonation facility can be availed as per the university norms.

SEMESTER-WISE CREDIT DISTRIBUTION OF THE BCA (HONOURS) AND BCA (HONOURS WITH RESEARCH) PROGRAMME:

Semester	CC	AEC	MDE	VAC	SEC	DSE	Total Credits
I	8	6	3	0	4	0	21
II	8	6	2	2	4	0	22
III	12	0	2	2	4	0	20
IV	12	0	0	3	6	4	25
V	16	0	0	0	3	4	23

VI	4	0	0	3	7	8	22
Total (6 Sems)	60	12	07	10	28	16	133
Exit option at the end of the third year with BCA degree							
BCA (Hons)							
VII	8	0	0	0	12	4	24
VIII	0	0	0	0	12	8	20
Total	68	12	07	10	52	28	177
*BCA (Hons) with Research							
VII	12	0	0	0	8	4	24
VIII	0	0	0	0	20	0	20
Total	72	12	07	10	56	20	177

* For BCA (Honours with Research), there shall be only project work for 20 credits in the eight semester

Course Summary

	CC	AEC	MDE	VAC	SEC	DSE	TOTAL
BCA	60	12	07	10	28	16	133
BCA (Honours)	68	12	07	10	52	28	177
BCA (Honours with Research	72	12	07	10	56	20	177

Students can take extra credit courses from their own department or from other departments of the college. Extra credits will not be counted for awarding BCA degree/ BCA (Honours)/BCA (Honours with Research).

Assessment and Evaluation

The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). 30% weightage shall be given for CCA. The remaining 70% weight shall be for the ESE.

Regarding evaluation, one credit may be evaluated for 25 marks in a semester; thus, a 5-credit course will be evaluated for 125 marks; 4-credit courses for 100; 2- credit courses for 50 marks. However, for tabulation purpose, courses with one credit will be evaluated for 50 marks and will be converted into 25 marks.

Distribution of CCA and ESE will be as given below

Credit	CCA	ESE
5	35	90
4	30	70
3	25	50
2	15	35

Suggestive methods for CCA are as follows: (anyone or in combinations as decided by the course faculty/ course coordinator)

a. Practical assignment
b. Observation of practical skills
c. Viva voce
d. Quiz
e. Written Tests
f. Oral presentations
g. Computerized adaptive testing
h. In-class discussions
i. Group tutorial work
j. Reflection writing assignments
k. Home assignments
l. Self and peer Assessments
m. Any other method as may be required for specific course/ student by the course faculty/ course coordinator.

The prerogative of arranging a CCA lies with the course faculty/ course coordinator. The course faculty/ course coordinator shall be responsible for evaluating all the components of CCA.

Evaluation of Project/ Dissertation

The evaluation of project work shall be CCA with 30% and ESE 70%. The scheme of evaluation of the Project is given below:

Project type	Maximum Marks	CCA	ESE
Research Project of Honours with Research (20 credits)	300	90	210
Project of Honours (12 credits)	200	60	140
Project of Honours (8 credits)	100	30	70

Evaluation of Internship

The evaluation of the internship shall be done by a committee constituted by the Department Council. The scheme of CCA and ESE is given below:

Components of Evaluation of Internship	Weightage	Marks for Internship 4 Credits/ 100 Marks
CCA	30%	30
ESE	70%	70

The department council may decide on any mode for the completion of the Internship.

Letter Grade and Grade Points

The mapping of marks to grades shall be done as per the following table

Percentage of Marks (Based on CCA& ESE marks put together)	Grade Point(G)	Letter Grade	Class
Above 90	10	A^+ (Excellent)	First Class with Distinction
Above 80 but 90 or below 90	9	A(Very Good)	
Above 70 but 80 or below 80	8	B^+ (Good)	First Class
Above 60 but 70 or below 70	7	B(Above Average)	
Above 50 but 60 or below 60	6	C^+ (Average)	Second Class
Above 45 but 50 or below 50	5	C (Satisfactory)	Third Class
40 or above but 45 or below 45	4	D (Pass)	
< 40 or ESE < 35 *	0	F(Fail)	Fail

*If the aggregate (both CCA and ESE) percentage of marks is less than 40 or the percentage of marks for ESE is less than 35, then the result is 'Fail'

If a course evaluation consists of both theory and practical components, the minimum pass criteria for each component must be met separately. The percentage of marks shall be rounded to two decimal places.

Credit Transfer and Credit Accumulation

i. The college will establish a digital storage (DIGILOCKER) of academic credits for the credit accumulation and transfer in line with ABC.
ii. The validity of credits earned shall be for a maximum period of seven (7) years or as specified in the University/ UGC /AICTE regulations.
iii. The students shall be required to earn at least 50% of the credits from the College.

Outcome Based Approach

The curriculum will be designed based on Outcome Based Education (OBE) practices. The Graduate Attributes (GA) and Programme Outcomes (PO) will be defined and specified in the syllabus of each programme.

Induction Program

There shall be a mandatory Induction program (as available on AICTE Portal) for students to be offered right at the start of the first year.

Mandatory Visits/ Workshop/Expert Lectures:

1. It is mandatory to arrange one industrial visit every year for the students of each branch.
2. It is mandatory to conduct a One-week workshop after fifth semester on professional/ industry/ entrepreneurial orientation.
3. It is mandatory to organize at least one expert lecture per semester for each branch by inviting resource persons from domain specific industry.

For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Modifications to the Regulations

Notwithstanding anything contained in these Regulations, any amendments or modifications issued or notified by the University Grants Commission or the State Government or the Mahatma Gandhi University from time to time, shall be incorporated into these Regulations by the appropriate regulatory bodies of the College and shall constitute an integral part thereof.

3.PROGRAMME STRUCTURE

SEM	Course Code	Course Title	Course Type	Credit	Hours per Week	
					Theory	Practical
I	24UBCASEC101	Programming in C	SEC	4	3	2
	24UBCADCC101	Digital Electronics & Computer Organization	DCC	4	3	2
	24UBCADCC102	Foundation of Mathematics	DCC	4	3	2
		AEC – English	AEC	3	3	0
		AEC – Other Languages	AEC	3	3	0
	24UBCAMDE101	Computer Hardware and Assembling	MDE	3	2	2
				21	**17**	**8**
II	24UBCADCC103	OOPS with C++	DCC	4	3	2
	24UBCASEC102	Linux Operating System	SEC	4	3	2
	24UBCADCC104	Statistical Methods for Computational Analysis	DCC	4	3	2
		AEC-Other Languages	AEC	3	3	0
		AEC – English	AEC	3	3	0
	24UBCAVAC101	IT, Environment and Holistic Living	VAC	2	2	0
	24UBCAMDE102	Web Designing	MDE	2	2	0
				22	**19**	**6**

III	24UBCASEC201	Programming in Java	SEC	4	3	2
	24UBCADCC201	DBMS	DCC	4	3	2
	24UBCADCC202	Data Structures using C++	DCC	4	3	2
	24UBCADCC203	Advanced Web Technologies	DCC	4	3	2
	24UBCAMDE201	Numerical Methods and Linear Programming Problem	MDE	2	1	2
	24UBCAVAC201	Green Computing	VAC	2	2	0
				20	**15**	**10**
	24UBCADCC204	Mobile Application Development	DCC	4	3	2
	24UBCADSE201	Professional Elective –I	DSE	4	3	2
	24UBCADCC205	Software Engineering	DCC	4	4	0
	24UBCADCC206	Operating System	DCC	4	4	0

IV	24UBCASEC202	Technical Writing using LATEX	SEC	3	2	2
	24UBCAVAC202	Health and Wellness	VAC	3	3	0
	24UBCASEC203	Internship I	SEC	3	0	0
				25	**19**	**6**
V	24UBCADSE301	Professional Elective -II	DSE	4	3	2
	24UBCADCC301	Computer Networks	DCC	4	4	0
	24UBCADCC302	Digital Image Processing	DCC	4	4	0
	24UBCADCC303	DevOps	DCC	4	4	0
	24UBCADCC304	Mobile Testing Tools	DCC	4	4	0
	24UBCASEC301	AI Tools	SEC	3	2	2
	24UBCASEC302	Mini Project [Evaluation in Sixth semester]	SEC	-	-	-
				23	**21**	**4**
VI	24UBCADSE302	Professional Elective -III	DSE	4	3	2
	24UBCASEC302	Mini Project	SEC	4	-	-
	24UBCADSE303	Professional Elective -IV	DSE	4	4	0
	24UBCADCC305	Theory of Automata	DCC	4	4	0
	24UBCASEC303	Machine Learning	SEC	3	2	2
	24UBCAVAC301	Cyber Security and Ethical Hacking	VAC	3	3	0
				22	**19**	**6**
*** Exit at 3rd Year with 133 Credits – BCA Degree**						
BCA (Honours Degree) **Specialization- Mobile Applications and Cloud Technology**						
VII	24UBCADCC401	Principles of Virtualization	DCC	4	4	0
	24UBCADSE401	Professional Elective -V	DSE	4	3	2
	24UBCADCC402	Artificial Intelligence	DCC	4	3	2
	24UBCASEC401	Internship II	SEC	4	-	-
	24UBCASEC402	Major Project -I	SEC	8	-	-
				24	**10**	**4**
VIII	24UBCADSE402	Professional Elective -VI	DSE	4	4	0
	24UBCADSE403	Professional Elective -VII	DSE	4	3	2
	24UBCASEC403	Major Project -II	SEC	12	-	-
				20	**7**	**2**

Completion of the Programme at 4th Year with 177 Credits – BCA Honours Degree						
BCA (Honours with Research Degree)						
VII	24UBCADCC401	Research Methodology	DCC	4	4	0
	24UBCADCC402	Research and Publication Ethics	DCC	4	4	0
	24UBCADCC403	Artificial Intelligence	DCC	4	3	2
	24UBCADSE403	Professional Elective-VII	DSE	4	3	2
	24UBCASEC401	Research Internship II	SEC	8	-	-
	24UBCASEC402	Dissertation**[Evaluation in Semester VIII]	SEC	-	-	-
				24	**14**	**4**
VIII	24UBCASEC402	Dissertation	SEC	20	-	-
				20	-	-
Completion of the Programme at 4th Year with 177 Credits – BCA Honours with Research Degree						

BCA (Honours Degree) *Specialization in Data Science*						
VII	24UBCADCC401	Deep Learning	DCC	4	3	2
	24UBCADCC402	Cloud Computing for Data Science	DCC	4	4	0
	24UBCADSE401	Professional Elective V	DSE	4	3	2
	24UBCASEC401	Internship II	SEC	4	-	-
	24UBCASEC402	Major Project-I	SEC	8	-	-
				24	**10**	4
VIII	24UBCADSE402	Professional Elective-VI	DSE	4	4	0
	24UBCADSE403	Professional Elective-VII	DSE	4	3	2
	24UBCASEC403	Major Project -II	SEC	12	-	-
				20	**7**	2
Completion of the Programme at 4th year with 177 credits – BCA-Specialization with Data Science						

Professional Electives for Mobile Applications and Cloud Technology

Professional Electives	Semester	Course Code	Professional Elective
1	IV	24UBCADSE201	Introduction to Cloud Technology
II	V	24UBCADSE301	Advanced Mobile Application Development
III	VI	24UBCADSE302	Full Stack Development
IV	VI	24UBCADSE303	Cloud Infrastructure and Management Mechanisms
V	VII	24UBCADSE401	Mobile Application Development with Machine Learning
VI	VIII	24UBCADSE402	Large Language Models
VII	VIII	24UBCADSE403	Generative AI

Professional Electives for Data Science

Professional Electives	Semester	Course Code	Professional Elective
I	IV	24UBCADSE201	Introduction to Data Science
II	V	24UBCADSE301	Big Data Analytics & R Programming
III	VI	24UBCADSE302	Data Mining & Data Analysis
IV	VI	24UBCADSE303	Data Visualization
V	VII	24UBCADSE401	Inferential Statistics for Computational Analysis
VI	VIII	24UBCADSE402	Large Language Models
VII	VIII	24UBCADSE403	Natural Language Processing

4. SYLLABUS

COURSE 01

Discipline/Programme	Computer Applications
Semester	I
Type of Course	SEC
Course Code	24UBCASEC101
Course Title	**Programming in C**
Course Level	100-199
Course Summary	Programming in C course equips you with the fundamentals of programming, often being a stepping stone to other languages. By the end of the course, students are able to write basic C programs to solve various problems with a foundation to delve deeper into the programming concepts .
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Interpret the fundamental concepts like datatype, tokens, operators, expression and evaluate an expression	Understand	PO1,PO2
2	Develop C programs that interact with users, make decisions, repeat tasks, manage data in arrays.	Apply	PO1,PO2
3	Develop C programs using functions, strings, pointers.	Apply	PO2,PO1
4	Create a C program using the user defined data structure, file handling.	Apply	PO8, PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to C Programming (8 hours)			
	1.1	Basics of C Programming Language, Structure of C Program.	2	CO1

1	1.2	Tokens, Keywords, Identifiers, Data types, Variables and Constants.	2	CO1
	1.3	Operators and Expressions.	2	CO1
	1.4	Expression, Evaluation–precedence and associativity, Type Conversions.	2	CO1
2	Input/Output, Control Flow & Arrays (14 hours)			
	2.1	Input-Output- Unformatted and Formatted Input and Output Functions, Escape Sequences.	2	CO2
	2.2	Control Statements- Selection Statements – if, if-else, nested if, if else if ,switch statement	3	CO2
	2.3	Iterative Statements–while, for, do-while, nested for loop, Special Control Statement–goto, break, continue, return, exit.	6	CO2
	2.4	Arrays-definition, Accessing array, Type of array, single dimensional array, two dimensional array, example programs using arrays (including linear search, bubble sort and matrix operations)	3	CO2
3	Strings, Functions, Storage Classes and Pointers (11 hours)			
	3.1	string, string operations, string functions in c, example programs using strings (including linear search, sort)	3	CO3
	3.2	Concept of Function, user defined Functions, Call-by-Value Vs Call-by-reference, Passing Arrays to Functions, Recursion	3	CO3
	3.3	Storage Classes, Scope and lifetime of variables	2	CO3
	3.4	Pointers: Introduction, Address of Operator (&), Pointer Arithmetic, Arrays and Pointers, Pointers and Strings, Pointers and functions, Array of Pointers	3	CO3
4	User Defined Data types and File Management (12 hours)			
	4.1	Structure: Declaring a Structure and its members, Accessing members of a Structure, Array of Structures, Pointers to structures, Structures and functions	3	CO4
	4.2	Union: Declaring a Union and its members, Structures vs Unions, Initialization Union, Accessing members of a Union, Enumeration Types.	3	CO4
	4.3	Files Management: Defining and opening a file, closing file, Input/output operations on files, predefined streams, Error handling I/O Operations, Random access to files	4	CO4
	4.4	Role of C Preprocessor - macro substitution, file inclusion, Dynamic memory allocation in C	2	CO4

Practicals (30 Hrs)

- Simple programs to familiarize printf() and scanf() functions
- Programs based on decision making statements, break, goto, continue, switch
- Programs using Loop controls statements
- Programs Based on One dimensional and two-dimensional arrays (linear search, bubble sort, matrix addition, multiplication, transpose etc.)
- Programs on Strings and string handling functions
- Programs using the concept of Pointers, operations on pointers, Pointers to one dimensional array
- Programs using the concept of functions, call by value, call by reference, Recursion
- Programs based on structure and union, array of structures, Pointer to structure, structure as argument to functions
- Simple programs using pointers and malloc ()
- Programs using concept of files

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Theory:
Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. Any other method as may be required for specific course by the course faculty.
Practical:
Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.</td></tr>
<tr><td>B. End Semester Examination (ESE)
Theory:
Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.
Practical:
Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.</td></tr>
</table>

References:

1. C Programming Absolute Beginner's Guide by Greg Perry and Dean Miller.
2. The C Programming Language by Brian W. Kernighan
3. Programming in ANSI C by E Balagurusamy

COURSE 02

Discipline/Programme	Computer Applications
Semester	I
Type of Course	DCC
Course Code	24UBCADCC101
Course Title	**Digital Electronics & Computer Organization**
Course Level	100-199
Course Summary	This course introduces the fundamentals of digital electronics and the internal organization of computer systems. It covers topics in digital logic design, including Boolean algebra, logic gates, combinational and sequential circuits, and memory systems. The course aims to provide a solid foundation in both the hardware components of digital systems and how these components interact within the context of computer organization.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Interpret the different number systems and conversion between the number systems.	Understand	PO1, PO8
2	Evaluate the Boolean functions and its simplification using K-MAP.	Apply	PO1, PO2
3	Design simple combinational and sequential circuits.	Apply	PO1, PO8
4	Explain the basic computer components and its organization	Understand	PO1, PO8
5	Illustrate the concepts of memory system, addressing modes and Input/Output data transfer techniques.	Understand	PO1, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	**Digital Number Systems and Boolean Algebra (10 Hours)**			
	1.1	Number Systems: Binary, Octal, Decimal, Hexadecimal - Conversion between different number systems Binary Arithmetic: Addition, Subtraction, Multiplication, Division.	4	CO1

		Complements in binary number systems – 1s complement, 2s complement		
	1.2	Boolean Algebra: Basic operations (AND, OR, NOT) - Properties of Boolean Algebra - Boolean Theorems and Simplification Canonical expressions, Min terms and Max terms, SOP and POS expressions Simplification of expression using K-MAP (up to 4 variables) - Don't care conditions	6	CO2
2	**Combinational Logic Circuits (9 Hours)**			
	2.1	Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR - Truth Tables	3	CO3
	2.2	Combinational Circuits Design: Half adder, Full adder, Multiplexers, Demultiplexers, Encoder, Decoder, and Code Converters.	6	CO3
3	**Sequential Logic Circuits (9 Hours)**			
	3.1	Flip-Flops: Latch, Clocked, RS, JK, T, D and Master slave	2	CO3
	3.2	Registers and their types - Shift Registers	2	CO3
	3.3	Counters: Asynchronous and Synchronous Counters, Modulo-N counters, Ripple counter, Johnson counter	3	CO3
	3.4	Design of Simple Sequential Circuits using Flip-Flops	2	CO3
4	**Computer Organization – Basic Architecture (8 Hours)**			
	4.1	Basic computer organization and design: Functional Units of a computer, General architecture, Instruction codes, Computer Registers	4	CO4
	4.2	Computer Instructions and Instruction cycle, Timing and Control, Memory-Reference Instructions, Input-Output.	4	CO4
5	**Memory Systems and Input/Output Organization (9 Hours)**			
	5.1	Memory system: Memory Hierarchy, RAM (Random Access Memory), Read Only Memory (ROM), Types of ROM, Cache Memory, Secondary Memory, Virtual Memory	2	CO5
	5.2	Addressing modes - Implied / Implicit Addressing Mode, Stack Addressing Mode, Immediate Addressing Mode, Direct Addressing Mode, Indirect Addressing Mode, Register Direct Addressing Mode, Register Indirect Addressing Mode, Relative Addressing Mode, Indexed Addressing Mode, Base Register Addressing Mode	3	CO5
	5.3	Input output: I/O interface, Programmed IO, Memory Mapped IO, Interrupt Driven IO, DMA.	4	CO5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Digital logic and computer design by Morris Mano, 4th Edition, Pearson Publication, Upper Saddle River, Nl07458
2. Digital fundamentals by Thomas L. Floyd, Publication details: Noida: Pearson, 2018 ISBN: 9789332584600
3. Modern Digital Electronics by R.P Jain, Fourth Edition, McGraw Hill Education
4. William Stallings, Computer Organization and Architecture: Designing for Performance (Seventh Edition), Prentice-Hall India, 2006
5. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization (Fifth Edition), McGraw Hill, 2000
6. M. Morris Mano (2006), Computer System Architecture, 3rd edition, Pearson/PHI, India

COURSE 03

Discipline/Programme	Computer Applications
Semester	I
Type of Course	DCC
Course Code	24UBCADCC102
Course Title	**Foundation of Mathematics**
Course Level	100-199
Lecture/Tutorial/Practicum	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	**POs**
1	Provide a strong foundation in matrix basics, operations, and multiplications.	Understand	PO2, PO8
2	Explore vector spaces, linear independence, eigenvalues, and eigenvectors.	Understand	PO2, PO8
3	Apply linear algebra concepts to real-world problems in image processing.	Create	PO2, PO8
4	Foster critical thinking and problem-solving skills in the context of linear algebra and image processing.	Analyse	PO1, PO2, PO8
5	Foster practical application of linear algebra principles in image processing through hands-on practicum experiences, cultivating critical thinking and problem-solving skills in real-world scenarios.	Apply	PO2, PO4

COURSE CONTENT

Module	Units	Description	Hours	CO
Module 1: Matrices	1.1	Basics of matrices	3	CO1
	1.2	Elementary operations	3	CO1
	1.3	Normalization	4	CO1
	1.4	Rank of matrix	3	CO1
	3.1	Determinant	2	CO2

Module 2– Determinants	2.2	Inverse of a matrix	3	CO2
	2.3	Linear independence	3	CO2
	2.4	Eigen values and Eigen vectors	3	CO2
Module 3: Solution of equations	3.1	Gauss Elimination method	3	CO3
	3.2	Gauss Jordan Method	3	CO3
	3.3	Gauss Seidal Method	3	CO3
Module 4- Basic logic	4.1	Propositional logic	6	CO4
	4.2	Propositional equivalences (all proofs are deleted in this module)	6	CO4
Module 5		Practicum	30	CO5

Teacher specified contents: (practicum)

- Analyzing the relationship between determinants and invertibility of matrices.
- Solve problems related to applying eigenvalue-eigenvector concepts to analyze stability of systems, image compression techniques, or diagonalization of matrices
- Problems involving solving systems of linear equations using different methods, analyzing the computational complexity of each method, and choosing the most efficient method for specific cases.
- Problems involving proving logical equivalences using truth tables, constructing logical statements to represent real-world scenarios, and analyzing the validity of arguments using propositional logic.

Mode of Assessment: The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). The percentage weightage for CCA and ESE will be as per the undergraduate regulations of the college.

References

1. Ian Chiswell & Wifrid Hodges: Mathematical Logic, Oxford university press
2. Shanti Narayan - Matrices (S. Chand & Company)
3. Introduction to Linear Algebra by Gilbert Strang
4. Linear Algebra and Its Applications by David C. Lay

COURSE 04

<table>
<tr><td>Course Title</td><td colspan="6">Fundamentals of English-Part 1</td></tr>
<tr><td>Course Code</td><td colspan="6"></td></tr>
<tr><td>Type of Course</td><td colspan="6">Ability Enhancement Course (AEC)</td></tr>
<tr><td>Discipline</td><td colspan="6">English</td></tr>
<tr><td>Course Level</td><td colspan="6">100-199</td></tr>
<tr><td>Semester</td><td colspan="6">1</td></tr>
<tr><td>Credits</td><td colspan="6">3</td></tr>
<tr><td>Course Description</td><td colspan="6">This Ability Enhancement Course aims to enhance learners' overall English proficiency by focusing on listening, speaking, reading, and writing. It also aims to build confidence in using grammatically correct English for effective communication, improve intelligible spoken English, teach self-study strategies, enhance interpersonal communication skills, foster critical thinking abilities, and develop analytical skills. Each Unit addresses specific Speaking, Grammar, Pronunciation/Listening, Reading/Writing and Practical Language use topics. The Grammar component of each unit is specified in the syllabus. The other topics covered in each module are listed in the contents page of the reference text.</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td><td>Total Hours</td></tr>
<tr><td>30</td><td>15</td><td></td><td>Blended learning using digital resources available with the reference text</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Preferably all students taking the course must have undergone a suitable diagnostic test to assess their competence in English. Recommended assessment test is Cambridge English Placement Test.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Enable students to assess their competence in the four key language domains of listening, speaking, reading and writing.	Understand, Evaluate	1,2,7
2	Understand the nuances of written and oral communication in English.	Understand	1,3,5
3	Understand the salient features of English grammar through practical language use.	Understand, Apply	2,4,8

4	Master practical aspects of communication such as pronunciation, intonation and stress through classroom activities.	Apply	3,5,4
5	Gain confidence to use English for communicating a wide range of ideas in various contexts	Skill	2,4,6
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Description	Hrs	CO
Module 1:	Units 1-2	Listening - Listening for descriptions of people; listening for opinions, Listening to the good and bad parts of a job; listening for complaints Speaking - Describing personalities; expressing likes and dislikes; agreeing and disagreeing; complaining, Talking about possible careers; describing jobs; deciding between two jobs Writing / Reading - Writing a description of a good friend, Reading about unusual social networking sites, Writing about two career choices, Reading about different types of workplaces Grammar - Relative pronouns as subjects and objects; it clauses + adverbial clauses with when, Gerund phrases as subjects and objects; comparisons with adjectives, nouns, verbs, and past participles Self-paced practice with Online Workbook (Units 3-4)	10	1,2,3,4,5

Module 2:	Units 3-4	Listening - Listening to people making, accepting, and declining requests, Listening to news stories; listening to messages and a podcast Speaking - Making direct and indirect requests; accepting and declining requests, Narrating a story; describing events and experiences in the past Writing/ Reading - Writing a message with requests, Reading about talking to friends about difficult, Writing a personal account, Reading about the reliability of online content topics Grammar - Requests with modals, if clauses, and gerunds; indirect requests, Past continuous vs. simple past; past perfect Self-paced practice with Online Workbook (Units 3-4)	10	1,2,3,4,5
Module 3:	Units 5-6	Listening – Listening for information about living abroad; listening to opinions about customs, Listening to complaints; listening to people exchange things in a store; listening to a conversation about a "throwaway culture" Speaking – Talking about moving abroad; expressing emotions; describing cultural expectations; giving advice, Describing problems; making complaints; explaining something that needs to be done Writing/ Reading – Writing a pamphlet for tourists, Reading about moving to another country, Writing a critical online review, Reading about a problem with a ride-sharing service Grammar – Noun phrases containing relative clauses; expectations: the custom to, (not) supposed to, expected to, (not) acceptable to, Describing problems with past participles as adjectives and with nouns; describing problems with need + gerund, need + passive infinitive, and keep + gerund Self-paced practice with Online Workbook (Units 5-6)	10	1,2,3,4,5

Module 4:	Units 7-8	UNIT IV Listening – Reduction of auxiliary verbs, Listening to environmental problems; listening for solutions, Listening to a conversation with a guidance counselor; listening for additional information Speaking – Identifying and describing problems; coming up with solutions, Asking about preferences; discussing different skills to be learned; talking about learning methods; talking about life skills Writing/ Reading – Writing a post on a community website, Reading about a creative solution to lionfish on St. Lucia, Writing about a skill, Reading about different studying styles Grammar – Passive in the present continuous and present perfect; prepositions of cause; infinitive clauses and phrases, Would rather and would prefer; by + gerund to describe how to do things Self-paced practice with Online Workbook (Units 7-8)	10	1,2,3,4,5
Module 5:		Additional practice with downloadable worksheets: ● Grammar worksheets ● Writing worksheets ● Vocabulary worksheets	5	4,5

Mode of Assessment: The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). The percentage weightage for CCA and ESE will be as per the undergraduate regulations of the college.

Reference Text: Richards, Jack C.. Interchange, Level 3. (Fifth Edition), Cambridge University Press, 2023.

COURSE 05

Discipline/Programme	Computer Applications
Semester	I
Type of Course	MDE
Course Code	24UBCAMDE101
Course Title	**Computer Hardware and Assembling**
Course Level	100-199
Course Summary	This course enables the students to be qualified for employment and to work in a corporate sector demands not only the technical knowledge and experience but interpersonal skills like speaking skills, Professional etiquettes and so on. Students will be taught how to develop these skills and apply them in our everyday interactions with people, both in personal and professional lives.
Lecture/Tutorial/Practical Hours	30/0/30
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the evolution and classification of computers, including their basic architecture and functions of various components such as input/output units, memory, and CPU.	A	1,2
2	Describe the internal hardware of a computer, including power supplies, expansion slots, memory types, storage devices, and input/output devices, and explain their functions and interconnections.	A	1,2
3	Demonstrate the ability to assemble a personal computer, configure the BIOS/CMOS settings, and install operating systems and drivers to build a functional computing system.	A	1,2

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Module	Units	Description	Hrs	CO No
Introduction to Computers(4 hrs)				
1.	1.1	Generations of Computer (I-V),Classification of Computers: Analog, Digital and Hybrid Computers, Micro, Mini, Mainframe, Super Computers, Servers, Laptop	1	CO1
	1.2	Block Diagram of a Computer, Functions of the Different Units: Input unit, Output unit, Memory unit, CPU (ALU+CU).	1	CO1
	1.3	Booting Process- POST, BIOS, clock speed, memory speed, memory capacity	2	CO1
Introduction to Computer Hardware(6 hours)				
2.	2.1	Introduction to Computer Hardware, DC regulated power supply- Block Diagram	1	CO1
	2.2	Concepts of Switch Mode Power supply	1	CO2
	2.3	Inverters, UPS and their applications.	2	CO2
	2.4	Basic Components of CPU, Mother Board.	2	CO2
Expansion Slots(7 hours)				
3.	3.1	ISA, EISA, MCA, VESA, PCI local bus,	1	CO2
	3.2	Processor, Connectors, CMOS memory	2	CO2
	3.3	SMPS, Serial and Parallel Ports, USB, BIOS chip	2	CO2
	3.4	Steps for assembling a PC	2	CO3
Memory and Input Devices (8 hours)				
4.	4.1	Primary Memory, RAM- SRAM, DRAM, ROM, PROM, EPROM, EEPROM, flash memory,	1	CO2
	4.2	Secondary memory: Hard Disk: Structure of a hard disk	2	CO2
	4.3	how data is stored in a hard disk, concept of tracks, sectors, clusters, cylinders, CD-R, RW, DVD-RW, Blue-ray disk, HVD	2	CO2
	4.4	PC memory Units: SIMM, DIMM, RIMM.	2	CO2
	4.5	Keyboard, Point and draw devices: mouse, joystick, track ball, light pen, Data Scanning devices: image scanner, OCR, OMR, MICR, Bar code reader, Voice Recognition Device: Microphone Output Devices: Monitor- CRT displays, Non-CRT displays, TFT: LED,LCD, Plasma. Printer, Impact and non-impact, Character, line and Page Printers.	2	CO2
PC Assembling, Installation (5 hours)				

5.	5.1	Assembling a PC -Mounting motherboard and CPU, Applying thermal paste and installing the CPU fan, Installing RAM and storage, Connecting power cables, front panel, Mounting GPU, Connecting peripherals, POST and BIOS setup, BIOS configuration and CMOS setup - Installing OS and drivers	2	CO3
	5.2	Installing Operating System and Drivers -Bootable USB preparation, BIOS boot sequence configuration, OS installation (Windows/Linux), Installing motherboard chipset, GPU, audio, network drivers, Activating OS and updates	2	CO3

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Brainstorming lectures • Explicit teaching • Active Cooperative learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **CCA for Theory: 30 Marks** ● Quiz / MCQ ● Assignment ● Tests
	B. Semester End Examination **ESE for Theory: Written Test (70 Marks, 2 Hrs)** Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

REFERENCES

1. Objective English: 3rd Edition, Edgar Thorpe and Showick Thorpe, Pearson Publishers
2. Presentation Skills. The essential guide for students, Patsy McCarthy & Caroline Hatcher, Sage Publications, 2002
3. Soft skills- An integrated approach to Maximise Personality, Gajendra Singh Chauhan & Sangeeta Sharma, Wiley Publicati

COURSE 06

Discipline/Programme	Computer Applications
Semester	II
Type of Course	DCC
Course Code	24UBCADCC103
Course Title	**OOPS with C++**
Course Level	100-199
Course Summary	OOPS with C++ syllabus is designed to teach students the fundamentals of OOP and to understand object-oriented programming.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Implement the programmes with the concepts of object-oriented programming language and statements.	Apply	PO1
2	Modify the C++ programmes by reuse the codes having C++ class concepts.	Apply	PO1, PO8
3	Apply the concept of polymorphism.	Apply	PO1, PO2
4	Implement the concept of constructors, inheritance and files.	Apply	PO1, PO2, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Programming(10 hrs)			
	1.1	Evolution of Programming methodologies, Procedure oriented Vs Object oriented programming	2	CO1
	1.2	Characteristics of OOPs	2	CO1
	1.3	Input and output statements	2	CO1
	1.4	Decision and loop statements, Arrays, string and structures	1	CO1

	1.5	Defining class, data members and member functions.	1	CO1
	1.6	Access Specifiers: private, protected and public	1	CO1
	1.7	Significance of scope resolution operator, defining member function inside and outside the class	1	CO1
	Constructors and Destructors (10 Hours)			
2	2.1	Introduction to constructor and destructor	2	CO4
	2.2	Types of constructors	2	CO4
	2.3	Characteristics of constructor	2	CO4
	2.4	Constructor overloading	2	CO4
	2.5	Destructor and its characteristics	2	CO4
	Polymorphism, Inheritance and Pointers (12 Hours)			
3	3.1	Polymorphism: runtime and compile time polymorphism	2	CO3
	3.2	Function overloading	2	CO3
	3.3	Operator overloading and rules for operator overloading	2	CO3
	3.4	Inheritance and need for inheritance	2	CO4
	3.5	Different forms of inheritance and Significance of 'virtual' keyword	2	CO4
	3.5	Pointers in C++	2	CO3
	File Handling and Error Handling (13 Hours)			
4	4.1	Virtual function, Friend function and Static Function	3	CO3
	4.2	Introduction to File Handling	2	CO4
	4.3	Different operations in file; opening and closing a file,	2	CO4
	4.4	Reading and writing operations in file	3	CO4
	4.5	Error handling in C++	3	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for a specific course by the course faculty*. **Practical:**

	Observation of practical skills , Laboratory record, Any other method as may be required for specific courses by the course faculty.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. "Object Oriented Programming with C++" by E. Balaguruswamy:
2. "Mastering C++", by K. R Venugopal
3. "The C++ Programming Language", by Bjarne Stroustrup

COURSE 07

Discipline/Programme	Computer Applications
Semester	II
Type of Course	SEC
Course Code	24UBCASEC102
Course Title	**Linux Operating System**
Course Level	100-199
Course Summary	To impart knowledge and skills on various practical and theoretical aspects of operating system basics and Linux OS based management and administration
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO'S
1	Explain basic concepts of Linux operating system	Understand	PO1
2	Work with basic linux commands	Analyse	PO1
3	Explain the inter-process communication in Linux	Apply	PO1, PO2
4	Analyse various duties of System administrator	Evaluate	PO1, PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Overview of Linux(10 hours)			
1.	1.1	Introduction, Objectives, Features and Drawbacks of Linux, Components of Linux, Linux Distributions	6	CO1
	1.2	Introduction, starting up/ Shutting down, User Names and Groups, Logging in, Format of Linux commands, Changing password, Linux Documentation.	4	CO1
2	Linux Commands and Utilities(10 Hours)			
	2.1	Basic Commands, Disk related commands Permission modes and Standards files. Pipes, Filters and redirection, Shell scripts	5	CO2

	2.2	The File System: Current directory, Absolute and relative pathnames, Commands related to file and directory, Creating and viewing files using cat command, file comparisons, viewing files	5	CO2
3.	Inter- Process Communication(10 Hours)			
	3.1	Process Management- Structure of processes, Process states and transitions- Process control, process creation- signals, Graphical User interface, Editors: Vi Editor, Nano editor Communication commands, Instant Messaging applications, Offline communications.	5	CO3
	3.2	System calls for file system, Process related system calls	5	CO3
4.	Duties of System Administrator(15 Hours)			
	4.1	Booting and shutting down: Boot Loader-GRUB, LILO, Bootstrapping, init process, rc scripts, enabling and disabling services	6	CO3
	4.2	Duties of System Administrator: Creating and maintaining user accounts, Backing up and restoring files, monitoring and tuning performance, Configuring a secure system, using tools to monitor security	9	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for a specific course by the course faculty*. **Practical:** *Observation of practical skills, Laboratory record, Any other method as may be required for specific courses by the course faculty*.
	B. End Semester Examination (ESE) **Theory:**

	Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Maurice J. Bach (2010), The Design of Unix Operating System, Pearson Education
2. S. Prata (2011), Advance UNIX a Programmers Guide, BPB Publications New Delhi
3. Sumitabh Das (2010), Unix Concepts and Applications, Tata McGrawHill Education
4. B.W. Kernighan & R. Pike (2009), The UNIX Programming Environment, Prentice Hall of India.
5. Jack Dent Tony Gaddis (2010), Guide to UNIX Using LINUX, Vikas/ Thomson Pub. House Pvt. Ltd

COURSE 08

Discipline/Programme	STATISTICS
Semester	II
Type of Course	CC
Course Code	24BCADCC104
Course Title	**Statistical Methods For Computational Analysis**
Course Level	100-199
Course Summary	This course helps to acquire foundational knowledge of Descriptive Statistics, probability theory, correlation and regression, Univariate- bivariate random variables and their properties, expectation and conditional variance.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Summarise data using various measure of central tendency	Apply and Analyze	1,2
2	Summarise data using the various measure of Dispersion	Apply and Analyze	1,2
3	Bivariate data analysis- correlation and regression analysis	Analyze and Apply	1,2
4	Understand different approaches to probability- Statistical, Classical and Axiomatic.	Understanda nd apply	1
5	Examine univariate and bivariate random variables - properties	Understand	
6	Evaluate Mathematical expectation	Evaluate and apply	
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Descriptive Statistics (15 hours)**			
	1.1	Measures of central tendency- mean, median, mode, harmonic mean and geometric mean, properties, merits	4	

		and demerits and partition values- quartiles, deciles, percentiles.		
	1.2	Measures of dispersion- range, quartile deviation, Standard deviation and relative measures- merits and demerits.	3	
	1.3	Moments, Skewness, Kurtosis – Different measure of skewness and Kurtosis.	2	
	1.4	Introduction to Correlation and regression, Types of correlation, Scatter diagram, Pearson's coefficient of correlation, Rank correlation.	3	
	1.5	Regression equations and their estimation. Coefficient of determination, Linear regression (Two variables case).	3	
2	**Basic Probability Theory (10 Hours)**			
	2.1	Basic Probability concepts, including random experiments sample space and elementary ideas of probability.	4	
	2.2	Different approaches to probability, Conditional probability, addition theorem, multiplication theorem, independence of events.	4	
	2.3	Baye's theorem and applications	2	
3	**Introduction to random variable (10 Hours)**			
	3.1	Random variable-discrete and continuous random variables. probability mass function (pmf), probability density function (pdf) and distribution functions. Change of variable.	4	
	3.2	Bivariate random variables: bivariate probability mass and density functions.	3	
	3.3	Marginal and conditional distributions. Independence of bivariate random variables.	3	
4	**Mathematical Expectation (10 Hours)**			
	4.1	Mathematical Expectations: Expectation of random variables and their properties. Definition of raw, central moments and their inter - relation, Covariance between variables - Correlation coefficient.	3	
	4.2	Moment generating function, Characteristic function – Properties (Without proof)	4	
	4.3	Conditional Expectation (Conditional mean) and Conditional variance.	4	
5	**Practicum- (30 hours)**			
	5.1	Numerical problems on central tendency, dispersion and correlation and regression using Excel /R	15	
	5.2	Problems based on probability	5	

	5.4	Numerical examples of random variables- discrete case (univariate, bivariate), marginal distributions and problems of independence.	5	
	5.5	Numerical examples of Mathematical expectation.	5	
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** Observation of practical skills, , Laboratory record, *Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report**.** **Practical:** Practical based assessment, Record, *Any other method as may be required for specific course by the course faculty*.

COURSE 09

<table>
<tr><td>Course Title</td><td colspan="6">Fundamentals of English- Part 2</td></tr>
<tr><td>Course Code</td><td colspan="6"></td></tr>
<tr><td>Type of Course</td><td colspan="6">Ability Enhancement Course (AEC)</td></tr>
<tr><td>Discipline</td><td colspan="6">English</td></tr>
<tr><td>Course Level</td><td colspan="6">100-199</td></tr>
<tr><td>Semester</td><td colspan="6">II</td></tr>
<tr><td>Credits</td><td colspan="6">3</td></tr>
<tr><td>Course Description</td><td colspan="6">The Ability Enhancement Course builds upon English 101 to further enhance learners' overall English proficiency.
It addresses further aspects of the four key language skills of listening, speaking, reading and writing. The course explores real world scenarios of communication using English to discuss specific language topics. Each Unit addresses specific Speaking, Grammar, Pronunciation/Listening, Reading/Writing and Practical Language use topics. The Grammar component of each unit is specified in the syllabus. The other topics covered in each module are listed in the contents page of the reference text</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td><td>Total Hours</td></tr>
<tr><td>30</td><td>15</td><td></td><td>Blended learning using digital resources available with the reference text</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">English 101. Preferably all students taking the course must have undergone a suitable diagnostic test to assess their competence in English.
Recommended assessment test is Cambridge English Placement Test.</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Enable students to advance their competence in the four key language domains of listening, speaking, reading and writing.	Understand, Evaluate	1,2,7
2	Familiarize students with further nuances of written and oral communication in English.	Understand	1,3,5

3	Become versatile users of English by understanding advanced features of English grammar through practical language use.	Understand, Apply	2,4,8
4	Gain practical experience of using English for communication and become practically proficient in aspects of language such as pronunciation,intonation and stress.	Analyse	3,5,4
5	Confidently use English for communicating a wide range of ideas in various contexts	Apply, Evaluate	2,4,6
*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Description	Hrs	CO
Module 1:	Units 9-10	Listening - Listening to New Year's resolutions, Listening for dates and time periods; listening to predictions Speaking - Talking about things you need to have done; asking for and giving advice or suggestions, Talking about historic events; talking about things to be accomplished in the future Writing / Reading - Writing a message of advice, Reading about young scientist Jack Andraka, Writing a biography, Reading about futurists and their predictions for the year 2050 Grammar - Get or have something done; making suggestions with modals + verbs, gerunds, negative questions, and infinitives, Referring to time in the past with adverbs and prepositions: during, in, ago, from…to, for, since; predicting the future with will, future continuous, and future perfect Self-paced practice with Online Workbook (Units 9-10)	10	1,2,3, 4,5

Module 2:	Units 11-12	Units 11-12 Listening - Listening to descriptions of important events; listening to regrets and explanations, Listening for features and slogans Speaking - Describing milestones; describing turning points; describing regrets and hypothetical situations, Describing qualities for success; giving reasons for success; interviewing for a job; talking about ads and slogans Writing / Reading - Writing a message of apology, Reading about a conflict with a friend and advice on how to fix it, Writing a TV or web commercial, Reading about what makes some advertisements memorable Grammar - Time clauses: before, after, once, the moment, as soon as, until, by the time; expressing regret with should (not) have + past participle; describing hypothetical situations with if clauses + past perfect and would/could have + past participle, Describing purpose with infinitive clauses and infinitive clauses with for; giving reasons with because, since, because of, for, due to, and the reason Self-paced practice with Online Workbook (Units 11-12)	10	1,2,3, 4,5
Module 3:	Units 13-14	UNIT III Units 13-14 Listening – Listening to explanations; listening for the best solution, Listening for parts of a movie Speaking – Drawing conclusions; offering explanations; describing hypothetical events; giving advice for complicated situations, Describing how something is done or made; describing careers in film, TV, publishing, gaming, and music Writing / Reading – Writing about a complicated situation, Reading about unexplained events, Writing about a process, Reading about what the job of film extra is like Grammar - Past modals for degrees of certainty: must (not) have, may (not) have, might (not) have, could (not) have; past modals for judgments and suggestions: should (not) have, could (not) have, would (not) have, The passive to describe process with is/are + past participle and modal + be + past participle; defining and non-defining relative clauses Self-paced practice with Online Workbook (Units 13-14)	10	1,2,3, 4,5
Module 4:	Units 15-16	Listening – Listening for solutions to everyday annoyances; listening to issues and Opinions, Listening to past obstacles and how they were overcome; listening for people's goals for the future	10	1,2,3, 4,5

		Speaking – Giving opinions for and against controversial topics; offering a different opinion; agreeing and disagreeing, Giving opinions about inspirational sayings; talking about the past and the future Writing / Reading – Writing a persuasive essay, Reading about plagiarism in the digital age, Writing a personal statement for an application, Reading about the athlete Michael Edwards Grammar - Giving recommendations and opinions with passive modals: should be, ought to be, must be, has to be, has got to be; tag questions for opinions, Accomplishments with the simple past and present perfect; goals with the future perfect and would like to have + past participle Self-paced practice with Online Workbook (Units 15-16)		
Module 5:		Additional practice with downloadable worksheets: ○ Grammar worksheets ○ Writing worksheets ○ Vocabulary worksheets	05	1,2,3, 4,5

Mode of Assessment: The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). The percentage weightage for CCA and ESE will be as per the undergraduate regulations of the college.

Reference Text: Richards, Jack C.. Interchange, Level 3. (Fifth Edition), Cambridge University Press, 2023.

COURSE 10

Discipline/Programme	Computer Applications
Semester	II
Type of Course	VAC
Course Code	24UBCAVAC101
Course Title	**IT, Environment and Holistic Living**
Course Level	100-199
Course Summary	This course aims to help students to explore environmental issues and be familiar with the internet. This course is also woven around the methods of strengthening the physical, emotional and intellectual aspects of 'self' based on the principles and practices of Yoga.
Lecture/Tutorial/Practical Hours	30/0/0
Credits	2

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Interpret Internet and Environment	Understand	PO 1
2	Evaluate the need for a holistic approach in assessing environmental impact and be able to Incorporate environmental considerations into a cost/benefit analysis.	Analyse	PO 4
3	Discuss about E-waste and Green computing	Understand	PO 5
4	Explain the environmental impact of Information System and be able to draw up realistic plans for reducing this impact	Understand	PO 7
5	Explain the need of yoga for a healthy living	Understand	PO 8

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to Internet and Environment(4 hours)			
	1.1	Introduction to Internet and Environment: Internet-Internet as a knowledge repository	1	CO2

1	1.2	Academic search techniques, creating cyber presence.	1	CO2
	1.3	Academic websites. Multidisciplinary nature of environmental studies -Definition, scope and importance	1	CO1
	1.4	Need for public awareness.	1	CO5
2	Impact of IT in E-Learning(4 Hours)			
	2.1	Introduction to use of IT in teaching and learning	1	CO2
	2.2	Learning Management System, Moodle, Edmodo, etc	1	CO1
	2.3	Academic services– A note on INFLIBNET, NPTEL, NICNET	2	CO2
3	Various aspects of IT (9 hours)			
	3.1	IT and Society-issues and concerns - digital divide	1	CO4
	3.2	IT & development-the free software movement	1	CO4
	3.3	IT industry: New opportunities and New threats	1	CO3
	3.4	Software piracy, Cyber ethics, Cybercrime, Cyber laws, Cyber threats, Cyber security, Privacy issues,cyber addictions, Information overload	2	CO3
	3.5	Health issues guidelines for proper usage of computers, Internet and mobile phones.	2	CO3
	3.6	Impact of IT on language & culture	2	CO5
4	E-waste and Green Computing(6 hours)			
	4.1	E-waste and Green Computing: E-waste- Problems-Solutions-Impact of E-waste in living beings and environment	2	CO5
	4.2	A study on - Waste Management in India	2	CO5
	4.3	Green computing, definition, meaning, scope. Green computing in India.	2	CO5
5	Yoga for life(7 hours)			
	5.1	Yoga Definition, Objectives of yoga Education, Principles of yogic life	1	CO5
	5.2	Difference between Yoga Asana and physical exercises. Importance of Yoga in daily life.	2	CO5
	5.3	Methods and benefits of Asanas, Pranayama and Concentration,	2	CO4

	5.4	Role of yoga in character building, Role of Yoga practices in developing concentration, will power and discipline, Techniques of stress management.	2	CO5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for a specific course by the course faculty*. **Practical:** *Observation of practical skills, Laboratory record, Any other method as may be required for specific courses by the course faculty.*
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Alan Evans, Kendall Martin, Mary Anne Poatsy Technology in Action, Pearson
2. Bharucha Erach (2013) Text Book of Environmental Studies for undergraduate Courses. 2nd Edition, University Press.
3. Clark.R.S Marine Pollution, Clanderson Press Oxford
4. Cunningham, W.P.Cooper, T.H.Gorhani, E & Hepworth, M.T (2001)Environmental Encyclopedia, Jaico Publication.
5. Dc A.K Environmental Chemistry, Wiley Eastern Ltd.
6. Heywood, V.H & Watson, R.T. (1995) Global Biodiversity Assessment, Cambridge University Press.
7. Dr Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, Third Edition, ORIENT BLACKSWAN PVT. LTD. 3-6-752 Himayatnagar, Hyderabad, 500 029 Telangana

COURSE 11

Discipline/Programme	Computer Applications
Semester	II
Type of Course	MDE
Course Code	24UBCAMDE102
Course Title	**Web Designing**
Course Level	100-199
Course Summary	It enables students to learn various techniques, tools and programming languages in order to create and maintain web pages. The web designing course syllabus contains a basic introduction to designing a website, its tools, software applications, and themes.
Lecture/Tutorial/Practical Hours	30/0/0
Credits	2
Pre-requisite, if any	Basic knowledge of HTML tags Knowledge of basic computer hardware and software

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Identify the elements of HTML	Apply	PO1,PO2,PO8
2	Understand the basic concept of CSS	Analyze	PO1,PO2,PO8
3	Develop the concept of web publishing	Evaluate	PO1,PO2,PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	**Introduction to Hyper text Markup Language (7 hours)**			
	1.1	HTML, HTML documents, Basic structure of an HTML document, Creating an HTML document, Markup tags, heading, paragraphs, Line breaks, HTML tags	3	CO1
	1.2	Elements of HTML: Introduction, Working with Text, Working with list, tables, and frames.	2	CO1
	1.3	Working with Hyperlinks, images and Multimedia	2	CO1

2	**Adding Stylesheets (8 hours)**			
	2.1	Introduction to CSS: Creating style sheet, CSS properties, CSS styling, working with block elements and objects, working with Lists and Tables, CSS Id and Class	4	CO2
	2.2	Box Model- Introduction, Border properties, Padding, Properties, Margin Properties	2	CO2
	2.3	Applying CSS to HTML,CSS colors and Backgrounds	2	CO2
3	**Publishing Websites (15 hours)**			
	3.1	Introduction to Web publishing or Hosting	5	CO3
	3.2	Creating the website, Saving and working on the website	5	CO3
	3.3	Creating website structure, Creating Titles for web pages, Themes- Publishing websites.	5	CO3

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References

1. HTML 5 in simple steps, Kogent Learning Solutions, Dreamtech Press
2. A Beginner's guide to HTML, NCSA
3. HTML,XHTML and CSS bible, Steven M. Schafer, Wiley India
4. Beginning HTML, XHTML, CSS and JavaScript, Wiley India
5. Beginning CSS: Cascading Style Sheets for Web Design, Ian Pouncey, Richard York, Wiley India
6. Web Technologies: HTML, JavaScript, Kogent Learning, Wiley India

COURSE 12

Discipline/Programme	Computer Applications
Semester	III
Type of Course	SEC
Course Code	24UBCASEC201
Course Title	**Programming in Java**
Course Level	200-299
Course Summary	This Course involves a structured syllabus covering fundamental concepts, syntax, object-oriented programming principles, and practical skills necessary to build a strong foundation in core Java.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate object oriented programming using Java, its data types, type conversion, operators	Understand	PO1
2	Develop the Java programmes using defining classes, invoking methods using libraries.	Understand, Apply	PO2
3	Demonstrate the designing, implementing and testing GUI in Java	Analyse	PO3
4	Design GUI applications in Java	Apply	PO2, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Overview of Java Programming(14 hours)			
	1.1	Overview of Java Object Oriented Programming, Writing a simple Java program, control statements and Selection statements in Java	5	CO1
	1.2	Data types: Integers, Floating point, characters, Boolean, A closer look at Literals, Variables, Conditional statements (if/else, switch), Looping statements (for, while, do-while), Understanding the concept of code blocks and indentation	5	CO1

	1.3	Type conversion and casting, Automatic type promotion in Expressions Arrays, Operators and its precedence, Functions Taking input from the user (using Scanner class), Printing output to the console (using System.out.println)	4	CO1
2	Working with class concepts(13 hours)			
	2.1	Class Fundamentals, Dealing with objects, 'this' keyword and finalise() method, Defining and calling methods, Parameters and arguments, Returning values from methods	5	CO2
	2.2	Method overloading (having multiple methods with the same name but different parameters), using objects as parameters, argument passing	4	CO2
	2.3	Returning objects, access control, final keyword Declaring and initializing arrays, Accessing elements in an array, Looping through arrays, Multidimensional arrays	4	CO2
	Inheritance and Exception Handling in Java(14 hours)			
3	3.1	Inheritance: using super, method overriding, Abstract class, Interfaces and packages, static, abstract keywords	5	CO3
	3.2	Exception Handling in Java, File handling basics (reading from and writing to files), Thread class	4	CO3
4	GUI in Java(9 hours)			
	4.1	GUI in Java: Understand the purpose and differences between AWT and Swing. Explore the basic components offered by AWT (buttons, labels, text fields, windows). Advantages of Swing over AWT (lightweight components, platform independence, richer set of components).	5	CO4
	4.2	Handle user interactions with components using event listeners (e.g., button clicks), Explore different range of components offered by Swing (JButtons, JTextFields, JPanels, JTables, JMenus, etc.), Event handling in Swing using action listeners and other event types.	4	CO4

Practicals (30 hrs)

- Setting Up Your Development Environment - Install JDK and explore a text editor (e.g., Visual Studio Code) or IDE (e.g., Eclipse, IntelliJ IDEA). Write and run a simple Java program to print a message.
- Conditional Statements and Loops - Create a program that utilizes if-else statements for decision-making and for or while loops for repetition. (e.g., Guessing game, calculating factorial)
- Building Methods and Functions - Design methods with parameters and return values. Implement logic for calculations or data manipulation within methods. Call these methods from your main program. (e.g., Area and perimeter calculator, temperature converter)

- Array Operations - programs demonstrating array declaration, initialization, accessing elements, looping through arrays, and searching elements within the array. (e.g., Finding the maximum element, sorting an array)
- Building Classes and Objects - Design a class representing a real-world entity (e.g., Book, Student) with attributes and methods. Create objects of that class and demonstrate accessing object properties and invoking methods.
- Reading and Writing Data - Utilize Scanner class for user input and System.out.println for output. Implement file handling basics
- Handling Exceptions - Write a program that demonstrates handling potential exceptions (e.g., division by zero) using try-catch blocks to prevent program crashes.
- Simple Application - Design a GUI java application with AWT/ Swing components like buttons and a drawing panel. Handle user interactions and perform some actions.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Java: The Complete Reference by Herbert Schildt
2. Thinking in Java by Bruce Eckel (Fourth Edition)
3. "Java 8 in Action" by Raoul-Gabriel Urma, Mario Fusco, and Alan Mycroft
4. "Head First Java" by Kathy Sierra and Bert Bates

COURSE 13

Discipline/Programme	Computer Applications
Semester	III
Type of Course	DCC
Course Code	24UBCADCC201
Course Title	**DBMS**
Course Level	200-299
Course Summary	DBMS is fundamental for all application development. This course examines principles of DBMS, data analysis, database design, data modelling and database management.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate the database characteristics, environment, entity-relationship model to develop database designs.	Understand	PO1, PO2
2	Design a database application from a real world scenario using ER model and relational model.	Evaluate	PO1, PO2, PO4, PO6, PO8
3	Develop a relational database by using the Structured Query Language (SQL) syntax for a given application.	Apply	PO1, PO2
4	Apply normalization techniques to remove anomalies in a database.	Analyse	PO1, PO2
5	Infer knowledge about other databases and NOSql	Understand	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to Database(10 Hours)			
1	1.1	Introduction: Characteristics of database approach, Database users-DBA, Database designers and end users, Advantages of using DBMS	3	CO1

	1.2	Data Models: Schemas and instances, DBMS architecture and data independence. DBMS language, Database system environment, DBMS Component and modules	3	CO1
	1.3	ER Modeling: Introduction- Entity types, Entity sets, Attributes and Keys, Relationship Types, Relationship Sets relationship instances, Constraints on relationship types, Weak entity types, and sample ER diagrams.	4	CO1
	Concepts of Relational Data Model(10 hours)			
2	2.1	Relational model concepts domains, attributes, tuples and relations, characteristics of relations. Relational Model constraints Relational Databases and relational database schemas, entity integrity, referential integrity and foreign keys with examples, Relational Database design using ER-to-Relational mapping	5	CO2
	2.2	Relational algebra and Relational calculus: SELECT, PROJECT, UNION, INTERSECTION, The CARTESIAN PRODUCT, JOIN, EQUIJOIN, Aggregate functions. Tuple relational calculus, Domain relational calculus.	5	CO2
	DML and DDL commands(8 hours)			
3	3.1	DDL and DML COMMANDS ,adding constraints, Substring comparisons using LIKE operator, BETWEEN operator, Complex Queries-Nested queries, EXISTS and UNIQUE functions, NULL values, Renaming of attributes and joining of tables, Aggregate functions and grouping, Managing views.	8	CO3
	Data Normalization and Indexing(17 hours)			
4	4.1	Data Normalization: Informal Design Guidelines for relation schemas, functional dependencies. Normal forms: first, second and third normal form, Boyce- Codd normal form, fourth and fifth Normalisation.	4	CO4
	4.2	Indexing structures for files: types of single level ordered indexes	3	CO4
	4.3	Transaction processing: Introduction to transaction processing, Transaction and system concepts, Desirable properties of f transactions. Database Security and Authorization: Types of f security, control measures, database security and the DBA	3	CO4
	4.4	Introduction about Advanced Topics: Object-Oriented and Object Relational databases. Logical Databases, Web Databases, Distributed Databases, Data Warehouse and Data Mining.	3	CO5
	4.5	NoSQL -Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, Column-oriented NoSQL databases, NoSQL Key/Value databases	4	CO5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Ramez Elmasri, Shamkant B. Navathe, Database Systems Models, Languages, Design and Application Programming, 6th Ed., Pearson
2. Abraham Silberschatz, Henry F Korth, S. Sudarshan, Data base System Concepts, 5 th Ed.,
3. McGraw Hill. Raghurama Krishnan, Johannes Gehrke, Data base Management Systems, 3 rd Ed., TMH.
4. C. J.Date, Introduction to Database Systems,8th Ed., Pearson

COURSE 14

Discipline/Programme	Computer Applications
Semester	III
Type of Course	DCC
Course Code	24UBCADCC202
Course Title	**Data Structures using C++**
Course Level	200-299
Course Summary	This course covers the fundamental concepts of data structures and algorithms, providing a strong foundation for efficient program design and problem solving.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	C++ concepts

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Demonstrate a strong understanding of fundamental data structures.	Understand	PO1
2	Interpret the strengths and weaknesses of each algorithm in terms of efficiency and suitability for different data sizes and types.	Understand	PO2
3	Build stacks and queues using arrays and perform different operations.	Apply	PO1, PO2, PO8
4	Build a linked list ,tree and graph and perform various operations .	Apply	PO8, PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Data Structures(8 hours)			
	1.1	Definition, Classification of Data structure and operations	1	CO1
	1.2	Time and space complexity of algorithms	2	CO1
	1.3	Arrays: - Definition, Types, memory representation, operations	5	CO1
2	Searching and Sorting Techniques(7 hours)			
	2.1	Searching Techniques -Linear search, Binary search, Iterative and Recursive method, Divide and Conquer method	2	CO2
	2.2	Sorting Techniques- Selection sort, Bubble sort, insertion sort, Quick sort and Merge sort	5	CO2
3	Overview of Stack and Queue (16 hours)			
	3.1	Stack overview- Definition, Array representation of stack, Operations on stack.	2	CO3
	3.2	Applications of stack -reversing a string , Infix, prefix and postfix notations, Conversion of an arithmetic expression from Infix to postfix, postfix evaluation.	6	CO3
	3.3	Queue- Definition, Array representation of queue, Types of Queue: Simple queue, Circular queue, Double ended queue (de-queue), Priority queue, Operations on all types of Queues, Applications of queues	8	CO3
4	Linked List, Tree and Graph(14 hours)			
	4.1	Linked list - Definition, Types-singly linked list, doubly linked list, circular linked list, doubly circular linked list and its operations.	6	CO4
	4.2	Tree-Definition, types of trees- Binary Tree, Binary Search Tree and its operations.	4	CO4
	4.3	Graph as Data structure- Definition, Types and its operations-BFS, DFS.	4	CO4

Practicals (30 Hrs)

- Array operations-insertion, deletion, merging two arrays
- Implement linear search, binary search
- Implement selection sort, bubble sort, insertion sort, quick sort, merge sort
- Implement Stack using array, linked list

- Infix expression into its postfix expression, Evaluation of a postfix expression
- Implement Queue using array, linked list
- Implement circular queue- insertion, deletion, Traversal
- Implement priority queue- insertion, deletion, Traversal
- Implement a singly linked list-creation, insertion, deletion, search, concatenate two linked lists, interchange any two nodes in a list, sort based on information field
- Implement a doubly linked list of integers-create, insertion, deletion, traversal
- Implement a circular linked list, doubly circular linked list
- Implement a binary search tree – creation, traversal
- Implement graph-creation, BFS, DFS

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Data Structures Through C++ Paperback – 28 February 2003 by Yashavant Kanetkar , BPB publications
2. Data Structures and Algorithms in Java by Robert Lafore
3. Introduction to Algorithms by Thomas H. Cormen, Chales E. Leiserson, Ronald L.Rivest and Clifford Stein.

COURSE 15

Discipline/Programme	Computer Applications
Semester	III
Type of Course	DCC
Course Code	24UBCADCC203
Course Title	**Advanced Web Technologies**
Course Level	200-299
Course Summary	This comprehensive PHP course empowers you to create dynamic and interactive web pages.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	Web Technologies

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Use PHP to create a data driven website.	Understand	PO1
2	Implement the functions, constructors, inheritance to use them in the PHP script.	Apply	PO1, PO2
3	Create web forms with PHP.	Create	PO3
4	Alter the content of a web page dynamically using the combination of data from the MySQL database and PHP methods	Create	PO2, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
Introduction to PHP(10 hours)				
1	1.1	Introducing PHP – What is PHP? Why use PHP? Evolution of PHP, Creating your first script.	2	CO1
	1.2	PHP Language Basics – Using variables, Understanding Data Types, Operators and Expressions, Constants.	2	CO1

	1.3	Decisions and Loops – Making Decisions, Doing Repetitive Tasks with Looping, Mixing Decisions and Looping with HTML.	2	CO1
	1.4	Strings – Creating and Accessing Strings, Searching Strings, Replacing Text with Strings, Dealing with Upper and Lowercase, Formatting Strings	2	CO1
	1.5	Arrays – Creating Arrays, Accessing Array Elements, Looping Through Arrays with for-each, Working with Multidimensional Arrays, Manipulating Arrays.	2	CO1
Working with Functions (14 Hours)				
2	2.1	Functions – What is a Function? Why Functions are useful? Calling Functions,	2	CO2
	2.2	Working with Variable Functions, Writing your own Functions	2	CO2
	2.3	Working with References, Writing Recursive Functions.	1	CO2
	2.4	Objects – Introduction OOP Concepts, Creating Classes and Objects in PHP,	2	CO2
	2.5	Creating and using Properties, Working with Methods, Object Overloading with _get(), _set() and _call(),	2	CO2
	2.6	Using Inheritance to Extend Power of Objects	2	CO2
	2.7	Constructors and Destructors	1	CO2
	2.8	Automatically Loading Class Files, Storing as Strings.	2	CO2
3	Form Handling(8 Hours)			
	3.1	Handling HTML Forms with PHP – How HTML form works	2	CO3
	3.2	Capturing Form Data with PHP, Dealing with Multi-Value Fields	2	CO3
	3.3	Generating Web Forms with PHP,Storing PHP Variables in Forms	2	CO3
	3.4	Creating File Upload Forms, Redirecting After a Form Submission	2	CO3
	Working with files and Directories(13 hours)			
4	4.1	Introduction to Files and Directories- Getting Information on Files, Opening and Closing Files	2	CO4
	4.2	Reading and Writing to Files, Copying, Renaming, and Deleting Files, Working with Directories.	1	CO4
	4.3	Introducing Databases and SQL – Deciding How to Store Data,	2	CO4
	4.4	Understanding Relational Databases, Setting Up MySQL, A Quick Play with MySQL, Connecting MySQL from PHP.	2	CO4

	4.5	Retrieving Data from MySQL with PHP – Setting Up the Book Club Database	2	CO4
	4.6	Retrieving Data with SELECT, Creating a Member Record Viewer. Manipulating MySQL Data with PHP – Inserting, Updating, and Deleting Records,	2	CO4
	4.7	Building a Member Registration Application.	2	CO4

Practicals (30 hrs)

- Local Development Stack: Install Apache/Nginx web server, configure PHP with it, and set up a local MySQL database for your project.
- PHP Framework Kickstart: Choose a framework (Laravel/Symfony) and follow official installation guides to get it running on your machine.
- Secure Development Practices: Implement security measures in your code (password hashing, escaping user input) and harden your web server configuration.
- Version Control with Git: Set up a Git repository for your project, practice basic commands, and explore pushing code to a platform like Git.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Matt Doyle, Beginning PHP 5.3 (Wrox – WileyPublishing)
2. Ellie Quigley, PHP and MySQL by Example
3. Joel Murach, Ray Harris, Murach's PHP and MySQL
4. Brett McLaughlin, PHP & MySQL: The Missing Manual
5. Luke Welling, Laura Thomson, PHP and MySQL Web Development
6. W. Jason Gilmore, Beginning PHP and MySQL from Novice to Professional

COURSE 16

Discipline/Programme	Computer Applications
Semester	III
Type of Course	MDE
Course Code	24UBCAMDE201
Course Title	**Numerical Methods and Linear Programming Problem**
Course Level	200-299
Course Summary	This course will introduce mathematical techniques that form the foundation of advanced computational methods focusing on numerical methods and optimization. It enables students to comprehend and apply various problem-solving strategies to address both theoretical and practical challenges in computer science.
Lecture/Tutorial/Practical Hours	45/0/0
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply numerical methods to approximate solutions to mathematical problems.	A	1,2
2	Understanding Linear Programming and Operations Research	A	1,2
3	Applying Optimization Techniques	A	1,2
4	Formulate and solve transportation problems	C	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO
1		**Numerical Methods (12 hours)**		
	1.1	Roots of Nonlinear equations: Bisection method and Newton- Raphson methods. (Section 6.1, 6.6, 6,8 of REF. 1) *Only formula and problem-solving for all the topics mentioned above.*	4	CO1
	1.2	Numerical Interpolation: Newton's Forward and Backward Interpolation Formula. (Section 9.1,9.7 of REF. 1) *Only formula and problem-solving for all the topics mentioned above.*	5	CO1
	1.3	Numerical Integration: Trapezoidal rule and Simpson's 1/3 rule. (Section 12.1- 12.4 of REF. 1) *Only formula and problem-solving for all the topics mentioned above.*	3	CO1
2		**Linear Programming Problem (11 hours)**		
	2.1	Linear programming: Introduction, Formulation of LPP. (REF. 2)	3	CO2
	2.2	Graphical method for solving LPP with two variables. **(**REF. 2)	4	CO2
	2.3	Special cases in graphical methods. **(**REF. 2)	4	CO2
3		**Optimization Problem (11 hours)**		
	3.1	Simplex method. **(**REF. 2)	3	CO3
	3.2	Artificial variable techniques. **(**REF. 2)	4	CO3
	3.3	Big M method. **(**REF. 2)	4	CO3

4	**Transportation and Assignment Problem (11 hours)**			
	4.1	Transportation problem: Definition, Linear form, North-west corner method, Least cost method, Vogel's approximation method for finding a feasible solution. **(**REF. 2)	4	CO4
	4.2	MODI method for finding the optimum solution. Degeneracy **(**REF. 2)	3	CO4
	4.3	Unbalanced Transportation Problem, Maximisation in transportation problem. **(**REF. 2)	4	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Brainstorming lectures ● Explicit teaching ● Active Cooperative learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) CCA for Theory: 30 Marks** ● Quiz / MCQ ● Assignment ● Tests
	B. Semester End Examination **ESE for Theory: Written Test (70 Marks, 2 Hrs)** Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

REFERENCES

1. E Balagurusamy - Numerical Methods, Tata McGraw Hill.
2. V K Kapoor - Operations Research- Concepts, Problems & Solutions, Sultan Chand & Sons

SUGGESTED READINGS

1. P Kandasamy, K Thilagavathy, K Gunavathi - Numerical Methods.
2. Belly E Gillet - Introduction to Operations Research (A Computer Oriented Arithmetic Approach), Tata Mc Graw Hill.

COURSE 17

Discipline/Programme	Computer Applications
Semester	III
Type of Course	VAC
Course Code	24UBCAVAC201
Course Title	**Green Computing**
Course Level	200-299
Course Summary	The course aims to teach students how to use computers and their resources in an environmentally friendly way.
Lecture/Tutorial/Practical Hours	30/0/0
Credits	2

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the concept of green computing and environment sustainability	Understand	PO 1, PO 3
2	Assess the benefits of Going Green.	Understand	PO 2, PO 3
3	Evaluate the importance and benefits of Paperless work	Analyse	PO 7, PO 6

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Concepts of Green IT(11 hours)			
	1.1	Concepts of Green IT: Environmental concerns and Sustainable Development, Carbon Footprint, Environmental impacts of IT,	3	CO 1
	1.2	Holistic Approach to Green IT, Greening IT: Green PC, Notebooks and Servers	4	CO 3
	1.3	Green Data Centers: Green Cloud computing, Green Data Storage, Green Software, Green Networking and Communications,	4	CO 3
	Concept of Green Device(7 hours)			

2	2.1	Concept of Green Devices: Green Device and Hardware, Lifecycle of a Device or Hardware,	3	CO 2
	2.2	Designing, Manufacturing, Packaging, Transportation, Use Reuse, Recycle and Dispose	4	CO 2
3	Green Storage(12 hours)			
	3.1	Going Paperless: Green Storage ,Paperless Office, using internet,	4	CO 3
	3.2	Intranets, EDI Green Data Storage,	4	CO 3
	3.3	Green Drives- SSD, RAID, MAID	4	CO 2

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty*.

References:

1. Green IT, Toby Velte, Anthony Velte, Robert Elsenpeter, McGraw Hill, 2008
2. Green Computing and Green IT Best Practice, Jason Harris Emereo.
3. Green Data Center: Steps for the Journey, Alvin Galea, Michael Shaefer, Mike Ebbers, Shroff Publishers and Distributors. 2011
4. Harnessing Green IT: Principles and Practices, San Murugesan, IEEE IT Professional.
5. Woody Leonhard, Katherine Murray- Green Home computing for dummies, August 2012/
6. John Lamb- The Greening of IT, Pearson Education, 2009.

COURSE 18

Discipline/Programme	Computer Science					
Semester	IV					
Type of Course	DCC					
Course Code	24UBCADCC204					
Course Title	**Mobile Application Development**					
Course Level	200-299					
Course Summary	This course provides an introduction to Android application development using the Java programming language. Students will learn the fundamentals of Android development, including user interface design, activity lifecycle, data storage, and networking.					
Lecture/Tutorial/Practical Hours	45/0/30					
Credits	Total	4	Theory	3	Practical	2
Pre-requisite, if any	Students should have knowledge in Java programming					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO'S
CO1	Explain the principles of UI design and layouts in Android.	Understand	PO1, PO2
CO2	Explain the lifecycle methods of an Android Activity and Fragments	Understand	PO1, PO2
CO3	Apply various data storage techniques to store application data locally	Apply	PO1, PO2
CO4	Create Android apps with various features	Create	PO1, PO2

COURSE CONTENT

Module	Units	Course description	Hrs	CO
1	Module 1 (12 hours)			
	1.1	Overview of the Android platform History and evolution of Android Setting up the development environment (Android Studio)	4	CO1
	1.2	Understanding Android project structure Components of an Android application (Activities, Services, Broadcast Receivers, Content Providers)	4	CO1

		Android Manifest file and its importance		
	1.3	Views and Layouts, XML Layouts, Event Handling	4	CO1
2	Module 2 (11 hours)			
	2.1	Understanding Activity lifecycle Managing state changes Handling configuration changes	3	CO2
	2.2	Intent and Intent Filters Implicit and Explicit Intents Broadcast Receivers	4	CO2
	2.3	Fragments, Fragment Life cycle Communicating between Fragments File I/O	4	CO2
3	Module 3(10 hours)			
	3.1	Data Storage in android: Internal and External Shared Preferences	2	CO3
	3.2	SQlite Database, CRUD Operations	4	CO3
	3.3	Content Providers Basics of Content Providers and their role in Android architecture. Implementing a custom Content Provider to share data within an app. Accessing data from built-in Content Providers like Contacts, Calendar, etc.	4	CO3
4	Module 4 (12 hours)			
	4.1	Dealing with multimedia Using ImageView to display images in an Android application. Loading images from various sources like resources, assets, and URLs. Techniques for optimizing image loading and caching to improve performance.	4	CO4
	4.2	Using MediaPlayer for audio and video playback. Handling audio focus and managing playback controls. Implementing features like play, pause, stop, seek, and volume control.	4	CO4
	4.3	Accessing the device camera using Camera API or Camera2 API. Capturing photos and videos programmatically.	2	CO4
	4.4	Deploying an app in playstore: steps	2	C04

Practicals (30 Hrs)

- Create an app that takes user input through EditText and displays it using TextView.
- Introduce the concept of references to UI elements using findViewById().
- Develop apps to store and retrieve data using SharedPreferences, SQLite database, and file I/O.
- Implement programs to read from and write to files, demonstrating file handling concepts.
- Explore concepts like Fragments, AsyncTask, and RecyclerView to build more complex Android applications.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. "Android Programming: The Big Nerd Ranch Guide" by Bill Phillips and Brian Hardy
2. "Android App Development for Dummies" by Michael Burton
3. "Android Programming: The Big Nerd Ranch Guide" by Bill Phillips and Chris Stewart
4. "Head First Android Development: A Brain-Friendly Guide" by Dawn Griffiths and David Griffiths

COURSE 19

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	DCC
Course Code	24UBCADCC205
Course Title	**Software Engineering**
Course Level	200-299
Course Summary	Learn the scientific way of software engineering models. This course imparts knowledge of designing, coding, testing, debugging and software applications.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate the characteristics of software engineering and the life cycle model.	Understand	PO1, PO8
2	Apply the concept of software requirement analysis and planning to develop software systems for real world problems.	Apply	PO1, PO2, PO4, PO6, PO8
3	Design a software design by considering the aspects of heuristics, modularity, uml.	Apply	PO1,PO3
4	Differentiate between the types of software testing methodologies.	Analyse	PO1,PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Software Engineering (15 hours)			
	1.1	Introduction to Software Engineering, Software Engineering Paradigm ,Verification and validation	3	CO1
	1.2	Life cycle Models	4	CO1
	1.3	Software Engineering Vs System Engineering	4	CO1

	1.4	Overview of Product Engineering	4	CO1
2	Software Requirements(13 hours)			
	2.1	Introduction to Software Requirements, Functional and Non-functional requirements, Software Document, Software Requirement Specification	5	CO2
	2.2	Requirement Engineering process, Feasibility study, project plan: Gantt chart, pert chart	3	CO2
	2.3	Software prototyping	3	CO2
	2.4	Functional and behavioral models, Data Dictionary	2	CO2
3	Software Design(16 hours)			
	3.1	Analysis Concepts	2	CO3
	3.2	Design Process and Concepts	2	CO3
	3.3	Modular Design, Design Heuristics	4	CO3
	3.4	User interface design	4	CO3
	3.5	DFD, UML diagrams: Use case diagram, Activity diagram, sequence diagram, object diagram, class diagram	4	CO3
	Software Testing(16 hours)			
4	4.1	Taxonomy of Software Testing, Types of Software Testing	4	CO4
	4.2	Black Box Testing	4	CO4
	4.3	White Box Testing	4	CO4
	4.4	System Testing and Debugging	4	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
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	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References :

1. Ian Sommerville (2007), Software engineering 7th Edition, Pearson Education Asia.
2. Roger S. Pressman (2005), Software Engineering A Practitioner Approach, 6th Edition

COURSE 20

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	DCC
Course Code	24UBCADCC206
Course Title	**Operating System**
Course Level	200-299
Course Summary	This course is the foundation of Computer Science and essential for software development, networking and architecture. It covers a fundamental overview of the operating system and the major components.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate the creation and working of a process, threads and the execution of these in single-processor and multi-processor systems.	Analyse	PO1, PO2
2	Discuss issues of Memory management and Process Management including process structure, synchronization, scheduling and communication.	Apply	PO1, PO2
3	Interpret the reasons for deadlock state, and the solution methods to handle deadlock.	Analyse	PO1, PO2
4	Analyse the various device and resource management techniques in time sharing and distributed systems	Analyse	PO1, PO2
5	Appreciate the need of access control and protection in an operating system.	Understand	PO2, PO6, PO7, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to Operating System(16 hours)			
1	1.1	Introduction, Definition, Objectives and Functions of OS, OS Structures, OS Services, System calls	4	CO1
	1.2	Types of operating system- Batch Processing, Multiprogramming, Multiprocessing, Time Sharing, Distributed OS, Real time Processing. System calls, Types of System call	4	CO1
	1.3	Process: Basic Concepts, Operations on Processes, Inter process communication	4	CO1
	1.4	Threads: Introduction to Threads, Single and Multithreaded processes, User and Kernel threads, Multithreading models, Threading issues.	4	CO1
	Concepts of CPU Scheduling and Process synchronization(14 Hours)			
2	2.1	CPU Scheduling: Basic concepts, Scheduling criteria, Scheduling Algorithms, Multiple Processor Scheduling.	4	CO2
	2.2	Process Synchronization: Mutual Exclusion, Critical – section problem, Synchronization hardware, Semaphores, Classic problems of synchronization, Critical Regions, Monitors,	5	CO2
	2.3	Deadlocks: System Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.	5	CO3
	Memory and Virtual Management(12 hours)			
3	3.1	Memory Management: Logical and physical Address Space, Swapping, Contiguous Memory Allocation, Paging, Segmentation with Paging.	6	CO2
	3.2	Virtual Management: Demand paging, Page Replacement Algorithms- FIFO, Optimal page replacement algorithm, LRU, Allocation of Frames, Thrashing,	6	CO2
	File System and Disk Management(18 hours)			
4	4.1	File-System Interface: File concept, Access Methods, Directory structure, File-System Implementation: File-System structure, File-System Implementations, Directory Implementation, Allocation Methods	6	CO4
	4.2	Disk Management: Disk Structure, Disk Scheduling- FCFS, SSTF, C Scan, Look, C-Look Disk Management	6	CO4
	4.3	Protection: Goals of Protection, Domain of Protection Access Matrix, implementation of access matrix. Security Security Problem, User Authentication, One – Time Password, Program Threats, System Threats	6	CO5

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	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific courses by the course faculty.*

References:

1. Milan Milonkovic, Operating System Concepts and Design, 2nd Edition.
2. Tanenbaum, Operating System Concepts, 2nd Edition, Pearson Education
3. Silberschatz Galvin Gagne, Operating System, 6th Edition WSE WILEY Publication
4. William Stallings, Operating System, 4th Edition, Pearson Education.

COURSE 21

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	SEC
Course Code	24UBCASEC202
Course Title	**Technical Writing using LATEX**
Course Level	200-299
Course Summary	This course empowers you to create professional and polished technical documents using LaTeX, the industry standard for scientific and academic writing.
Lecture/Tutorial/Practical Hours	30/0/30
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
1	LaTeX syntax for formatting elements like text styles (bold, italics), sections, and chapters	Understand	PO1
2	Effectively utilize tables, figures, and equations within LaTeX documents.	Apply	PO1, PO2
3	Explore tools and workflows for efficient LaTeX document creation.	Analyze	PO2
4	Evaluate best practices for clear, concise, and professional technical writing	Evaluate	PO2
5	Create Tables, Graphics and Pictures Lists, Arrays and Bibliography by using LaTeX. Create Slides with Beamers and posters.	Create	PO2, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Latex Introduction and basics (10 hours)			
	1.1	Introduction to LaTeX. Various integrated development environment (IDE) for LaTeX. Installation of TexStudio. Online Overleaf access.LaTeX content.	5	CO1

	1.2	Structure of LaTeX document. Defining class of the document through \documentclass. Packages and different environments. Creating a Title, chapters and sections and their labeling. Page style, fonts, font sizes, font styles.	5	CO2
2	Creating Document, Tables and formatting (10 hours)			
	2.1	Basic document creation, Preparing basic document, Changing the class – article, report Sectioning, Chapters	5	CO3
	2.2	Labeling Table of Contents, font Effects, coloured text, boxes, theorems, comments & spacing Special characters, line breaking. Columns, multi-columns and minipages. Page numbering, footnotes, headers and footers. Fancy page styles. Short cuts and definitions.	5	CO2
3	Adding references (5 hours)			
	3.1	Inserting pictures and tables. Special environments enumerates, tabular, cases etc. Citation in LaTeX using BibTeX. Creating reference database as .bib file. Bibliography styles.	5	CO4
4	Building ppts and CVs (5 hours)			
	4.1	Presentations in LaTeX. Introduction to beamer class. Themes of beamer presentations. Familiarizing Overleaf and different templates. Journal article templates in Overleaf. Creating CVs in LaTeX	5	CO5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.

	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References

1. The LaTeX Companion, Second Edition by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, and Sebastian Rahtz.
2. Getting Started with LaTeX by Geoffrey Grimmett.
3. How to Write Mathematics by Edward P. Griffiths and Derek J. Higham.
4. Overleaf Learn LaTeX https://www.overleaf.com/learn/latex/Tutorials: A collection of interactive tutorials covering various LaTeX features.
5. The Comprehensive TeX Archive Network (CTAN) https://ctan.org/?lang=en: A vast repository of LaTeX packages, documentation, and resources.

COURSE 22

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	VAC
Course Code	24UBCAVAC202
Course Title	**Health and Wellness**
Course Level	200-299
Course Summary	This course imparts the knowledge of personal health concepts with emphasis on the body system, emotional health, drug use and abuse, disease, nutrition and community health.
Lecture/Tutorial/Practical Hours	45/0/0
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Importance of a healthy lifestyle	Understand	PO4,PO6,PO8
2	Improve the physical and mental health	Apply	PO4,PO6,PO8
3	Interpret the various lifestyle related diseases	Understand	PO4,PO8
4	Explain the stress management.	Understand	PO4,PO8,PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Health and Wellness (11 hours)			
	1.1	Define and differentiate health and wellness, Importance of health and wellness Education.	3	CO1
	1.2	Local, demographic, societal issues and factors affecting health and wellness Diet and Nutrition for health and Wellness	3	CO1
	1.3	Essential components of balance diet for health living with specific reference to the role of carbohydrates, proteins, fats, vitamins and minerals	3	CO1

	1.4	Processed foods and unhealthy eating habits	2	CO1
2	Deficiencies and Diseases (14 hours)			
	2.1	Malnutrition, undernutrition and overnutrition. Body systems and common diseases. Sedentary lifestyle and its risk of disease.	2	CO2
	2.2	Stress, anxiety and depression. Factors affecting mental health. Identification of suicidal tendencies	6	CO2
	2.3	Healthy food for prevention and progression of cancer.	6	CO2
3	Diseases and Substance Abuse(13 hours)			
	3.1	Hypertension, Cardiovascular, and metabolic diseases such as Obesity, Diabetes, Polycystic Ovarian Syndrome.	5	CO3
	3.2	Substance abuse, Types of Physical Fitness and its Health benefits.	5	CO3
	3.3	Postural deformities and corrective measures. Spirituality and mental health.	3	CO3
4	Management of Health and Wellness(7 hours)			
	4.1	Role of Yoga, asanas and meditation in maintaining health and wellness.	4	CO4
	4.2	Role of sleep in maintenance of physical and mental health	3	CO4

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Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.

	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Physical Activity and Health by Claude Bouchard,Steven N.Blair, Williams L. Haskell
2. Mental Health Workbook by Emily attached & Marizia Fernandez, 2021
3. Mental Health Workbook for Women: Exercise to Transform negative thoughts and Improve Well-Being by Nashay Loric, 2022
4. Lifestyle Diseases: Lifestyle Disease management by C. Nyambichu & Jeff Lumiri,

COURSE 23

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	SEC
Course Code	24UBCASEC203
Course Title	**Internship I**
Course Level	
Course Summary	Internship program allows students to gain practical exposure to real-world computing environments and with tools and technologies used in the software industry.This helps students to bridge the gap between theoretical learning and industry practices, enhancing employability skills and professional outcomes. Students will be able to prepare for industry roles through active engagement in project development and technical documents.
Lecture/Tutorial/Practical Hours	
Credits	3

Comprehensive Guidelines for Internship

Objectives of the Internship

1. Gain exposure to real-time software/application development or IT processes.
2. Understand the work culture, team collaboration and Project management.
3. Develop soft skills such as communication, reporting and time management.
4. Build a portfolio or prototype project under industry mentorship.

Duration and Timing

1. Internship Duration should be minimum 4 weeks(1 month).
2. Suggested Timing: after the 4th Semester(Summer break)
3. Working Hours: Minimum 5 days of week and 5 -6 hours/ day or as agreed with the host organization.

Responsibilities of the student for the successful completion of internship program:

1. Students should complete the assigned tasks or project work in a relevant domain.

2. Students should maintain a daily work log detailing tasks and learning
3. Weekly progress reports should be submitted to both academic and industry mentors.
4. Students should complete assigned tasks/project modules within deadlines.
5. Maintain professionalism and follow company policies.
6. Final internship report detailing objectives, methodologies, tools used, challenges faced and learning objectives.
7. Viva - voce or presentation at the end of the internship.

Deliverables

1. Students should obtain an Internship completion certificate from the host company.
2. Final Internship report(20-25 pages approximate including following details:
    a. Company profile
    b. Objectives of the internship
    c. Description of tasks performed
    d. Tools/ Technologies used
    e. Challenges faced and solutions
    f. Key Learning
    g. Screenshots or code snippets (if applicable)
3. Presentation/ Viva to be evaluated by the internship coordinator.

Evaluation and Acceptance Criteria

1. Internship Report
2. Industry Supervisor Feedback
3. Attendance should be 100%.
4. Viva-voce / Final Presentation

Code of Conduct

1. Respect confidentiality and intellectual property rights of the organization.
2. Abide by company rules and maintain decorum
3. Avoid plagiarism in reports and presentations.
4. Ensure timely attendance, punctuality and active participation.

COURSE 24

Discipline/Programme	Computer Applications
Semester	V
Type of Course	DCC
Course Code	24UBCADCC301
Course Title	**Computer Networks**
Course Level	300-399
Course Summary	Learn the basics of computer networking, the various protocols, to acquire networking skills and its troubleshooting.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Design a network or network topologies using the various network devices and the reference models with OSI, TCP/IP.	Understand	PO 1, PO 3
2	Select protocols from application layer protocols, transport layer protocols and network layer protocols to implement the network and its switching.	Apply	PO 2, PO 4
3	Discuss the data transmission techniques in the networks with its control flow and error correction strategies.	Analyse	PO 1, PO 4
4	Explain wireless communication networks, devices, security protocols and its generations	Understand	PO 6, PO 3

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Communication(11 Hours)			
	1.1	Introduction to Communication: Basics of Network & Networking, Advantages of Networking.	2	CO1
	1.2	LAN, MAN, WAN, Network Terms: Host, Workstations, Server; Client; Node; Types of Network Architecture: Peer-to-Peer & Client/Server; Workgroup Vs. Domain;	2	CO1

	1.3	Network Devices- NIC- Functions of NIC, Hub, Switch, Bridge, Router, Gateways, And Other Networking Device, and Modem;	2	CO1
	1.4	Network Topologies: Types of Topologies, Logical and physical topologies, Selecting the Right Topology;	2	CO1
	1.5	Models of Network Introduction of OSI model, Seven layers of OSI model, Functions of the seven layers, Introduction of TCP/IP Model, Comparison between OSI model & TCP/IP model.	3	CO1
2	Multiplexing, Switching Techniques and different Protocols(15 Hours)			
	2.1	Multiplexing: FDM, TDM, WDM, SONET.	2	CO2
	2.2	Switching techniques: Packet switching, Structure of packet switching, Circuit switching.	4	CO2
	2.3	Transport protocols: TCP, UDP	3	CO2
	2.4	Network layer Protocols: IPv4, IPv6, ICMPV4, ICMPV6, IGMP, ARP, RARP, DHCP	3	CO2
	2.5	Protocols: HTTP/HTTPS, FTP, TFTP, SFTP, Telnet; Email: SMTP, POP3/IMAP. Point-to-Point Protocol (PPP), PPP standards	3	CO2
3	Basic Concepts of Network(14 Hours)			
	3.1	Basics of Network, Transport and Application Layer protocols	1	CO2
	3.2	Framing: fixed size framing; variable size framing Routing algorithms: Shortest Path (Bellman Ford Algorithm) Dijkstras' algorithm.	3	CO3
	3.3	Flow Control: Noiseless Channel Protocol: simplest protocol, stop and wait protocol. Noisy channel protocol: Stop and wait ARQ, Goback N ARQ, selective repeat ARQ, piggy backing.	2	CO3
	3.4	Error detection and correction: Types of errors; Redundancy- detection and correction. Parity check; polynomial codes Hamming distance – minimum Hamming distance.	4	CO3
	3.5	Congestion control algorithms: Leaky bucket algorithm; Token bucket algorithm.	2	CO3
	3.6	Network Utilities commands: ping, traceroute, tracert, ipconfig, arp, nslookup, netstat, nbtstat; Hardware TroubleShooting Tools, System Monitoring Tools.	2	CO3
4	Wireless Network and its components (20 Hours)			
	4.1	WAN Technology File-System Implementations, Directory Implementation, Allocation Methods, Digital representation of information: properties of signals, Transmission modes: parallel and serial transmission.	4	CO4
	4.2	PSTN, ISDN, DSL, CATV, Satellite-Based Services, Types of Wireless Networks: Ad-hoc mode; Infrastructure mode;	5	CO4

	4.3	Wireless network Components: Wireless Access Points Wireless NICs; Wireless LAN standards: IEEE 802.11a IEEE 802.11b, IEEE 802.11g, wireless LAN modulation techniques	4	CO4
	4.4	Wireless security Protocols: WEP, WPA, 802.1X Connecting to the Internet	4	CO4
	4.5	Cellular Technologies: 2G;3G;4G;5G	3	CO4

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References:

1. Andrew s. Tanenbaum; David j. Wetherall; Computer Networks; fifth edition; Pearson Publications 2011
2. CCNA (2011), Cisco Certified Network Associate: Study Guide (With CD) ; 5th Edition
3. CCENT/CCNA ICND1 (2013), Official Cert Guide; 3rd Edition (Paperback)
4. CCNA (2008), Routing Protocols and Concepts CCNA Exploration Companion Guide (With CD) (Paperback); Pearson
5. CCNA (2010), Exploration Course Booklet Routing Protocols and Concepts Version 4.0 (Paperback), Pearson

COURSE 25

Discipline/Programme	Computer Science
Semester	V
Type of Course	DCC
Course Code	24UBCADCC302
Course Title	**Digital Image Processing**
Course Level	300-399
Course Summary	This course provides a comprehensive introduction to the principles and applications of digital image processing. It is- designed to equip students with the knowledge and skills to process, analyze, and interpret digital images using computational techniques.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Understand the fundamental concepts of digital im representation, sampling, quantization, and pixel relationships.	U	PO1
2	Apply spatial and frequency domain techniques fo filtering.	A	PO2
3	Analyze and implement algorithms for image resto and compression.	An	PO2
4	Apply image segmentation and feature extraction techniques.	A	PO2
5	Apply various image processing techniques to different domains.	A	PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Image formation and Acquisition (12 hours)			

1	1.1	Principles of image formation and camera models (pinhole, perspective)	4	CO1
	1.2	Image properties like brightness, color, and texture.	2	CO1
	1.3	Color models (RGB, HSV, YCbCr, etc.), Relationships between pixels: Neighbors, connectivity, and distance metrics.	4	CO1
	1.4	Basic image processing operations like filtering, scaling, and color space transformations.	2	CO1
2	Image Enhancement and Filtering Techniques (20 hours)			
	2.1	**Spatial Domain Processing:** Point operations: Contrast stretching, thresholding. Histogram processing: Equalization, CLAHE	4	CO2
	2.2	Spatial filters: Smoothing and sharpening filters.	4	CO2
	2.3	Frequency domain filters: lowpass, high pass and bandpass	4	CO2
	2.4	Fourier transform	4	CO2
	2.5	Image sharpening, smoothing in frequency domain, color enhancement	4	CO2

3	Image restoration and compression (16 hours)			
	3.1	Noise Models: Gaussian, salt-and-pepper, Poisson, etc.	4	CO3
	3.2	Restoration techniques: Mean filters, Wiener filter, and adaptive filtering.	4	CO3
	3.3	Inverse filtering and blind deconvolution.	4	CO3
	3.4	Lossy and lossless compression techniques. Coding techniques: Huffman, Run-length encoding, and arithmetic coding. Image compression standards: JPEG, PNG, and GIF.	4	CO3
4	Segmentation and representation (12 hours)			
	4.1	Edge detection: Sobel, Prewitt, Laplacian, and Canny. Thresholding techniques: Global, adaptive, and Otsu's method.	3	CO4
	4.2	Region-based segmentation: Region growing and splitting-and-merging.	3	CO4
	4.3	Boundary representation: Chain codes, signatures, and boundary segments.Region representation: Area, Euler number, and moments.	3	CO4
	4.4	Feature extraction: Shape, texture, and color features.	3	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Jojo Moolayil, "Smarter Decisions: The Intersection of IoT and Data Science", PACKT, 2016.
2. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015.
3. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big data Analytics", EMC 2013
4. Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global.

COURSE 26

Discipline/Programme	Computer Applications
Semester	V
Tpe of Course	DCC
Course Code	24UBCADCC303
Course Title	**DevOps**
Course Level	300-399
Course Summary	DevOps is for fostering collaboration between development and operations teams, streamlining software delivery pipelines, and ensuring rapid, reliable, and continuous delivery of high-quality software products. Its principles and practices enable organizations to achieve faster time-to-market, increased efficiency, and better alignment with customer needs through automation, monitoring, and iterative improvement.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4
Pre-requisite, if any	Computer Networks

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Describe the DevOps principles and practices in the area of software development and the project management.	Understand	PO1, PO8
2	Implement the version control during the software development process.	Apply	PO1, PO2
3	Familiarize the Docker containers including Application, Operating System, Database, programming languages.	Analyze	PO1, PO2, PO8
4	Implement the container orchestration using kubernets	Evaluate	PO1, PO2, PO8
5	Explain the importance of automation process in DevOps with the help of ansible.	Create	PO1, PO2, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to DevOps (15 hours)			
	1.1	DevOps and Project management: Agile vs DevOps, DevOps principles and Practices	5	CO1
	1.2	DevOps and Software development process, DevOps and Project management.	5	CO1
	1.3	Case study: with tools like Jira, Jenkins, Maven, AWS DevOps	5	CO1
2	Version Control (15 hours)			
	2.1	Version Control: Version control, benefits of version control, Use of Version Control System, key features,	5	CO2
	2.2	Types of version control systems: local, centralized, distributed version control, selection of optimal version control system, use cases in each types, Update, Commit, push, pull.	5	CO2
	2.3	Common pitfalls in version control, Case study: Discus different version control tools such as Git, CVS, SVN	5	CO2
3	Docker Containers (15 hours)			
	3.1	Containerization: Containers, Container orchestration, benefits, types, virtualization vs containerization	3	CO3
	3.2	Docker: features, component, installation in windows/Linux, Docker hub, Docker containers	4	CO3
	3.3	Docker Architecture, multi container architecture in Docker, containers and hosts, containers and shells, Docker file, Docker networks, pushing images to remote repositories.	4	CO3
	3.4	Case study: Prometheus - Monitoring system & time series database, Grafana: The open observability platform	4	CO3
4	DevOps Automation (15 hours)			
	4.1	Container orchestration with Kubernets: Kubernets: introduction, architecture, different approaches of setting kubernet, namespaces, Objects, cluster setup in any of the platforms like AWS, terraform	4	CO4
	4.2	Automation: DevOps automation, Docker vs automation, automation tools and their key features.	3	CO4
	4.3	Ansible: Ansible architecture, ansible cluster formation, ansible adhoc commands and modules.	4	CO4

	4.4	ansible inventory grouping, playbooks, variables, loops, Debug module, Handlers, error handling tagging, ansible Vault, ansible docker automation	4	CO4

Practical (30 hours)

- Implement tools like Jira, Jenkins, Maven, AWS DevOps
- Implement version control tools such as Git, CVS, SVN
- Implement Prometheus - Monitoring system & time series database, Grafana: The open observability platform
- Setup kubernets, namespaces, Objects, cluster setup in any of the platforms like AWS, terraform
- Implement ansible docker automation.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. The DevOps Adoption Playbook: A Guide to Adopting DevOps in a Multi-Speed IT Enterprise Published by John Wiley & Sons, Inc
2. DevOps for digital: leaders reignite business with a modern DevOps-enabled software factory by Aruna Ravichandran, Kieran Taylor, Peter Waterhouse
3. Ansible: From Beginner to Pro by Michael Heap, Apress publications
4. Red Hat Ansible Automation Platform: A beginner's guide by Red Hat
5. Version Control with Git, Second Edition by Jon Loeliger and Matthew McCullough Published by O'Reilly Media, Inc.,
6. The Docker Book by James Turnbull

COURSE 27

Discipline/Programme	Computer Science					
Semester	V					
Type of Course	DCC					
Course Code	24UBCADCC304					
Course Title	**Mobile Testing Tools**					
Course Level	300-399					
Course Summary	This course provides a comprehensive introduction to mobile application testing, focusing on ensuring the quality and performance of mobile applications across diverse platforms and devices. Students will explore key mobile testing concepts, including manual and automated testing techniques, test case creation, performance testing, and device compatibility testing.					
Lecture/Tutorial/Practical Hours	60/0/0					
Credits	Total	4	Theory	4	Practical	0
Pre-requisite, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Understand the SDLC and importance of testi	U	1
2	Understand types of testing and testing paradigms	U	1
3	Understand the Junit Apply unit testing on sample classes and perfo	A	2
4	Apply testing on mobile phones using Calabash and Appium	A	2
5	Apply testing on mobile phones using Robotium	A	2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	SDLC steps and testing basics (15 hours)			
	1.1	SDLC phases, Testing Fundamentals	4	CO1
	1.2	Types of testing - Whitebox, greybox, black box etc, Regression, stress and monkey testing	4	CO1
	1.3	Testcase, Rules to write TestCase,	4	CO1
	1.4	Test plan, Test suite, test runners	3	CO1
2	JUnit (15 hours)			
	2.1	Junit: Junit Test Framework	4	CO2
	2.2	Features of Junit Test Framework, Juint classes	4	CO2
	2.3	Juint testing framework, Android Testing Framework	4	CO2
	2.4	Test Projects-Directory Structure, Android Testing API,Mock Objects	3	CO2
3	Testing Tools: Appium (15 hours)			
	3.1	Introduction to Appium - Appium Architecture and Components, Supported Platforms	4	CO3
	3.2	Appium Ecosystem: Appium Desktop, Appium Inspector, Appium Server, Introduction to Appium client libraries (Java, Python, JavaScript, C#, etc.)	4	CO3
	3.3	Launching and Interacting with Native Apps, Basic Appium commands: Find elements, Click, Send Keys, Get Text, etc.	4	CO3
	3.4	Understanding Appium Locators, handling different element types – Interacting with Native, WebView and Hybrid App elements, managing context switching between Native and WebView, working with multi-touch actions – swipe, pinch, zoom.	3	CO3
4	Testing Tools: Calabash(15 hours)			
	4.1	Calabash – Introduction to calabash, Calabash ecosystem, Introduction to Cucumber and Gherkin Syntax.	4	CO4
	4.2	Basic Calabash Commands – Interacting with Mobile Elements (Buttons, Text Fields etc.), Writing test for UI Interactions	4	CO4
	4.3	Assertions and Validations (Text, Visibility, etc), Navigating between screens in the App, Running test, Locating elements in Calabash, Handling different	4	CO4

		types of elements (Text Fields, Buttons, Drop-downs, Radio Buttons)		
	4.4	Multi-touch actions, Synchronization in calabash, Dealing with slow app behaviour.	3	CO4

References

[1] Diego Torres Milano (2010) *Android Application Testing Guide*.
[2] Hrushikesh Zadgaonkar (2011) *Robotium Automated Testing for Android.*
[3] Julian Harty, Mahadev Satyanarayanan (2011*) A Practical Guide to Testing Wireless Smartphone Applications.*
[4] Hung Q. Nguyen, Bob Johnson, Michael Hackett (2012) *Testing Applications on the Web: Test Planning for Mobile and Internet-Based Systems*

COURSE 28

Discipline/Programme	Computer Applications
Semester	V
Type of Course	SEC
Course Code	24UBCASEC301
Course Title	**AI Tools**
Course Level	300-399
Course Summary	An AI tool is a software application that uses artificial intelligence algorithms to perform specific tasks and solve problems. AI tools can be used in a variety of industries, from healthcare and finance to marketing and education, to automate tasks, analyze data, and improve decision-making.
Lecture/Tutorial/Practical Hours	30/0/30
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Learn the concept of LLMs and their impact on various fields and analyze the strengths and limitations of ChatGPT compared to other LLMs.	Understand	PO2, PO4, PO8
2	Understand AI tools to enhance personal and professional productivity.	Understand	PO4, PO5, PO8
3	Develop ChatGPT and AI tools in a real-world project, showcasing your creativity and problem-solving skills.	Apply	PO1, PO2, PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO
1.	Introduction to ChatGPT and Large Language Models (LLMs) (10 hours)			
	1.1	Understanding LLMs: Fundamentals of LLMs, its history, architecture, core functionalities.	3	CO1

	1.2	ChatGPT: Capabilities of ChatGPT, its strengths, limitations, ethical considerations.	3	CO1
	1.3	Interacting with ChatGPT: Art of prompting and querying ChatGPT to achieve desired outcomes in various creative and informative tasks.	4	CO1
2.	Exploring the AI Tool Landscape (10 hours)			
	2.1	AI for Content Creation: AI tools for writing, storytelling, poetry generation, code writing, and design.	3	CO2
	2.2	AI for Productivity: Explore tools for automation, scheduling, data analysis, research, and personal project management.	3	CO2
	2.3	AI for Communication: Uncover tools for translation, video conferencing, and virtual assistants.	4	CO2
3.	Putting AI Tools to Work: Project-Based Learning (10 hours)			
	3.1	Choose your project: Select a project based on your personal interests, focusing on creative applications or practical problem-solving.	3	CO3
	3.2	Design and implement: Apply your new found knowledge of ChatGPT and AI tools to bring your project to life.	3	CO3
	3.3	Share and reflect: Present your project to the class, discuss challenges and learnings, and provide feedback on your peers' work.	4	CO3

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:**

	Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

Practical (30 hrs):

1. LLM Basics: Explain how a transformer model works and why it's effective for language generation.
2. ChatGPT Prompting: Write three different prompts for ChatGPT to generate a creative piece (story/poem) and compare the results.
3. AI for Content Creation: Use ChatGPT to generate a blog post, and then use a different AI writing tool for comparison.
4. AI in Productivity: Use an AI scheduling tool (e.g., Calendar with AI) to organize a weekly plan and assess its efficiency.
5. AI for Coding: Generate a basic Python script with ChatGPT and test its functionality for a simple task (e.g., data filtering).
6. Project Presentation: Implement a small project using ChatGPT or other AI tools and present the results, including any challenges faced.

References:

7. Bender, E. M., Gebru, T., Mitchell, M., & Friedman, D. (2021). On the dangers of stochastic parrots: Can language models be too big? Proceedings of the National Academy of Sciences, 118(45), e2100478.
8. Russell, S. J., & Norvig, P. (2021). Artificial intelligence: A modern approach (4th ed.). Pearson.

Additional References

1. Stanford Encyclopedia of Philosophy. (n.d.). Artificial intelligence https://plato.stanford.edu/entries/artificial-intelligence/

COURSE 29

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	SEC
Course Code	24UBCASEC302
Course Title	**MINI PROJECT**
Course Level	300-399
Course Summary	This course is focused on develop plan for a Software Project, develop test cases, reengineer the Software, Prepare and implement change requests and Develop Software with good quality..
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	Software Engineering

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate the concepts of developing software projects.	Understand	PO1, PO2
2	Analyse and develop test cases and Software Requirement Specification	Apply	PO1, PO2
3	Design Document and Testing	Apply	PO1, PO2, ,PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Description	Hrs	CO No.
	Introduction (30 hours)			
1.	1.1	Introduction, Objectives	6	**CO1**
	1.2	Software Project Management- project plan, activities and milestones, resource requirement, scheduling	8	**CO1**
	1.3	Working with Requirements - Feasibility Report	8	**CO2**
	1.4	Software Requirement Specifications	8	**CO2**
	Design Document and Testing (30 hours)			
2.	2.1	Design Document - Architecture design, data design, Interface design, procedural design	8	**CO3**
	2.2	Testing	8	**CO3**
	2.3	Implementation- validation checks, error and exception handling	8	**CO3**
	2.4	List of Problems and Summary	6	**CO3**

This course includes a project work and the project topic shall be chosen from areas of current day interest using latest packages/ languages running on appropriate platforms, so that the student can be trained to meet the requirements of the industry. This is an individual project. The students can do project in any advanced language which is included in their syllabus.

A project report shall be submitted in hard bound complete in all aspects. For internal evaluation, the progress of the student shall be systematically assessed through various stages of evaluation at periodic intervals.

End Semester Evaluation is completely based on Practical assessment, *Record* and Viva Voice.

References:

1. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill, 7th edition, 2010.
2. R. Fairley, "Software Engineering Concepts", Tata McGraw Hill Edition -1997.
3. Jack T.Marchewka, "Information Technology and Project Management",John Wiley & sons P.Ltd, 2003.

COURSE 30

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	DCC
Course Code	24UBCADCC305
Course Title	**Theory of Automata**
Course Level	300-399
Course Summary	Automata theory is basically about the study of different mechanisms for generation and recognition of languages. Automata theory is basically for the study of different types of grammars and automata. A grammar is a mechanism for the generation of sentences in a language.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Evaluate concepts in automata theory	Understand	PO1
2	Formulate grammars and recognizers for different formal languages	Apply	PO2
3	Prepare Finite Automata, NFA, Push Down Automata	Apply	PO2, PO3
4	Explain Turing Machines and types of Turing Machines	Understand	PO2
5	Analyze the lexical, syntactic and semantic structures of language features	Analyse	PO2, PO3

COURSE CONTENT

Module	Units	Course description	Hrs	CO
1	Automata Theory(20 hours)			
	1.1	Automata Theory: Concepts of Automata Theory	2	CO1
	1.2	Formal Language and Regular Expressions	2	CO1

	1.3	Chomsky Hierarchy of Grammar	2	CO1
	1.4	Regular Grammar	2	CO1
	1.5	Finite Automata – DFA, NFA	2	CO2
	1.6	Conversion of regular expression to NFA, NFA to DFA	2	CO2
	1.7	Finite Automata with Epsilon Transitions	2	CO2
	1.8	Eliminating Epsilon Transition	2	CO2
	1.9	FAs & Regular Expressions	2	CO2
	1.10	Minimization of DFA, FA with outputs	2	CO2
2	Context Free grammars (16 hours)			
	2.1	CFG	2	CO2
	2.2	Parse Trees	2	CO2
	2.3	Ambiguity in Grammar	2	CO2
	2.4	Removal of Left Recursion	2	CO2
	2.5	Left Factoring	2	CO2
	2.6	Push Down Automata-Languages	2	CO3
	2.7	Equivalence of PDA's and CFG's	2	CO3
	2.8	Deterministic Pushdown Automata	2	CO3
3	Turing Machines(10 hours)			
	3.1	Transition Diagrams for Turing Machines	2	CO4
	3.2	Language of a Turing Machine Turing Machines and Halting	2	CO4
	3.3	Multitape Turing Machines	2	CO4
	3.4	Equivalence of OneTape and Multitape TM's	2	CO4
	3.5	Undecidable Problems about Turing Machines	2	CO4
4	Compiler (14 hours)			
	4.1	Phases of Compiler	2	CO5
	4.2	Role of Lexical Analyzer	2	CO5
	4.3	specification & recognition of Tokens using Regular Expressions	2	CO5
	4.4	Syntax Analysis: Parsing	2	CO5
	4.5	Top-Down Parsing: Recursive Descent parsing, Predictive parsing	2	CO5
	4.6	Bottom-Up Parsing: Shift Reduce parsing LR , SLR , CLR & LALR parsers	2	CO5
	4.7	Compiler Construction Tools	2	CO5
5	Teacher specific course components			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
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Practical:
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</table>

References:

1. Aho, Ullman, Ravi Sethi , 'Compilers Principles, Techniques and Tools' , Pearson Education.
2. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman ,' Introduction to automata theory, languages and computation'
3. Sipser ' Introduction to Theory of computation ' ,2nd Edition, Thomson.
4. Andrew W.Appel, 'Modern Compiler Construction in C ', Cambridge University Press.
5. LOUDEN, ' Compiler Construction , Principles & Practice' , Thomson.

COURSE 31

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	SEC
Course Code	24UBCASEC303
Course Title	**Machine Learning**
Course Level	300-399
Course Summary	This course provides a broad introduction and basic theory underlying machine learning and covers the techniques on how to make learning by a model, how it can be evaluated and different algorithms to construct a learning model.
Lecture/Tutorial/Practical Hours	30/0/30
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Identify the life cycle of ML and its types	Understand	PO1
2	Learn the various classification algorithms used in supervised learning.	Understand	PO1, PO2, PO3
3	Explain various clustering algorithms and dimensionality reduction techniques used in unsupervised learning	Understand	PO1, PO2
4	Analyze the performance of machine learning models using evaluation metrics like accuracy, precision, and recall.	Analyse	PO2, PO3, PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO1
	Introduction to Machine Learning (8 hours)			
1	1.1	Definition and applications of Machine Learning	4	CO1
	1.2	Types of ML algorithms and their uses	2	CO1

	1.3	Machine Learning lifecycle and process	2	CO1
	Supervised Learning (8 hours)			
2	2.1	Introduction to supervised learning	2	CO2
	2.2	Regression algorithms - linear regression, polynomial regression	2	CO2
	2.3	Classification algorithms - decision trees, logistic regression, support vector machines	4	CO2
	Unsupervised Learning (7 hours)			
3.	3.1	Introduction to unsupervised learning	4	CO3
	3.2	Clustering algorithms - k-means clustering, hierarchical clustering, Dimensionality reduction techniques - principal component analysis, t-SNE	3	CO3
	Model Evaluation and Validation (7 hours)			
4.	4.1	Techniques for evaluating ML models: Cross-validation and train-test splits, Performance metrics - accuracy, precision, recall, F1 score	4	CO4
	4.2	Feature Engineering and Selection - Preprocessing and cleaning of data	3	CO4

Practical (30 hrs):

1.Regression algorithms - linear regression, polynomial regression
2. Classification algorithms - decision trees, logistic regression, support vector machines
3.Techniques for evaluating ML models: Cross-validation and train-test splits , Performance metrics - accuracy, precision, recall, F1 score.
4.Clustering algorithms - k-means clustering, hierarchical clustering, Dimensionality reduction techniques - principal component analysis, t-SNE
5.Feature Engineering and Selection - Preprocessing and cleaning of data

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*.

	Practical: *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.*
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Murphy, K. P. (2021). Probabilistic Machine Learning: An Introduction (2nd ed.). MIT Press
2. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An Introduction to Statistical Learning with Applications in R (2nd ed.). Springer.
3. Géron, A. (2023). Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems (3rd ed.). O'Reilly Media.

Additional References:

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
2. Goldberg, Y. (2021). A Primer on Neural Network Models for Natural Language Processing. John Wiley & Sons.

COURSE 32

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	VAC
Course Code	24UBCAVAC301
Course Title	**Cyber Security and Ethical Hacking**
Course Level	300-399
Course Summary	This course is intended to inculcate the significance of ethical hacking and cyber security apart from creating awareness about various types of security threats that may affect data integrity.
Lecture/Tutorial/Practical Hours	45/0/0
Credits	3

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Describe the cybersecurity principles and ethical hacking techniques	Understand	PO1, PO6
2	Identify and mitigate potential cyber threats, reducing the risk of data breaches	Analyse	PO1, PO6
3	Enhance the practical proficiency of learned concepts	Apply	PO1, PO2, PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Cyber Security (15 Hours)			
	1.1	Introduction to cybersecurity: Understanding the Cyber Threat Landscape, Importance of cybersecurity in Today's world.	5	CO1
	1.2	Fundamentals of Ethical Hacking, Legal and Ethical considerations	5	CO1
	1.3	Network Security: Securing Network Infrastructure	5	CO1
	Network Security and Best Practices (15 Hours)			

2	2.1	Wireless network Security	5	CO2
	2.2	Web Application Security: Common Web application vulnerabilities	5	CO2
	2.3	Best Practices in Web Application Security	5	
3	Incident Response and Management & Applications of Ethical Hacking (15 Hours)			
	3.1	Incident Response and Management: Identifying and responding to cyber incidents, Developing an incident response plan	5	CO3
	3.2	Hands-on Labs and Practical Exercises: Application of Ethical Hacking techniques	5	CO3
	3.3	Real world Scenarios and Case studies	5	CO3

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Fadia Ankit. An unofficial guide to Ethical Hacking.
2. Hacking: The Art of Exploitation by Jon Erickson.
3. The Basics of Hacking and Penetration Testing by Patrick Engebretson.
4. The Web Application Hacker's Handbook by Dafydd Stuttard.

BCA HONOURS DEGREE

Specialization in Mobile Applications and Cloud Technology

COURSE 33

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC401
Course Title	**Principles of Virtualization**
Course Level	400-499
Course Summary	This course aims to give students introductory information, essentials and current practices in virtualization.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the basics of Virtualization	Understand	PO1, PO4
2	Compare various types of Virtualization technologies	Apply	PO1, PO6
3	Appraise techniques for virtualizing and managing the hardware components of a computer system	Evaluate	PO1, PO2
4	Evaluate various top end virtualization products	Evaluate	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Basics of Virtualization (14 Hours)			
1	1.1	Basics of Virtualization: Origins and Influences, A Brief History, Definitions, Business Drivers, Technology Innovations: Clustering, Grid computing, Virtualization, Technology Innovations vs Enabling technologies	4	CO1
	1.2	Understanding Virtualization, Important terms of Virtualization, Need of Virtualization, Benefits of Virtualization technology.	4	CO1
	1.3	Types of Hardware Virtualization: Full Virtualization, Para virtualization	3	CO1
	1.4	Hypervisor and its types, Major Hypervisor vendors	3	CO1
	Server Virtualization (16 hours)			
2	2.1	Server Virtualization and Desktop Virtualization Virtual Machine Basics, Taxonomy of Virtual Machines, Process Virtual Machines, System Virtual Machines.	3	CO2
	2.2	Understanding Server Virtualization- types of Server Virtualization, Business cases for Server Virtualization	4	CO2
	2.3	Uses of server Consolidation: Studying Server Consolidation-Development and Test Environment and Helping with Disaster Recovery	4	CO2
	2.4	Selecting Server Virtualization Platform	3	CO2
	2.5	Desktop Virtualization and types of desktop virtualization	2	CO2
	Virtualization Technologies (12 hours)			
3	3.1	Storage Virtualization	2	CO2, CO3
	3.2	Input/Output Virtualization	3	CO2, CO3
	3.3	Network Virtualization	2	CO2, CO3
	3.4	Client and Application Virtualization	2	CO2, CO3
	3.5s	Operating system based Virtualization	3	CO2, CO3
	Virtualization Software (18 Hours)			
	4.1	List of Virtualization Software Available: VMWare, Amazon AWS, Microsoft Hyper V, Oracle VM Virtual Box, IBM PowerVM, Google Virtualization VMWare- VMWare Infrastructure Architecture	4	CO4
4	4.2	Introduction to Vsphere and its components	4	CO4

	4.3	VMWare Features	3	CO4
	4.4	Introduction to Hyper- V	3	CO4
	4.5	Introduction to Citrix and other virtualization products	4	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, Laboratory record, Any other method as may be required for specific course by the course faculty.*
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. William Von Hagen, Professional Xen Virtualization (2008), Wrox Publications, January, 2008.
2. James E. Smith, Ravi Nair, Virtual Machines (2005), Virtual Machines: Versatile Platforms for Systems and Processes, Elsevier/Morgan Kauffman.
3. Twan Grotenhuis, Rogier Dittner, Aaron Tiensivu, Ken Majors, Geoffrey Green, David Rule, Andy Jones, Matthijs ten Seldam (2006) Virtualization with Microsoft Virtual Server 2005, Syngress Publications.
4. Ivanka Menken, Gerard Blokdijk (2008) Virtualization the complete cornerstone guide to Virtualization best practices, Lightning Source Incorporated.
5. Chris Wolf, Erick M. Halter (2005) Virtualization: From the Desktop to the Enterprise, EBook

COURSE 34

Discipline/Programme	Computer Science
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC402
Course Title	**Artificial Intelligence**
Course Level	400-499
Course Summary	This course provides an in-depth introduction to Artificial Intelligence (AI), covering its evolution, key methodologies, and practical applications. Through a combination of theoretical concepts and practical approaches, students will gain a strong understanding of the fundamental areas of AI, including problem-solving, knowledge representation, reasoning, and planning.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
CO1	Understand the evolution, category, applications, key concepts and methodologies	Understand	PO1
CO2	Learn problem solving techniques and heuristics search techniques	Apply	PO2
CO3	Understand knowledge representation, its techniques and reasoning	Understand	PO3
CO4	Understand planning and its different types.	Understand	PO4

COURSE CONTENT

Module	Units	Description	Hrs	CO'S
Introduction to AI (10 hrs)				
1.	1.1	Evolution of AI	3	CO1
	1.2	Turing Machine, Turing test	3	CO1
	1.3	Category of AI, Applications of AI	2	CO1
	1.4	Key AI concepts and methodologies	2	CO1
Problem Solving (10 hrs)				
2.	2.1	Problem-solving techniques and strategies	3	CO2
	2.2	Solving problems by searching	3	CO2
	2.3	Heuristic search techniques, Best first search, mean and end analysis, A*, Game Playing.	4	CO2
Knowledge Representation and Reasoning (10 hrs)				
3	3.1	Knowledge representation techniques: predicate logic, semantic networks	3	CO3
	3.2	Rule-based reasoning and expert systems	3	CO3
	3.3	Common-sense reasoning	4	CO3
Planning (10 hrs)				
4	4.1	Classical Planning, Heuristics for Planning, Hierarchical Planning	3	CO4
	4.2	Planning and Acting in Nondeterministic Domains	4	CO4
	4.3	Representing temporal and resource constraints	3	CO4

Practical (30 hrs):
(Samples)

- Predicate Logic: Represent "Dogs bark" & "Fido is a dog" logically.
- Semantic Net: Draw a network for "Cat has fur, lives in house."
- Rule-Based: Create a "If temp high, then turn on AC" rule.
- Forward Chaining: Apply the rule to "temp high."
- Common Sense: Infer "wet" from "rain."
- Classical Planning: Plan "move block A to B" (initial/goal states, actions).
- Planning Heuristic: Suggest a heuristic for block stacking.
- Hierarchical Planning: Break down "plan a dinner party" into levels.
- Nondeterministic Planning: How to plan if a robot's path is uncertain?
- Temporal Constraints: Represent "task A before B."

Primary References:

1. Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th ed.). Pearson Education.
2. Poole, D. L., & Mackworth, A. K. (2022). Artificial Intelligence: Foundations of Computational Agents (3rd ed.). Cambridge University Press.
3. Luger, G. F. (2021). Artificial Intelligence: Structures and Strategies for Complex Problem Solving (7th ed.). Pearson Education.

Additional References:

1. Nilsson, N. J. (2020). Artificial Intelligence: A New Synthesis (5th ed.). Morgan Kaufmann.
2. Stuart, R. (2020). Human-Compatible AI: Artificial Intelligence and the Problem of Control. Penguin Books.

COURSE 35

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	SEC
Course Code	24UBCASEC401
Course Title	**Internship II**
Course Level	400-499
Course Summary	The Internship course for BCA students provides practical, real-world experience by allowing them to apply theoretical knowledge gained in the classroom to actual projects within a company developing skills like coding, problem-solving, project management, teamwork and communication while gaining valuable industry exposure, ultimately preparing them for a career in the IT field.
Lecture/Tutorial/Practical Hours	
Credits	4

Comprehensive Guidelines for Internship

Objectives of the Internship

1. Gain exposure to real-time software/application development or IT processes.
2. Understand the work culture, team collaboration and Project management,
3. Develop soft skills such as communication, reporting and time management.
4. Build a portfolio or prototype project under industry mentorship.

Duration and Timing

1. Internship Duration should be minimum 4 weeks(1 month).
2. Suggested Timing: after the 4th Semester(Summer break)
3. Working Hours: Minimum 5 days of week and 5 -6 hours/ day or as agreed with the host organization.

Responsibilities of the student for the successful completion of internship program:

1. Students should complete the assigned tasks or project work in a relevant domain.
2. Students should maintain a daily work log detailing tasks and learning

3. Weekly progress reports should be submitted to both academic and industry mentors.
4. Students should complete assigned tasks/project modules within deadlines.
5. Maintain professionalism and follow company policies.
6. Final internship report detailing objectives, methodologies, tools used, challenges faced and learning objectives.
7. Viva - voce or presentation at the end of the internship.

Deliverables

1. Students should obtain an Internship completion certificate from the host company.
2. Final Internship report(20-25 pages approximate including following details:
   a. Company profile
   b. Objectives of the internship
   c. Description of tasks performed
   d. Tools/ Technologies used
   e. Challenges faced and solutions
   f. Key Learning
   g. Screenshots or code snippets (if applicable)
3. Presentation/ Viva to be evaluated by the internship coordinator.

Evaluation and Acceptance Criteria

1. Internship Report
2. Industry Supervisor Feedback
3. Attendance should be 100%.
4. Viva-voce / Final Presentation

Code of Conduct

1. Respect confidentiality and intellectual property rights of the organization.
2. Abide by company rules and maintain decorum
3. Avoid plagiarism in reports and presentations.
4. Ensure timely attendance, punctuality and active participation.

COURSE 36

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	SEC
Course Code	24UBCASEC402
Course Title	**Major Project-I**
Course Level	400-499
Lecture/Tutorial/Practical Hours	
Credits	8

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
1	Apply core computer science and application concepts to develop a real-world software or data science project	Apply	PO1, PO2
2	Analyse and define computing requirements appropriate to the solution of real-world problems	Analyze	PO1, PO2
3	Design and implement efficient software applications using appropriate tools, technologies and platforms	Apply	PO1, PO2, ,PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

This course includes a project work and the project topic shall be chosen from areas of current day interest using latest packages/ languages running on appropriate platforms, so that the student can be trained to meet the requirements of the industry. This is an individual project. The students can do project in any advanced language which is included in their syllabus.

A project report shall be submitted in hard bound complete in all aspects. For internal evaluation, the progress of the student shall be systematically assessed through various stages of evaluation at periodic intervals.

End Semester Evaluation is completely based on Practical assessment, *Record* and Viva Voice.

COURSE 37

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	SEC
Course Code	24UBCASEC403
Course Title	**Major Project II**
Course Level	400-499
Lecture/Tutorial/Practical Hours	-
Credits	12

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
1	Apply core computer science and application concepts to develop a real-world software or data science project	Apply	PO1, PO2
2	Analyse and define computing requirements appropriate to the solution of real-world problems	Analyze	PO1, PO2
3	Design and implement efficient software applications using appropriate tools, technologies and platforms	Apply	PO1, PO2, ,PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

This course includes a project work and the project topic shall be chosen from areas of current day interest using latest packages/ languages running on appropriate platforms, so that the student can be trained to meet the requirements of the industry. This is an individual project. The students can do project in any advanced language which is included in their syllabus.

A project report shall be submitted in hard bound complete in all aspects. For internal evaluation, the progress of the student shall be systematically assessed through various stages of evaluation at periodic intervals.

End Semester Evaluation is completely based on Practical assessment, *Record* and Viva Voice.

BCA HONOURS DEGREE

Specialization in Data Science

COURSE 38

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC401
Course Title	**Deep Learning**
Course Level	400-499
Course Summary	This course introduces to deep learning, branch of machine learning concerned with the development and application of neural networks. Students will learn the basic model types used in Deep Learning and their suitability for various data domains.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisites	Machine Learning

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *
CO1	Understand the basic principles of deep learning and its applications in various domains.	Understand
CO2	Implement and train various deep learning models using popular libraries like TensorFlow and PyTorch.	Understand
CO3	Evaluate the performance of deep learning models and analyze their results.	Apply
CO4	Apply their understanding of deep learning to solve real-world problems.	Apply

COURSE CONTENT

Module	Units	Description	Hrs	CO's
	Foundations of Deep Learning (8 hrs)			
Module 1	1.1	Introduction to deep learning - history, objectives, applications.	1	CO1
	1.2	Mathematical foundations - linear algebra, calculus, probability theory.	1	CO1
	1.3	Artificial neural networks - architectures, activation functions, backpropagation.	2	CO1
	1.4	Optimization algorithms - gradient descent, stochastic gradient descent, Adam.	2	CO1
	1.5	Loss functions - cross-entropy, mean squared error, binary cross-entropy.	2	CO1
	Deep Learning Techniques (12 hrs)			
Module 2	2.1	Convolutional Neural Networks (CNNs) - architectures, convolutional layers, pooling layers, applications in computer vision.	3	CO2
	2.2	Recurrent Neural Networks (RNNs) - architectures, hidden states, long short-term memory (LSTM), gated recurrent units (GRU).	3	CO2
	2.3	Transformers - architecture, self-attention mechanism, applications in natural language processing (NLP).	3	CO2
	2.4	Unsupervised learning - autoencoders, generative adversarial networks (GANs).	3	CO2
	Advanced Techniques in Deep Learning (12 hrs)			
Module 3	3.1	Regularization - L1 and L2 regularization, dropout, data augmentation.	3	CO3
	3.2	Hyperparameter tuning - grid search, random search, Bayesian optimization.	2	CO3
	3.3	Transfer learning - pre-trained models, fine-tuning, domain adaptation.	2	CO3
	3.4	Multimodal learning - combining different modalities of data like text and images.	2	CO3
	3.5	Responsible AI - bias, fairness, explainability, privacy.	3	CO3
	Deep Learning Applications (13 hrs)			
Module 4	4.1	Computer vision - image classification, object detection, image segmentation.	3	CO4

	4.2	Natural language processing - text classification, sentiment analysis, machine translation.	2	CO4
	4.3	Speech recognition and generation - automatic speech recognition (ASR), text-to-speech (TTS).	2	CO4
	4.4	Time series forecasting - predicting future values based on historical data.	3	CO4
	4.5	Anomaly detection - identifying unusual events in data.	3	CO4

Mode of Assessment: The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). The percentage weightage for CCA and ESE will be as per the undergraduate regulations of the college.

Primary References:

1. Goodfellow, I., Bengio, Y., & Courville, A. (2023). Deep Learning (2nd ed.). MIT Press.
2. Goldberg, Y. (2021). A Primer on Neural Network Models for Natural Language Processing. John Wiley & Sons.
3. Aggarwal, C. C. (2023). Neural Networks and Deep Learning: A Textbook (3rd ed.). Springer.

Additional References:

1. Li, Z., Zhang, J., & Sun, Y. (2022). Neural Networks for Natural Language Processing. Springer Nature Switzerland AG.
2. Yang, X., Li, L., & Liu, J. (2022). Interpretable Deep Learning for Natural Language Processing. Springer Nature Switzerland AG.

COURSE 39

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC402
Course Title	**Cloud Computing for Data Science**
Course Level	400-499
Course Summary	This course bridges the gap between data science and cloud computing. This course imparts and equips with the knowledge and explores the latest trends. It also delves into the tools needed to thrive in this dynamic domain.
Lecture/Tutorial/Practical Hours	**60/0/0**
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO's
1	Understand the cloud landscape and its service deployment models	U	PO1
2	Evaluate various types of data storage systems available for use in the cloud	U	PO1,PO2
3	Evaluate various techniques used to scale cloud deployments	A	PO1
4	Analyze cloud data analytics and related programming frameworks.	A	PO1

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
I	**Module 1: Introduction**			
	1.1	Introduction to Cloud Computing, Definition and Characteristics	3	1
	1.2	Cloud Computing and Service Oriented Architecture	3	1
	1.3	Enterprise cloud drivers and adoptions trends, Typical cloud enterprise workloads,	4	1
	1.4	Cloud service models, Cloud deployment models, Cloud Reference Architectures	3	2
	1.5	Cloud Standards (Example: OSDIAPIs), Top Cloud providers	2	2
II	**Module II: Managing Data in the Cloud and Computing Services**			
	2.1	Introduction to Storage Models and Storage as a service	3	2
	2.2	Amazon cloud storage services via Portal and API's, Microsoft Azure Cloud storage Services via Portal and API's	3	2
	2.3	Using Google Cloud Storage Services via Portal and API's, IBM Cloud storage Services via Portal and API's, Using Openstack cloud storage services via portal and API's	2	2
	2.4	Cloud Based Computing and Hosting Services	2	2
	2.5	Virtualization in Cloud computing systems, use of hypervisors to create virtual machines	2	2
	2.6	Computing as a service, Serverless computing, Using managing Virtual machines on the Big Clouds, Use of Docker Containers and the docker hub, Understanding and use of Google	3	2
III	**Module III: Scaling Cloud Deployment**			
	3.1	Cloud architecture and infrastructure design	3	3
	3.2	Dynamic deployment of virtual clusters	2	3
	3.3	Parallel Computing in the Cloud	3	3
	3.3	Scaling Cloud Deployment via SPMD and HPC-style parallelism	3	3
	3.4	Task Parallelism, MapReduce and Bulk Synchronous Parallelism, Graph Dataflow Execution and Spark, Agents and Microservices	4	3
	Module IV: Cloud Big Data Analytics Services			
	4.1	Data Science and Big Data Characteristics, Data collection, Mining, Scalable Parallel computing	3	4

IV		over Large Clusters		
	4.2	Data Analytics Frameworks	3	4
	4.3	Hadoop, MapReduce with YARN, Amazon Elastic MapReduce, Amazon Athena Analytics, Google Cloud datalab.	2	4
	4.4	Case Study: Example: Big Data Analytics for Healthcare applications	3	4
	4.5	Case study: Big Data Analytics for Social Media Applications. Examples: Use Google's Datalab to explore contagious disease records from the U.S. Centers for Disease Control, specifically looking at Rubella cases over a period of time; use Google's Datalab to examine weather station data and to identify an anomaly in one station's reporting.	4	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Brainstorming lectures • Explicit teaching • Active Cooperative learning
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) CCA for Theory: 30 Marks** • Quiz / MCQ • Assignment • Tests
	B. Semester End Examination **ESE for Theory: Written Test (70 Marks, 2 Hrs)** Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

TEXT BOOKS

1. Cloud Computing for Science and Engineering, by Ian Foster and Dennis B. Gannon (ISBN: 978-0-262-03724-2)
2. Cloud Computing for Machine Learning and Cognitive Applications, by Kai Hwang (ISBN: 978-0-262-03641-2)
3. Cloud Data Management" by Kennesaw State University, Alvaro A. Cárdenas
4. *Cloud Computing: Concepts, Technology & Architecture*. Prentice Hall, Publisher: Prentice Hall
   ISBN: 978-0133387520.
5. Ghosh, K. (2019). *Cloud Computing for Data Science*. Wiley, 2019, ISBN: 978-1119528585

COURSE 40

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	SEC
Course Code	24UBCASEC401
Course Title	**Internship II**
Course Level	400-499
Lecture/Tutorial/Practical Hours	
Credits	4

Comprehensive Guidelines for Internship

Objectives of the Internship

1. Gain exposure to real-time software/application development or IT processes.
2. Understand the work culture, team collaboration and Project management,
3. Develop soft skills such as communication, reporting and time management.
4. Build a portfolio or prototype project under industry mentorship.

Duration and Timing

1. Internship Duration should be minimum 4 weeks to 8 weeks(can be extended based on the project scope).
2. Suggested Timing: After the completion of sixth semester.
3. Working Hours: Minimum 5 days of week and 5 -6 hours/ day or as agreed with the host organization.

Responsibilities of the student for the successful completion of internship program:

1. Students should complete the assigned tasks or project work in a relevant domain.
2. Students should maintain a daily work log detailing tasks and learning

3. Weekly progress reports should be submitted to both academic and industry mentors.
4. Students should complete assigned tasks/project modules within deadlines.
5. Maintain professionalism and follow company policies.
6. Final internship report detailing objectives, methodologies, tools used, challenges faced and learning objectives.
7. Viva - voce or presentation at the end of the internship.

Deliverables

1. Students should obtain an Internship completion certificate from the host company.
2. Final Internship report(20-25 pages approximate including following details:
    a. Company profile
    b. Objectives of the internship
    c. Description of tasks performed
    d. Tools/ Technologies used
    e. Challenges faced and solutions
    f. Key Learning
    g. Screenshots or code snippets (if applicable)
3. Presentation/ Viva to be evaluated by the internship coordinator.

Evaluation and Acceptance Criteria

1. Internship Report
2. Industry Supervisor Feedback
3. Attendance should be 100%.
4. Viva-voce / Final Presentation

Code of Conduct

1. Respect confidentiality and intellectual property rights of the organization.
2. Abide by company rules and maintain decorum
3. Avoid plagiarism in reports and presentations.
4. Ensure timely attendance, punctuality and active participation.

COURSE 41

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	SEC
Course Code	24UBCASEC402
Course Title	**Major Project I**
Course Level	400-499
Lecture/Tutorial/Practical Hours	
Credits	8

COURSE 42

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	SEC
Course Code	24UBCASEC402
Course Title	**Major Project II**
Course Level	400-499
Lecture/Tutorial/Practical Hours	-
Credits	12

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Apply core computer science and application concepts to develop a real- world software or data science project	Apply	PO1, PO2
2	Analyse and define computing requirements appropriate to the solution of real-world problems	Analyze	PO1, PO2
3	Design and implement efficient software applications using appropriate tools, technologies and platforms	Apply	PO1, PO2, ,PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

This course includes a project work and the project topic shall be chosen from areas of current day interest using latest packages/ languages running on appropriate platforms, so that the student can be trained to meet the requirements of the industry. This is an individual project. The students can do project in any advanced language which is included in their syllabus.

A project report shall be submitted in hard bound complete in all aspects. For internal evaluation, the progress of the student shall be systematically assessed through various stages of evaluation at periodic intervals.

End Semester Evaluation is completely based on Practical assessment, *Record* and Viva Voice.

BCA HONOURS WITH RESEARCH DEGREE

COURSE 43

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC401
Course Title	**Research Methodology**
Course Level	400-499
Course Summary	This course helps students to understand the issues involved in selecting a research problem, and the techniques and tools needed in the research.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOME

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the basics of research methodology and how to apply them to research projects	Understand	PO1, PO4, PO8
2	Develop advanced critical thinking skills and select appropriate method for data collection	Apply	PO1, PO2, PO7
3	Perform data analysis in qualitative and quantitative manner	Create	PO1, PO2, PO8
4	Develop enhanced writing skills	Create	PO1, PO2, PO4, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO's
1	**Introduction to concepts of Research (16 hours)**			
	1.1	Meaning and importance of Research	3	CO1
	1.2	Types of Research and Approaches, Selection and Formulation of Research Problem- Research Design	3	CO1
	1.3	Ethics in Research and Plagiarism	3	CO1

	1.4	Types and Methods of Research: Different Patterns of Research: Inductive and Deductive, Comparison & Contrast, Spatial, Chronological, Cause & Effect.	3	CO1
	1.5	Quantitative and Qualitative Approach	2	CO1
	1.6	Collection of Information and Evaluation	2	CO1
2	**Material Collection and Analysis(14 hours)**			
	2.1	Objectives and Classification, Primary and Secondary sources	3	CO2
	2.2	Different methods of data collection: Observation, Questionnaire, Interview etc.	3	CO2
	2.3	Scaling Techniques- different types of scales	4	CO2
	2.4	Sampling- Different types- Sampling Errors, Different types of variables.	4	CO2
3	**Data Analysis and Interpretation (12 hours)**			
	3.1	Classification and Tabulation of data	4	CO3
	3.2	Descriptive analysis: Central Tendency and Dispersion, Coefficient of variation, Correlation and Regression Analysis	4	CO3
	3.3	Analysis of Data: Different approaches, Testing of Hypothesis	4	CO3
4	**Report Writing and Project Proposal (18 hours)**			
	4.1	Organization of Research Report	5	CO4
	4.2	Types of Research report, structure and components	5	CO4
	4.3	Style Manuals	4	CO4
	4.4	Evaluation of Research Report	1	CO4
	4.5	Preparation of Project proposal, Application of Computer in Research	3	CO4

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	MODE OF ASSESSMENT Continuous Comprehensive Assessment (CCA) Theory: Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group

	discussion. Any other method as may be required for specific course by the course faculty. Practical: Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.
	End Semester Examination (ESE) Theory: Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report. Practical: Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.

References:

1. Garg B. L Karadia R, Agarwal, F and Agarwal, Introduction to Research Methodology
2. Kothari C. R. Research Methodology: Methods and Techniques
3. Sinha S.C and Dhiman A. K, Research Methodology
4. Wilcox R. Rand, Fundamentals of Modern Statistics Method

COURSE 44

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC402
Course Title	**Research and Publication Ethics**
Course Level	400-499
Course Summary	This course has a total of 6 units focusing on basics of philosophy of science and ethics, research integrity, publication ethics. This course is designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, and research metrics are also introduced.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO'S
1	Aware of publication ethics and misconducts	Understand	PO4, PO5, PO6
2	Developing skills to identify research misconduct and predatory publications	Apply	PO1, PO4, PO6
3	Differentiating indexing and citation databases, open access publications, and research metrics	Analyze	PO6
4	Acquiring knowledge and professional competence and expertise about patents, copyrights, and other forms of intellectual property right	Evaluate	PO4, PO6

COURSE CONTENT

Module	Units	Description	Hrs	CO's
1.	Introduction to Philosophy and Ethics (15 hours)			
	1.1	Introduction to Philosophy, Definition, Nature and scope, concept branches	8	CO1
	1.2	Ethics: Definition, Moral Philosophy, Nature of moral judgements and reactions	7	CO1
2.	Scientific misconduct and Redundant Publications (15 hours)			
	2.1	Scientific Misconduct: Ethics with respect to Science and research, intellectual honesty and research integrity, Scientific mis-conducts,: falsification, Fabrication and Plagiarism, Intellectual honesty and research integrity.	5	CO2
	2.2	Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)	5	CO2
	2.3	Redundant publications: duplicate and overlapping publications, salami slicing elective reporting and misrepresentation of data	5	CO2
3.	Publication Ethics and Open Access Publishing (17 hours)			
	3.1	Publication ethics: definition, introduction and importance Best practices/standards setting initiatives and guidelines: COPE, WAME etc.	4	CO3
	3.2	Conflicts of interest 4. Publication misconduct: Definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship.	4	CO3
	3.3	Identification of publication misconduct, complaints and appeals, Predatory publishers and journals	5	CO3
	3.4	Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc	4	CO3
4.	Software Tools and Research Metrics (13 hours)			
	4.1	A. Group Discussions, subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad Software tools:Use of plagiarism software like Turnitin, Urkund and other open source software tools	6	CO4
	4.2	Databases Indexing databases Citation databases: Web of Science, Scopus etc. Research Metrics	3	CO4

	4.3	Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index, i10 index, other metrics.	4	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty.* **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.*
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Garg.B.L.,Karadia, R., Agarwal,F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R.(2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes

4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog
Publishing. 270 p.
5. Day RA (1992) How to write and publish a scientific paper. Cambridge University press. London
6. Hempel,C. Philosophy of Natural science Englewood Cliffs, N.J: Prentice Hall, 1966.
7. Burtt, E.A. The Metaphysical Foundations of Modern Science. London, 2003.
8. Latour, B. &Woolgar. 3. Laboratory Life. The construction of scientific facts. 2nd Edition. Princeton:
Princeton University Press.1986
9. Gupta S.P. (2008). Statistical Methods. 37th ed. (Rev)Sultan Chand and Sons. New Delhi. 1470 p.

COURSE 45

Discipline/Programme	Computer Science
Semester	VII
Type of Course	DCC
Course Code	24UBCADCC403
Course Title	**Artificial Intelligence**
Course Level	400-499
Course Summary	This course provides an in-depth introduction to Artificial Intelligence (AI), covering its evolution, key methodologies, and practical applications. Through a combination of theoretical concepts and practical approaches, students will gain a strong understanding of the fundamental areas of AI, including problem-solving, knowledge representation, reasoning, and planning.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *
CO1	Understand the evolution, category, applications, key concepts and methodologies	Understand
CO2	Learn problem solving techniques and heuristics search techniques	Apply
CO3	Understand knowledge representation, its techniques and reasoning	Understand
CO4	Understand planning and its different types.	Understand

COURSE CONTENT

Module	Units	Description	Hrs
Introduction to AI (10 hrs)			
1.	1.1	Evolution of AI	3
	1.2	Turing Machine, Turing test	3
	1.3	Category of AI, Applications of AI	2
	1.4	Key AI concepts and methodologies	2
Problem Solving (10 hrs)			
2.	2.1	Problem-solving techniques and strategies	3
	2.2	Solving problems by searching	3
	2.3	Heuristic search techniques, Best first search, mean and end analysis, A*, Game Playing.	4
Knowledge Representation and Reasoning (10 hrs)			
3	3.1	Knowledge representation techniques: predicate logic, semantic networks	3
	3.2	Rule-based reasoning and expert systems	3
	3.3	Common-sense reasoning	4
Planning (15 hrs)			
4	4.1	Classical Planning, Heuristics for Planning, Hierarchical Planning	5
	4.2	Planning and Acting in Nondeterministic Domains	5
	4.3	Representing temporal and resource constraints	5

Practical (30 hrs):
(Samples)

- Predicate Logic: Represent "Dogs bark" & "Fido is a dog" logically.
- Semantic Net: Draw a network for "Cat has fur, lives in house."
- Rule-Based: Create a "If temp high, then turn on AC" rule.
- Forward Chaining: Apply the rule to "temp high."
- Common Sense: Infer "wet" from "rain."
- Classical Planning: Plan "move block A to B" (initial/goal states, actions).
- Planning Heuristic: Suggest a heuristic for block stacking.
- Hierarchical Planning: Break down "plan a dinner party" into levels.
- Nondeterministic Planning: How to plan if a robot's path is uncertain?
- Temporal Constraints: Represent "task A before B."

Primary References:

1. Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th ed.). Pearson Education.
2. Poole, D. L., & Mackworth, A. K. (2022). Artificial Intelligence: Foundations of Computational Agents (3rd ed.). Cambridge University Press.
3. Luger, G. F. (2021). Artificial Intelligence: Structures and Strategies for Complex Problem Solving (7th ed.). Pearson Education.

Additional References:

1. Nilsson, N. J. (2020). Artificial Intelligence: A New Synthesis (5th ed.). Morgan Kaufmann.
2. Stuart, R. (2020). Human-Compatible AI: Artificial Intelligence and the Problem of Control. Penguin Books

COURSE 46

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	SEC
Course Code	24UBCASEC401
Course Title	**Research Internship II**
Course Level	400-499
Course Summary	This program aims to build analytical, critical thinking and technical writing skills by engaging students in research based learning.
Lecture/Tutorial/Practical Hours	
Credits	8

Comprehensive Guidelines for Internship

Objectives of the Internship

1. Gain exposure to real-time software/application development or IT processes.
2. Enhance understanding of research methodology and technical writing.
3. Opens up opportunities for paper presentations and publications.
4. Build analytical and problem-solving capabilities.
5. Develop soft skills such as communication, reporting and time management.
6. Build a portfolio or prototype project under industry mentorship.

Duration and Timing

1. Duration: 4 to 8 weeks (can be extended based on project scope).
2. Working Hours: Minimum 5 days of week and 5 -6 hours/ day or as agreed with the host organization.

Research Internship Scope:

Students may work on research-oriented tasks such as

1. Literature Survey and analysis
2. Writing and presenting Technical papers
3. Algorithm design and evaluation
4. Data collection and analysis
5. Prototype development or simulations

Responsibilities of the student for the successful completion of research internship program:

1. Students select a research problem/ topic in collaboration with industry experts and research guide.
2. Students should complete the assigned tasks or project work in a relevant domain.
3. Students should maintain a research journal/work log detailing daily tasks and findings.
4. Participate in a regular review meeting with the research guide.
5. Weekly progress reports should be submitted to both academic and industry mentors.
6. Students should complete assigned tasks/project modules within deadlines.
7. Students originality and ethical conduct in all work. (no plagiarism).
8. Maintain professionalism and follow company policies.
9. Students should ensure full academic honesty.
10. Properly cite all references using standard citation styles.
11. Follow guidelines for ethical research practices.
12. Final research internship report should be submitted without fail.
13. Students should attend the Viva - voce or presentation after the completion of a research internship.

Deliverables

1. Students should obtain an Internship completion certificate from the host company.
2. Final Internship report(25-30 pages approximate) including following details:
    a. Introduction and Background
    b. Objectives of the internship
    c. Problem Statement
    d. Literature Review
    e. Methodology/ Approach
    f. Results/ finding(if any)
    g. Discussions and conclusions
    h. Description of tasks performed
3. Technical paper(optional but encourage), in IEEE format/ ACM format.
4. Presentation/ Viva on research finding to be evaluated.

Evaluation and Acceptance Criteria

1. Research Report
2. Industry Supervisor Feedback
3. Attendance should be 100%.
4. Viva-voce / Final Presentation

Code of Conduct

1. Respect confidentiality and intellectual property rights of the organization.
2. Abide by company rules and maintain decorum.
3. Avoid plagiarism in reports and presentations.
4. Ensure timely attendance, punctuality and active participation.

COURSE 47

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	SEC
Course Code	24UBCASEC402
Course Title	**Dissertation**
Course Level	400-499
Course Summary	This course includes a project work and the project topic shall be chosen from areas of current day interest using latest packages/ languages running on appropriate platforms, so that the student can be trained to meet the requirements of the industry
Lecture/Tutorial/Practical Hours	
Credits	20

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Illustrate the concepts of developing software projects.	Understand	PO1, PO2
2	Analyse and develop test cases and Software Requirement Specification	Apply	PO1, PO2
3	Design Document and Testing	Apply	PO1, PO2, ,PO8
Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)			

COURSE CONTENT

Module	Units	Description	Hrs	CO's
	Introduction (30 hours)			
1.	1.1	Introduction, Objectives	6	**CO1**
	1.2	Software Project Management- project plan, activities and milestones, resource requirement, scheduling	8	**CO1**

	1.3	Working with Requirements - Feasibility Report	8	**CO2**
	1.4	Software Requirement Specifications	8	**CO2**
	Design Document and Testing (30 hours)			
2.	2.1	Design Document - Architecture design, data design, Interface design, procedural design	8	**CO3**
	2.2	Testing	8	**CO3**
	2.3	Implementation- validation checks, error and exception handling	8	**CO3**
	2.4	List of Problems and Summary	6	**CO3**

This is an individual project. The students can do project in any advanced language which is included in their syllabus. A project report shall be submitted in hard bound complete in all aspects. For internal evaluation, the progress of the student shall be systematically assessed through various stages of evaluation at periodic intervals.

End Semester Evaluation is completely based on Practical assessment, *Record* and Viva Voice.

5. Professional Electives for Mobile Applications and Cloud Technology

COURSE 48

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	DSE
Course Code	24UBCADSE201
Course Title	Introduction to Cloud Technology
Course Level	200-299
Course Summary	This course aims to provide students with a comprehensive insight into the world of cloud computing. Topics covered are cloud architecture, cloud deployment and service models and cloud security.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
1	Analyse the trade-offs between deploying application in the cloud over traditional IT Infrastructure	Understand	PO1
2	Compare the advantages and disadvantages of various cloud computing platforms	Analyse	PO1
3	Analyse industry platforms, new developments and Deploy application on AWS	Apply	PO1 , PO2
4	Identify security and privacy issues in cloud computing	Evaluate	PO1 , PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to cloud Technology(10 hours)			
1	1.1	Introduction to cloud Technology: History, The NIST Definition of Cloud, five essential Characteristics of Cloud: On-demand self-service, Broad Network Access, Resource pooling, Rapid Elasticity, Measured Service, Need for cloud technology	6	CO1
	1.2	Pros and cons of cloud, Challenges in cloud, Vulnerabilities of cloud Technology	2	CO1
	1.3	Comparing Cloud providers with traditional IT service providers and attributes of cloud computing	2	CO1
	Cloud insights & Service Models of Cloud (10 hours)			
2	2.1	Cloud Insights: Architectural influences: High Performance Computing, Utility and Enterprise grid computing.	2	CO2
	2.2	Principles of Parallel and Distributed Computing: Parallel vs Distributed computing, Elements of Distributed computing, Technologies for Distributed computing	2	CO2
	2.3	Basic Cloud Model, The NIST Cloud Model	3	CO2
	2.4	Service Models of cloud: SaaS, PaaS and IaaS, Deployment Models or types of cloud: Private, public cloud, Community cloud and Hybrid cloud	3	CO2
	Fundamentals of Cloud Security(10 hours)			
3	3.1	Basic Terms of cloud security	3	CO3
	3.2	Threat agents, Cloud Security Threats, Additional considerations, Risk Management	2	CO3
	3.3	Industrial Platforms and New Developments: Amazon Web Service, Google App Engine, Microsoft Azure	1	CO3
	Cloud Migration(15 hours)			
4	4.1	Migrating into Cloud: Introduction, Challenges while migrating into Cloud, Broad Approaches for migrating into a cloud,	3	CO3

	4.2	The Seven Step Model for Migrating into a cloud, Migration Risks and Mitigation.	4	CO4
	4.3	Enterprise Cloud computing Paradigm, Relevant Deployment Model for Enterprise Cloud Computing	3	CO1
	4.4	Adoption and Consumption strategies, issues for enterprise applications on the cloud	3	CO2
	4.5	Case Study on Cloud Providers	2	CO3

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA)** Theory: Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. Practical: *Observation of practical skills, Laboratory record, Any other method as may be required for specific courses by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** ***Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.*** **Practical:** ***Practical based assessment, Record, Any other method as may be required for specific courses by the course faculty.***

References :

1. Cloud Computing a practical approach- Anthony T. Velte, Toby J. Velte Robert Elsenpeter, TATA McGraw- Hill, New Delhi
2. Cloud Computing: Web Based Applications that change the way you work and Collaborate Online- Michael Miller-Que 2008.
3. Cloud Computing for Dummies- Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, Wiley Publishing, Inc, 2010.

COURSE 49

Discipline/ Programme	Computer Applications
Semester	V
Type of Course	DSE
Course Code	24UBCADSE301
Course Title	**Advanced Mobile Application Development**
Course Level	400-499
Course Summary	This course propels your Android development skills beyond the basics, equipping you to create complex, high-performance, and user-friendly mobile applications.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	Students with a solid foundation in Android development (Java/Kotlin) and basic app functionalities.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Design and implement complex and responsive user interfaces using advanced UI components and custom views.	Understand	PO1
2	Implement efficient data management techniques using local storage, SQLite databases, and content providers..	Apply	PO2
3	Integrate advanced features like location-based services, push notifications, and background processing into Android applications.	Analyze	PO1, PO2
4	Utilize advanced app architecture patterns such as MVVM, MVP, or Clean Architecture to build scalable and maintainable Android applications.	Evaluate	PO1, PO8
5	Deploy and publish Android applications to the Google Play Store following best practices and guidelines.	Create	PO1, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Android Development(12 hours)			
	1.1	Recap of Kotlin syntax and features relevant to Android development, Understanding type systems, null safety, and operator overloading, Working with collections, lambdas, and higher-order functions, Advanced UI/UX Design: Custom views and view groups, Material Design components Responsive layouts and adaptive design Animation and transition effects	8	CO1
	1.2	Functional programming with Kotlin Extension functions and properties	4	CO1
	Memory Management Techniques in Kotlin(12 hours)			
2	2.1	Threading and concurrency with Kotlin Coroutines Memory management techniques in Kotlin Optimizing network requests and image loading with Kotlin	6	CO2
	2.2	Implement asynchronous programming with coroutines Handle background tasks and UI updates effectively Asynchronous data loading and updating UI components effectively Implementing background tasks with coroutines	6	CO2
3				
	3.1	Understanding HTTP methods (GET, POST, PUT, DELETE) , Building and manipulating HTTP requests and responses, Working with headers, parameters, and payload formats (JSON, form data), Utilize Retrofit for Making Network Calls (6 hours), Introduction to Retrofit library for simplifying network interactions, Defining API endpoints, creating interfaces, and making requests, Handling asynchronous responses, error handling, and parsing data	6	CO3
	3.2	Understanding JSON format and its use in Android development, Using libraries like Gson or kotlinx.serialization for parsing JSON data, Serializing data objects into JSON format for sending to servers	6	CO3

	3.3	Optimizing network requests and image loading with Kotlin Handling network requests with Retrofit and coroutines Efficient image loading with Glide and coroutines	3	CO4
4	Working with Location Based Services in Kotlin(6 hours)			
	4.1	location-based services and maps with Kotlin Integrating Google Maps SDK with Kotlin Geolocation services and location-based features Push notifications and Firebase Cloud Messaging (FCM) with Kotlin Implementing push notifications with Firebase Cloud Messaging Advanced messaging features with Kotlin Background tasks and services with Kotlin Creating background services with WorkManager Handling long-running tasks and background processing	6	CO4

Practical (30 hrs)

- Kotlin for Android: Master core syntax & build custom UI.
- Advanced Layouts: Design modern & responsive interfaces.
- Network Calls with Retrofit: Simplify data fetching & parsing (JSON).
- Optimize Performance: Leverage coroutines & Glide for smooth app experience.
- Advanced Features: Integrate Maps, Push Notifications & Background Services.

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:**

	Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References :

1. Kotlin Programming: The Big Nerd Ranch Guide" by Josh Skeen and David Greenhalgh
2. "Effective Kotlin" by Marcin Moskala and Igor Wojda
3. "Android Programming with Kotlin for Beginners" by John Horton

COURSE 50

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	DSE
Course Code	24UBCADSE302
Course Title	**Full Stack Development**
Course Level	300-399
Course Summary	Full Stack Development course helps to equip with most on-demand skills of both front-end and back end to develop dynamic and interactive web applications.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Describe the most recent web development technologies	Understand	PO4
2	Develop a full function website and deploy on a web server	Understand, Apply	PO1, PO2, PO4
3	Find and use code packages based on the documentation to produce working results in a project	Analyse	PO1, PO2
4	Build a complete project incorporating front-end, back-end and database technologies	Analyse	PO1, PO2, PO4
5	Apply the concept of both front end and back-end programming	Apply	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to HTML (10 Hours)			
	1.1	Understanding HTML: Introduction to HTML, Browsers and HTML	2	CO1

	1.2	Editor's offline and online	2	CO1
	1.3	Tags, attribute and elements, Doctype element	2	CO1
	1.3	Comments, Heading, Paragraphs and Formatting Text, List and Links, Images and Tables	4	CO1
2	Introduction to CSS(10 hours)			
	2.1	Introduction to CSS, Applying CSS to HTML	3	CO1
	2.2	Selectors, Properties and Values	3	CO1
	2.3	CSS colors and Backgrounds CSS Box Model, CSS Margins, Padding and Borders, Text and Font Properties	4	CO1
3	Introduction to Javascript(10 Hours)			
	3.1	Fundamentals of JavaScript, Applying JavaScript	1	CO1, CO2
	3.2	Understanding JS Syntax, Introduction to Document and Window Object	1	CO1, CO2
	3.3	Variables and Operators, Data types and Num type conversion	2	CO1, CO2
	3.4	Math and String Manipulation, Object and arrays, Date and Time, Conditional Statements, Switch case, Looping in JS, Functions	2	CO1, CO2
	3.5	Introduction to Reactjs, Template using JSX, Components, state and Props	2	CO3
	3.6	Lifecycle of components, rendering list and Portals, Error Handling, Immutable.js	2	CO3
4	Working with Nodejs(15 hours)			
	4.1	Nodejs overview, Basics and setup, console and command utilities	5	CO5
	4.2	Node js modules and events	2	CO5
	4.3	Node js Database access	3	CO4, CO5
	4.4	SQL and Nosql concepts, create and Manage MongoDB	5	CO4, CO5

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty.* **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty.*
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.* **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Web Design with HTML, CSS, Javascript and JQuery Set book by Jon Duckett Professional
2. "JavaScript for Web Developers", by Nicholas C. Zakas
3. Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites by Robin Nixon
4. Full Stack JavaScript: Learn Backbone.js, Node.js and MongoDB by Azat Mardan
5. Full stack JavaScript Development by Eric Bush

COURSE 51

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	DSE
Course Code	24UBCADSE303
Course Title	**Cloud Infrastructure and Management Mechanisms**
Course Level	300-399
Course Summary	This course imparts knowledge to build cloud infrastructure and manage cloud resources efficiently
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the basics of cloud computing delivery model considerations	Understand	PO1
2	Evaluate the cloud metrics and pricing models	Analyse	PO1, PO4
3	Analyse various Cloud infrastructure mechanisms and evaluate the risk assessment	Analyse	PO1, PO2, PO6
4	Evaluate the Cloud Management Mechanisms	Evaluate	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Overview of Cloud computing (9 Hours)			
	1.1	Brief Overview of cloud, Building cloud computing environments	3	CO1
	1.2	Cloud Delivery model considerations: Cloud delivery Models: The cloud provider Perspective, Cloud Delivery Models: The Cloud Consumer Perspective.	3	CO1

	1.3	Cloud Metrics and Pricing Models: Business Cost Metrics, Cloud Usage Cost Metrics, Cloud Management Considerations, Service Quality Metrics and SLAs: Service quality Metrics, SLA Guidelines	3	CO1
2	Cloud Infrastructure mechanisms(20 Hours)			
	2.1	Introduction to Cloud Infrastructure Mechanisms and specialized mechanisms	2	CO2
	2.2	Logical Network Perimeter and Virtual Server	3	CO2
	2.3	Cloud Storage Device and Cloud Usage Monitor	3	CO2
	2.4	Resource Replication and Ready-made environment	3	CO2
	2.5	Specialized Cloud Mechanisms: Automated Scaling Listener and Load Balancer	3	CO2
	2.6	SLA monitor, Pay-per use monitor, audit monitors	2	CO2
	2.7	Failover system	2	CO2
	2.8	Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database	2	CO2
3	Cloud Architectures(13 Hours)			
	3.1	Introduction to Cloud Architecture	2	CO3
	3.2	Workload Distribution Architecture	2	CO3
	3.3	Resource pooling architecture	2	CO3
	3.4	Dynamic Scalability architecture	3	CO3
	3.5	Elastic Resource Capacity Architecture	2	CO3
	3.6	Service Load Balancing Architecture	2	CO3
4	Cloud Management Mechanisms(18 hours)			
	4.1	Cloud Management Mechanisms: Remote administration system	3	CO4
	4.2	SLA Management System	4	CO4
	4.3	Billing Management System	3	CO4
	4.4	Cloud Security Mechanisms: Encryption, Hashing, Digital Signature, Public Key Infrastructure	4	CO4
	4.5	Identity and Access Management, Single Sign-On, Cloud Based Security Groups, Hardened Virtual Server images	4	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini (2013), Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, ISBN-13: 978-0-13-338752
2. John W. Rittinghouse and James F. Ransome (2010), Cloud Computing: Implementation, Management, and Security, CRC Press.
3. Toby Velte, Anthony Velte, Robert Elsenpeter (2009), Cloud Computing, A Practical Approach, TMH.
4. Kumar Saurabh (2011), Cloud Computing insights into New Era Infrastructure, Wiley India.
5. George Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly.
6. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, John Wiley (2011), Cloud Computing: Principles and Paradigms, Sons Publications

COURSE 52

Discipline/Programme	Computer Applications
Semester	VII
Type of Course	DSE
Course Code	24UBCADSE401
Course Title	**Mobile Application Development with Machine Learning**
Course Level	400-499
Course Summary	This course will equip you with the skills to build powerful and intelligent Android applications by integrating Machine Learning (ML) functionalities.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisite, if any	Should be thorough with Android App development

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Explain the fundamentals of Android development, including components, activities, views, and Java programming basics and Explain core concepts of Machine Learning, including supervised vs unsupervised learning and common algorithms.	Understand	PO1, PO2
2	Utilize Firebase ML Kit to integrate basic ML functionalities like face detection and text recognition into your Android apps.	Apply	PO2
3	Analyze how Machine Learning models work and how to evaluate their performance.	Analyze	PO2, PO3
4	Employ TensorFlow Lite to load and use pre-trained machine learning models in your Android applications.	Evaluate	PO2
5	Develop a simple Android application that incorporates Machine Learning functionalities.	Create	PO1, PO8

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to Machine Learning(13 hours)			
1	1.1	Introduction to Machine Learning: What is Machine Learning? (Supervised vs Unsupervised learning), Common ML algorithms (Linear Regression, K-Nearest Neighbors) , Understanding Machine Learning Models: Training and Testing Data Evaluating Model Performance (Accuracy, Precision, Recall)	8	CO1
	1.2	Setting up the Android Studio environment for ML projects Introduction to popular frameworks (e.g., ML Kit) for simplifying ML integration Exploring Android Studio features and functionalities for ML development Importing and using pre-trained models	5	CO1
	Introduction to Firebase(16 hours)			
2	2.1	Introduction to Firebase ML Kit and its functionalities (face detection, text recognition, etc.) Using Firebase ML Kit APIs in your Android App Building simple ML-powered apps (e.g., face detection camera app)	8	CO2
2	2.2	Loading TensorFlow Lite models into your Android app Preparing and feeding data to the model Making predictions and handling results Building more complex ML-powered apps (e.g., image classification)	8	CO2
	Introduction to Object Detection Models and applications(8 hours)			
3	3.1	Object detection models and their applications Utilizing pre-trained object detection models (e.g., YOLO) with TensorFlow Lite Hands-on coding: Implementing real-time object detection in Android apps using camera input Lab: Developing an Android app for real-time object identification in camera frames	8	CO3
	Overview of CNN(8 hours)			
4	4.1	In-depth exploration of CNNs for image recognition tasks Hands-on coding: Implementing pre-trained CNN models (e.g., MobileNet) for image classification Introduction to transfer learning techniques for leveraging pre-trained models	8	CO4

		Lab: Building an Android app for real-time object classification in camera frames using a pre-trained CNN		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, , Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Hands-On Artificial Intelligence for Android by Vasco Correia Veloso
2. Machine Learning for Mobile by Laurence Moroney
3. Building Machine Learning Systems with Python by Luis Pedro Coelho
4. Deep Learning with Python by Francois Chollet
5. The official Android developer documentation on machine learning: https://developer.android.com/ml
6. A codelab that shows you how to use ML Kit to recognize text from a camera feed: https://developer.android.com/courses

COURSE 53

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	DSE
Course Code	24UBCADSE402
Course Title	**Large Language Models**
Course Level	400-499
Course Summary	This course introduces the fundamental concepts underlying large language models (LLMs). It starts with an introduction to the various problems in NLP and discusses how to approach the language modeling problem. It describes the architectural intricacies of Transformers and the pre-training objectives of the different Transformer-based models. This course prepares a student to comprehend, critique, and approach various problems on LLMs.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisites	Machine Learning, Python Programming, Deep Learning (optional)

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Understanding the introductory concept of transformers	Understand	PO1, PO4
2	Implement language models	Apply	PO1, PO6
3	Applying attention mechanisms and positional encoding techniques	Apply	PO1, PO2
4	Implement effective fine-tuning mechanisms and evaluate the performances	Evaluate	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	COs
1	**Transformers (**14 Hours)			
	1.1	Introduction to Transformers	2	CO1
	1.2	Self-Attention, Cross-attention, Masked attention, Positional encoding	2	CO1
	1.3	A deep dive into a number of parameters. Computational Complexity and FLOPS	3	CO1
	1.4	Introduction to Language Modeling	3	CO1
2	**Casual Language Modeling** (16 hours)			
	2.1	Casual Language Modeling: what is a language model	2	CO2
	2.2	Generative pre-trained transformers (GPT), Training and inference	2	CO2
	2.3	Masked Language Modeling	2	CO2
	2.4	Bidirectional Encoder representations of transformers (BERT)	2	CO2
	2.5	Fine-tuning, A deep dive into tokenization	2	CO2
3	**Bigger Picture: T5**(12 hours)			
	3.1	Introduction, A deep dive into text-to-text, taxonomy of models	2	CO2, CO3
	3.2	Data: Datasets, Pipelines, Effectiveness of clean data	2	CO2, CO3
	3.3	Architecture: Types of attention,	2	CO2, CO3
	3.4	Positional Encoding (PE) techniques.	2	CO2, CO3
	3.5	Scaling techniques	2	CO2, CO3
	Optimizers (18 Hours)			
4	4.1	Revisiting Optimizers, LION vs ADAM	2	CO4
	4.2	Loss functions, Learning scheduled	2	CO4
	4.3	Gradient Clipping, Typical failures during training	2	CO4
	4.4	Fine Tuning: Prompt tuning, Multi-task Fine-tuning	2	CO4
	4.5	Parametric Efficient fine-tuning, Instruction fine-tuning datasets	2	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method may be required for specific course by the course faculty*. **Practical:** *Observation of practical skills, Laboratory record, Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025. ISBN : 9789363864740
2. Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd edition, Pearson Press, 2008.
3. Jacob Eisenstein, Natural Language Processing, First edition, The MIT Press, 2019.

COURSE 54

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	DSE
Course Code	24UBCADSE404
Course Title	**Generative AI**
Course Level	100-199
Course Summary	This course introduces students to the dynamic field of Generative Artificial Intelligence (Generative AI), covering foundational concepts, model architectures, and practical applications. The curriculum is structured into four modules, each addressing key aspects of Generative AI.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Describe generative models' ethical usage, including bias and fairness.	U	PO1
2	Apply GANs and VAEs: Implementing architectures, training models, and exploring applications.	A	PO2
3	Explore recent advances in generative AI:	An	PO2
5	Apply generative models (GANs, VAEs) using Python/Tensor Flow	A	PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
1	Introduction to Generative Models (12 hours)			
	1.1	Overview of Generative Models, Introduction to generative models and their role in artificial intelligence. Understanding the difference between generative and discriminative models	4	CO1

	1.2	Types of Generative Models, Probabilistic models: Gaussian Mixture Models (GMM), Hidden Markov Models (HMM).Variational Autoencoders (VAEs) and their applications.	4	CO1
	1.3	Introduction to Generative Adversarial Networks (GANs). Applications, Ethical Considerations and Privacy concerns related to generative models. Understanding bias and fairness in generative AI. Responsible use of generative models in various domains.	4	CO1
2	Introduction to GANs Core concepts of GANs: (28 hours)			
	2.1	Generator, discriminator, adversarial training. Historical development and key milestones in GAN research.	4	CO2
	2.2	Architectures and Variants of GANs, DCGAN, WGAN, and other variants. Conditional GANs and their applications.	4	CO2
	2.3	Training and Stability Issues: Techniques for stable GAN training. Dealing with mode collapse and other common issues.	4	CO2
	2.4	Applications of GANs:Image-to-image translation using GANs. Super-resolution and style transfer.	4	CO2
	2.5	Introduction to VAEs:Understanding the encoder-decoder architecture. The role of variational inference in VAEs.	4	CO2
	2.6	Training VAEs:The reparameterization trick and backpropagation. Comparing VAEs to traditional autoencoders.	4	CO2
	2.7	Applications of VAEs:Image generation and reconstruction.Latent space exploration and manipulation.VAEs in semi-supervised learning.	4	CO2
3	(16 hours)			
	3.1	Advanced Topics and Future Directions:Recent Advances in Generative AI Attention mechanisms in generative models. Self-supervised learning and its application in generative tasks.	4	CO3
	3.2	Generative AI in Industry,Use cases and applications in various industries.Challenges and opportunities in deploying generative models.	4	CO3

	3.3	Research Trends and Future Directions, Cutting-edge research in generative AI.Potential breakthroughs and challenges on the horizon.	4	CO3
	3.4	Final Project and Capstone,Students work on a generative AI project of their choice.Presentation and discussion of project outcomes.	4	CO3
4	Introduction to Python and TensorFlow(19 hours)			
	4.1	Introduction to Python and TensorFlow: Setting up TensorFlow environment, Basic operations in TensorFlow.	3	CO4
	4.2	Fundamentals of Generative Models: Implementing basic probabilistic models (Gaussian Mixture Models, Hidden Markov Models) using Python. Hands-on exercise on Variational Auto encoders (VAEs).	3	CO4
	4.3	Introduction to Generative Adversarial Networks (GANs): Building a simple GAN model for generating synthetic data. Understanding the generator and discriminator networks. Training a GAN on a small dataset.	3	CO4
	4.4	4: Advanced GANs and Applications: Implementing conditional GANs for specific tasks. Exploring image-to- image translation using Pix2Pix or CycleGAN. Applying GANs in medical imaging or other domains.	3	CO4
	4.5	Variational Autoencoders (VAEs) in Depth: Building a VAE for image generation. Understanding the concept of latent space. Exploring applications in semi-supervised learning.	4	CO4
	4.6	Attention Mechanisms and Self-Supervised Learning: Implementing attention mechanisms in generative models. Hands-on with self-supervised learning techniques	3	CO4
5		Teacher specific content		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● ICT Enabled lecture ● Interactive sessions ● Class discussions ● Lab exercise
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **CCA for Theory: 25 Marks** 1. Written test 2. Assignments 3. Quiz 4. Viva **CCA for Practical: 15 Marks** 1. Practical assignments 2. Lab Record 3. Observation of practical skills **4.** Viva
	B. Semester End Examination **ESE for Theory: 50 Marks (1.5 Hrs) Written Test (50 Marks)** Part A: Very Short Answer Questions (Answer all) - (10*1=10 Marks) Part B: Short Answer Questions (4 out of 6 Questions) - (4*5=20 Marks) Part C: Essay Questions (2 out of 3 Questions) - (2*10=20 Marks) **ESE for Practical: 35 Marks (1.5 Hrs)** 1. Coding and Output - 20 Marks 2. Viva - 10 Marks *3.* Record - 5 Mark

References:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville(2016) . Deep Learning" . MIT Press
2. David Foster(2019)."Generative Deep Learning". O'Reilly Media
3. "Hands-On Generative Adversarial Networks with Keras" by Rajalingappaa Shanmugamani

6. Professional Electives for Data Science

COURSE 55

Discipline/Programme	Computer Applications
Semester	IV
Type of Course	DSE
Course Code	24UBCADSE201
Course Title	**Introduction to Data Science**
Course Level	200-299
Course Summary	This course will introduce students to a rapidly growing field and equip them with some of its basic principles and tools to deal with various facets of data.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	4
Pre-requisite, if any	Students should have basic knowledge of algorithms and reasonable programming experience.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO'S
1	Describe the basic concepts of Data Science	Understand	PO1, PO2
2	Explain various data collection strategies	Apply	PO1, PO2
3	Interpret the significance of data analysis in data science	Understand	PO1, PO2
4	Identify common approaches used for model evaluation	Understand	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO
	Introduction to Data Science(15 hours)			
1.	1.1	Introduction to Data science, Evolution of Data Science, Data Science roles	3	CO1
	1.2	Stages in a Data science project	4	CO1
	1.3	Applications of Data Science in Various fields	4	CO1
	1.4	Data Security issues	4	CO1
	Data Collection and Data Pre-processing(15 hours)			
2.	2.1	Data Collection Strategies	3	CO2
	2.2	Data Pre-processing overview-	6	CO2
	2.3	Data Cleaning, Data integration and transformation, Data Reduction- Data Discretization	6	CO2
	Exploratory Data Analytics and Model Development(15 hours)			
3.	3.1	Descriptive Statistics- Mean- Standard deviation, Skewness and Kurtosis	6	CO3
	3.2	Box plots, pivot Table- Heap Map- Correlation Statistics- ANOVA	5	CO3
	3.3	Model Development: Simple and Multiple Regression- Model Evaluation using Visualization – Residual Plot- Polynomial Regression and Pipelines- Measure for in-sample evaluation- Prediction and Decision making	4	CO3
	Model Evaluation(15 hours)			
4.	4.1	Model Evaluation, Generalization Error	6	CO4
	4.2	Out-of-Sample Evaluation metrics- cross validation- overfitting-	4	CO4
	4.3	Under fitting and model selection- Testing multiple parameters by using grid search	5	CO4

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.</td></tr>
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A. Continuous Comprehensive Assessment (CCA)
Theory:
Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. Any other method as may be required for specific course by the course faculty.
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Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report.
Practical:
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</table>

References:

1. Jojo Moolayil, “Smarter Decisions: The Intersection of IoT and Data Science”, PACKT, 2016.
2. Cathy O’Neil and Rachel Schutt, “Doing Data Science”, O'Reilly, 2015.
3. David Dietrich, Barry Heller, Beibei Yang, “Data Science and Big data Analytics”, EMC 2013
4. Raj, Pethuru, “Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global.

COURSE 56

Discipline/Programme	Computer Applications
Semester	V
Type of Course	DSE
Course Code	24UBCADSE301
Course Title	**Big Data Analytics and R Programming**
Course Level	300-399
Course Summary	This course will enable students to learn the fundamentals of data analytics and examine the benefits of R programming language. The concepts and components of R packages is explored in this course.
Lecture/Tutorial/Practical Hours	**45/0/30**
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	POs
1	Understand the data science processes and challenges	U	PO1
2	Develop and appreciate various techniques for data modeling and mining	U	PO1, PO2
3	Analyze real time problems using R	A	PO1
4	Perform exploratory data analysis on real time datasets	A	PO1

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	**Module 1: Introduction to Big Data Analytics**			
	1.1	Classification of Digital Data, Structured and Unstructured Data, Introduction and Overview of business intelligence.	3	1
	1.2	Traditional Business Intelligence Versus Big Data, Data Science and Analytics.	2	1
	1.3	Meaning and Characteristics of Big Data analytics, Need of BigData Analytics.	3	1
	1.4	Classification of Analytics, Challenges of Big Data Analytics, Terminologies used in Big Data Environment	3	2
	1.5	Top Analytical Tools	4	2
2	**Module II: Introduction to R**			
	2.1	Introduction of R, Features of R, Environment. R studio	2	2
	2.2	Basic of R, Assignment, Modes, Operators, Special numbers. Logical values,	2	2
	2.3	Basic functions, R help functions, R Data structures, Control structures.	2	2
	2.4	Vectors: Definition, Declaration, Generating, Indexing, Naming, Adding and removing elements	2	2
	2.5	Operators on vectors, recycling, special operators, vectorized if-then-else	1	2
	2.6	Vector Equality, Functions for Vectors, Missing values, Null values, Filtering and Sub Setting	1	2
	Module III: R operations			
	3.1	Matrices, Creating Matrices, Adding or Removing rows/columns, Reshaping, Operations, Special functions on Matrices.	2	3
	3.2	List, Creating list, General list operations, Special functions, Recursive List.	2	3
	3.3	Data frames, creating data frames, Naming, Accessing, Adding, Removing, Applying Special functions to DataFrames, Merging Data Frames, Factors and Tables	2	3
	3.3	Input/Output, Reading and writing datasets in various formats, Functions, Creating user-defined functions, Function on Function object	2	3

	3.4	Scope of Variables, Accessing Global Environment, Closures, Recursion. Exploratory Data Analysis, Data Preprocessing.	2	3
	Module IV: Descriptive Statistics			
	4.1	Descriptive Statistics, Central Tendency, Variability, Mean-Median-Range, Variance, Handling missing values and outliers, Normalization	2	4
	4.2	Data Visualization in R: Types of visualization, Packages for visualization, Basic Visualizations, Advanced Visualizations and creating 3D plots	2	4
	4.3	Inferential Statistics with R, Types of Learning, Linear Regression, Simple Linear regression, Implementation in R, Functions on lm() and predict(), plotting and fitting regression line	2	4
	4.4	Multiple Regression line, Introduction, Comparison with simple linear regression, Correlation Matrix, F-statistic	2	4
	4.5	Target Variable Vs predictors, Identification of Significant Features, Implementation of Multiple Linear Regression in R.	2	4

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) • Brainstorming lectures • Explicit teaching • Active Cooperative learning
Assessment Types	a. MODE OF ASSESSMENT **A.** Continuous Comprehensive Assessment (CCA) CCA for Theory: 30 Marks ● Quiz / MCQ ● Assignment ● Tests
	B. Semester End Examination ESE for Theory: Written Test (70 Marks, 2 Hrs) Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

TEXT BOOKS

1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publication, 2014
2. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Mining of Massive Datasets, Cambridge university press, 2014.
3. Mark Gardener, Beginning R- The statistical programming Language”, John wiley & Sons, Inc.,2012
4. W. N Venables D.M Smith and the R core Team, “ An Introduction to R”, 2013

REFERENCES

1. Elegant graphics for data analysis, Hadley Wickham (2009)

COURSE 57

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	CC
Course Code	24UBCADCC402
Course Title	**Data Mining and Data Analysis**
Course Level	400-499
Course Summary	This course typically covers the techniques and processes used to extract valuable insights and patterns from large datasets by employing statistical analysis, and data visualization tools, allowing users to identify trends, make informed decisions, and solve complex problems across various domains.
Lecture/Tutorial/Practical Hours	60/0/0
Credits	**4**

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand and demonstrate data mining	U	1,2
2	Analyse various concepts of data mining as evidenced in both research and application.	U	1,2
3	Evaluate mathematical methods underlying the effective application of data mining	A	1
4	Analyse the data using statistical methods and gain hands-on skills on data mining tools	A	1

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	Module 1: Introduction to Data Mining			
	1.1	Introduction to Data mining- KDD Vs Data mining	3	1
	1.2	Stages of Data Mining process	3	1
	1.3	Task Primitives, Data Mining techniques- Data Mining Knowledge Representation	4	1
	1.4	Major issues in Data Mining, Measurement and Data	3	1
	1.5	Data Cleaning, Data Transformation, Feature Selection, Dimensionality reduction	2	1
2	Module II: Predictive Analytics			
	2.1	Classification and Prediction	3	2
	2.2	Basics of Classification and Prediction, General approach to solving a classification problem	2	2
	2.3	Logistic Regression- LDA	2	2
	2.4	Decision Trees: Tree Construction Principle	2	2
	2.5	Feature Selection measure- Tree pruning, Decision Tree construction algorithm	2	2
	2.6	Random Forest, Bayesian classification, Accuracy and Error Measures	2	2
	2.7	Evaluating the accuracy of the classifier/ predictor, Ensemble methods and model selection	2	2
	Module III: Classification and Descriptive Analytics			
	3.1	Rule Based classification, Classification by Backpropagation	5	3
	3.2	Support Vector Machines, Associative classification, Lazy Learners and other classification Methods	5	3
	3.3	Prediction, Descriptive Analytics, Mining Frequent Itemsets, Market based model- Association and Sequential Rule Mining	5	3
	Module IV: Cluster Analysis and Factor Analysis			
	4.1	Cluster analysis: Basis concepts and methods, Partitioning methods, Hierarchical methods-	3	4
	4.2	Density based methods- grid based methods, Evaluation of Clustering	4	4
	4.3	Factor analysis: Meaning, objectives and assumptions	3	4

	4.4	Designing a factor analysis, Deriving factors and assessing overall factors.	3	4
	4.5	Interpreting the factors and validation of factor analysis	2	4

Teaching and Learning Approach	Classroom Procedure (Mode of transaction) • Brainstorming lectures • Explicit teaching • Active Cooperative learning
Assessment Types	MODE OF ASSESSMENT **B.** Continuous Comprehensive Assessment (CCA) CCA for Theory: 30 Marks ● Quiz / MCQ ● Assignment ● Tests
	B. Semester End Examination ESE for Theory: Written Test (70 Marks, 2 Hrs) Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

TEXT BOOKS

1. Data Mining Techniques: A.K. Pujari, Sangam Books Ltd 2001.
2. Mastering Data Mining: M. berry and G Linoff, John Wiley and sons, 2000

REFERENCES

1. Data Mining Cookbook: Modeling Data for Marketing, Risks, and Customer Relationship Management, Olivia Parr Rud, Wiley.

COURSE 58

Discipline/Programme	Computer Applications
Semester	VI
Type of Course	DSE
Course Code	24UBCADSE401
Course Title	**Data Visualization**
Course Level	400-499
Course Summary	This course helps to understand the importance of data visualization in data science reports and various data visualization techniques. It also imparts knowledge about important libraries in data visualization tools and use cases of data visualization.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the importance of data visualization in data science	U	1,2
2	Understand uni, bi and multidimensional data visualization techniques	U	1,2
3	Apply important libraries in data visualization tools like R and Tableau	A	1
4	Apply visualization tools and the use cases of data visualization	A	1

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	**Module 1: Introduction to Data Visualization**			
	1.1	Introduction to Data Visualization,	3	1
	1.2	Importance of Data Visualization in Data Science,	3	1
	1.3	Seven Stages of Visualizing data – acquire, parse, filter, mine, represent, refine and interact	3	1
	1.4	Creating Data Visualization- explanatory, exploratory and hybrid	3	2
	1.5	Different perspectives of data visualization- the designer, the reader and the data – shape what you create	3	2
2	**Module II: R Tool**			
	2.1	Data visualization using R,	3	3
	2.2	Data visualization libraries,	3	3
	2.3	Features of libraries, ggplot library for data visualization	4	3
	Module III: Tableau			
	3.1	Data visualization using Tableau,	3	3
	3.2	Features of Tableau Public Version	3	3
	3.3	Configuration of Tableau, various libraries of Tableau	4	3
	Module IV: Data Visualization Best Practices			
	4.1	Visualization Best Practices	5	4
	4.2	Data Science Use cases for Data Visualization	5	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Brainstorming lectures • Explicit teaching • Active Cooperative learning
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA) CCA for Theory: 30 Marks** ● Quiz / MCQ ● Assignment ● Tests
	B. Semester End Examination **ESE for Theory: Written Test (70 Marks, 2 Hrs)** Part A: Answer any 5 questions out of 8. Each question carries 2 marks. (5 x 2 = 10 marks) Part B: Answer any 5 questions out of 8. Each question carries 6 marks. (5 x 6 = 30 marks). Part C: Answer any 2 questions out of 4. Each question carries 15 marks. (2 x 15 = 30 marks)

TEXT BOOKS

1. Data points visualization That means something by Nathan Yau. John Wiley & sons(20130.
2. Beautiful Visualization: Looking at Data through the Eyes of Experts by Julie Steele and Noah Illinsky

REFERENCES

1. Designing Data Visualizations: Representing Informational Relationships, Noah Illinsky, Julie Steele (2011).
2. Elegant graphics for data analysis, Hadley Wickham (2009)

COURSE 59

Discipline/ Programme	**STATISTICS**				
Semester	VII				
Type of Course	DSE				
Course Code	24UBCADSE401				
Course Title	**Inferential Statistics For Computational Analysis**				
Course Level	400-499				
Course Summary	This course helps to acquire foundational knowledge of probability distributions and their properties, sampling distributions, theory of estimation, testing of hypothesis and ANOVA.				
Lecture/Tutorial/Practical Hours	45/0/30				
Credits	Total	4	Theory	3	Practical
Pre-requisite, if any					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Understand the various probability distributions.	Understand	1
2	Apply the various probability distributions in real life situations and evaluation of various probabilities.	Apply, Evaluate	1, 2
3	Understand different Sampling Distributions.	Understand	1
4	Apply estimation theory in practical situations.	Apply	1, 2
5	Apply hypothesis testing on a given situation and analyze various parametric test procedure.	Apply, Analyze	1,2,3
6	Apply ANOVA in real world problems to critically interpret and communicate findings effectively.	Apply, Analyze	1,2,4

COURSE CONTENT

Module	Units	Course description	Hrs	COs
1	**Probability distributions (12 hours)**			
	1.1	Discrete Distributions – Binomial distribution and its properties: Mean, variance, m.g.f and fitting of Binomial.	4	CO1, CO2
	1.2	Poisson distribution and its properties: Mean, variance, m.g.f and fitting of Poisson.	4	CO1, CO2
	1.3	Continuous Distributions -Explain Normal distribution and its properties. Explain standard Normal distribution and problems using standard normal tables.	4	CO1, CO2
	Sampling Distributions (10 hours)			
	2.1	Sampling Distributions: Concept of sampling distributions, Statistic(s) and standard error(s).	2	CO3

2	2.2	Sampling distribution of mean (With proof) and variance (Statement only) from normal distribution.	3	CO3
	2.3	Chi-square, t, F distributions and statistics following these distributions. Relation among Normal, Chi- square, t and F distributions - Application of Chi – square, t and F distribution.	5	CO3
3	**Theory of Estimation and Testing of Hypothesis (12 Hours)**			
	3.1	Concepts of Estimation, Estimators and Estimates. Point and interval estimation. Properties of good estimators- unbiasedness, efficiency, consistency and sufficiency	4	CO4
	3.2	Testing of Hypotheses: Statistical hypotheses, null and alternative hypotheses, simple and composite hypotheses, type-I and type-II errors. Critical Region. Size and power of a test, p-value.	4	CO4
	3.3	large sample tests - Z-tests for means, difference of means (when σ known). test for proportion and, difference of proportion.	4	CO4

4	**Small sample tests and ANOVA (11 Hours)**			
	4.1	Small sample tests - t-tests for mean and difference of means (when σ unknown), t-test for paired t-test.	4	CO5
	4.2	F-test for ratio of variances. Chi-square tests for independence and goodness of fit.	4	CO5
	4.3	Analysis of variance (ANOVA): one - way classification and two – way classification.	3	CO6
5	**Practicum- (30 hours)**			
	5.1	Numerical problems on Binomial, Poisson and Normal probabilities using excel /R	8	CO2
	5.2	Fitting of Binomial and Poisson distributions.	4	CO2
	5.4	Numerical problems on Unbiasedness, consistency, Efficiency and consistency (discrete case).	8	CO4
	5.5	Numerical problems on large sample, small sample tests and ANOVA using Excel/R	10	CO5, CO6
5	**Teacher specific course components**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory:** Quiz, Oral Presentation, Self and Peer assessments, Written test, Open book test, Problem based assignment, Field study report/Group discussion. *Any other method as may be required for specific course by the course faculty*. **Practical:** Observation of practical skills, , Laboratory record, *Any other method as may be required for specific course by the course faculty*.
	B. End Semester Examination (ESE) **Theory:** Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report**.** **Practical:** Practical based assessment, Record, *Any other method as may be required for specific course by the course faculty*.

COURSE 60

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	DSE
Course Code	24UBCADSE402
Course Title	**LARGE LANGUAGE MODELS**
Course Level	400-499
Course Summary	This course introduces the fundamental concepts underlying large language models (LLMs). It starts with an introduction to the various problems in NLP and discusses how to approach the language modeling problem. It describes the architectural intricacies of Transformers and the pre-training objectives of the different Transformer-based models. This course prepares a student to comprehend, critique, and approach various problems on LLMs.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisites	Machine Learning, Python Programming, Deep Learning (optional)

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO
1	Understanding the introductory concept of transformers	Understand	PO1, PO4
2	Implement language models	Apply	PO1, PO6
3	Applying attention mechanisms and positional encoding techniques	Apply	PO1, PO2
4	Implement effective fine-tuning mechanisms and evaluate the performances	Evaluate	PO1, PO2

COURSE CONTENT

Module	Units	Description	Hrs	COs
1	**Transformers (**14 Hours)			
	1.1	Introduction to Transformers	2	CO1
	1.2	Self-Attention, Cross-attention, Masked attention, Positional encoding	2	CO1
	1.3	A deep dive into a number of parameters. Computational Complexity and FLOPS	3	CO1
	1.4	Introduction to Language Modeling	3	CO1
2	**Casual Language Modeling** (16 hours)			
	2.1	Casual Language Modeling: what is a language model	2	CO2
	2.2	Generative pre-trained transformers (GPT), Training and inference	2	CO2
	2.3	Masked Language Modeling	2	CO2
	2.4	Bidirectional Encoder representations of transformers (BERT)	2	CO2
	2.5	Fine-tuning, A deep dive into tokenization	2	CO2
3	**Bigger Picture: T5**(12 hours)			
	3.1	Introduction, A deep dive into text-to-text, taxonomy of models	2	CO2, CO3
	3.2	Data: Datasets, Pipelines, Effectiveness of clean data	2	CO2, CO3
	3.3	Architecture: Types of attention,	2	CO2, CO3
	3.4	Positional Encoding (PE) techniques.	2	CO2, CO3
	3.5	Scaling techniques	2	CO2, CO3
	Optimizers (18 Hours)			
4	4.1	Revisiting Optimizers, LION vs ADAM	2	CO4
	4.2	Loss functions, Learning scheduled	2	CO4
	4.3	Gradient Clipping, Typical failures during training	2	CO4
	4.4	Fine Tuning: Prompt tuning, Multi-task Fine-tuning	2	CO4
	4.5	Parametric Efficient fine-tuning, Instruction fine-tuning datasets	2	CO4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Interactive lectures, flipped classroom, Lecture-based Learning, Project-Based Learning, Experiential Learning, Peer Teaching, invited lecture, group discussions, Discussion-based Learning, Inquiry-Based Learning, Field based collection and interactions, Online Learning, Blended Learning, and other innovative learning approaches.
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	B.End Semester Examination (ESE) **Theory:** *Written test/Standardized Test (MCQ)/Open book/ Problem based assignments/Individual project report/Team project report*. **Practical:** *Practical based assessment, Record, Any other method as may be required for specific course by the course faculty.*

References:

1. Tanmoy Chakraborty, Introduction to Large Language Models, Wiley India, 1st Edition, 2025. ISBN : 9789363864740
2. Dan Jurafsky and James H. Martin, Speech and Language Processing, 2nd edition, Pearson Press, 2008.
3. Jacob Eisenstein, Natural Language Processing, First edition, The MIT Press, 2019.

COURSE 61

Discipline/Programme	Computer Applications
Semester	VIII
Type of Course	DSE
Course Code	24UBCADSE403
Course Title	**Natural Language Processing**
Course Level	400-499
Course Summary	This course covers the fundamental concepts of language models, syntactic and semantic analysis. including tokenization. Text processing includes tokenization, stemming, text classification, and advanced techniques are also covered.
Lecture/Tutorial/Practical Hours	45/0/30
Credits	4
Pre-requisites	Machine Learning, Python Programming, Deep Learning (optional)

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO'S
CO1	Understand the core concepts and challenges of Natural Language Processing.	Understand	PO1
CO2	Analyze and process textual data using NLP techniques.	Analyse	PO1
CO3	Implement machine learning and deep learning models for various NLP tasks.	Understand	PO2
CO4	Apply NLP techniques to solve real-world problems in different domains.	Apply	PO2

COURSE CONTENT

Module	Units	Description	Hrs	CO's
	Introduction to Natural Language Processing			
	1.1	Define Natural Language Processing and its core tasks	2	CO1
	1.2	Understand the history and evolution of NLP	2	CO1

	1.3	Explore various applications of NLP in different domains, such as machine translation, text summarization, sentiment analysis, and chatbots	2	CO1
	1.4	Identify the challenges and limitations of NLP techniques, such as ambiguity, linguistic diversity, and computational complexity	2	CO1
	Fundamentals of Language			
2.	2.1	Language structure and levels - phonology, morphology, syntax, semantics, and pragmatics	2	CO2
	2.2	Morphological analysis - segmentation, stemming, and lemmatization	2	CO2
	2.3	Syntactic analysis - parts-of-speech tagging and parsing (constituency parsing and dependency parsing)	2	CO2
	2.4	Semantic analysis - word sense disambiguation and semantic representation models (WordNet, ontologies)	2	CO2
	2.5	Pragmatics - understanding context, speaker intention, and non-literal language	2	CO2
	NLP Techniques and Tools			
3.	3.1	Text processing - tokenization, normalization, stemming, lemmatiz ation, stop word removal	2	CO3
	3.2	Machine learning for NLP - classification algorithms (Naive Bayes, Support Vector Machines), feature extraction, and evaluation metrics	2	CO3
	3.3	Deep learning for NLP - recurrent neural networks (RNNs), Long Short-Term Memory (LSTM) networks, transformers, and their applications in NLP tasks	3	CO3
	3.4	Popular NLP libraries and frameworks - NLTK, spaCy, TensorFlow, PyTorch	3	CO3
	Advanced NLP Applications			
4.	4.1	Machine translation - statistical machine translation (SMT) and neural machine translation (NMT)	2	CO4
	4.2	Text summarization - extractive and abstractive summarization techniques	2	CO4
	4.3	Chatbot development - conversational agents and dialogue systems	2	CO4
	4.4	Information extraction - named entity recognition, relation extraction, and event extraction	2	CO4

	4.5	Question answering systems - open-domain and closed-domain question answering	2	CO4
	4.6	Ethical considerations in NLP - bias, fairness, and transparency	2	CO4
	4.7	Emerging trends in NLP - explainable AI, natural language understanding, and multimodality	3	CO4

Mode of Assessment: The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE). The percentage weightage for CCA and ESE will be as per the undergraduate regulations of the college.

Primary References:

1. Manning, C. D., Schütze, H., & Raghavan, P. (2008). Introduction to Information Retrieval. Cambridge University Press.
2. Jurafsky, D., & Martin, J. H. (2020). Speech and Language Processing (3rd ed.). Pearson Education.
3. Bird, S., Klein, E., & Loper, E. (2009). Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit. O'Reilly Media.

Additional References:

1. Goldberg, Y. (2017). Neural Network Methods for Natural Language Processing. Morgan Kaufmann.
2. Collobert, R., Weston, J., Bottou, L., Karlen, M., Kavukcuoglu, K., & Kuksa, P. (2011). Natural language processing (almost) from scratch. Journal of Machine Learning Research, 12(Aug), 2493-2537.